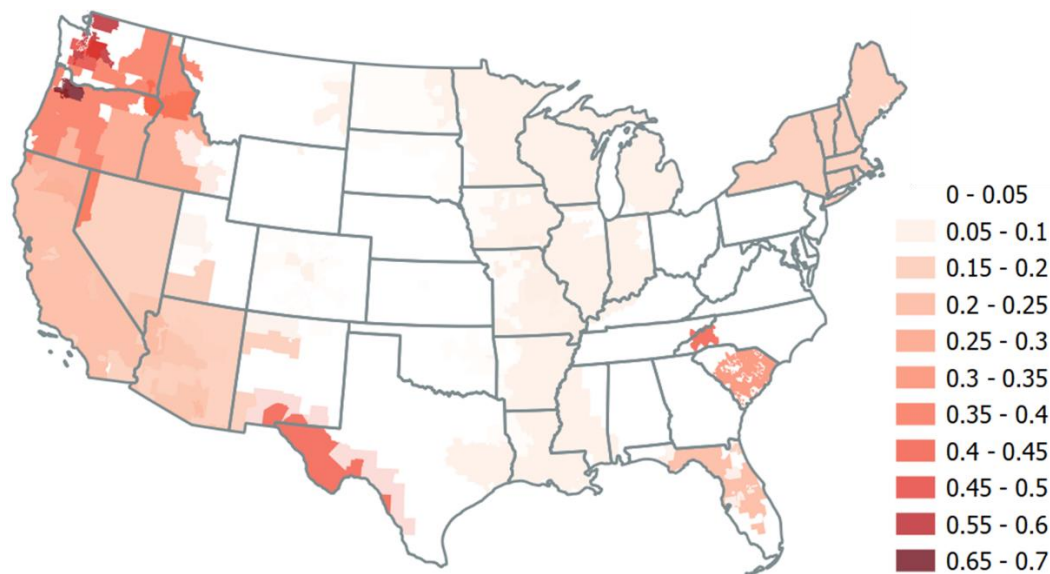


# Import Reliance

Import reliance is defined as the fraction of domestic consumption covered by net electricity imports over a period of interest. This is a simple metric that is easy to interpret and commonly identified in the research literature on electricity supply security [1–4], sometimes also referred to “import dependence.”

Figure 1 displays import reliance by balancing authority. In general, it shows the areas in the U.S. with relatively higher levels of imports include the Northwest, Southwest, and Northeast. The highest levels of import reliance in the U.S. from 2016-2023 were among balancing authorities in the Northwest U.S. Specifically, Portland General Electric Company, Puget Sound Energy, and the City of Tacoma Department of Public Utilities had the highest shares of imports at 0.70, 0.57, and 0.48, respectively. Nearly all the imports into these three regions came from the Bonneville Power Administration balancing authority. Table 1 in the Appendix provides the import reliance numbers annually and across the full sample, for U.S. balancing authorities with average demand greater than 500 MW.



*Figure 1 Import share of total electricity consumption by U.S. Balancing Authority, 2016-2023.*

There are a few additional import-dependent balancing authorities shown in Figure 1 that appear to be outliers relative to their neighbors. El Paso Electric Company in southwest Texas was 44% reliant on imports over the sample period; 67% of its imports were from Public Service Company of New Mexico and 30% from Tucson Electric Power.

Duke Energy Progress (DEP) in the Carolinas is administratively split into two BAs in the west and the east part of its footprint. DEP west is 42% reliant on imports and significantly smaller than DEP east. Most DEP west imports come from its neighboring Duke-controlled BAs. In this way, the high level of import reliance in DEP west may not reflect significant import reliance risk if the Duke

parent company likely owns and controls much of the resources being traded across the multiple BAs it administers in the Carolinas.

Duke Energy Florida (DEF) is also relatively import-reliant at 24% compared to its neighboring systems. It is relatively diverse in its sources of imports and, unlike the Duke balancing authorities in the Carolinas, does not trade with company affiliates. Rather, 32% of its imports were from Florida Power & Light, 26% from Florida Municipal Power Pool, and 24% from Seminole Electric Cooperative. It also receives smaller levels of imports from Gainesville Regional Utilities, Southern Company, and Tampa Electric Company.

The import reliance metric is simple to calculate and interpret and provides an accurate perspective on the reliance of a balancing authority on electricity supply outside its control. In this way it presents a useful starting point for an analysis. The import reliance metric, while a useful descriptive statistic, is somewhat limited in describing reliability risk because it does not account for relevant characteristics of the contractual arrangements underlying electricity imports. For example, a balancing authority whose imports are provided under firm delivery arrangements may have lower reliability risk than a BA that relies on significant imports purchased from a spot market.

It is as;sp important to note that high “import reliance” is not necessarily a concern- there are likely good reasons when a system operator imports electricity to supply local demand. Several studies have shown economic efficiency gains from trade available when two regions increase electricity trade [5–8]. The magnitude and characteristics of electricity trade in any given system vary depending on the underlying characteristics of individual systems, including resource mixes, demand characteristics, geographic traits, and local politics.

