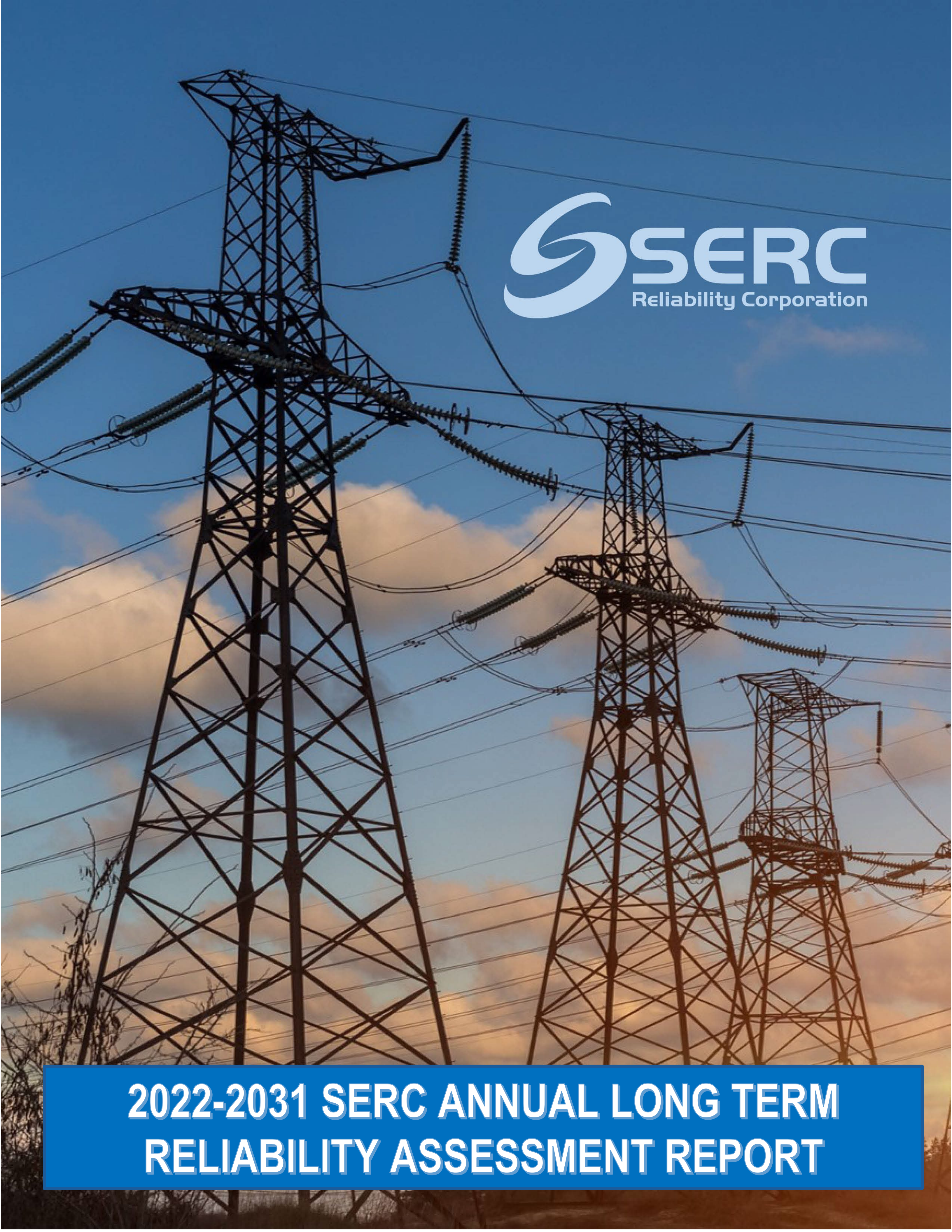


# 2022-2031 SERC ANNUAL LONG TERM RELIABILITY ASSESSMENT REPORT

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# 1. EXECUTIVE SUMMARY

## INTRODUCTION

SERC collaborates with its registered entity subject matter experts and conducts data gathering and analyses to perform an independent reliability assessment of the Bulk Power System (BPS) for the long-term planning horizon (ten years) within the SERC Region per the North American Electric Reliability Corporation's (NERC's) Rules of Procedure[1] and the SERC-NERC Delegation Agreement.[2] The assessment uses information from its internal data collection sources along with other external programs regarding the overall reliability, performance, and adequacy of the SERC Region.

## PURPOSE

This assessment provides an overview of the reliability of the SERC Region based on standard metrics of adequacy and engineering studies performed throughout the year. In addition, it identifies various trends related to electric generation, demand, and risks for the next ten-year period.

## DEVELOPMENT PROCESS

This report is based on data and narrative information collected by SERC from its registered entities to independently assess the long-term reliability of the SERC Region while identifying trends, emerging issues, and potential risks during the ten-year assessment period for SERC and the seven subregions within SERC: SERC Central, SERC East, SERC FL-Peninsula, SERC MISO-Central, SERC MISO-South, SERC PJM, and SERC Southeast. The SERC Reliability Review Subcommittee (RRS), at the direction of the SERC Engineering Committee (EC), supported the development of this assessment through a review process that leveraged the knowledge and experience of system planners, RRS members, SERC staff, and other subject matter experts. This review process ensures the accuracy and completeness of data and information used in this assessment.

[1] NERC ROP effective 20220825_with appendicies.pdf

[2] https://www.nerc.com/AboutNERC/RDAs/Fully%20Executed%20SERC_RDA_2021_FERC_Revisions(CLEAN).pdf

## DATA CONSIDERATIONS

The assessment period for the 2022 SERC Annual Long-Term Reliability Assessment Report is from 2022 to 2031. This report does not predict events or conditions during this period; rather it presents the expected demand levels, generating resources and transmission system additions, transmission adequacy, and the adequacy of the resources to meet the expected load demands. The information shared in this assessment report is based on forecasts SERC created using the data supplied by its registered entities. The collection of data began in the first quarter of 2022, with updates incorporated before publication. SERC developed this assessment using a consistent approach for projecting future resource adequacy through the application of SERC's assumptions and assessment methods.

SERC's standardized data reporting and instructions were developed through stakeholder processes to promote data consistency across all the reporting entities. SERC assembled and reviewed sources of data to assess the future reliability of the Region for resource adequacy and transmission system performance. SERC also closely coordinated with NERC in the development of the 2022 NERC Long Term Reliability Assessment (LTRA) report by preparing assessments specific to the SERC Region that help to inform the overall anticipated impact on the BPS reliability in North America for the upcoming 10 years. Some of the information contained in this report reflects further updates from SERC member entities since the release of the NERC report.

This report considers four focus areas for each of the seven subregions: demand, capacity resources, reserve margins, and transmission adequacy. This report uses studies and reports from SERC committees, Dynamics Working Group (DWG), Resource Adequacy Working Group (RAWG), Near-Term Working Group (NTWG), and Long-Term Working Group (LTWG) to assess transmission and resource adequacy impacts.

The future additions of generating resources considered in this report are classified as tier 1, tier 2, or tier 3. The generation projects that are under construction and have met planning requirements are tier 1. The generating resources that are in the early stages of interconnection request and have not met the approved planning requirements fall under tier 2 and tier 3. The definitions of the terms used throughout the document are provided in "Section 12: Data Concepts and Assumptions." The main body of this report provides additional detail to support the following key observations.

## KEY OBSERVATIONS FOR THE ASSESSMENT PERIOD: 2022-2031

1. One of the seven SERC subregions does not expect its anticipated generating reserves to meet the NERC recommended planning reserve margin during summer months.

The SERC MISO-Central subregion's Anticipated Reserve Margin for summer falls below the Reference Reserve Margin of 15% in 2023 and beyond. However, the subregion is within the footprint of the Midcontinent Independent System Operator (MISO) Regional Transmission Organization (RTO), and has access to additional firm deliverable resources, up to the MISO Regional Directional Transfer (RDT) Limit between the MISO areas.

2. SERC continues to see the growth of Inverter-Based Resources (IBRs) throughout the Region.

Utility-scale solar photovoltaic (PV) projects totaling approximately 37 GW of nameplate capacity are expected within the SERC footprint in the next 10 years. The rapid increase of IBRs brings associated challenges as they are integrated into the system, such as primary frequency response, ramping capability, voltage control, etc. SERC provides a platform for its entities to discuss the risks of increased renewable resources within the SERC footprint and help identify mitigations. The SERC Variable Energy Resource Working Group (VERWG) explores the reliability considerations related to variable energy resource integration in the SERC Region.

3. SERC projects accelerated coal retirement in the future. Both conventional and renewable capacity additions are expected to offset the coal-fired capacity retirements.

The SERC Region will continue to see the retirement of coal resources in the next 10 years. Approximately 8 GW (11%) of the coal generation fleet in SERC is projected to be retired by 2031. Nuclear, natural gas and solar PV generation are expected to grow to support the resource requirement.

4. Throughout the SERC Region, registered entities report plans to build transmission, especially in the first five years of the assessment period, to ensure a reliable interconnected power system.

Entities within the SERC Region anticipate adding a significant amount of transmission lines - more than 2,500 miles - during the 10-year reporting period. As of August 2022, there are approximately 118,000 miles of existing transmission lines at 100 kV and above in the SERC Region. New transmission facilities are being added to support generation interconnections, resolve transmission constraints, and support areas of load growth.

5. Expected demand projections are almost flat for the SERC Region.

The SERC Region's load is expected to grow at a rate of 0.64% on average per year for the next 10 years (2022-2031), which is slightly higher than the 0.50% 10-year projection (2021-2030) reported last year. The SERC PJM and SERC Central subregions are projecting the highest and the lowest load growth at 2.17% and 0.26%, respectively.

## CONCLUSION

The electric grid has changed over the past few decades, but the transformation of the grid is accelerating with the push for de-carbonization of energy resources supported by Federal and State policies. Challenges from grid transformation, extreme weather, and physical and cyber security of the BPS introduce risks that the industry is currently facing and working to mitigate. This publication provides projections for the next 10 years (2022-2031) and assesses electric reliability for SERC Region on demand, capacity resources, reserve margins, and transmission adequacy.

