SPP Southwest Power Pool
MARKET MONITORING UNIT

FREQUENTLY CONSTRAINED AREAS 2023 STUDY

JUNE 2024

Published on June 25, 2024

TABLE OF CONTENTS

LIST OF FIGURES

1 EXECUTIVE SUMMARY

The SPP Market Monitoring Unit (MMU) analyzed real-time market data from March 1, 2023, through February 29, 2024. The MMU also evaluated recent trends through April 30, 2024. Based on our analysis, the Market Monitor proposes retaining the Oklahoma City, Oklahoma; Tulsa, Oklahoma; and Williston, North Dakota Frequently Constrained Areas (FCA). Collectively these three areas include 107 unique resources. Overall, pivotal supplier hours and congestion magnitude decreased relative to the prior 2022 study period but remained at levels warranting their retention as Frequently Constrained Areas. The MMU will remove the current Frequently Constrained Area: Joplin, Missouri.

Figure 1-1 Pivotal supplier hour heat map with Frequently Constrained Area resources

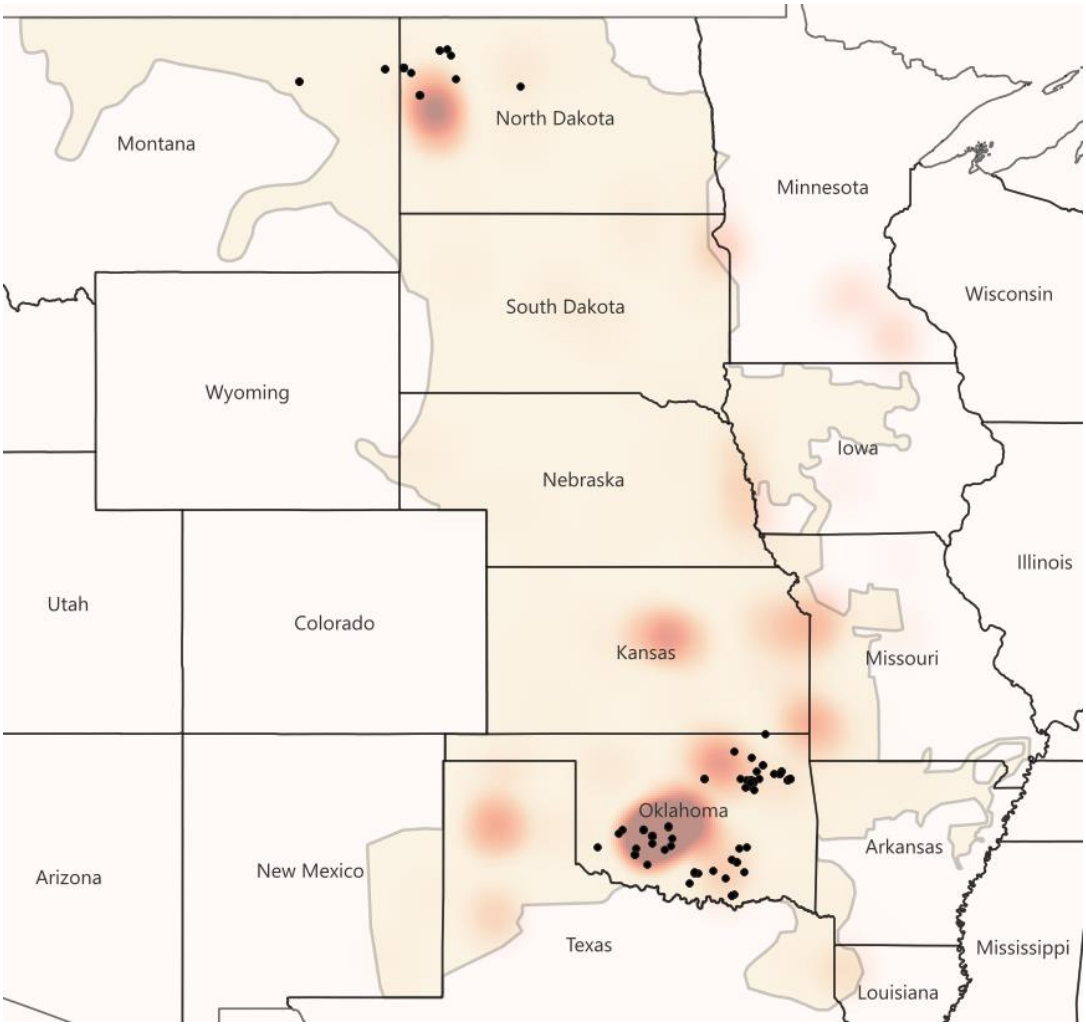


Figure 1-1 displays pivotal supplier hours in heat map form, as well as the Frequently Constrained Area resources with their respective locations. The map highlights the concentrations of pivotal supplier hours in the southeastern and eastern portions of the footprint. It also calls attention to the pivotal resources positioned to relieve the congestion associated with the Frequently Constrained Areas. This relationship follows with the general power flow of the footprint. Inexpensive wind generation in the western footprint tends to flow toward the population centers in the east and southeast. In addition, the map points to a pocket in the northwest corner of North Dakota. In this area, a few key resources continue to materially influence pricing outcomes.

Figure 1-2 displays the resource count within the respective Frequently Constrained Areas.

Figure 1-2 Frequently Constrained Area, resource count

FCA name, state	FCA resource count
Oklahoma City, Oklahoma	44
Tulsa, Oklahoma	37
Williston, North Dakota	26
Total	**107**

2 GOVERNING LANGUAGE

Frequently Constrained Areas are areas of the Integrated Marketplace footprint that experience high levels of congestion and are associated with one or more pivotal suppliers. The SPP Open Access Transmission Tariff[1] defines Frequently Constrained Areas as:

> "an electrical area identified by the Market Monitor that is defined by one or more binding transmission constraints or binding Reserve Zone constraints that are expected to be binding for at least five-hundred (500) hours during a given twelve (12)-month period and within which one (1) or more suppliers are pivotal."

The SPP Market Monitor reevaluates the Frequently Constrained Area designations at least annually.[2]

[1] SPP OATT Att. AF Section 3.1.1 (Frequently Constrained Areas)
[2] SPP OATT Att. AF Section 3.1.1.3 (Changes to Frequently Constrained Area Designation)

3 METHODOLOGY

3.1 Data and study period

The study period runs from March 1, 2023, through February 29, 2024. The analysis incorporates real-time balancing market (RTBM) congestion and dispatch data, and resource parameter offers for online resources. Also included in the analysis is real-time transmission system topology, including but not limited to transmission elements, ratings, effective and termination times, temporary operating conditions, etc.

3.2 Study process

The study consists of the following process.

1. **Binding hours computation:** The study calculates binding hours for each modeled transmission constraint. A constraint counts as binding in a five-minute interval if the loading on the constraint is within the greater of five megawatts or two percent of the effective constraint limit.

2. **Pivotal supplier analysis:** The study calculates pivotal supplier hours for each modeled transmission constraint. A constraint counts as having a pivotal supplier during a five-minute interval if the supplier can cause a constraint to exceed its effective limit by decreasing generation on resources that provide congestion relief and by increasing generation on resources that exacerbate congestion. The submitted ramp rates, economic minimum, and maximum capabilities govern the redispatch of the potential pivotal supplier's resources. In this analysis, we consider a thirty-minute redispatch period. We account for the market's ability to react to the actions of the potential pivotal supplier by allowing a similar redispatch of all resources not owned or controlled by the potential pivotal supplier.

3. **Selection of evaluation areas, Frequently Constrained Area candidates, and Frequently Constrained Areas:** The geographical concentration of pivotal supplier hours determines

the evaluation areas. Candidate areas meet the pivotal supplier hour test, in addition to the locational and electrical tests associated with the selection of primary and secondary constraints. Frequently Constrained Areas meet the evaluation area and candidate area requirements in addition to the financial impact test.

4. **Selection of primary constraints:** A primary constraint for the Frequently Constrained Area candidate is generally the constraint with the highest number of pivotal supplier hours within a given area. However, there are instances where additional individual primary constraints are considered within the same area. The areas are determined by evaluating pivotal supplier hours in conjunction with each constraint.

5. **Selection of secondary constraints:** Secondary constraints incorporate information from the primary constraint and test the results against other relevant constraints. This test is electrical in nature. First, the test identifies resources with shift factors to the primary constraint(s) of less than or equal to negative five percent.[3] This primary constraint resource group is then tested against all other constraints. Specifically, the test identifies the constraints where resources have shift factors less than or equal to negative three percent, relative to the same resource group identified by the primary constraint. The constraints which pass this test are secondary constraints.