Despite economic efficiencies that can be realized from regional trade, there are reasons why expanding electricity trade could be more costly than the available benefits. One potentially significant barrier is if physical links connecting two BAs are already congested, alongside the sometimes-prohibitive cost of building new electric transmission lines [9]. Furthermore, the integration and associated regional efficiencies associated with electricity price equalization will produce some economic losers [10], including electricity customers who face higher prices after increasing exports, and producers facing reduced profits from imports [11].

Other factors to consider for a better understanding of the observed trading situation between two electricity systems include the political relationships between regions, market trading rules, and other institutional realities that could create to trading friction or other sources of risk associated with expanded trade [12]. Sometimes regional integration is accompanied by efforts to expand BA territory, which can involve an expansion of centralized control over dispatch and resource adequacy for a grid operator in one of the regions, which requires a level of acceptance from all local market participants and stakeholders. It is often tempting for analysts to consider trading opportunities from an economic efficiency lens without similarly considering the potentially significant political cooperation needed as a foundation for successful and lasting economic integration of regional electricity systems [13,14].

Finally, the import reliance metric also does not incorporate the diversity of external sources of supply, which is a relevant factor for assessing reliability risk. A region relying on imports may be more reliable if it has many different sources of external supply. In contrast, a balancing authority

that is heavily reliant on imports from a single system operator may have higher risk. This perspective is analyzed further in subsequent sections.

## Import Diversity

A diverse set of import sources is beneficial for multiple reasons. Reduced dependency on one or a small number of exporters increases the probability of available supply when needed. Regions may have differences in weather and climate and weather, demand patterns, and technology mix, which can improve the availability of supply, increase economic efficiency, and may support mitigating local extreme events such as a heat wave, natural disaster, or infrastructure failure [15–17]. On the other hand, achieving import diversity through additional trading relationships with neighboring systems may require managing greater transaction costs and administrative requirements, as different balancing authorities have varying trading procedures [18]. Furthermore, expanding the physical links across systems needed to enhance diversity can be slowed down by incompatible infrastructure cost allocation and development procedures across regions [19,20].

It is useful in this context to apply a metric for quantifying and comparing import diversity. The Shannon Diversity Index is useful for this application. It was initially applied through information theory to measure the quantity of information included in a communication signal [21]. Since then, it has been applied as a measure of diversity for a range of applications, notably in ecologic systems [22,23] and economics [24].

The Shannon Diversity Index (herein “diversity index”) has also been widely considered in energy security-focused studies as a metric for diversity of primary energy and energy import sources, commonly at the nation-state level as part of geo-political energy analysis [27–41]. A smaller number of studies have utilized the diversity metric to assess electricity system-specific generation diversity [42–46]. This study is the only one the author is aware of that applies a formal index to assess diversity of electricity imports among electric balancing authorities within the United States.

The diversity index applied to electric balancing authority imports is defined in equation **Error! Reference source not found.**, where  $p_i$  is the share of imports from neighboring BA  $i$ , relative to total imports into the balancing authority of interest.

$$H = - \sum_i^n p_i \ln(p_i) \quad (1)$$

Mathematically, the diversity index  $H$  is inversely related to the geometric mean of the relative shares  $p_i$  such that a higher value  $H$  describes a system with a more diverse set of imports. It can be shown that  $\frac{1}{e^H}$  is the geometric mean of the relative shares  $p_i$  [25,26], so that a relatively concentrated (less diverse)  $p_i$  set leads to a lower  $H$  value. In a bookend case, if a system’s imports were fully served by a single neighbor ( $p_j = 1$  and all other  $p_i = 0$ ), then the diversity metric would equal zero.

Conversely, the diversity metric  $H$  increases with more trading partners (e.g. a higher  $n$ ). For any given set of import sources (e.g. holding  $n$  constant), the diversity metric  $H$  is maximized when all  $p_i$

are equal (e.g.  $p_i = \frac{1}{n} \forall i$ ). In this way, the diversity index considers the “evenness” of import sources, which is analogous to a less concentrated set of import sources. A set of “even”  $p_i$  suggests a system’s imports are provided roughly equally by its trading partners such that one isn’t more dominant than others, representing a “diverse” import situation.

In considering both the number of import sources and the concentration of imports from a set of trading partners, the Shannon diversity index provides an effective quantitative measurement of diversity of imports at the US balancing authority level for this study application.

Figure 2 maps the diversity indices calculated at the balancing-authority level across the United States. It is worth noting here that the shapefile territories of balancing authorities (obtained from [47]) can have overlapping boundaries, where multiple BA’s share parts of the same spatial extent on the map. In these cases, the darkest among the overlapping polygons is retained and displayed.