The resource mix on the grid is transitioning from coal to natural gas and IBRs like solar, wind, and battery storage. As the retirement of coal-fired generation continues in the SERC Region and the IBRs continue to increase, the system planning and operations cannot limit resource adequacy focus to the peak load hour due to the variability of the renewable resources. There is a need to place an emphasis on evaluating energy availability to serve the load every hour of the day. As we learn the new operational characteristics of IBRs, we find that the opportunities to integrate these resources bring challenges to providing essential services, such as frequency response, ramping capability, and voltage control, which are currently provided by conventional generation.

The SERC Region expects a significant near-term increase in renewables, natural gas, and nuclear resources. While the increase in renewable generation reported by SERC member entities is modest, SERC views this as the tip of the iceberg. Other data sources, such as the Energy Information Administration (EIA) point to a steeper increase in renewable resources. With many states in the SERC Region adopting clean energy targets and federal energy policies promoting clean energy development, more resource changes are likely during the assessment period and beyond.

The SERC Region is prone to extreme weather throughout the year, which stresses the system and disrupts the electric supply to consumers. Natural gas provides more than 50% of the generation for the SERC Region. Extreme weather can disrupt the gas fuel supply and increase the risk to the reliability of the system.

The electric demand in the SERC Region is reported to be relatively flat due to several factors, including the growth of rooftop solar that masks the residential load on the system, energy efficiency programs, and the netting of distributed energy resources (DERs) generation with the system loads. Planned changes to encourage the electrification of transportation and de-carbonization of energy sources going forward are drivers of both load growth and increases in renewable generation connected to the distribution system.

The planning reserve margins with current assumptions in the SERC Region are sufficient over the 10 years, with the notable exception of the SERC MISO-Central subregion during the summer months. While generation retirements have taken place over the past few years, and renewable generating resource additions are planned, the SERC MISO subregions will rely upon resources in the other areas of MISO and imports from other areas outside of MISO to meet the load. Considering the variability of renewable resources, the increases in solar and wind penetration on the system coupled with the retirement of more dispatchable generation will necessitate reevaluation of the current NERC 15% reference reserve margin requirements.

SERC conducted a long-term transmission planning study with a focus on transmission system readiness for the 2027 summer peak season for normal load conditions. A heavy power transfer scenario from PJM to MISO areas was also completed. No thermal or voltage constraints were identified in the 2027 summer peak study for normal conditions. For the heavy power transfer scenario in the 2027 summer peak season, a few areas of SERC identified potential thermal overloads that can be mitigated with operating guides or other mitigation strategies such as re-dispatch options and future projects. The conclusions are based upon a specific set of assumptions and conditions, including potential risks. Extreme weather events such as prolonged colder or hotter than normal temperatures, wetter winters or drier summers will need to be assessed on a seasonal basis. SERC recommends communication and coordination activities between Reliability Coordinators (RCs) and/or Balancing Authorities (BAs) as an essential measure to maintaining reliability during extreme weather conditions, largely unplanned power transfer scenarios, or other risks to the BPS.

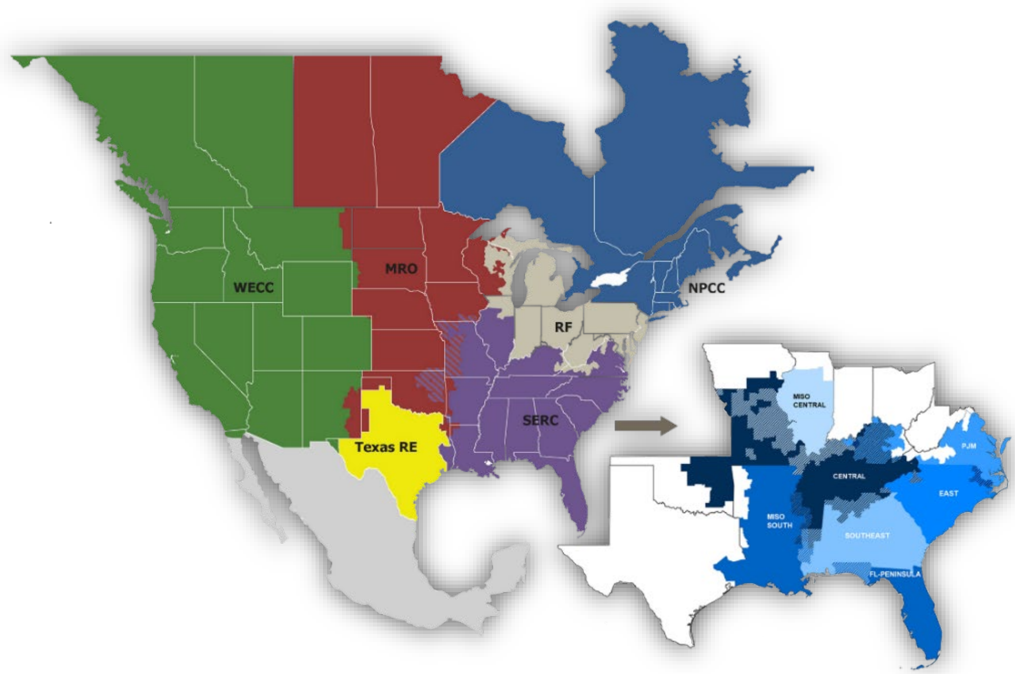
The SERC Region looks forward to the emerging challenges in the industry. SERC continues to work with its stakeholders to address reliability and security concerns of the Region and develop solutions to identified risks through collaboration with its technical committees and working groups.

## 2. PREFACE

SERC Reliability Corporation (SERC) is a nonprofit regulatory authority with a mission to assure effective and efficient reduction of risks to the reliability and security of the BPS. To achieve this mission, SERC maintains a diverse team of experts across numerous disciplines to address the complex, evolving, and dynamic challenges facing the grid. Our team also partners with the best and brightest individuals from both the power industry and the federal government to understand and address the challenges facing the grid. These key partnerships make our work more informed, pragmatic, responsive, and impactful.

SERC is one of six regional entities across North America responsible for this important work under the Federal Energy Regulatory Commission (FERC) approved delegation agreements with the North American Electric Reliability Corporation (NERC). SERC is specifically responsible for the reliability and security of the electric grid across the southeastern and central regions of the United States. The SERC Region covers approximately 630,000 square miles and serves a population of more than 91 million. It includes all or portions of 16 states: Florida, Georgia, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Arkansas, Missouri, Iowa, Illinois, Kentucky, Tennessee, Virginia, North Carolina, and South Carolina. Geographically, the SERC Region is divided into seven subregions. These subregions are SERC Central, SERC East, SERC FL-Peninsula, SERC MISO-Central, SERC MISO-South, SERC PJM, and SERC Southeast. More information about the SERC Region and SERC Reliability Assessments is available on the SERC website.[3]

**FIGURE 1: NERC AND SERC REGION**

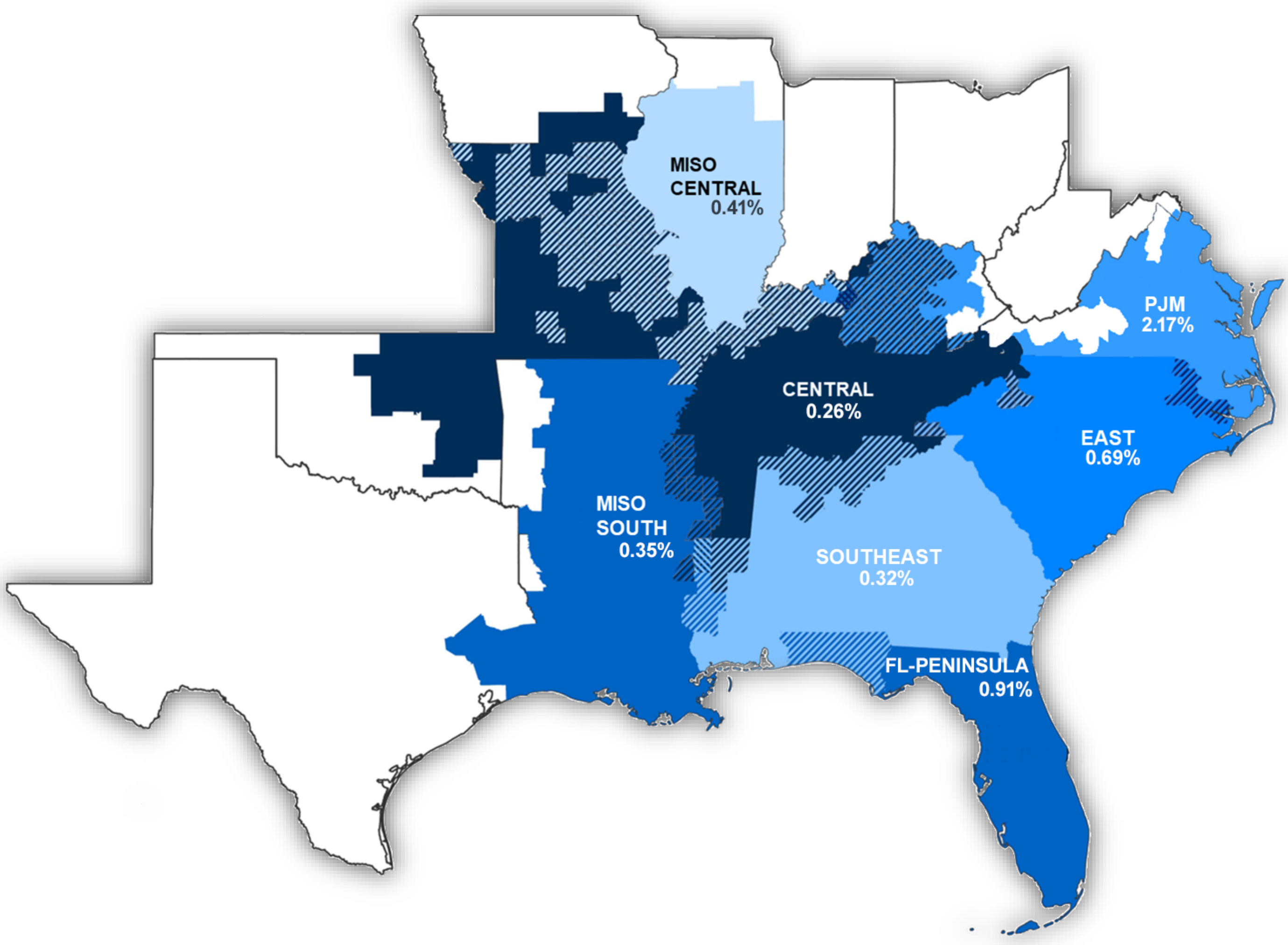



[3] https://www.serc1.org/program-areas/reliability-assessments/reliability-assessments

## 3. DEMAND PROJECTIONS

SERC is historically a summer peaking Region. However, we are seeing some transition in forecasted load demand to peak during the winter months in a few subregions. It is anticipated that this trend will continue. Some contributing factors include the adoption of the electrification of transportation, which is still in the early stages in the SERC Region, and the transition to electric residential heating, which also increases electric demand in the winter months. The 2022-2031 10-year forecast shows a 0.64% annual growth rate in total load demand. Figure 2 breaks down the forecasted annual load growth in each of the 7 SERC subregions.