6. **Identify the Frequently Constrained Area candidate resources:** A resource is a Frequently Constrained Area candidate resource if it has an average shift factor of less than or equal to negative five percent[3] to the constraints identified as primary and secondary constraints. This cut-off of negative five percent is consistent with the local market power test.[4]

7. **Impact analysis:** An impact analysis is used to determine the number of hours for which the Frequently Constrained Area candidate resource group has significant impacts on

[3] A negative ten percent shift factor cut-off may be used in some instances for constraints with elements greater than 200 kV.
[4] SPP OATT Att. AF Section 3.1 (Local Market Power Test)

prices in the candidate area. For each five-minute interval in the study period, the resource price impacts on each defining constraint are calculated by multiplying the shadow price and the candidate resource's corresponding shift factor. The resource price impacts are then summed over the Frequently Constrained Area candidate defining constraints to obtain a five-minute price impact for each candidate resource. This calculation determines the contribution from the Frequently Constrained Area candidate constraints to the candidate resource's marginal congestion component of the locational marginal price.

Any interval for which a candidate resource's price impact exceeds the impact test threshold will count as a binding interval and is susceptible to the exercise of market power when a pivotal supplier is present. The market impact test incorporates a $25/MWh threshold.[5] A threshold value is needed to account for periods when there is low-cost relief capability in the Frequently Constrained Area. This low-cost relief prohibits a pivotal supplier from accruing significant benefits by pursuing a withholding strategy in the Frequently Constrained Area.

Actual binding hours from real-time are adjusted based on the percentage of pivotal supplier hours to binding hours calculated in the analysis. This is called real-time pivotal supplier hours. A candidate area with at least 500 hours for each of the pivotal supplier hours from the analysis, real-time pivotal supplier hours, and impact test will be a Frequently Constrained Area.

[5] This threshold has been used in the mitigation system since March 1, 2015.

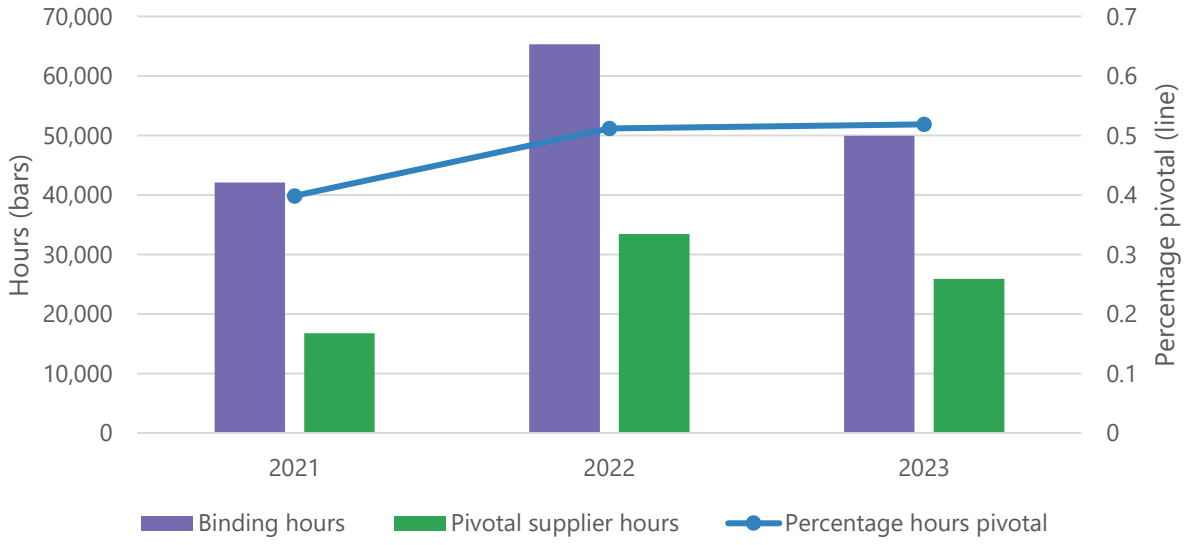
4 ANALYSIS

The Methodology section mentions several tests and processes, which drive the results of the Frequently Constrained Area study. Those tests and processes generally fall into two main categories.

1. Computation and evaluation of binding and pivotal supplier hours
2. Quantifying the pivotal supplier's potential financial impact

With respect to the computation and evaluation of pivotal supplier hours, Figure 4-1 highlights, the material decrease in both binding hours and pivotal supplier hours compared to the 2022 study but remained higher than the 2021 study.

Figure 4-1 Binding hours and pivotal supplier hours, study period



From 2022 to 2023, binding hours and pivotal supplier hours decreased by more than 20 percent. The percentage of binding hours with at least one pivotal supplier remained the same from 2022 to 2023 at just over 50 percent.

With respect to the financial impact test, the decreases in binding and pivotal supplier hours coincide with periods of decreases in congestion. When quantifying a pivotal supplier's potential financial impact, congestion plays a material role in the magnitude of the impact.

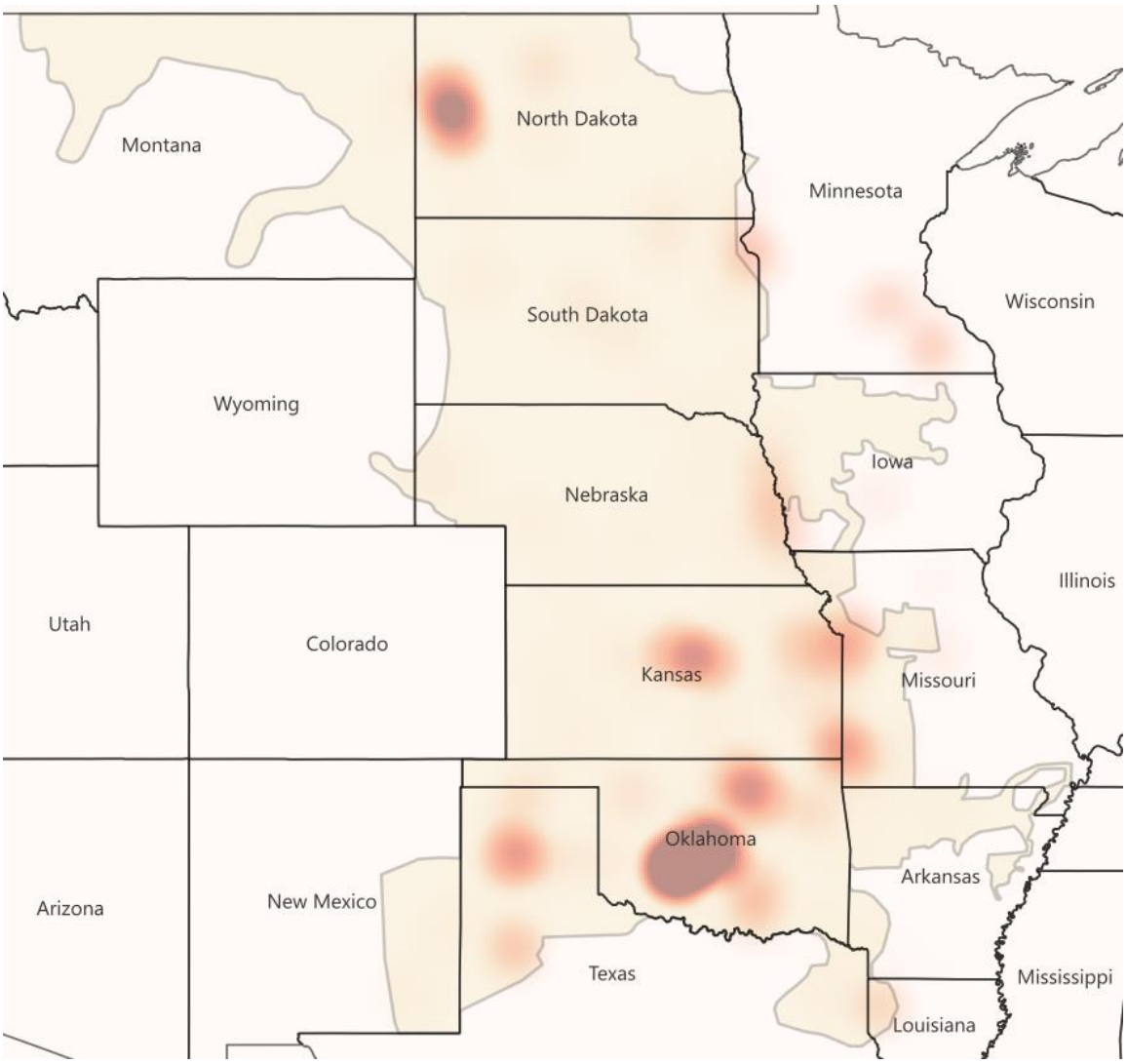
Figure 4-2 Total congestion, calendar year

Figure 4-2 shows an increase in congestion from 2021 to 2022 and a decrease in 2023.[6] From 2021 to 2022, real-time congestion increased 77 percent, followed by a decrease of 32 percent from 2022 to 2023. Although the congestion level decreased from 2022 to 2023, the congestion level remains at some of the highest since the start of the Integrated Marketplace in 2014. Elevated congestion levels materially influence the financial impact test.