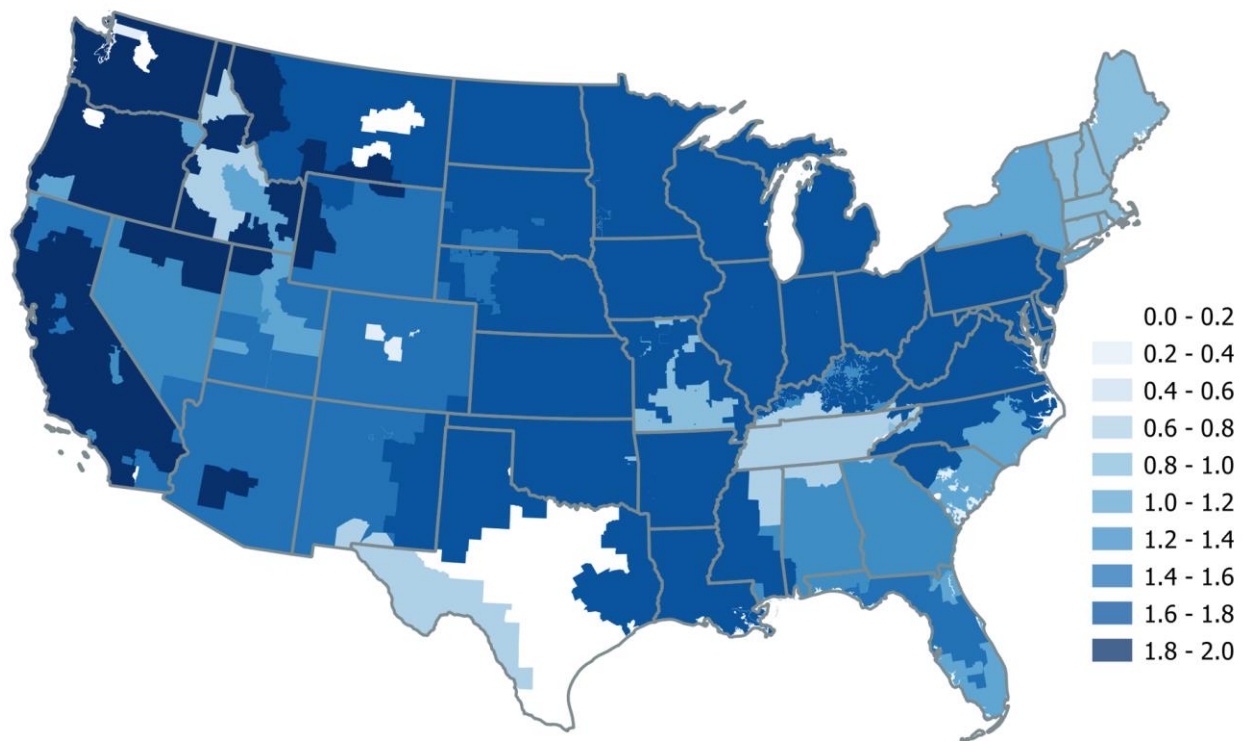


Figure 2 Import diversity metric by U.S. Balancing Authority, 2016-2023

The Bonneville Power Administration (BPA), California ISO (CAISO), Salt River Project (SRP), Midcontinent ISO, and Southwest Power Pool, have the highest measured import diversity levels for US balancing authorities during the sample periods. BPA, for example, imports from 18 different neighboring systems. The largest shares of BPA imports come from Northwestern Energy, followed by a handful of public utility districts. CAISO imports from 12 systems, with its highest levels of imports coming from Los Angeles Department of Water and Power, followed by Bonneville Power, Salt River Project, and Arizona Public Service. SRP imports from 8 systems, and its import sources are relatively balanced across 6 of them, including WAPA Desert Southwest, Arlington Valley, Arizona Public Service, Tucson Electric Power, Gridforce, and New Harquahala.

Balancing authorities with low measured diversity scores include a small handful in the Pacific Northwest, JEA in Northeast Florida, ERCOT in Texas, and Public Service Company of Colorado. Those with low import diversity in the Pacific Northwest get most of their external supply from the Bonneville Power Authority (BPA). For example, Tacoma Power received over 99% of its imports from BPA during the sample period, while Portland General Electric and Seattle City Light are at 96% and 94%, respectively. For JEA in Florida, 97% of imports came from Florida Power & Light. Over 95% of the limited amount of imports into ERCOT came from the Southwest Power Pool, while 93% of Public Service Company of Colorado's imports were from Western Area Power Administration Rocky Mountain Balancing Authority.

Table 2 in the Appendix provides diversity indices for the full sample period (2016-2023) and individually by year for U.S. Balancing Authorities with average demand greater than 500 MW. It can be noted from this table that, in most cases, the diversity metric across the full sample is higher than the average diversity metric for individual years. In general, import diversity tends to be less concentrated when considered across a larger sample because system conditions and the trading dynamics with neighboring BA's tend to change, often in a manner that improves total diversity when considered over a longer period.

Calculating the diversity index at the balancing authority is a straightforward choice for this analysis, as the U.S. Energy Information Administration tracks and reports on electric interchange at the balancing authority level [48]. These results provide a starting point to begin to understand diversity of imports across relevant control areas in the United States for high-level comparisons. However, sweeping conclusions for any individual balancing authority based on these results should be avoided, and more scrutiny and analysis of local situations should be conducted prior to making policy or business decisions for any individual regions.