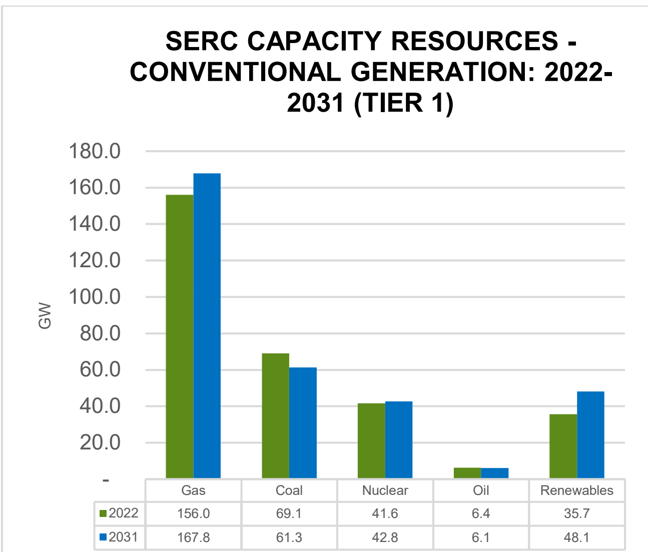
### FIGURE 2: SERC ANNUAL LOAD GROWTH BY SUBREGION

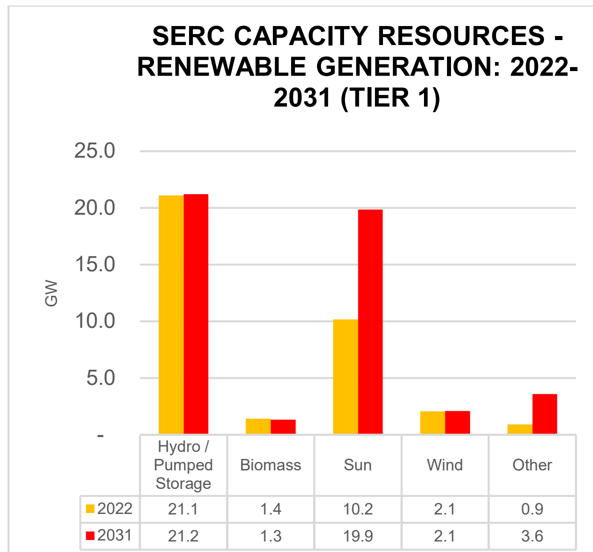


# 4. CAPACITY RESOURCE BY FUEL TYPES

In general, generation projects that are under construction and have met planning requirements are classified as tier 1. Future generating resources that are in the early stages of interconnection requests and have not met the approved planning requirements fall under tier 2 and tier 3. Considering only the tier 1 future capacity additions, the total internal capacity for the SERC Region grows from 308.8 GW in 2022 to 326.0 GW in 2031. Figure 3 breaks down the capacity resource mix in 2022 and 2031 by fuel types for conventional and renewable generation. The renewable resources shown in Figure 3 include hydroelectric generation, including pumped storage, solar, wind, biomass, and other fuel types such as compressed air, battery energy storage, etc.

**FIGURE 3: CAPACITY RESOURCE BY FUEL TYPES – CONVENTIONAL & RENEWABLES**




Natural gas is the primary fuel source in the SERC Region in 2022. It is projected to increase from 156 GW to 167.8 GW over the next 10 years. Natural gas will continue to provide more than 50% of the generation in the SERC footprint.

For the next 10 years, 2022-2031, coal-fired capacity is projected to decrease from 22% to 19% of the total resource mix. SERC members in SERC East, SERC FL-Peninsula, and SERC MISO-Central subregions have announced approximately 2,722 MW of large-scale coal-fired capacity retirements in the next 5 years.

Nuclear resources supply 13% of the SERC capacity in 2022. SERC Southeast is adding 2,200 MW of nuclear generation between 2022 and 2023. Overall, the contribution of nuclear to the overall fuel mixture remains steady through the end of the assessment period.

Hydroelectric generation (with and without pumped storage) capacity resources are projected to remain unchanged through the forecast period at approximately 7% of the Regional total.

Existing solar PV capacity resources in the SERC Region are reported at 10,185 MW, which is roughly 3% of the overall resource mix. Planned additions to tier 1 solar generation (around 8,795 MW) are projected through 2026. By 2031, solar generation in the SERC Region will account for 6% of the overall resource mix.

Biomass, wind, and other resources, such as compressed air and battery energy storage systems, are small in the SERC Region, and do not contribute significantly to the capacity totals or resource mix (approximately 2% combined).

The additions of natural gas-fired generation and variable energy generation is anticipated to offset planned coal-fired capacity retirements. Overall, the capacity resource projections will increase over the planning horizon. The total internal capacity in the planning horizon for SERC will increase and is projected to reach 375,832 MW in 2031, which includes tier 1, 2, and 3 generation additions.

# 5. RESERVE MARGIN PROJECTIONS

The reserve margins for all SERC subregions are above the NERC Reference Level of 15% over the next 10 years except for the SERC MISO-Central subregion for summer months as shown in Table 1.

The Reference Margin Levels allow SERC to assess the level of planning reserves, recognizing factors of uncertainty involved in long-term planning (e.g., forced generator outages, extreme weather impacts on demand, fuel availability, and intermittency of variable generation). Trends such as retirements of conventional generating capacity, the variability of IBR generation and available capacity, the adoption of electric vehicles, and conversion to electric heating could result in declining Anticipated Reserve Margin levels going forward. It is also important to note that SERC MISO-Central and SERC MISO-South subregions are parts of one MISO BA with access to reserves in both subregions up to the RDT limit. PJM calculates its Reserve Margin for the entire PJM footprint. Therefore, there is no calculated reserve margin for the SERC subregion of PJM. Rather, the reserve margin shown in Table 1 is for the entire PJM footprint.

## TABLE 1: CALCULATED RESERVE MARGINS BY SUBREGION

| | SERC Central | | SERC East | | SERC FL-Peninsula | | SERC MISO Central | | SERC MISO South | | SERC PJM | | SERC Southeast | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter |
| 2022 | 17% | 24% | 20% | 21% | 22% | 37% | 15% | 39% | 29% | 44% | 31% | 46% | 35% | 36% |
| 2023 | 20% | 22% | 20% | 21% | 26% | 36% | 7% | 33% | 31% | 48% | 37% | 48% | 41% | 39% |
| 2024 | 21% | 26% | 19% | 21% | 27% | 36% | 6% | 31% | 31% | 43% | 40% | 49% | 49% | 44% |
| 2025 | 20% | 24% | 19% | 22% | 28% | 34% | 6% | 31% | 30% | 43% | 39% | 46% | 49% | 44% |
| 2026 | 20% | 24% | 19% | 22% | 27% | 33% | 6% | 30% | 29% | 43% | 39% | 46% | 50% | 43% |
| 2027 | 18% | 23% | 19% | 24% | 24% | 27% | 6% | 30% | 29% | 42% | 39% | 45% | 49% | 43% |
| 2028 | 22% | 27% | 19% | 26% | 21% | 27% | 6% | 30% | 29% | 42% | 38% | 44% | 49% | 42% |
| 2029 | 21% | 26% | 23% | 27% | 21% | 27% | 6% | 29% | 28% | 41% | 38% | 44% | 48% | 41% |
| 2030 | 20% | 25% | 23% | 24% | 21% | 27% | 5% | 29% | 28% | 40% | 37% | 43% | 47% | 40% |
| 2031 | 20% | 25% | 23% | 23% | 20% | 28% | 4% | 27% | 27% | 40% | 37% | 42% | 46% | 39% |

# 6. PROBABILISTIC ASSESSMENT OF RESOURCE ADEQUACY

The SERC 2020 Probabilistic Assessment calculated the resource adequacy metrics of loss of load hours (LOLH), loss of load expectation (LOLE), loss of load frequency (LOLF), and expected unserved energy (EUE) for the years 2022 and 2024. The Planning Reserve Margin, which is the level of installed reserves required to maintain an assessment area at a daily LOLE of 0.1 days/year, was also determined for each of the SERC subregions. Sensitivities were performed for the year 2024 which include scenarios with reduced planning margins and increased planned maintenance rates and their impacts were also determined for each of the subregions. The published SERC 2020 Probabilistic Assessment report is available on SERC's website.[4] Some of the key findings are as follows:

1. The “base-case” system for 2022 and 2024 showed that each of the SERC subregions has reserves and the availability of assistance from neighboring subregions more than needed to meet the 0.1 days/year daily LOLE level.