As previously mentioned, concentrations of binding and pivotal supplier hours factor into the selection of Frequently Constrained Area evaluation areas. Figure 4-3 displays pivotal supplier hours in heat map form.

[6] While calendar years do not perfectly align with the study periods, the general trend remains the same.

Figure 4-3 Pivotal supplier hours, 2023 study period, heat map



The map highlights the concentrations of pivotal supplier hours in the southeastern and eastern portions of the footprint.[7] The most significant concentrations of pivotal supplier hours surround Oklahoma City, Tulsa, Joplin, Salina, Kansas City, and Amarillo. These six areas account for 29 percent of all binding hours, and 35 percent of all pivotal supplier hours during the study period. In addition, the Williston area in North Dakota accounts for almost four percent of all binding hours and seven percent of all pivotal supplier hours during the study period.

[7] The pivotal hour concentrations contribute to the process of selecting Frequently Constrained Area evaluation areas.

Additional analysis of pivotal hour concentrations yielded eleven Frequently Constrained Area evaluation areas.

Figure 4-4 highlights these areas, along with the resulting Frequently Constrained Area candidates and Frequently Constrained Areas.

Figure 4-4 Evaluation areas, candidate areas, and Frequently Constrained Areas

Evaluation areas[8] – name, state	Candidate areas[9] – name, state	Frequently Constrained Areas[10] – name, state
Oklahoma City, Oklahoma	Oklahoma City, OK	Oklahoma City, OK
Tulsa, Oklahoma	Tulsa, OK	Tulsa, OK
Williston, North Dakota	Williston, ND	Williston, ND
Joplin, Missouri	Joplin, MO	
Big Stone City, SD	Big Stone City, SD	
Kansas City, Kansas	Kansas City, KS	
Omaha, Nebraska	Omaha, NE	
Tupelo, Oklahoma	Tupelo, OK	
Amarillo, Texas	Amarillo, TX	
Saint Paul, Minnesota	Saint Paul, MN	
Salina, Kansas	Salina, KS	

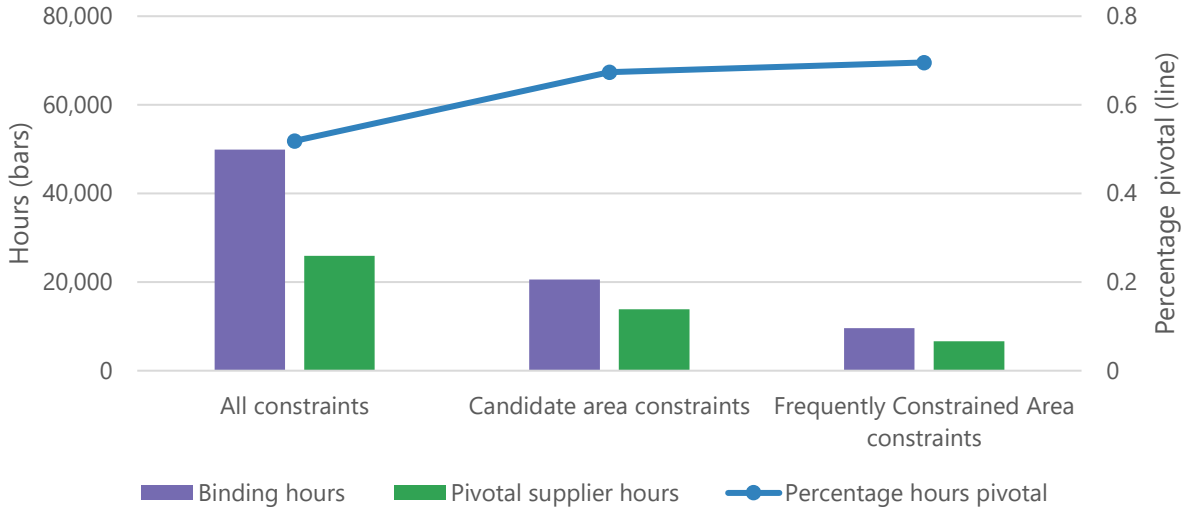
All evaluation areas met the location test, the electrical test and the pivotal supplier hour requirement. As a result, all areas warranted further consideration as Frequently Constrained Area candidates.

Oklahoma City, Tulsa, Williston, and Joplin met the Frequently Constrained Area candidate requirements in addition to the impact test threshold. Joplin did not meet the real-time pivotal supplier hour requirement of 500 hours.

[8] Evaluation areas are determined by the geographical concentration of pivotal supplier hours.
[9] Candidate areas meet the pivotal supplier hour test, in addition to the locational and electrical tests outlined in the methodology.
[10] Frequently Constrained Areas meet the candidate area requirements and the impact test requirements outlined in the methodology.

Figure 4-5 shows the concentration of binding and pivotal supplier hours by area classification.

Figure 4-5 Binding hours and pivotal supplier hours, by area classification, 2023

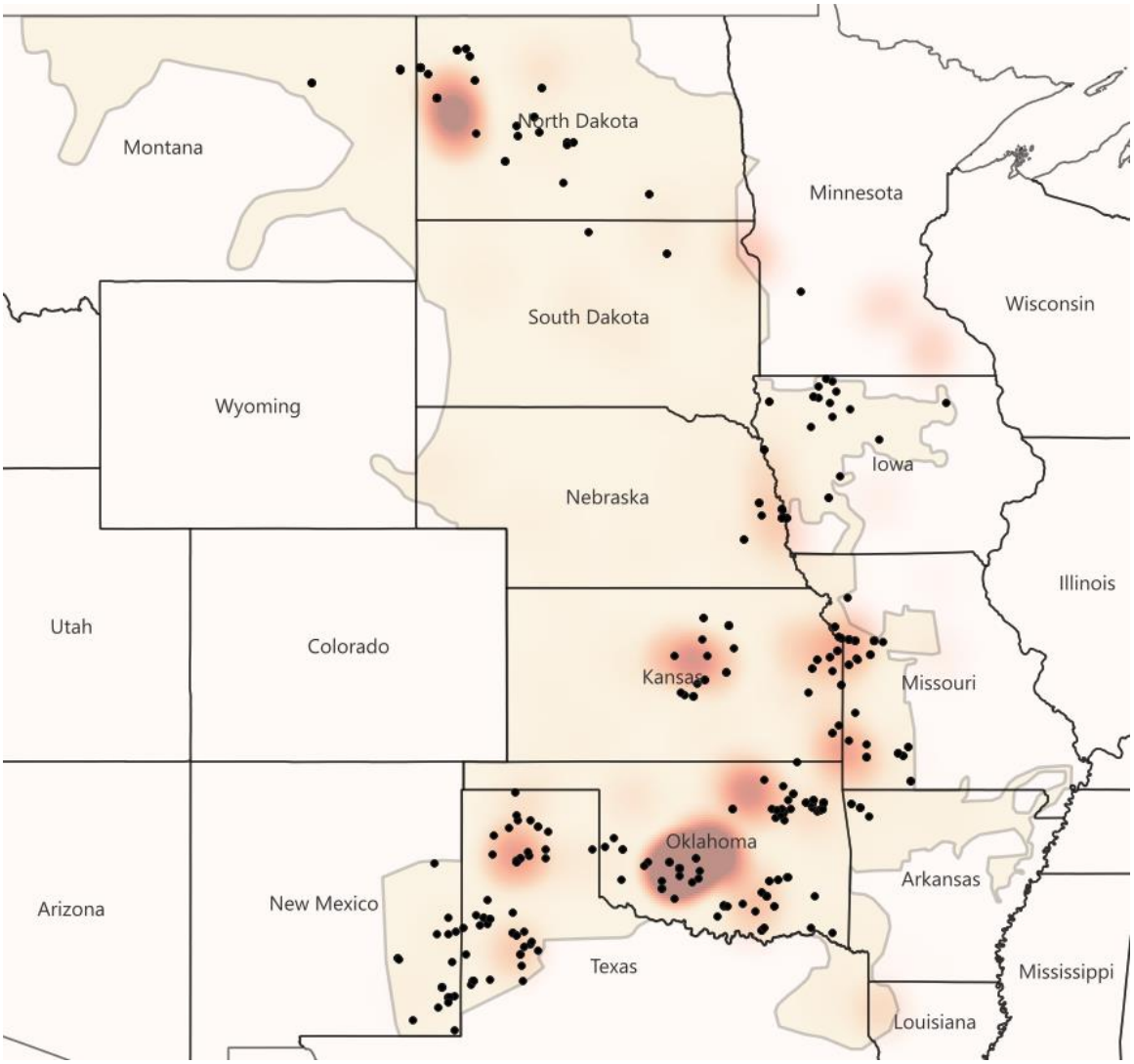


For the 2023 study period, Frequently Constrained Area candidates make up 41 percent of the binding hours and 53 percent of the pivotal supplier hours. The proposed Frequently Constrained Areas account for 19 percent of the binding hours and 26 percent of the pivotal supplier hours. Of note, all constraints carried a 52 percent ratio of pivotal supplier hours to binding hours. Whereas the Frequently Constrained Area candidates and proposed Frequently Constrained Areas bear concentrations of 67 and 70 percent respectively. In general, when the constraints within these areas bind, there is at least one pivotal supplier 29 percent[11] more often than the other areas overall.