Balancing authorities vary widely in size across the United States, ranging from over 9 GW of average demand in PJM to less than 50 MW for the NERC-certified electric balancing authority of New Smyrna Beach, a surfers' hub in eastern Florida. There are also several generation-only BAs that serve no load, consisting of power plant owners who made the business decision to provide their own required reliability services rather than purchase them from and integrate into an available pre-existing balancing authority in their territory [49].

Some large balancing authorities in this analysis consist of several local systems, which may be a more suitable unit of analysis to compare with other small balancing authorities. For example, MISO is a balancing authority which has many "local balancing authorities" (LBAs), many of which are electric operating companies roughly comparable to balancing authorities outside of regional transmission organizations. However, electricity trade data are not available at the LBA level. Thus, additional analysis that dives deeper into local systems of interest is important to reflect the varying characteristics of balancing authorities across the industry.

## Considering Electricity Import Reliance and Diversity Jointly

*One pattern observed in the results from Appendix*

Table 2 is a correlation between a balancing authority's size and its diversity index.<sup>1</sup> Larger systems tend to have higher numbers of trading partners to import from, contributing to a larger diversity index. Furthermore (and perhaps relatedly) some large balancing authorities with higher diversity have low import reliance. Bonneville Power Administration, Salt River Project, Southwest Power Pool, and PJM are among the strongest examples of systems with high import diversity but minimal import reliance, though there are other examples as well. Across all U.S. balancing authorities, the correlation between import diversity and reliance is -0.42.

In cases like the above examples where import reliance is low, diversity may be of less concern to an electric company or policymaker from a reliability perspective because local supply dispatchable by the system operator serves a large share of demand. Conversely, diversity may be more important for systems with high levels of imports. An electricity system that relies heavily on imports could have a higher risk of a supply disruption if they rely on a less diverse set of imports concentrated amongst a smaller set of trading partners.

Consider Figure 3, which includes a scatterplot of import reliance versus import diversity for each US balancing authority. In this sample, among the balancing authorities with low import reliance there is wide variation in the corresponding diversity, categorized in blue. On average, diversity may be less important to the overall system for the BAs in the blue region relative to others. A diverse set of imports may be more important for systems with higher levels of import reliance (the green region). Conversely, a system highly reliant on a concentrated (less diverse) set of imports may be more susceptible to reliability issues (red region).

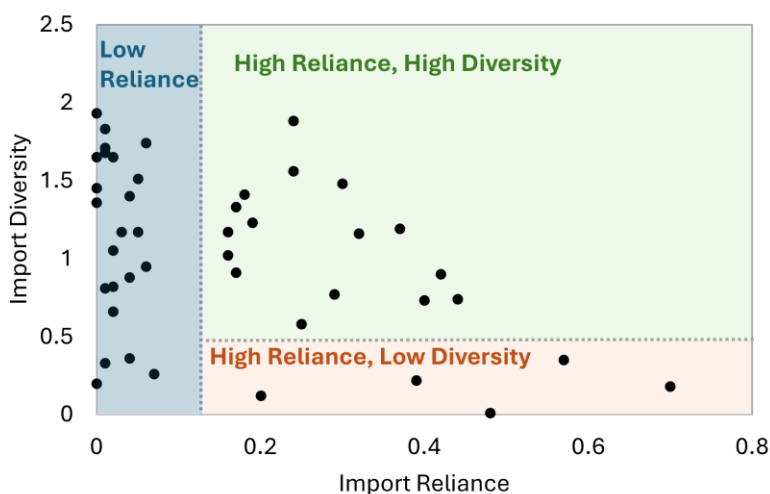


Figure 3 Scatter plot of U.S. balancing authority import reliance versus import diversity metrics, partitioned into three spaces.

Following the premise that import diversity is more important for electricity systems that rely more heavily on imports, a third metric is applied that rescales the balancing authority diversity score by its import reliance. The new joint import reliance-diversity metric for U.S. BAs is reported in Appendix Table 3, which is calculated by simply multiplying the import reliance value in Table 1 by

<sup>1</sup> The correlation coefficient between the import diversity metric and balancing authority average electricity demand across the sample period is 0.30.

import diversity in Table 2. The balancing authorities with the highest reliance-diversity metric values in Table 3 are those in the upper right frontier of the Figure 3 scatterplot. These are the balancing authorities that have high reliance on imports from a diverse set of trading partners, and include California ISO, Tucson Electric Power, PacifiCorp, and Duke.