2. The Planning Reserve Margins were determined by removing or adding capacity with no planned or forced outage to each SERC subregion until the daily LOLE for each, on an interconnected basis, was approximately 0.1 days/year. Another set of Planning Reserve Margins was determined by isolating each SERC subregion without allowing capacity transfers between subregions.
   i. When reserve margins for an isolated subregion are reduced to 2/3 of the initial value for the year 2024 the system showed loss of load for SERC East and SERC Southeast and minor loss of load for SERC FL-Peninsula subregions. With only 1/3 of the reserve margin, SERC FL-Peninsula, SERC Southeast, SERC East, SERC Central and SERC MISO-South observed significant loss of load.
   ii. With the reserve margins reduced across the entire SERC footprint, the 2024 metrics worsened when compared to the “individual” cases, although they were within the same order of magnitude. The 2/3 reserve margin cases showed loss of load events in SERC East, SERC Southeast and SERC Central subregions. The reduction of reserve margin to 1/3 of the original value increased the frequency of events dramatically in all of the SERC subregions except for SERC PJM.

3. In performing the Increased Maintenance Rate sensitivity for the year 2024, increasing planned outage rates were applied for units, by factors of 1.5, 2, and 2.5, effectively increasing the duration of planned maintenance. More maintenance was scheduled simultaneously in shoulder months, i.e., when loads are typically lower; also “spilling” into months with higher loads, i.e., in the summer and winter.

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[4] https://www.serc1.org/docs/default-source/committee/resource-adequacy-working-group/2020-serc-probabilistic-assessment-report-redacted.pdf?sfvrsn=58904e0c_2

i. The base case with increased maintenance outages observed rapid increase in the loss of load metrics for the SERC East and SERC FL-Peninsula subregions.

ii. As the maintenance outages increased with higher rates, all SERC subregions experienced an exponential increase of LOLE and other metrics.

   a. SERC MISO-South and SERC FL-Peninsula subregions showed a larger-than-average increase in LOLE.

   b. SERC MISO-South observed a rapid increase of LOLE during the summer, whereas the loss of load events in SERC-FL-Peninsula happen in the winter.

   c. SERC PJM, however, observed a smaller increase in LOLE, probably due to the proximity to other PJM areas, which did not experience the increase in maintenance rates.

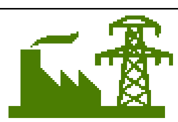
The 2022 winter storm Elliot and the 2021 winter storm Uri impacted parts of the SERC footprint. SERC is currently concluding the 2022 Probabilistic Assessment for resource adequacy for 2024 and 2026 study years. It includes a severe cold weather sensitivity scenario. In performing this study, SERC has considered reduced unit reliability scenarios and non-weather-normal conditions to stress test the system and assess factors contributing to risk. The results from the study and a copy of the assessment will be available from NERC later this year. The study report will be finalized and posted on SERC website early April.

# 7. CAPACITY RESOURCE AND DEMAND RISKS

Throughout the next ten-year planning horizon, the new generation will be added to the SERC Region through area interconnection planning processes. During this time, many traditional baseload generation fuel types will continue to decline as older generators retire. Table 2 breaks down the current state and discusses the potential reliability issues for the SERC footprint impacted by the capacity resource mix and demand projections during the ten-year assessment period.

### TABLE 2: CAPACITY RESOURCE AND DEMAND RISKS

| TOPIC | CURRENT STATE | POTENTIAL RELIABILITY ISSUES AND CONSIDERATIONS |
|---|---|---|
| Demand | All SERC subregions have reported relatively flat 10-year compound annual growth rates for an overall SERC-wide growth rate below 1%. | SERC foresees no potential reliability issues relating to demand at projected levels. However, when the growing load values are netted with the generation capacity in forecast models, it masks local demand growth and impacts the planning reserve assessments significantly. This is especially true for variable generation and capacity resources such as solar, wind, and energy storage systems. |
| Demand Response | Demand Response involves customers reducing electricity consumption temporarily in response to economic or reliability signals. | The growth of Demand Response programs presents a solution to the reliability issues due to the rapid growth of IBRs. Hours of high demand relative to energy supply may warrant a reduction of energy usage in areas where ramping is a concern. |
| Natural Gas | Natural gas for electricity generation is the primary fuel source used in the SERC Region, and additions to natural gas generation are planned for the next 10 years. The SERC Region expects 15.3 GW of all tier projects, of which more than 11.7 GW are tier 1, by 2031. | Fuel delivery for gas units is a concern in the unlikely event that a gas pipeline is lost. The existence of utility-sized natural gas storage and dual-fuel capability for natural gas units may alleviate some concerns in subregions where those exist. With the growth of natural gas generation in the future, further analysis of the impact of natural gas supply and transportation will be needed. |

| TOPIC | CURRENT STATE | POTENTIAL RELIABILITY ISSUES AND CONSIDERATIONS |
|---|---|---|
|  **Solar PV** | Solar generation is expected to continue to increase through the end of the assessment period. The SERC Region expects nearly 37 GW of all tier projects, of which nearly 10 GW are tier 1, by 2031. These projections include only those solar generation facilities that are considered part of the BES. If we were to consider those below the current BES threshold, the numbers of current and planned solar generation would be even greater. | IBRs, including solar generation, are inherently different from conventional generation. Planning processes, models, interconnection studies, protection and control systems, and operating processes will need to be considered to ensure reliability going forward. The provision of essential reliability services such as contingency reserves, voltage regulation, frequency response, dynamic response, and ability to respond to variability in generator output will have to be considered. |
|  **Battery Energy Storage Systems (BESS)** | SERC currently does not have a considerable amount of BESS within the Region. However, the SERC Region expects more than 12 GW of all tier projects, of which nearly 4 GW are tier 1, by 2031. | As the SERC Region continues to see BESS in interconnection queues, planning processes, models, interconnection studies, protection and control systems, and operating processes will need to be considered to ensure reliability going forward. The provision of essential reliability services such as contingency reserves, voltage regulation, frequency response, dynamic response, and ability to respond to variability in generator output, as well as operating strategies for utilizing the BESS will have to be considered. |
|  **Conventional Generation** | The use of coal- and oil-fired generation is declining by 12 GW through the end of the assessment period. Hydroelectric generation with and without pumped storage is staying constant, and nuclear generation is increasing slightly, with two nuclear units planned in SERC Southeast during the years 2022 and 2023. | With higher penetrations of variable supply and less predictable demand, there is a need to have more system ramping capability to maintain load-and-supply balance in real-time operation. Even with the growth in natural gas resources, a projected 3.5% reduction of conventional generating resources can be expected in the SERC Region in the next 10 years. With ensuing retirements, significant delays in the in-service dates for new projects could cause capacity shortfalls. As conventional generation represents a smaller percentage of generation within each subregion, additional analysis will be needed to understand the overall characteristics of the generation in the Region, and how essential reliability services will be planned for and provided in real-time. |

| TOPIC | CURRENT STATE | POTENTIAL RELIABILITY ISSUES AND CONSIDERATIONS |
|---|---|---|
| **Load demand for winter vs. summer vs. dual peaking areas** | SERC has traditionally been a summer peaking Region. However, several SERC subregions have reported winter peak demand projections for the next ten years that exceed summer peak demands. A few of the subregions show nearly equal peak demand in both the summer and winter months. | Electrification and projections for growth in electric vehicles over the ten-year horizon are a component of the demand and energy estimates provided by each subregion. Growth rate increases in winter peak demand are being influenced by electric winter heating systems. Summer peak demand growth rates are lower compared to winter; growth in DERs and some energy efficiencies are contributing to lower summer demand growth. More reliability analyses are needed to focus on the impacts specific to each SERC subregion. |

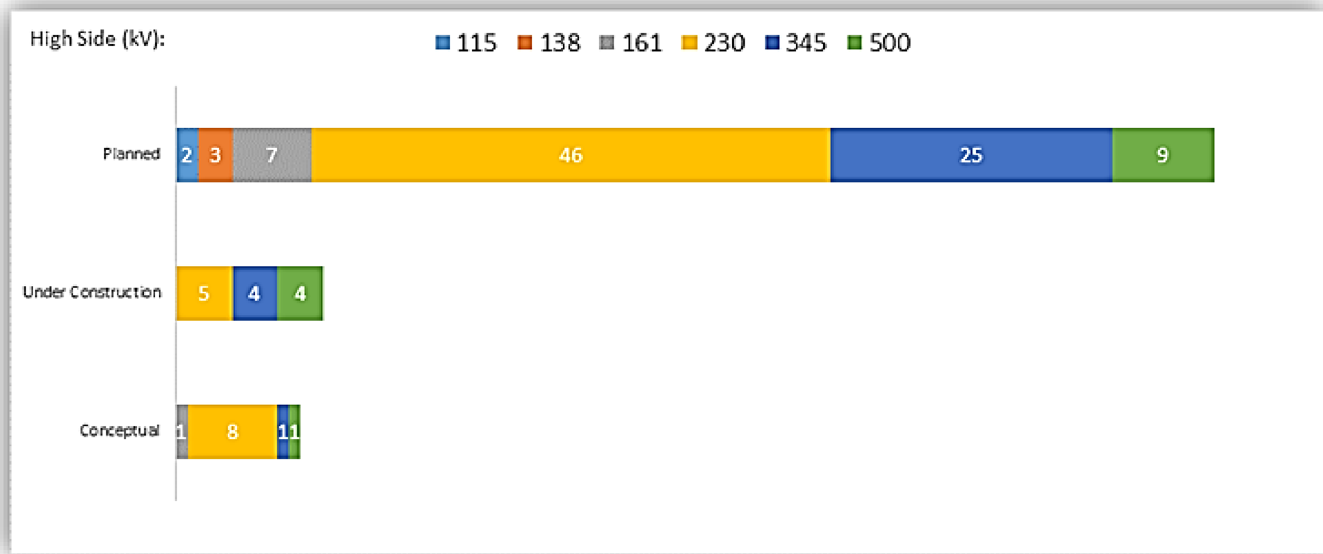
## 8. TRANSMISSION ADDITIONS AND PROJECTS

As of August 2022, there are approximately 118,000 miles of transmission lines operated at 100 kV and above in the SERC Region. Registered entities within the SERC Region anticipate adding approximately 2,500 miles during the 10-year reporting period. SERC entities coordinate transmission expansion plans in the Region annually through joint model-building efforts that include the plans of all SERC Transmission Planners (TPs) and Planning Coordinators (PCs). The coordination of transmission expansion plans with entities outside the Region is achieved through annual participation in joint modeling efforts with the Eastern Interconnection Reliability Assessment Group (ERAG) Multi-regional Modeling Working Group (MMWG). Transmission expansion plans by most SERC entities are dependent on regulatory support at the federal, state, and local levels since regulatory approval can influence the siting, permitting, and cost recovery of new transmission facilities.