Figure 4-6 shows the pivotal hour heat map and the Frequently Constrained Area candidate resources associated with the Frequently Constrained Area candidates.

[11] (67% - 52%) / 52% = 29%

Figure 4-6 Heat map, pivotal supplier hours, and Frequently Constrained Area candidate resources, study period

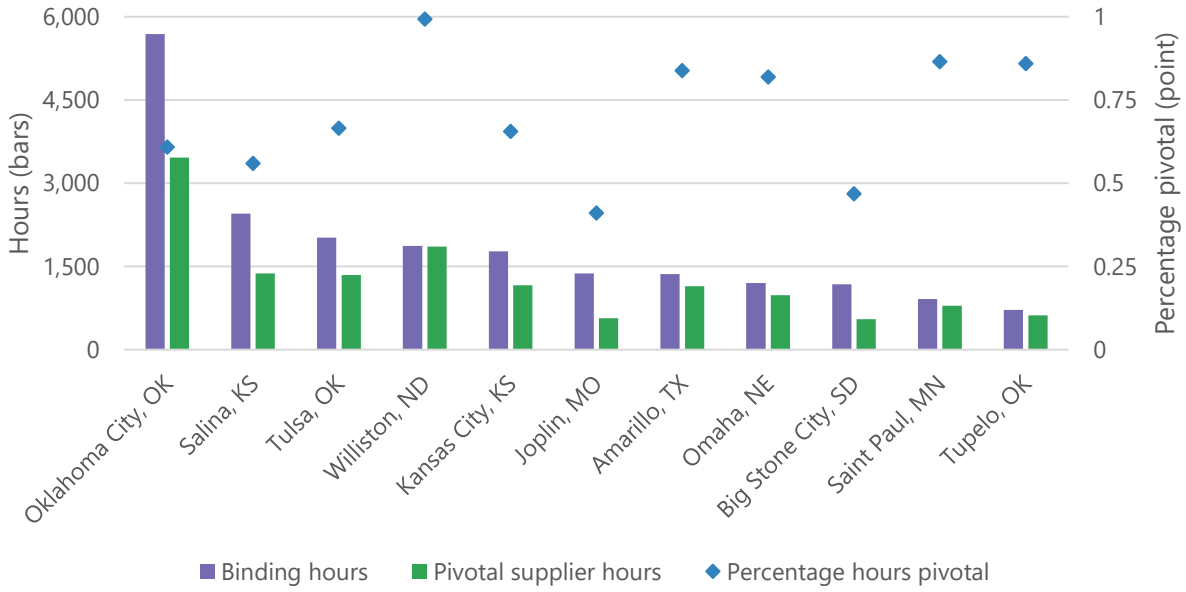


A significant asset enjoyed by customers and participants within the Integrated Marketplace is generator fuel diversity. Each fuel and related generator has benefits and limitations. It is the combination of these characteristics that leads to a more robust system overall. A significant proportion of the generators in SPP carry a very low fuel cost. By extension these resources often earn commitments in the day-ahead market and produce energy in real-time. Most of these resources exist in the western portions of the footprint and do not reside near population centers. To serve the load in the population centers within and beyond the SPP region, resources compete for the same transmission capacity. Congestion materializes when the

demand approaches, meets, or exceeds the transmission capacity. In SPP, the transmission in the southeastern and eastern portions of the footprint is often in high demand due to its proximity to load. This causes congestion to materialize in these areas, and as such, resources in an electrical position to alleviate this congestion will often reside on the opposite side of the general direction of power flows. This is why the map shows material Frequently Constrained Area candidate resource concentrations in the southeastern and eastern portions of the footprint.

Figure 4-7 provides more information on the binding and pivotal supplier hours within the Frequently Constrained Area candidates for the 2023 study period.

Figure 4-7 Binding hours and pivotal supplier hours, Frequently Constrained Area candidates, study period



For the 2023 study period, we observed a significant concentration of both binding hours and pivotal supplier hours in these areas. The percentage of pivotal supplier hours to binding hours ranged from 41 percent in the Joplin area to 99 percent in the Williston area.

Binding and pivotal supplier hours are constraint level calculations summed over the constraints within the Frequently Constrained Area candidates. Figure 4-8 displays the constraint counts within each Frequently Constrained Area candidate.

Figure 4-8 Frequently Constrained Area candidate primary and secondary constraint counts

FCA candidate	Number of primary and secondary constraints	Percentage of pivotal supplier hours, primary and secondary constraints
Oklahoma City, OK[12]	15	61%
Tulsa, OK	3	67%
Williston, ND	1	99%
Joplin, MO	14	41%
Big Stone City, SD	8	46%
Kansas City, KS	19	66%
Omaha, NE	21	82%
Tupelo, OK	3	86%
Amarillo, TX	3	84%
Saint Paul, MN	4	87%
Salina, KS	11	56%
FCA candidate, total	**102**	**67%**

While the constraint counts vary among the Frequently Constrained Area candidates, each candidate area exceeded 500 binding hours and 500 pivotal supplier hours over their respective constraints.

Figure 4-9 lists the top 15 binding constraints for the study period along with binding hours, pivotal supplier hours, and geographic area.

[12] Three terminated secondary constraints were included in the analysis for the Oklahoma City candidate area. These three constraints were binding during the study period and totaled 33 binding hours and 27 pivotal supplier hours. Because of the low binding hours, inclusion of these three terminated constraints did not impact the end results of Oklahoma City remaining an FCA.

Figure 4-9 Top 15 binding constraints

Constraint name	Binding constraint hours	Pivotal supplier hours	Geographical area
TEMP89_22229	2,721	1,681	Oklahoma City, Oklahoma
CHAWATCHAPAT	1,871	1,858	Williston, North Dakota
SMKSUMPOSAXT	1,500	873	Salina, Oklahoma
TMP253_27481	1,391	706	Oklahoma City, Oklahoma
TMP541_28628	1,342	0	Williston, North Dakota
TMP551_26749	1,222	255	Amarillo, Texas
TMP266_27514	1,115	400	Joplin, Missouri
OSAWEBCLESOO	994	624	Tulsa, Oklahoma
FRAMIDCANCED	967	800	Oklahoma City, Oklahoma
TMP270_23432	859	610	Tulsa, Oklahoma
TEMP50_23126	837	731	Amarillo, Texas
TMP511_28511	832	605	Shreveport, Louisiana
TMP109_22593	562	470	Tupelo, Oklahoma
TMP200_25341	519	409	Amarillo, Texas
TMP443_24626	518	401	Saint Paul, Minnesota

TEMP89_22229	Gracemont-Anadarko 138kV (WFEC-OKGE) ftlo Washita-Southwestern 138kV (CSWS-WFEC)
CHAWATCHAPAT	Charlie Creek-Watford City 230kV (WAUE) ftlo Charlie Creek-Patentgate 345kV (WAUE)
SMKSUMPOSAXT	Smokey Hills – Summit 230kV (MIDW) ftlo Macon – Axtell 345 (NPPD)
TMP253_27481	Gracemont-Anadarko 138kV (WFEC-OKGE) ftlo Minco-Cimarron 345kV (OKGE)
TMP541_28628	Lonesome Creek Sw-Arnegard 115kV (WAUE) no contingent element
TMP551_26749	Conway-Kirby Sw. Station 115kV (SPS) ftlo Nichols-Grapevine 230kV (SPS)
TMP266_27514	Franklin transformer 161/69kV (WR) ftlo Franklin-Litchfield 161kV (WR)
OSAWEBCLESOO	Osage-Webb Tap 138 kV (CSWS-OKGE) ftlo Sooner-Cleveland 345 kV (GRDA-OKGE)
FRAMIDCANCED	Franklin-Midwest 138kV (OKGE-WFEC) ftlo Cedar Lane-Canadian 138kV
TMP270_23432	Cleveland-Cleveland AECI 138 kV (AECI-GRDA) ftlo Cleveland-Tulsa North 345 kV (CSWS-GRDA)
TEMP50_23126	Potter County transformer 345/230kV (SPS) ftlo Border – Tuco 345 kV (OKGE-SPS)
TMP511_28511	Arsenal Hill 138/69kV (CSWS) ftlo Arsenal Hill – McWillie 138kV (CSWS)
TMP109_22593	Stonewall Sw-Tupelo 138kV (WFEC) ftlo Seminole-Pittsburg 345kV (CSWS-OKGE)
TMP200_25341	Potter Co. transformer 345/230kV (SPS) ftlo Hitchland-Moore Co 230kV (SPS)
TMP443_24626	Pleasant Valley-Byron 161kV (NSP-GRE) ftlo Pleasant Valley-Byron 345kV (NSP)

In the 2023 study period, the top 15 constraints, ranked by binding hours, contributed over 17,000 binding hours and more than 10,000 pivotal supplier hours. In the previous study period,

the top 15 constraints, ranked by binding hours, amounted to over 18,500 binding hours and more than 10,500 pivotal supplier hours.