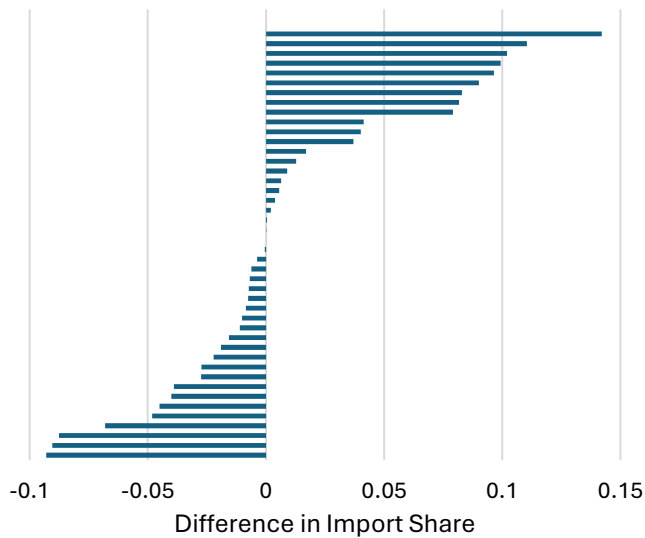
To summarize this analysis of electricity import metrics across the U.S., quantifying import reliance and diversity highlights key patterns that can inform understanding of a system's operating risks. Larger balancing authorities, with a wider range of trading partners, tend to have higher diversity scores, and those with high diversity often show lower reliance on imports, indicating strong local supply. However, the value of diversity varies across systems; for balancing authorities with high import reliance, a diverse set of import sources can be more important for maintaining reliability. While the metrics used in this analysis offer a useful means of comparative assessment across balancing authorities, they do not fully capture the complexities of system reliability. Specifically, they overlook the role of available imports during periods of extreme demand, especially when considering net demand after accounting for wind and solar variability.

## Electricity imports during stressful events

The import reliance and diversity metrics discussed in prior sections describe conditions across all operating periods. This section analyzes imports during periods of high net electricity demand when availability of imports alongside other resources becomes more important. Specifically, average import shares for U.S. balancing authorities during hours when net electricity demand is at or above the 95<sup>th</sup> percentile across are calculated and reported in the Appendix Table 4. Net demand is used to determine stressful periods because it represents the share of demand net of variable wind and solar generation to be served by imports and other dispatchable resources. High electricity demand is less of a reliability concern during a period of high variable renewable production. For these reasons, grid operators and planners operators often focus on net load, especially on systems with growing wind and solar penetrations [50].

The sample period used to calculate import shares during periods of high demand is smaller than the sample used in prior sections of this article, because hourly data on technology-level electric generation at the balancing authority level is available starting July 1, 2018. It is interesting to compare the difference between import shares during high net-demand periods with average import shares, which is done in Table 4 and plotted in Figure 4. This shows 21 balancing authorities with a positive difference (e.g. their import shares increase during high net demand periods), and 22 balancing authorities with a negative difference.





*Figure 4 Difference in average import share during high net load periods ( $\geq p95$ ) and average net load across US balancing authorities, 2018-2023*

Balancing authorities with larger import shares during high net demand periods were able to procure more imports when resources are most needed. The balancing authorities with the largest increases in import shares during high net demand periods include PacifiCorp, Associated Electric Coop., Idaho Power Company, Arizona Public Service Company, and Nevada Power Company. All these operators had increases in import shares of 10 percentage points or more during high net-demand periods. Conversely, balancing authorities with a decrease in average import shares during high net-demand periods are receiving less imports during periods when electricity supply is most needed. More local supply is required to maintain reliability in these areas during high demand periods to make up for the decrease in electricity imports. These findings highlight the importance of understanding import behavior during high net-demand periods to inform strategies for maintaining reliability across diverse grid conditions.

Do a case-study approach that looks at import performance etc during selected extreme events in certain BAs

- As the events of August 2020 in California and February 2021 in Texas demonstrate, supply shortfalls can have large economic and public health consequences (Wolak 2022)
- Winter storm Uri was studied relatively well in the scientific literature [51–53], but imports played a negligible role in that extreme event due to Texas' lack of interconnection with neighboring system.

- Given the increased uncertainty associated with availability of imports, system planners may discount or not consider their contributions to reliability in future plans. (now transitioning to that nice Larsen 2023 quote)
- A crucial question to address in this research is “how should planners consider availability of imports from a capacity adequacy perspective in long term plans ? Larsen 2023 says it should be decided by policymakers and not individual market participants:

*We conclude that policy makers can go into one of two directions. The first option is to ignore cross-border trading in their planning. While this would create security of supply for individual countries [balancing authorities], it would come at the cost of very significant investment subsidies. The alternative is to rely on cross-border trade, an option which requires not only close cooperation and coordination, but also significant trust between the jurisdictions and institutions involved, to ensure sufficient capacity. The choice between these options is a political decision, to be made at the national and supranational levels, not by regulators, and even less by market participants. (Larsen, 2023)*

## Appendix

Table 1 Import reliance (net imports divided by domestic consumption) for USA balancing authorities with annual average demand >500 MW.