### FIGURE 4: BES TRANSMISSION MILEAGE BY OPERATING VOLTAGE CLASS


Projects to maintain or improve transfer capabilities between the Regions or subregions are not necessarily obvious in planned transmission additions. Tie lines themselves infrequently limit transfers between areas. Rather, the limiting elements are often internal to the entities' systems. Projects to improve transfer capabilities can include reconductoring transmission lines, replacing transformers, and upgrading terminal equipment. In addition to transmission lines, several new transmission transformers are planned to come into service during the next 10 years within the SERC Region. Of the 116 transformer projects, 59 have high-side voltages of 200 kV and above.

## FIGURE 5: TRANSFORMER ADDITIONS




NERC Registered Entities in the SERC Region are committed to planning for a reliable delivery system. Transmission upgrades and the installation of new facilities will be necessary to enhance the reliability of the transmission system, improve both intraregional and interregional transfer capabilities, relieve congestion, and ensure generation deliverability. SERC will continue to assess transmission adequacy in the SERC Region and will monitor the implications to current and future reliability.

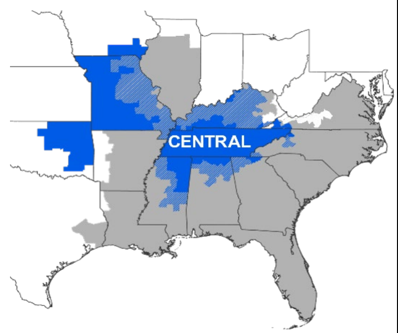
# 9. SUBREGIONAL DASHBOARDS AND HIGHLIGHTS

Sections 8A through 8G in the following pages break down the long-term reliability assessment for each subregion using dashboards and highlights.

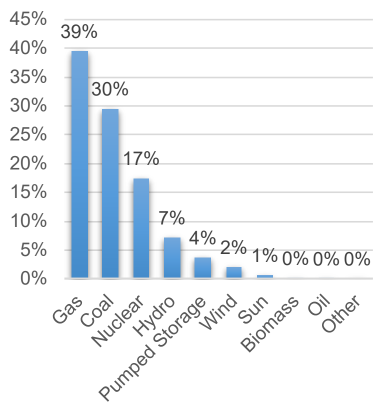
Each dashboard includes the subregion's location within the SERC footprint shown in a map, total internal demand, demand response, net internal demand, anticipated resource, and prospective resource in MW, followed by its anticipated and prospective reserve margins in percentage for the years 2022-2031. The existing on-peak summer generation for each subregion is broken down into both MW and percentage of total generation. The dashboards also include a graphical representation of the respective subregion's summer vs. winter total internal demand in MW as well as its net internal demand vs. anticipated capacity in GW for the 10-year planning horizon. The definitions of the terms used throughout the dashboards can be found in Section 12: Data Concepts and Assumptions.

Following each dashboard is a summary that provides more details about the geographic location and lists the names of member entities within each subregion. Additionally, it incorporates and highlights the subregion's load demand and growth, reserve margin, resource, and transmission adequacy.

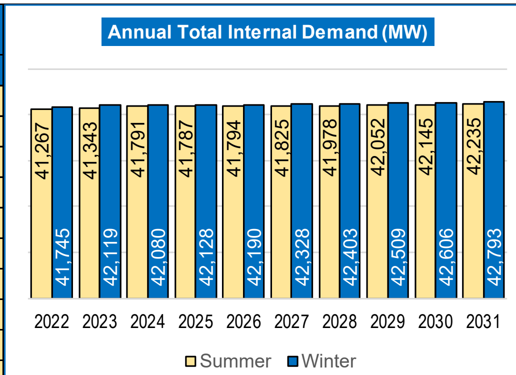
# A. SERC CENTRAL SUBREGION

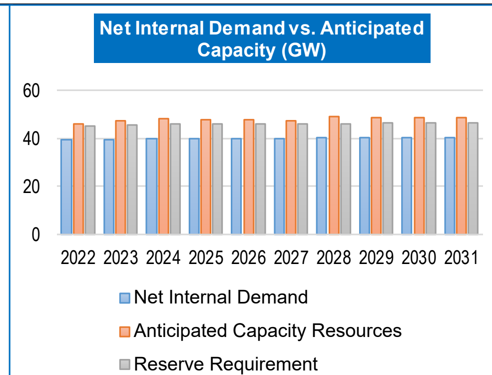



| Year | Total Internal Demand (MW) Summer | Total Internal Demand (MW) Winter | Demand Response (MW) Summer | Demand Response (MW) Winter | Net Internal Demand (MW) Summer | Net Internal Demand (MW) Winter | Anticipated Resource (MW) Summer | Anticipated Resource (MW) Winter | Prospective Resource (MW) Summer | Prospective Resource (MW) Winter | Anticipated Reserve Margin Summer | Anticipated Reserve Margin Winter | Prospective Reserve Margin Summer | Prospective Reserve Margin Winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2022 | 41,267 | 41,745 | 1,841 | 1,671 | 39,426 | 40,074 | 45,956 | 49,684 | 45,956 | 49,684 | 17% | 24% | 17% | 24% |
| 2023 | 41,343 | 42,119 | 1,786 | 1,638 | 39,557 | 40,481 | 47,417 | 49,472 | 47,507 | 49,492 | 20% | 22% | 20% | 22% |
| 2024 | 41,791 | 42,080 | 1,751 | 1,643 | 40,040 | 40,437 | 48,286 | 50,924 | 48,530 | 50,944 | 21% | 26% | 21% | 26% |
| 2025 | 41,787 | 42,128 | 1,754 | 1,648 | 40,033 | 40,480 | 47,882 | 50,286 | 48,126 | 50,306 | 20% | 24% | 20% | 24% |
| 2026 | 41,794 | 42,190 | 1,758 | 1,654 | 40,036 | 40,536 | 47,882 | 50,286 | 48,126 | 50,306 | 20% | 24% | 20% | 24% |
| 2027 | 41,825 | 42,328 | 1,762 | 1,654 | 40,063 | 40,674 | 47,473 | 49,973 | 47,717 | 49,993 | 18% | 23% | 19% | 23% |
| 2028 | 41,978 | 42,403 | 1,761 | 1,654 | 40,217 | 40,749 | 48,955 | 51,610 | 49,199 | 51,630 | 22% | 27% | 22% | 27% |
| 2029 | 42,052 | 42,509 | 1,759 | 1,654 | 40,293 | 40,855 | 48,673 | 51,392 | 48,917 | 51,412 | 21% | 26% | 21% | 26% |
| 2030 | 42,145 | 42,606 | 1,758 | 1,654 | 40,387 | 40,952 | 48,643 | 51,352 | 48,887 | 51,372 | 20% | 25% | 21% | 25% |
| 2031 | 42,235 | 42,793 | 1,757 | 1,654 | 40,478 | 41,139 | 48,643 | 51,352 | 48,887 | 51,372 | 20% | 25% | 21% | 25% |




| Existing On-Peak Generation (Summer) | | |
|---|---|---|
| Type | MW | Percent |
| Gas | 18,715 | 39.5% |
| Coal | 14,002 | 29.5% |
| Nuclear | 8,282 | 17.5% |
| Hydro | 3,381 | 7.1% |
| Pumped Storage | 1,735 | 3.7% |
| Wind | 958 | 2.0% |
| Sun | 287 | 0.6% |
| Biomass | 44 | 0.1% |
| Oil | 20 | 0.0% |
| Other | - | 0.0% |




## LOCATION - SERC CENTRAL

The SERC Central subregion includes all or parts of Alabama, Georgia, Iowa, Kentucky, Mississippi, Missouri, North Carolina, Oklahoma, Tennessee, and Virginia.

## MEMBER ENTITIES - SERC CENTRAL

The Planning Coordinators in this subregion include Associated Electric Cooperative Inc., Louisville Gas & Electric/Kentucky Utilities, and Tennessee Valley Authority. Other SERC members include Brookfield/Smoky Mountain, Memphis Light, Gas and Water Division, Nashville Electric Service, and Owensboro Municipal Utilities.

## LOAD DEMAND AND GROWTH - SERC CENTRAL

The SERC Central subregion is winter peaking. The total internal demand for the SERC Central subregion is expected to grow annually at the rate of 0.26% over the 10-year planning horizon.

## RESERVE MARGIN - SERC CENTRAL

The Anticipated Reserve Margins for the SERC Central subregion will remain above the Reference Reserve Margin of 15% for the next 10 years.

## RESOURCE ADEQUACY - SERC CENTRAL

Natural gas makes up about 39% of the total generation, followed by coal (30%), and nuclear (17%). Renewable resources such as hydroelectric, pumped storage, wind, and solar round up the remaining 14% of the generating resources.

The SERC Central subregion expects to add approximately 6,600 MW of mostly natural gas resources over the 10-year planning horizon. The subregion is also planning to retire approximately 4,200 MW of coal generation during this time.

The 2020 SERC Probabilistic Assessment did not observe resource adequacy issues in the subregion for the study years 2022 and 2024. The sensitivity analysis showed that the loss of load metrics would increase due to increasing levels of outages which can be triggered by extreme weather events.

Currently, the SERC Central subregion does not have many IBRs. Entities continue to work with the local distribution power companies to account for the magnitude and characteristics of DERs, such as distribution-connected solar generation. Generally, smaller (< 5 MW) DERs that are behind the wholesale meter are accounted for as offsetting load in the load forecast. Larger (>5 MW) DERs that are not behind the wholesale meter are represented explicitly in the transmission system models as generating resources. For those larger DERs, the models also include their dynamic characteristics.