Figure 4-10 shows the number of resources included in each Frequently Constrained Area candidate and the corresponding capacity in each candidate area.

Figure 4-10 Candidate resource summary

FCA candidate	Number of resources	Total capacity in megawatts	Potential relief capability in megawatts	Relief capability as percentage of total capacity
Oklahoma City, OK	44	3,077	-923	-30%
Tulsa, OK	37	1,768	-133	-8%
Williston, ND	26	1,819	-629	-35%
Joplin, MO	51	4,090	-597	-15%
Big Stone City, SD	11	1,172	-72	-6%
Kansas City, KS	52	6,109	-1,247	-20%
Omaha, NE	41	2,153	-549	-26%
Tupelo, OK	15	662	-80	-12%
Amarillo, TX	94	10,589	-3,359	-32%
Saint Paul, MN	45	4,836	-392	-8%
Salina, KS	26	1,228	-107	-9%

The total capacity is the sum of the registered maximum capacity of all resources in the Frequently Constrained Area candidate. An area's relief capability is the sum of each resource's registered maximum capacity multiplied by the constituent resource's average shift factor during the study period to a constraint in the Frequently Constrained Area candidate. The calculation represents an observed best-case potential relief capability.

The impact analysis determines the number of hours each Frequently Constrained Area candidate was both binding and susceptible to the exercise of market power by applying a price impact test or impact analysis (see Study process.) The price impacts were computed for each five-minute interval in the study period. The results are represented and tested at the hourly granularity. If the price impact on a single candidate resource exceeds the price impact

threshold, then the Frequently Constrained Area candidate is deemed susceptible to the exercise of market power in the presence of a pivotal supplier. We display the results of this impact test in Figure 4-11.

Figure 4-11 Impact analysis results

FCA Candidate	Binding hours over $25/MWh impact threshold	FCA total		
		Binding hours	Pivotal supplier hours	Percent hours with pivotal supplier
Oklahoma City, OK	2,401	5,690	3,462	61%
Tulsa, OK	1,358	2,019	1,344	67%
Williston, ND	1,095	1,871	1,858	99%
Joplin, MO	539	1,365	559	41%

The four areas shown in the table above met the impact threshold test, but Big Stone City, Kansas City, Omaha, Tupelo, Amarillo, Saint Paul, and Salina did not. These seven areas met all Frequently Constrained Area candidate requirements, but the price impact fell short of the $25/MWh threshold. This illustrates the significance of locational marginal prices in determining the final Frequently Constrained Areas. Even if these areas were to be included as Frequently Constrained Areas, the prices would often fall below the mitigation threshold.

The final step adjusts the actual binding hours in real-time by the percentage of pivotal supplier hours from the analysis. These are called the real-time pivotal supplier hours. These results are in Figure 4-12.

Figure 4-12 Adjusted real-time pivotal supplier hours

FCA candidate	FCA total binding hours		Percent hours with pivotal supplier	FCA total pivotal supplier hours	
	Analysis	Real-time		Analysis	Real-time
Oklahoma City, OK	5,690	4,912	61%	3,462	2,969
Tulsa, OK	2,019	1,639	67%	1,344	1,092
Williston, ND	1,871	1,480	99%	1,858	1,470
Joplin, MO	1,365	1,072	41%	559	440

The Oklahoma City, Tulsa, and Williston areas all exceeded 60 percent of the binding hours being pivotal in the analysis. The Joplin area only had 41 percent of its binding hours being pivotal. Applying this percentage to the actual real-time binding hours resulted in 440 hours possible real-time pivotal supplier hours for the Joplin area.

The impact threshold hours, pivotal supplier hours, and the real-time pivotal supplier hours are compared in Figure 4-13.

Figure 4-13 Final results

FCA candidate	Binding hours over $25/MWh impact threshold	Pivotal supplier hours	Real-time pivotal supplier hours
Oklahoma City, OK	**2,401**	**3,462**	**2,969**
Tulsa, OK	**1,358**	**1,344**	**1,092**
Williston, ND	**1,095**	**1,858**	**1,470**
Joplin, MO	**539**	**559**	440

The Oklahoma City, Tulsa, and Williston areas all exceeded the threshold of 500 hours for the impact test, pivotal supplier, and real-time pivotal supplier. These three areas will be retained as Frequently Constrained Areas. The Joplin area only had 440 hours of real-time pivotal supplier hours which falls below the threshold of 500 hours and will be removed as a Frequently Constrained Area.

Conclusion

Binding hours, pivotal supplier hours, and congestion decreased this study period compared to the previous year's study but remained at levels that retained three of the four currently defined Frequently Constrained Areas. As the resource mix and transmission infrastructure changes, so too will the flow of power and the ability of participants to influence market outcomes. The aim of the Frequently Constrained Areas study is to follow the tariff and limit the exercise of market power.

5 APPENDIX

5.1 Impact analysis, FCA candidates

FCA candidate	Binding hours over $25/MWh impact threshold	FCA total		
		Binding hours	Pivotal supplier hours	Percent hours with pivotal supplier
Oklahoma City, OK	2,401	5,690	3,462	61%
Tulsa, OK	1,358	2,019	1,344	67%
Williston, ND	1,095	1,871	1,858	99%
Joplin, MO	539	1,365	559	41%
Big Stone City, SD	484	1,155	529	46%
Kansas City, KS	431	1,770	1,159	65%
Omaha, NE	422	1,194	979	82%
Tupelo, OK	418	717	616	86%
Amarillo, TX	281	1,362	1,142	84%
Saint Paul, MN	16	915	792	87%

5.2 Adjusted real-time, FCA candidates

FCA candidate	FCA total binding hours		Percent hours with pivotal supplier	FCA total pivotal supplier hours	
	Analysis	Real-time		Analysis	Real-time
Oklahoma City, OK	5,690	4,912	61%	3,462	2,969
Tulsa, OK	2,019	1,639	67%	1,344	1,092
Williston, ND	1,871	1,480	99%	1,858	1,470
Joplin, MO	1,365	1,072	41%	559	440
Big Stone City, SD	1,155	1,105	46%	529	507
Kansas City, KS	1,770	1,466	66%	1,159	972
Omaha, NE	1,194	895	82%	979	729
Tupelo, OK	717	464	86%	616	399
Amarillo, TX	1,362	1,069	84%	1,142	897
Saint Paul, MN	915	905	87%	792	784
Salina, KS	2,322	1,969	56%	1,301	1,107

5.3 Frequently Constrained Area resource summary by fuel type and megawatt capacity

Fuel type	FCA area		
	Oklahoma City, OK	Tulsa, OK	Williston, ND
Coal	—	—	—
Fuel oil	5	7	—
Municipal solid waste	—	3	—
Natural gas	1,559	1,310	611
Other fuel	53	62	226
Water	—	386	218
Wind	1,461	—	764

5.4 Frequently Constrained Area resource summary by fuel type and resource count

Fuel type (Number of Resources)	FCA Area		
	Oklahoma City, OK	Tulsa, OK	Williston, ND
Coal	—	—	—
Fuel oil	1	1	—
Municipal solid waste	—	1	—
Natural gas	20	7	16
Other fuel	10	18	3
Water	—	10	2
Wind	13	—	5