Name	Total	2016	2017	2018	2019	2020	2021	2022	2023
Portland General Electric Company	0.70	0.71	0.75	0.67	0.73	0.75	0.71	0.75	0.65
Puget Sound Energy, Inc.	0.57	0.47	0.51	0.54	0.44	0.30	0.73	0.79	0.68
City of Tacoma, Department of Public Utilities, Light Division	0.48	0.36	0.38	0.51	0.67	0.45	0.46	0.45	0.58
El Paso Electric Company	0.44	0.55	0.52	0.39	0.36	0.42	0.44	0.46	0.36
Duke Energy Progress West	0.42	0.64	0.66	0.56	0.58	0.26	0.19	0.19	0.17
Avista Corporation	0.40	0.43	0.46	0.40	0.40	0.35	0.33	0.36	0.38
Seattle City Light	0.39	0.29	0.35	0.35	0.45	0.37	0.37	0.39	0.52
PacifiCorp West	0.37	0.14	0.13	0.22	0.36	0.40	0.39	0.61	0.75
South Carolina Public Service Authority	0.32	0.27	0.32	0.28	0.39	0.38	0.33	0.36	0.30
Tucson Electric Power	0.30	0.38	0.40	0.24	0.28	0.32	0.28	0.30	0.22
Idaho Power Company	0.29	0.32	0.22	0.23	0.22	0.27	0.34	0.40	0.27
Balancing Authority of Northern California	0.25	0.25	0.23	0.26	0.17	0.28	0.25	0.40	0.16
California Independent System Operator	0.24	0.28	0.26	0.28	0.25	0.27	0.25	0.22	0.14
Duke Energy Florida, Inc.	0.24	0.26	0.26	0.26	0.25	0.25	0.23	0.20	0.24
JEA	0.20	0.07	0.06	0.27	0.33	0.15	0.25	0.28	0.31
Los Angeles Department of Water and Power	0.19	0.17	0.15	0.16	0.15	0.17	0.19	0.25	0.27
Western Area Power Administration - Desert Southwest Region	0.18	0.24	0.34	0.30	0.16	0.10	0.08	0.13	0.11
ISO New England	0.17	0.16	0.16	0.17	0.19	0.20	0.16	0.14	0.14
Nevada Power Company	0.17	0.17	0.22	0.20	0.17	0.17	0.17	0.17	0.15
Arizona Public Service Company	0.16	0.00	0.00	0.00	0.00	0.24	0.37	0.34	0.40
New York Independent System Operator	0.16	0.16	0.18	0.17	0.16	0.14	0.18	0.19	0.16
Public Service Company of Colorado	0.07	0.12	0.11	0.07	0.07	0.08	0.05	0.04	0.00
Associated Electric Cooperative, Inc.	0.06	0.02	0.03	0.04	0.05	0.06	0.09	0.08	0.11
Midcontinent Independent System Operator, Inc.	0.06	0.07	0.08	0.06	0.08	0.09	0.06	0.05	0.06
PacifiCorp East	0.05	0.04	0.07	0.05	0.07	0.06	0.03	0.02	0.04
Public Service Company of New Mexico	0.05	0.02	0.01	0.09	0.08	0.05	0.04	0.05	0.06

[illegible]

Table 2 Import diversity (measured by Shannon Diversity Index) by USA balancing authorities with annual average demand >500 MW.

Name	Total	2016	2017	2018	2019	2020	2021	2022	2023
Bonneville Power Administration	1.93	1.64	1.71	1.68	1.86	1.72	1.86	1.92	2.11
California Independent System Operator	1.88	1.73	1.73	1.69	1.73	1.82	1.93	1.91	1.92
Salt River Project Agricultural Improvement and Power District	1.83	1.30	1.41	1.43	1.10	1.14	1.61	1.61	1.68
Midcontinent Independent System Operator, Inc.	1.74	1.88	1.83	1.84	1.79	1.62	1.61	1.67	1.39
Southwest Power Pool	1.71	1.54	1.77	1.87	1.61	0.83	1.47	1.62	1.58
NorthWestern Corporation	1.68	1.32	1.44	1.57	1.65	1.53	1.67	1.66	1.64
Duke Energy Carolinas	1.65	1.81	1.62	1.68	1.58	1.48	1.55	1.62	1.50
PJM Interconnection, LLC	1.65	1.62	1.48	0.85	0.91	1.30	1.38	1.54	1.35
Duke Energy Florida, Inc.	1.56	1.59	1.57	1.71	1.59	1.51	1.54	1.42	1.36
Public Service Company of New Mexico	1.51	0.95	1.25	1.49	1.42	1.38	1.36	1.50	1.62
Tucson Electric Power	1.48	1.33	1.32	1.33	1.50	1.46	1.45	1.48	1.59
Western Area Power Administration - Rocky Mountain Region	1.45	0.87	0.72	1.40	1.31	1.24	1.22	1.47	1.14
Western Area Power Administration - Desert Southwest Region	1.41	1.37	1.38	1.29	1.29	1.32	1.22	1.25	1.46
Louisville Gas and Electric Company and Kentucky Utilities Company	1.40	1.26	1.26	1.21	0.93	0.81	1.23	1.23	0.99
Southern Company Services, Inc. - Trans	1.36	1.55	1.25	1.27	1.34	1.38	1.23	1.29	1.26
Nevada Power Company	1.33	1.37	1.38	1.27	1.33	1.32	1.21	1.17	1.05
Los Angeles Department of Water and Power	1.23	1.22	1.17	1.19	1.21	1.07	1.20	1.25	1.35
PacifiCorp West	1.19	0.89	1.00	0.86	1.16	1.15	1.20	1.26	1.33
Duke Energy Progress East	1.17	1.08	1.00	1.01	1.17	1.10	1.16	1.18	1.09
New York Independent System Operator	1.17	1.15	1.23	1.16	1.10	1.11	1.16	1.17	0.96
PacifiCorp East	1.17	0.96	1.03	1.01	1.05	1.09	1.00	1.23	1.00
South Carolina Public Service Authority	1.16	1.19	1.19	1.15	1.18	1.20	1.17	1.09	1.03
Florida Power & Light Co.	1.05	1.18	1.16	0.87	0.89	0.90	0.95	1.07	1.00
Arizona Public Service Company	1.02	1.18	1.45	1.33	1.17	0.76	0.52	0.54	0.42
Associated Electric Cooperative, Inc.	0.95	0.89	0.76	0.89	0.81	0.90	1.01	0.88	1.04
ISO New England	0.91	0.98	0.87	0.93	0.94	0.92	0.86	0.79	0.89
Duke Energy Progress West	0.90	0.95	0.96	0.95	0.75	0.64	0.87	0.96	0.74
Florida Municipal Power Pool	0.88	0.93	0.92	0.79	0.93	0.91	0.85	0.80	0.76
Public Utility District No. 2 of Grant County, Washington	0.82	0.58	0.66	0.75	0.83	0.48	0.75	0.85	1.03