Upwards of 10,000 MW (nameplate) of solar resource additions are expected to be in service in the next 15 years. To accommodate this growth in the variable generation, entities are completing projects on coal and gas resources to improve ramping capabilities, extending the life of their peaking resources, adding new highly flexible combustion turbines (CTs), and constructing battery storage projects.

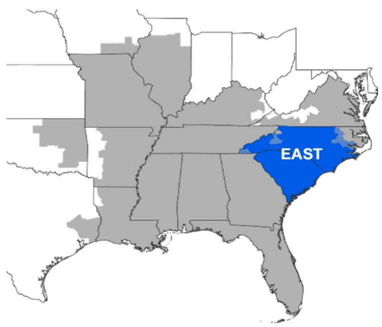
## TRANSMISSION ADEQUACY - SERC CENTRAL

SERC conducted a planning study with a focus on the future projection of load, generation, and transmission system readiness for the 2027 summer peak season along with a heavy power transfer scenario from PJM to MISO areas. No thermal or voltage constraints were observed in the 2027 summer peak season study for this subregion.

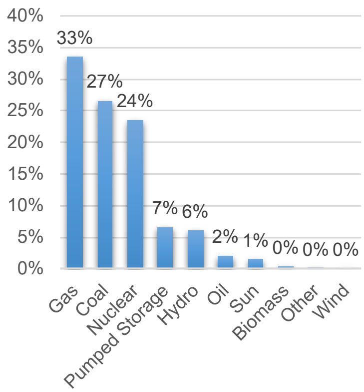
The heavy power transfer scenario resulted in transmission constraints in the SERC Central subregion. Based on the study findings it was recommended that requests for large interregional transfers between BAs must be planned, analyzed, and coordinated on a regular basis. Existing operational guides, emergency operating procedures, and Transmission Loading Relief (TLR) process will be necessary to promote reliability in the SERC Central subregion during a similar extreme weather scenario.

More than 200 miles of new transmission lines in the SERC Central subregion are being designed or constructed. These transmission additions are projected to enhance system reliability, support the interconnection of new generators, and meet the growing load demand. Other transmission projects include adding new extra-high voltage transformers, upgrading existing transmission lines, and other system reconfigurations/additions to support transmission system reliability.

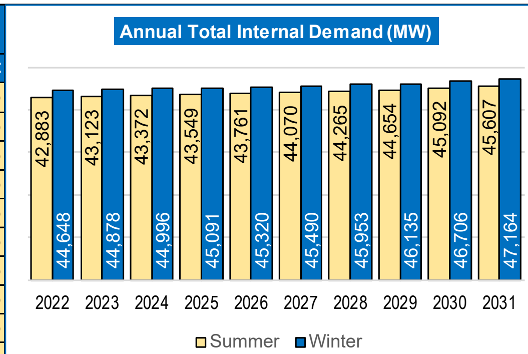
# B. SERC EAST SUBREGION

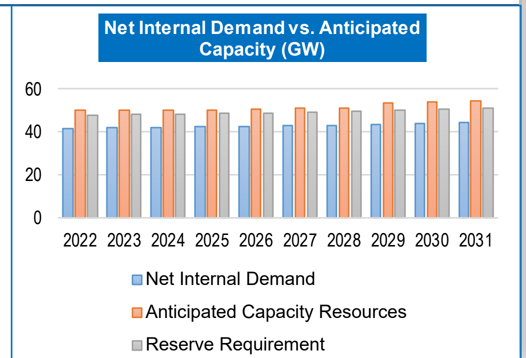



| Year | Total Internal Demand (MW) Summer | Total Internal Demand (MW) Winter | Demand Response (MW) Summer | Demand Response (MW) Winter | Net Internal Demand (MW) Summer | Net Internal Demand (MW) Winter | Anticipated Resource (MW) Summer | Anticipated Resource (MW) Winter | Prospective Resource (MW) Summer | Prospective Resource (MW) Winter | Anticipated Reserve Margin Summer | Anticipated Reserve Margin Winter | Prospective Reserve Margin Summer | Prospective Reserve Margin Winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2022 | 42,883 | 44,648 | 1,298 | 1,180 | 41,585 | 43,468 | 49,980 | 52,761 | 49,980 | 52,761 | 20% | 21% | 20% | 21% |
| 2023 | 43,123 | 44,878 | 1,284 | 1,130 | 41,839 | 43,748 | 50,250 | 53,031 | 50,250 | 53,031 | 20% | 21% | 20% | 21% |
| 2024 | 43,372 | 44,996 | 1,256 | 1,131 | 42,116 | 43,865 | 50,061 | 53,244 | 50,061 | 53,244 | 19% | 21% | 19% | 21% |
| 2025 | 43,549 | 45,091 | 1,262 | 1,136 | 42,287 | 43,955 | 50,264 | 53,534 | 50,264 | 53,534 | 19% | 22% | 19% | 22% |
| 2026 | 43,761 | 45,320 | 1,269 | 1,141 | 42,492 | 44,179 | 50,683 | 53,991 | 50,683 | 53,991 | 19% | 22% | 19% | 22% |
| 2027 | 44,070 | 45,490 | 1,272 | 1,142 | 42,798 | 44,348 | 50,926 | 55,130 | 50,926 | 55,130 | 19% | 24% | 19% | 24% |
| 2028 | 44,265 | 45,953 | 1,273 | 1,143 | 42,992 | 44,810 | 51,053 | 56,574 | 51,053 | 56,574 | 19% | 26% | 19% | 26% |
| 2029 | 44,654 | 46,135 | 1,274 | 1,144 | 43,380 | 44,991 | 53,461 | 57,031 | 53,461 | 57,031 | 23% | 27% | 23% | 27% |
| 2030 | 45,092 | 46,706 | 1,275 | 1,145 | 43,817 | 45,561 | 53,880 | 56,696 | 53,880 | 56,696 | 23% | 24% | 23% | 24% |
| 2031 | 45,607 | 47,164 | 1,276 | 1,146 | 44,331 | 46,018 | 54,318 | 56,716 | 54,318 | 56,716 | 23% | 23% | 23% | 23% |




| Existing On-Peak Generation (Summer) | | |
|---|---|---|
| Type | MW | Percent |
| Gas | 16,726 | 33.5% |
| Coal | 13,274 | 26.6% |
| Nuclear | 11,744 | 23.5% |
| Pumped Storage | 3,284 | 6.6% |
| Hydro | 3,005 | 6.0% |
| Oil | 1,034 | 2.1% |
| Sun | 718 | 1.4% |
| Biomass | 158 | 0.3% |
| Other | 11 | 0.0% |
| Wind | - | 0.0% |




## LOCATION - SERC EAST

The SERC East subregion includes the states of North Carolina and South Carolina.

## MEMBER ENTITIES - SERC EAST

The Planning Coordinators in this subregion include Cube Hydro Carolinas, Duke Energy Carolinas, Duke Energy Progress, Dominion Energy South Carolina, and South Carolina Public Service Authority. Other SERC members include Cube Hydro Carolinas-Yadkin Division and Southeastern Power Administration.

## LOAD DEMAND AND GROWTH - SERC EAST

The SERC East subregion is winter peaking. The total internal demand for the SERC East subregion is expected to grow annually at the rate of 0.69% over the 10-year planning horizon.

## RESERVE MARGIN - SERC EAST

The Anticipated Reserve Margins for the SERC East subregion will remain above the Reference Reserve Margin of 15% for the next 10 years.

## RESOURCE ADEQUACY - SERC EAST

Natural gas makes up about 33% as the largest generation fuel type in the SERC East subregion, followed by coal (27%), and nuclear (24%). Oil and renewable resources such as hydro, pumped storage, and solar round up the remaining 16% of the generating resources.

SERC East expects to add approximately 5,800 MW of mostly natural gas resources over the 10-year planning horizon. The subregion is also planning to retire approximately 1,600 MW of coal, 700 MW of nuclear, and 30 MW of oil generation.

The 2020 SERC Probabilistic Assessment observed adequate resources for the study years 2022 and 2024. The sensitivity analysis showed that the loss of load metrics would increase for a reduction in reserves of 1/3 as observed during winter storm Elliott in 2022 or due to increasing levels of planned outages.

The solar generation interconnection queue shows future generation additions are very likely across the subregion. The SERC East subregion does not anticipate any periods of increased resource adequacy risk that fall outside the expected peak demand hour. Ramping needs are increasing with the addition of solar generation but are within the ability of the system to balance.

The entities within the SERC East subregion continue to monitor the increases in DERs, and incorporate these changes in their system model for studies and assess their impacts. Unlike solar resources connected at transmission voltages, which are modeled as generating resources, DERs (i.e., rooftop solar) are typically smaller resources, connected at distribution voltages or sub-transmission voltages, and are netted against load in the energy management system and transmission planning models. The entities within the SERC East subregion continue to plan for these changes in resources and load through balancing reserves, and essential reliability services in the operations planning and real-time operating horizons to mitigate potential operational impacts in the near term.

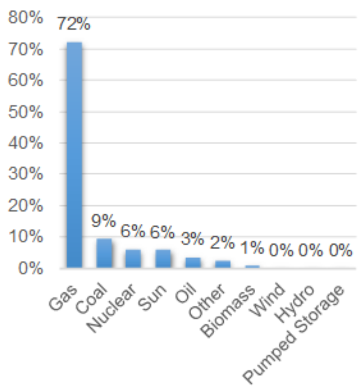
## TRANSMISSION ADEQUACY - SERC EAST

SERC conducted a planning study with a focus on the future projection of load, generation, and transmission system readiness for the 2027 summer peak season along with a heavy power transfer scenario from PJM to MISO areas. No thermal or voltage constraints were observed in the 2027 summer peak study or the heavy power transfer scenario for this subregion.