5.5 Frequently Constrained Area constraints

Frequently Constrained Area constraints		
Constraint name	**Frequently Constrained Area**	**Element(s)**
FRAMIDCANCED	Oklahoma City	LN MDWST - FRNKLN1 138 kV for the loss of LN CDRLN - CANDN 138 Kv
TEMP89_22229	Oklahoma City	LN GRACMONT - ANADARKO 138 kV for the loss of LN WASHIT1 - SW_STA 138 kV
TMP253_27481	Oklahoma City	LN GRACMONT - ANADARKO 138 kV for the loss of LN MINCO - CIMARRON 345 kV
TMP374_25996	Oklahoma City	LN GRACMONT - ANADARKO 138 kV for the loss of LN LAW_ES - TREASURE 345 kV
MIDFRAMINGRA	Oklahoma City	LN MDWST - FRNKLN1 138 kV for the loss of LN MINCO - GRACMONT 345 kV
SWSANAGRAANA	Oklahoma City	LN SW_STA - ANADARKO 138 kV for the loss of LN GRACMONT - ANADARKO 138 kV
TMP906_29213	Oklahoma City	LN GRACMONT - ANADARKO 138 kV for the loss of LN MINCO - CIMARRON 345 kV (multiple elements)
TMP285_27302	Oklahoma City	LN CIMARRON - TUTCONTP 138 kV for the loss of LN MINCO - GRACMONT 345 kV
TMP311_28316	Oklahoma City	XF GRACMONT 345/1 kV for the loss of LN MINCO - CIMARRON 345 kV
TMP781_29254	Oklahoma City	LN PITTSB9 - SEMINOLE 345 kV for the loss of LN PITTSB9 - CND_RIVR 345 kV
MIDFRNPHAWET	Oklahoma City	LN MDWST - FRNKLN1 138 kV for the loss of LN PHAROAH - WTMPKATP 138 kV
SWSANASWSWAS	Oklahoma City	LN SW_STA - ANADARKO 138 kV for the loss of LN SW_STA - WASHIT1 138 kV
OSAWEBCLESOO	Tulsa	LN OSAGE_OG - WEBBTAP4 138 kV for the loss of LN SONR1 - CLEVLND7 345 kV
TEMP47_28178	Tulsa	LN KINZE - KINZEG1 138 kV for the loss of LN SONR1 - CLEVLND7 345 kV
TMP270_23432	Tulsa	LN CLEVLND7 - CLEV_AEC 138 kV for the loss of LN CLEVLND7 - TULSA_NO 345 kV
CHAWATCHAPAT	Williston	LN CHAR_CK - WATFORD 230 kV for the loss of LN CHAR_CK - PATENT_G 345 kV and ZBR JUDSON - JUDSON 230 kV

5.6 Frequently Constrained Area resources

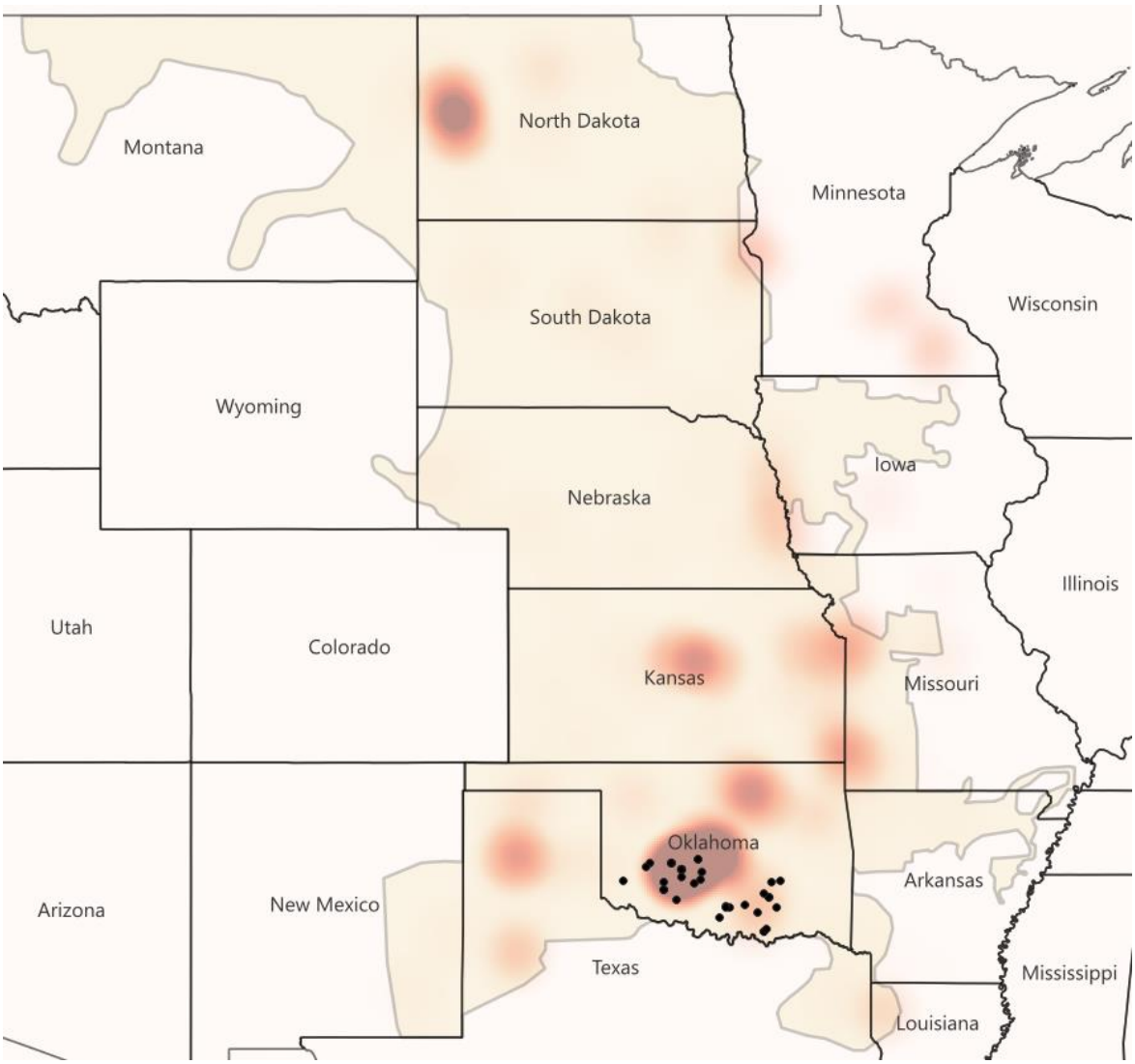
Frequently Constrained Area details			
Settlement location	**Resource**	**Fuel type**	**FCA area**
BLUECANYON1	BLUECANYON1	Wind	Oklahoma City
BLUECANYON2	BLUECANYON2	Wind	Oklahoma City
BLUECANYON5	BLUECANYON5	Wind	Oklahoma City
BLUECANYON6	BLUECANYON6	Wind	Oklahoma City
CSWCOMANCHE1	CSWCOMANCHE1	Natural Gas	Oklahoma City
CSWS.AECC.DRIFTSAND	CSWS.AECC.DRIFTSAND	Wind	Oklahoma City
CSWS.HCPP.RBPW	CSWS.HCPP.RBPW	Wind	Oklahoma City
CSWS.NUEN.MDT1	CSWS.NUEN.MDT1	Other Fuel	Oklahoma City
CSWS.VOLT.0060	CSWS.VOLT.0060	Other Fuel	Oklahoma City
CSWS.VOLT.0144	CSWS.VOLT.0144	Other Fuel	Oklahoma City
CSWS.VOLT.0145	CSWS.VOLT.0145	Other Fuel	Oklahoma City
CSWS.WRWW.WEST	CSWS.WRWW.WEST	Wind	Oklahoma City
CSWSOUTHWESTERN1	CSWSOUTHWESTERN1	Natural Gas	Oklahoma City
CSWSOUTHWESTERN2	CSWSOUTHWESTERN2	Natural Gas	Oklahoma City
CSWSOUTHWESTERN3	CSWSOUTHWESTERN3	Natural Gas	Oklahoma City
CSWSOUTHWESTERN4	CSWSOUTHWESTERN4	Natural Gas	Oklahoma City
CSWSOUTHWESTERN5	CSWSOUTHWESTERN5	Natural Gas	Oklahoma City
OKGE.GLAS.GLAS	OKGE.GLAS.GLAS	Wind	Oklahoma City
OKGE.LES.ARBKL	OKGE.LES.ARBKL	Wind	Oklahoma City
OKGE.RCKW.RCKWIND	OKGE.RCKW.RCKWIND	Wind	Oklahoma City
OKGE.VOLT.0039	OKGE.VOLT.0039	Other Fuel	Oklahoma City
OKGE.VOLT.0116	OKGE.VOLT.0116	Other Fuel	Oklahoma City
OKGE.VOLT.0129	OKGE.VOLT.0129	Other Fuel	Oklahoma City
OKGE.VOLT.0195	OKGE.VOLT.0195	Other Fuel	Oklahoma City
OKGE.VOLT.0208	OKGE.VOLT.0208	Other Fuel	Oklahoma City
OKGE.VOLT.0209	OKGE.VOLT.0209	Other Fuel	Oklahoma City
OKGE_ORIGINWIND	OKGE_ORIGINWIND	Wind	Oklahoma City
OMPA_MANGUM	OMPA_MANGUM	Fuel Oil	Oklahoma City
WFEC.PEOP.CENTRAHOMAEAST	WFEC.PEOP.CENTRAHOMAEAST	Natural Gas	Oklahoma City
WFEC.PEOP.CENTRAHOMAWEST	WFEC.PEOP.CENTRAHOMAWEST	Natural Gas	Oklahoma City
WFEC.PEOP.LELK	WFEC.PEOP.LELK	Wind	Oklahoma City
WFEC.PEOP.LITTLEDIXIE	WFEC.PEOP.LITTLEDIXIE	Natural Gas	Oklahoma City
WFEC.PEOP.STUART	WFEC.PEOP.STUART	Natural Gas	Oklahoma City
WFEC_ANA_COMB_CYC_4	WFEC_ANA_COMB_CYC_4	Natural Gas	Oklahoma City
WFEC_ANA_COMB_CYC_5	WFEC_ANA_COMB_CYC_5	Natural Gas	Oklahoma City
WFEC_ANA_COMB_CYC_6	WFEC_ANA_COMB_CYC_6	Natural Gas	Oklahoma City
WFEC_ANA_GENCO_7	WFEC_ANA_GENCO_7	Natural Gas	Oklahoma City
WFEC_ANA_GENCO_8	WFEC_ANA_GENCO_8	Natural Gas	Oklahoma City
WFEC_ANA_ORME_10	WFEC_ANA_ORME_10	Natural Gas	Oklahoma City
WFEC_ANA_ORME_11	WFEC_ANA_ORME_11	Natural Gas	Oklahoma City
WFEC_ANA_ORME_9	WFEC_ANA_ORME_9	Natural Gas	Oklahoma City