Tampa Electric Company	0.81	0.77	0.68	1.28	1.03	0.79	0.88	0.66	0.45
Idaho Power Company	0.77	0.82	0.84	0.87	0.64	1.02	0.56	0.76	0.56
El Paso Electric Company	0.74	0.76	0.74	0.64	0.62	0.48	0.68	0.79	0.62
Avista Corporation	0.73	0.60	0.56	0.62	0.71	0.57	0.83	0.81	0.99
Tennessee Valley Authority	0.66	0.62	0.78	0.75	0.71	0.65	0.60	0.47	0.59
Balancing Authority of Northern California	0.58	0.22	0.39	0.37	0.52	0.55	0.51	0.71	1.02
PowerSouth Energy Cooperative	0.36	0.25	0.21	0.16	0.31	0.54	0.41	0.00	0.00
Puget Sound Energy, Inc.	0.35	0.22	0.30	0.19	0.28	0.78	0.40	0.40	0.41
Dominion Energy South Carolina, Inc.	0.33	0.16	0.23	0.37	0.51	0.50	0.40	0.31	0.15
Public Service Company of Colorado	0.26	0.04	0.02	0.06	0.14	0.25	0.38	0.53	0.52
Seattle City Light	0.22	0.27	0.13	0.25	0.21	0.26	0.33	0.09	0.16
Electric Reliability Council of Texas, Inc.	0.20	0.05	0.06	0.09	0.15	0.32	0.26	0.23	0.16
Portland General Electric Company	0.18	0.30	0.28	0.31	0.19	0.08	0.09	0.06	0.00
JEA	0.12	0.04	0.06	0.04	0.06	0.05	0.18	0.19	0.18
City of Tacoma, Department of Public Utilities, Light Division	0.01	0.00	0.00	0.02	0.00	0.03	0.00	0.02	0.00

Table 3 Import reliance-diversity metric for U.S. BAs.