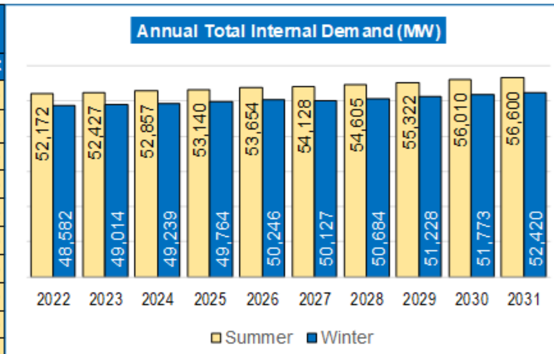
Nearly 250 miles of new transmission lines in the SERC East assessment area are in the phases of design and construction. They are projected to enhance system reliability, support the interconnection of new generators, and meet the growing load demand. Other projects include adding new extra-high voltage transformers, upgrades to existing transmission lines, and other system reconfigurations/additions to support transmission system reliability.

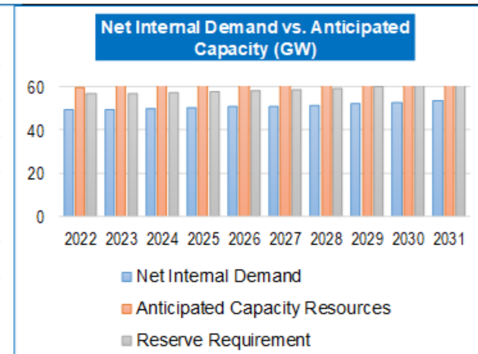
## C. SERC FL-PENINSULA SUBREGION


| Year | Total Internal Demand (MW) Summer | Total Internal Demand (MW) Winter | Demand Response (MW) Summer | Demand Response (MW) Winter | Net Internal Demand (MW) Summer | Net Internal Demand (MW) Winter | Anticipated Resource (MW) Summer | Anticipated Resource (MW) Winter | Prospective Resource (MW) Summer | Prospective Resource (MW) Winter | Anticipated Reserve Margin Summer | Anticipated Reserve Margin Winter | Prospective Reserve Margin Summer | Prospective Reserve Margin Winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2022 | 52,172 | 48,582 | 2,932 | 2,870 | 49,240 | 45,712 | 59,837 | 62,521 | 59,837 | 62,521 | 22% | 37% | 22% | 37% |
| 2023 | 52,427 | 49,014 | 2,949 | 2,892 | 49,478 | 46,122 | 62,383 | 62,556 | 62,383 | 62,556 | 26% | 36% | 26% | 36% |
| 2024 | 52,857 | 49,239 | 2,965 | 2,913 | 49,892 | 46,326 | 63,244 | 62,859 | 63,244 | 62,859 | 27% | 36% | 27% | 36% |
| 2025 | 53,140 | 49,764 | 2,990 | 2,950 | 50,150 | 46,814 | 64,237 | 62,720 | 64,237 | 62,720 | 28% | 34% | 28% | 34% |
| 2026 | 53,654 | 50,246 | 3,024 | 2,989 | 50,630 | 47,257 | 64,231 | 62,630 | 64,231 | 62,630 | 27% | 33% | 27% | 33% |
| 2027 | 54,128 | 50,127 | 3,064 | 3,035 | 51,064 | 47,092 | 63,356 | 59,822 | 63,356 | 59,822 | 24% | 27% | 24% | 27% |
| 2028 | 54,605 | 50,684 | 3,107 | 3,083 | 51,498 | 47,601 | 62,296 | 60,227 | 62,296 | 60,227 | 21% | 27% | 21% | 27% |
| 2029 | 55,322 | 51,228 | 3,154 | 3,134 | 52,168 | 48,094 | 63,215 | 61,230 | 63,215 | 61,230 | 21% | 27% | 21% | 27% |
| 2030 | 56,010 | 51,773 | 3,197 | 3,148 | 52,813 | 48,625 | 63,686 | 61,883 | 63,686 | 61,883 | 21% | 27% | 21% | 27% |
| 2031 | 56,600 | 52,420 | 3,205 | 3,159 | 53,395 | 49,261 | 64,341 | 62,990 | 64,341 | 62,990 | 20% | 28% | 20% | 28% |




| Existing On-Peak Generation (Summer) | | |
|---|---|---|
| Type | MW | Percent |
| Gas | 43,057 | 72.3% |
| Coal | 5,579 | 9.4% |
| Nuclear | 3,502 | 5.9% |
| Sun | 3,461 | 5.8% |
| Oil | 2,015 | 3.4% |
| Other | 1435.1 | 2.4% |
| Biomass | 491 | 0.8% |
| Wind | 0 | 0.0% |
| Hydro | 0 | 0.0% |
| Pumped Storage | 0 | 0.0% |




## LOCATION - SERC FL-PENINSULA

The SERC Florida Peninsula (FL Peninsula) subregion includes almost the entire state of Florida.

## MEMBER ENTITIES - SERC FL-PENINSULA

The Planning Coordinators in this subregion include Duke Energy Florida, Florida Municipal Power Agency, Florida Power & Light Company, Florida Reliability Coordinating Council, Gainesville Regional Utilities, City of Homestead, JEA, Lakeland Electric, Orlando Utilities Commission, Seminole Electric Cooperative, City of Tallahassee, and Tampa Electric Company. Other SERC members include the City of Homestead, the City of Tallahassee, Gainesville Regional Utilities, Jacksonville Electric Authority, and Lakeland Electric.

## LOAD DEMAND AND GROWTH - SERC FL-PENINSULA

SERC FL-Peninsula subregion is summer peaking. The total internal demand for the SERC FL-Peninsula subregion is expected to grow annually at the rate of 0.91% over the 10-year planning horizon.

## RESERVE MARGIN - SERC FL-PENINSULA

The Anticipated Reserve Margins for the SERC FL-Peninsula subregion will remain above the Reference Reserve Margin of 15% for the next 10 years.

## RESOURCE ADEQUACY - SERC FL-PENINSULA

Natural gas makes up about 72% as the greatest generation fuel type, followed by coal (9%), and nuclear (6%). Solar, oil, biomass, and battery energy systems make up the remaining 13% of the capacity resources. Due to heavy reliance on natural gas resources, fuel delivery could be an issue in this subregion in the unlikely event of gas pipeline disruption(s) in this subregion. The most severe disruptions can reduce or eliminate the flow of natural gas through a section of pipeline for several months, thereby reducing available generating capacity.

The SERC FL-Peninsula is planning to retire more than 850 MW of coal, and 300 MW of oil generation in the next 10 years. The subregion expects to add more than 3,700 MW of tier 1 solar generation and 2,400 MW of tier 1 battery energy storage facilities during the 10-year planning horizon. Additionally, the interconnection queue continues to see large numbers of IBR projects requesting interconnection.

The 2020 SERC Probabilistic Assessment observed adequate resources for the study years 2022 and 2024. The sensitivity analysis showed that the loss of load metrics would increase for a reduction in reserves of 1/3 or due to increasing levels of outages which can be triggered by extreme weather events.

Controllable Demand Response from interruptible and dispatchable load management programs within the FL-Peninsula subregion is treated as a load modifier and is projected to be around 6% of the summer and winter total peak demands for all years of the assessment period.

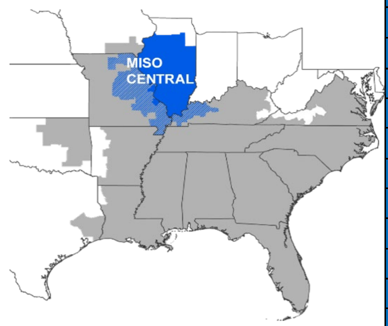
Currently, the SERC FL-Peninsula subregion has low levels of DERs; however, distributed resources are expected to grow in this subregion throughout the planning horizon. The entities within the SERC FL-Peninsula subregion work through the Florida Reliability Coordinating Council (FRCC) standing committees and subcommittees to monitor the projected growth jointly within the subregion. Entities within the SERC FL-Peninsula subregion model DERs output netted with the associated loads.

## TRANSMISSION ADEQUACY - SERC FL-PENINSULA

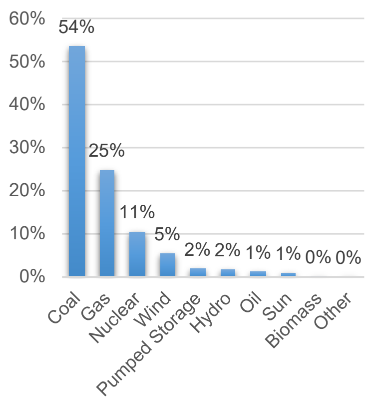
SERC conducted a planning study with a focus on the future projection of load, generation, and transmission system readiness for the 2027 summer peak season along with a heavy power transfer scenario from PJM to MISO areas. No thermal or voltage constraints were observed in the 2027 summer peak study or the heavy power transfer scenario for this subregion.

SERC assessment found that the existing transmission system in the subregion may not be able to serve its 90/10 load projection in future years. More than 230 miles of new transmission lines are in the design and construction phases which are projected to enhance system reliability, support the interconnection of new generator resources, and meet the growing load demand. Other projects include upgrading existing transmission lines and other system reconfigurations/additions to support transmission system reliability.