Frequently Constrained Area details			
Settlement location	**Resource**	**Fuel type**	**FCA area**
WFEC_ANA_STEAM_PLANT	WFEC_ANA_STEAM_PLANT	Natural Gas	Oklahoma City
WFEC_RKYRIDGE_WIND_FARM	WFEC_RKYRIDGE_WIND_FARM	Wind	Oklahoma City
WR.PEOP.BUZZARDFLOP	WR.PEOP.BUZZARDFLOP	Natural Gas	Oklahoma City
CSWNORTHEASTERN1	CSWNORTHEASTERN1	Natural Gas	Tulsa
CSWNORTHEASTERN2	CSWNORTHEASTERN2	Natural Gas	Tulsa
CSWS.NUEN.CSI1	CSWS.NUEN.CSI1	Other Fuel	Tulsa
CSWS.NUEN.CSI2	CSWS.NUEN.CSI2	Other Fuel	Tulsa
CSWS.NUEN.CSI3	CSWS.NUEN.CSI3	Other Fuel	Tulsa
CSWS.VOLT.0044	CSWS.VOLT.0044	Other Fuel	Tulsa
CSWS.VOLT.0056	CSWS.VOLT.0056	Other Fuel	Tulsa
CSWS.VOLT.0086	CSWS.VOLT.0086	Other Fuel	Tulsa
CSWS.VOLT.0122	CSWS.VOLT.0122	Other Fuel	Tulsa
CSWS.VOLT.0124	CSWS.VOLT.0124	Other Fuel	Tulsa
CSWS.VOLT.0135	CSWS.VOLT.0135	Other Fuel	Tulsa
CSWS.VOLT.0175	CSWS.VOLT.0175	Other Fuel	Tulsa
CSWS.VOLT.0201	CSWS.VOLT.0201	Other Fuel	Tulsa
CSWS.VOLT.0202	CSWS.VOLT.0202	Other Fuel	Tulsa
CSWS.VOLT.0204	CSWS.VOLT.0204	Other Fuel	Tulsa
CSWS.VOLT.0205	CSWS.VOLT.0205	Other Fuel	Tulsa
CSWS.VOLT.0206	CSWS.VOLT.0206	Other Fuel	Tulsa
CSWTULSA2	CSWTULSA2	Natural Gas	Tulsa
CSWTULSA4	CSWTULSA4	Natural Gas	Tulsa
GRDA.SEC1	GRDA.SEC1	Natural Gas	Tulsa
GRDA.SEC2	GRDA.SEC2	Natural Gas	Tulsa
GRDA.SEC3	GRDA.SEC3	Natural Gas	Tulsa
GRDA.VOLT.0130	GRDA.VOLT.0130	Other Fuel	Tulsa
KERR_1	KERR_1	Water	Tulsa
KERR_2	KERR_2	Water	Tulsa
KERR_3	KERR_3	Water	Tulsa
KERR_4	KERR_4	Water	Tulsa
OKGE.VOLT.0197	OKGE.VOLT.0197	Other Fuel	Tulsa
OKGE.VOLT.0210	OKGE.VOLT.0210	Other Fuel	Tulsa
OMPA_AEL	OMPA_AEL	Municipal Solid Waste	Tulsa
OMPA_PAWHUSKA	OMPA_PAWHUSKA	Fuel Oil	Tulsa
SALINA_1	SALINA_MSR1	Water	Tulsa
SALINA_2	SALINA_MSR2	Water	Tulsa
SALINA_3	SALINA_MSR3	Water	Tulsa
SALINA_4	SALINA_MSR4	Water	Tulsa
SALINA_5	SALINA_MSR5	Water	Tulsa
SALINA_6	SALINA_MSR6	Water	Tulsa
WAUE.AWD1.AURAWIND	WAUE.AWD1.AURAWIND	Wind	Williston
WAUE.BEPM.AURORA	WAUE.BEPM.AURORA	Wind	Williston