Name	Total	2016	2017	2018	2019	2020	2021	2022	2023
California Independent System Operator	0.45	0.48	0.45	0.47	0.43	0.49	0.48	0.42	0.27
Tucson Electric Power	0.44	0.51	0.53	0.32	0.42	0.47	0.41	0.44	0.35
PacifiCorp West	0.44	0.12	0.13	0.19	0.42	0.46	0.47	0.77	1.00
Duke Energy Progress West	0.38	0.61	0.63	0.53	0.44	0.17	0.17	0.18	0.13
Duke Energy Florida, Inc.	0.37	0.41	0.41	0.44	0.40	0.38	0.35	0.28	0.33
South Carolina Public Service Authority	0.37	0.32	0.38	0.32	0.46	0.46	0.39	0.39	0.31
El Paso Electric Company	0.33	0.42	0.38	0.25	0.22	0.20	0.30	0.36	0.22
Avista Corporation	0.29	0.26	0.26	0.25	0.28	0.20	0.27	0.29	0.38
Western Area Power Administration - Desert Southwest Region	0.25	0.33	0.47	0.39	0.21	0.13	0.10	0.16	0.16
Los Angeles Department of Water and Power	0.23	0.21	0.18	0.19	0.18	0.18	0.23	0.31	0.36
Nevada Power Company	0.23	0.23	0.30	0.25	0.23	0.22	0.21	0.20	0.16
Idaho Power Company	0.22	0.26	0.18	0.20	0.14	0.28	0.19	0.30	0.15
Puget Sound Energy, Inc.	0.20	0.10	0.15	0.10	0.12	0.23	0.29	0.32	0.28
New York Independent System Operator	0.19	0.18	0.22	0.20	0.18	0.16	0.21	0.22	0.15
Arizona Public Service Company	0.16	0.00	0.00	0.00	0.00	0.18	0.19	0.18	0.17
ISO New England	0.15	0.16	0.14	0.16	0.18	0.18	0.14	0.11	0.12
Balancing Authority of Northern California	0.15	0.06	0.09	0.10	0.09	0.15	0.13	0.28	0.16
Portland General Electric Company	0.13	0.21	0.21	0.21	0.14	0.06	0.06	0.05	0.00
Midcontinent Independent System Operator, Inc.	0.10	0.13	0.15	0.11	0.14	0.15	0.10	0.08	0.08
Seattle City Light	0.09	0.08	0.05	0.09	0.09	0.10	0.12	0.04	0.08
Public Service Company of New Mexico	0.08	0.02	0.01	0.13	0.11	0.07	0.05	0.08	0.10
PacifiCorp East	0.06	0.04	0.07	0.05	0.07	0.07	0.03	0.02	0.04
Associated Electric Cooperative, Inc.	0.06	0.02	0.02	0.04	0.04	0.05	0.09	0.07	0.11
Louisville Gas and Electric Company and Kentucky Utilities Company	0.06	0.00	0.00	0.00	0.03	0.05	0.09	0.11	0.12
Florida Municipal Power Pool	0.04	0.05	0.06	0.04	0.03	0.03	0.02	0.02	0.04
Duke Energy Progress East	0.04	0.02	0.02	0.03	0.04	0.03	0.06	0.05	0.03
Duke Energy Carolinas	0.03	0.04	0.03	0.02	0.02	0.01	0.02	0.03	0.03
JEA	0.02	0.00	0.00	0.01	0.02	0.01	0.05	0.05	0.06
Florida Power & Light Co.	0.02	0.06	0.05	0.01	0.01	0.00	0.00	0.00	0.00

[illegible]



Table 4 Import shares during high net load periods ( $\geq p95$ ) compared to import shares during all periods by US balancing authority, 2018-2023.

Name	Average Import Share with High Net Load	Average Import Share	Difference
PacifiCorp West	0.60	0.46	0.14
Associated Electric Cooperative, Inc.	0.18	0.07	0.11
Idaho Power Company	0.39	0.29	0.10
Arizona Public Service Company	0.33	0.23	0.10
Nevada Power Company	0.27	0.17	0.10
Tucson Electric Power	0.36	0.27	0.09
Avista Corporation	0.45	0.37	0.08
Public Service Company of New Mexico	0.14	0.06	0.08
Seattle City Light	0.49	0.41	0.08
Duke Energy Progress East	0.08	0.04	0.04
PacifiCorp East	0.09	0.05	0.04
Tennessee Valley Authority	0.06	0.02	0.04
Public Service Company of Colorado	0.07	0.05	0.02
Electric Reliability Council of Texas, Inc.	0.01	0.00	0.01
Florida Power & Light Co.	0.01	0.00	0.01
NorthWestern Corporation	0.02	0.01	0.01
El Paso Electric Company	0.41	0.4	0.01
Balancing Authority of Northern California	0.25	0.25	0.00
Bonneville Power Administration	0.00	0.00	0.00
Duke Energy Carolinas	0.01	0.01	0.00
Midcontinent Independent System Operator, Inc.	0.06	0.06	0.00
PJM Interconnection, LLC	0.00	0.00	0.00
Southern Company Services, Inc. - Trans	0.01	0.01	0.00
Salt River Project Agricultural Improvement and Power District	0.00	0.00	0.00
Southwest Power Pool	0.01	0.01	0.00
Tampa Electric Company	0.02	0.02	0.00
Western Area Power Administration - Rocky Mountain Region	0.00	0.00	0.00
Louisville Gas and Electric Company and Kentucky Utilities Company	0.05	0.06	-0.01

Dominion Energy South Carolina, Inc.	0.00	0.01	-0.01
Florida Municipal Power Pool	0.03	0.04	-0.01
Duke Energy Florida, Inc.	0.22	0.24	-0.02
Public Utility District No. 2 of Grant County, Washington	0.01	0.03	-0.02
Duke Energy Progress West	0.31	0.33	-0.02
Portland General Electric Company	0.69	0.71	-0.02
New York Independent System Operator	0.14	0.17	-0.03
JEA	0.24	0.27	-0.03
California Independent System Operator	0.19	0.23	-0.04
ISO New England	0.13	0.17	-0.04
Puget Sound Energy, Inc.	0.59	0.63	-0.04
PowerSouth Energy Cooperative	0.01	0.06	-0.05
South Carolina Public Service Authority	0.27	0.34	-0.07
Los Angeles Department of Water and Power	0.10	0.19	-0.09
Western Area Power Administration - Desert Southwest Region	0.06	0.15	-0.09
City of Tacoma, Department of Public Utilities, Light Division	0.43	0.52	-0.09

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