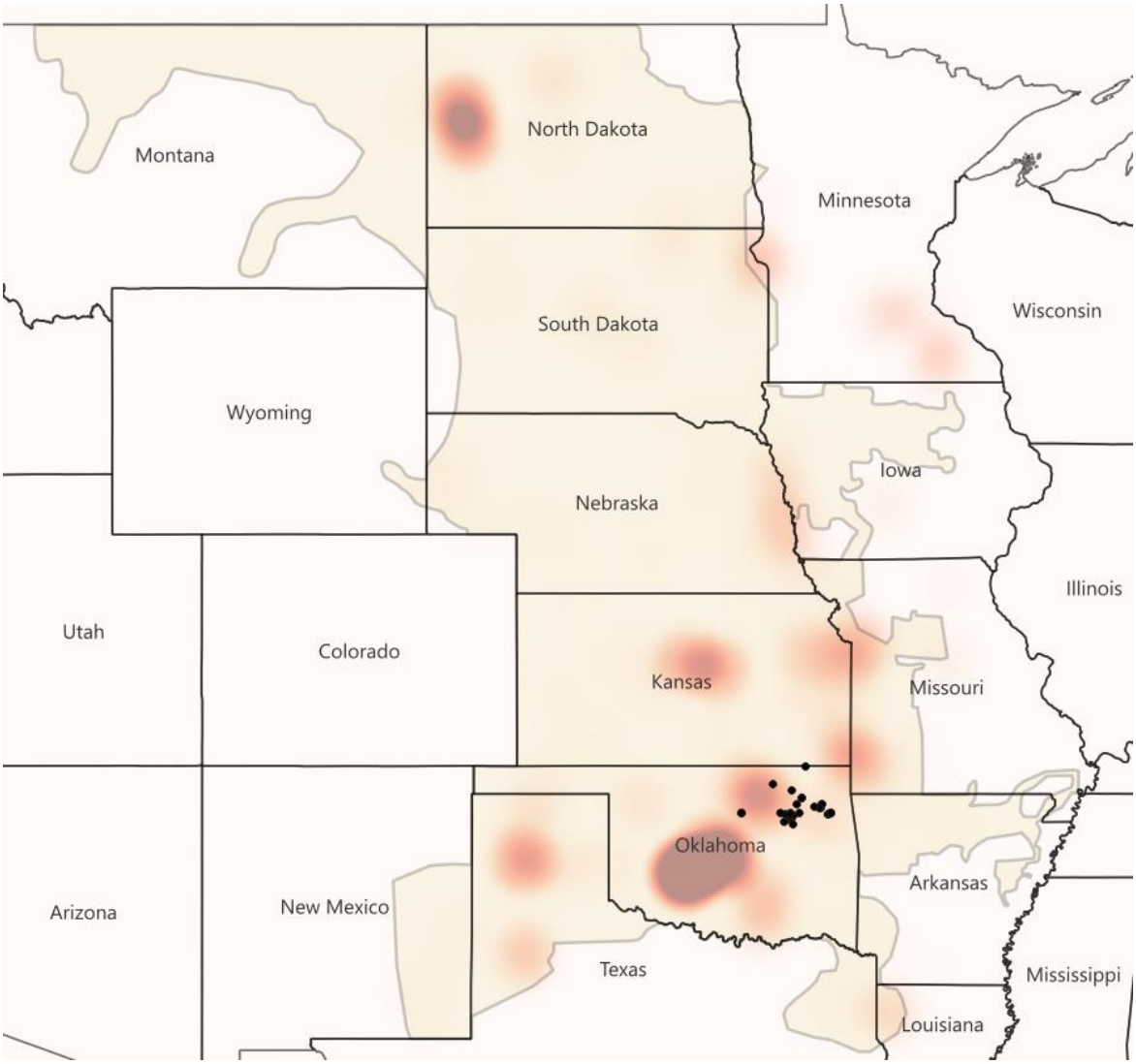
Frequently Constrained Area details			
Settlement location	**Resource**	**Fuel type**	**FCA area**
WAUE.BEPM.BURKE	WAUE.BEPM.BURKE	Wind	Williston
WAUE.BEPM.CULBERTSON1	WAUE.BEPM.CULBERTSON1	Natural Gas	Williston
WAUE.BEPM.CULBERTSONWH	WAUE.BEPM.CULBERTSONWH	Other Fuel	Williston
WAUE.BEPM.LCS1	WAUE.BEPM.LCS1	Natural Gas	Williston
WAUE.BEPM.LCS2	WAUE.BEPM.LCS2	Natural Gas	Williston
WAUE.BEPM.LCS3	WAUE.BEPM.LCS3	Natural Gas	Williston
WAUE.BEPM.LCS4	WAUE.BEPM.LCS4	Natural Gas	Williston
WAUE.BEPM.LCS5	WAUE.BEPM.LCS5	Natural Gas	Williston
WAUE.BEPM.LCS6	WAUE.BEPM.LCS6	Natural Gas	Williston
WAUE.BEPM.LINDAHL	WAUE.BEPM.LINDAHL	Wind	Williston
WAUE.BEPM.PGS1	WAUE.BEPM.PGS1	Natural Gas	Williston
WAUE.BEPM.PGS11	WAUE.BEPM.PGS11	Natural Gas	Williston
WAUE.BEPM.PGS12	WAUE.BEPM.PGS12	Natural Gas	Williston
WAUE.BEPM.PGS13	WAUE.BEPM.PGS13	Natural Gas	Williston
WAUE.BEPM.PGS14_16	WAUE.BEPM.PGS14_16	Natural Gas	Williston
WAUE.BEPM.PGS17_19	WAUE.BEPM.PGS17_19	Natural Gas	Williston
WAUE.BEPM.PGS2	WAUE.BEPM.PGS2	Natural Gas	Williston
WAUE.BEPM.PGS20_22	WAUE.BEPM.PGS20_22	Natural Gas	Williston
WAUE.BEPM.PGS3	WAUE.BEPM.PGS3	Natural Gas	Williston
WAUE.BEPM.PW1	WAUE.BEPM.PW1	Wind	Williston
WAUE.FTPECK.1_3	WAUE.FTPECK.1_3	Water	Williston
WAUE.FTPECK.4_5	WAUE.FTPECK.4_5	Water	Williston
WAUE.VOLT.0152	WAUE.VOLT.0152	Other Fuel	Williston
WAUE.VOLT.0172	WAUE.VOLT.0172	Other Fuel	Williston

5.7 Frequently Constrained Area maps

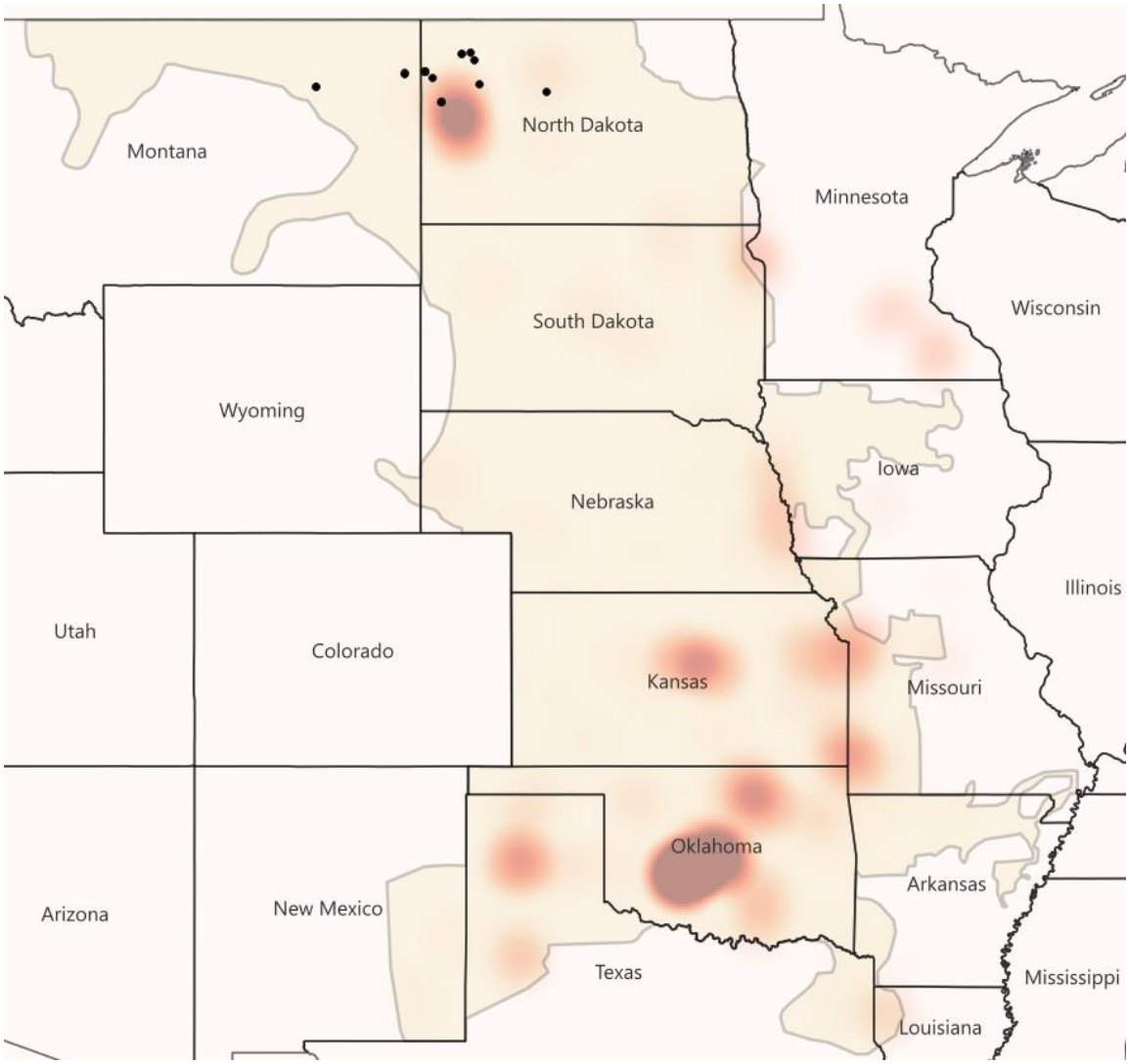
5.7.1 Oklahoma City, Oklahoma



5.7.2 Tulsa, Oklahoma



5.7.3 Williston, North Dakota



The data and analysis provided in this report are for informational purposes only and shall not be considered or relied upon as market advice or market settlement data. All analysis and opinions contained in this report are solely those of the SPP Market Monitoring Unit (MMU), the independent market monitor for Southwest Power Pool, Inc. (SPP). The MMU and SPP make no representations or warranties of any kind, express or implied, with respect to the accuracy or adequacy of the information contained herein. The MMU and SPP shall have no liability to recipients of this information or third parties for the consequences that may arise from errors or discrepancies in this information, for recipients' or third parties' reliance upon such information, or for any claim, loss, or damage of any kind or nature whatsoever arising out of or in connection with:

i. *the deficiency or inadequacy of this information for any purpose, whether or not known or disclosed to the authors;*
ii. *any error or discrepancy in this information;*
iii. *the use of this information, and;*
iv. *any loss of business or other consequential loss or damage whether or not resulting from any of the foregoing.*