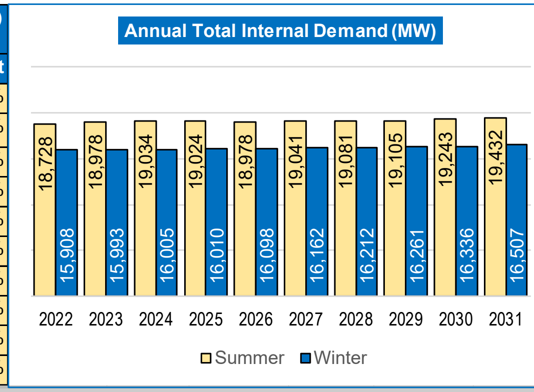
# D. SERC MISO-CENTRAL SUBREGION

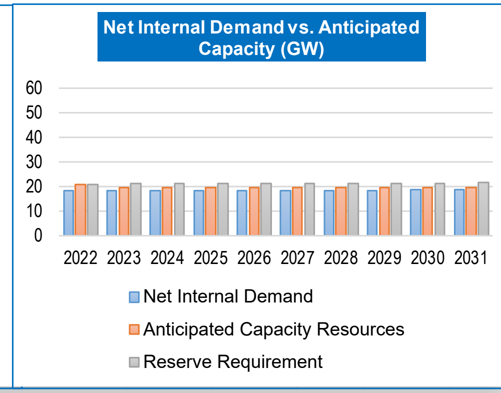



| | Total Internal Demand (MW) | | Demand Response (MW) | | Net Internal Demand (MW) | | Anticipated Resource (MW) | | Prospective Resource (MW) | | Anticipated Reserve Margin | | Prospective Reserve Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter |
| 2022 | 18,728 | 15,908 | 769 | 325 | 17,959 | 15,583 | 20,710 | 21,717 | 20,710 | 21,717 | 15% | 39% | 15% | 39% |
| 2023 | 18,978 | 15,993 | 818 | 727 | 18,160 | 15,266 | 19,374 | 20,377 | 19,374 | 20,377 | 7% | 33% | 7% | 33% |
| 2024 | 19,034 | 16,005 | 738 | 483 | 18,296 | 15,522 | 19,424 | 20,377 | 19,424 | 20,377 | 6% | 31% | 6% | 31% |
| 2025 | 19,024 | 16,010 | 738 | 483 | 18,286 | 15,527 | 19,424 | 20,377 | 19,424 | 20,377 | 6% | 31% | 6% | 31% |
| 2026 | 18,978 | 16,098 | 738 | 483 | 18,240 | 15,615 | 19,424 | 20,377 | 19,424 | 20,377 | 6% | 30% | 6% | 30% |
| 2027 | 19,041 | 16,162 | 738 | 483 | 18,303 | 15,679 | 19,424 | 20,377 | 19,424 | 20,377 | 6% | 30% | 6% | 30% |
| 2028 | 19,081 | 16,212 | 738 | 483 | 18,343 | 15,729 | 19,424 | 20,377 | 19,424 | 20,377 | 6% | 30% | 6% | 30% |
| 2029 | 19,105 | 16,261 | 738 | 483 | 18,367 | 15,778 | 19,424 | 20,377 | 19,424 | 20,377 | 6% | 29% | 6% | 29% |
| 2030 | 19,243 | 16,336 | 738 | 483 | 18,505 | 15,853 | 19,424 | 20,377 | 19,424 | 20,377 | 5% | 29% | 5% | 29% |
| 2031 | 19,432 | 16,507 | 738 | 483 | 18,694 | 16,024 | 19,424 | 20,377 | 19,424 | 20,377 | 4% | 27% | 4% | 27% |




| Existing On-Peak Generation (Summer) | | |
|---|---|---|
| Type | MW | Percent |
| Coal | 11,411 | 53.6% |
| Gas | 5,282 | 24.8% |
| Nuclear | 2,244 | 10.6% |
| Wind | 1,152 | 5.4% |
| Pumped Storage | 393 | 1.8% |
| Hydro | 359 | 1.7% |
| Oil | 229 | 1.1% |
| Sun | 198 | 0.9% |
| Biomass | 3 | 0.0% |
| Other | - | 0.0% |




## LOCATION – SERC MISO-CENTRAL

The SERC MISO-Central subregion includes all or parts of the states of Iowa, Kentucky, Missouri, and Illinois.

## MEMBER ENTITIES – SERC MISO-CENTRAL

The Midcontinent Independent System Operator, Inc. is the Planning Coordinator for this subregion. Other SERC members include Ameren Illinois, Ameren Missouri, Big Rivers Electric Corporation, City of Columbia, MO Water and Light Department, City Water Light and Power of Springfield, IL, GridLiance Heartland, Henderson Municipal, Prairie Power Inc., Southern Illinois Power Cooperative, and Wabash Valley Power Association, Inc.

## LOAD DEMAND AND GROWTH – SERC MISO-CENTRAL

The SERC MISO-Central subregion is summer peaking. The total internal demand for the SERC MISO-Central subregion is expected to grow annually at the rate of 0.41% over the 10-year planning horizon.

## RESERVE MARGIN – SERC MISO-CENTRAL

To evaluate the resources, transmission adequacy, and anticipated reserves for the SERC MISO-Central subregion, SERC only considers the areas of the SERC MISO-Central subregion, which lies within the BA area of MISO. The Anticipated Reserve Margins for the SERC MISO-Central subregion fall short of the Reference Reserve Margin of 15% in the summer months for the next 10 years. However, the areas within SERC MISO-Central subregion have access to additional firm deliverable resources within the MISO BA footprint and up to the RDT limit between MISO-Central and MISO-South.

## RESOURCE ADEQUACY - SERC MISO-CENTRAL

Coal makes up about 54% of the primary fuel type in the SERC MISO-Central subregion, followed by natural gas (25%), and nuclear (11%). Wind, hydro, pumped storage, oil, and solar round up the remaining 10% of the capacity resources.

Reported demand-side management response in the SERC MISO-Central subregion is roughly 4% of the total internal demand through the forecast period.

The SERC MISO-Central subregion is planning to retire more than 1,100 MW of coal generation. On the other hand, the MISO Generation Interconnection (GI) queue indicates a significant amount of IBR additions in the SERC MISO-Central subregion. Depending on the completion of these projects, the subregion could see anywhere between 1.5 GW and 7.3 GW of additional IBRs in the next 5 years. The approval of MISO's Long Range Transmission Plan (LRTP) Tranche 1 will enable more transfer capability across the MISO footprint and more generation to come online through the GI queue.

The 2020 SERC Probabilistic Assessment observed less than 15% planning reserve margins in the subregion for the study years 2022 and 2024. The sensitivity analysis showed that the loss of load metrics would increase for a reduction in reserves of 2/3 or due to increasing levels of outages which can be triggered by extreme weather events.

MISO is moving to a seasonal capacity market starting next year, Planning Year (PY) 2023-24, which will shed further light on seasonality and resource adequacy in non-peak times.

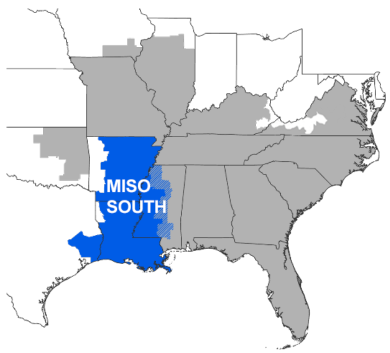
At this time, no significant solar PV developments have been connected to either the transmission or distribution systems in the SERC MISO-Central subregion. Connections of large DERs in the subregion have been limited to wind farms. Interest in DERs is continuing but to date, DERs have not caused a substantial change to the net internal demand in the subregion. Both transmission and distribution planning engineers in many areas of the subregion are experiencing increased interest from customers regarding the possible connection of solar PV and IBRs.

## TRANSMISSION ADEQUACY - SERC MISO-CENTRAL

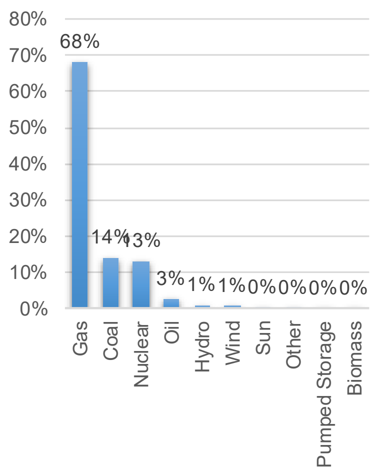
SERC conducted a planning study with a focus on the future projection of load, generation, and transmission system readiness for the 2027 summer peak season along with a heavy power transfer scenario from PJM to MISO areas. No thermal or voltage constraints were observed in the 2027 summer peak study or the heavy power transfer scenario for this subregion.

More than 1,400 miles of new transmission lines in the SERC MISO-Central subregion are in the design and construction phases. Most of the new transmission lines will be constructed in the first 5 years. These lines are projected to enhance system reliability, provide additional capacity, and enhance local area voltages. Other projects include adding new extra-high voltage transformers, existing transmission line updates, and other system reconfigurations/additions to support transmission system reliability. MISO’s LRTP Tranche 1 contains additional transmission lines in the SERC MISO-Central region. These transmission lines will help interconnect and upgrade the connections throughout MISO’s footprint. The expected in-service dates for these lines vary from 2028 to 2030.

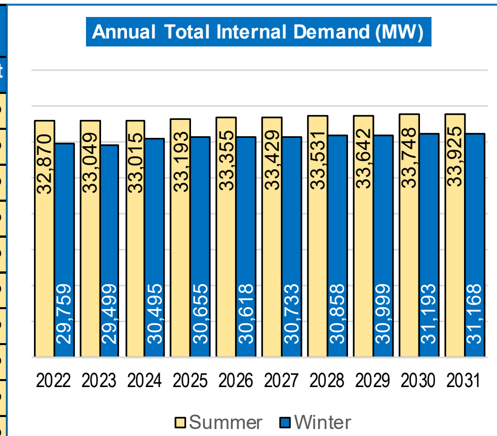
# E. SERC MISO-SOUTH SUBREGION

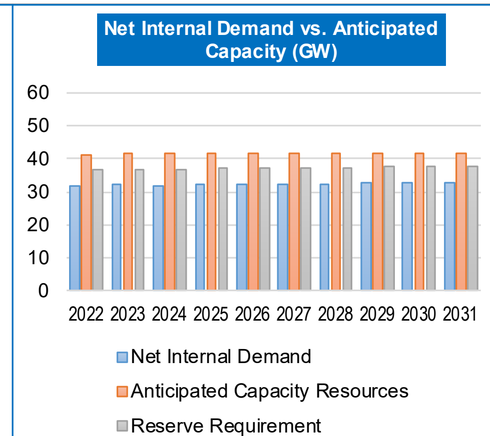



| | Total Internal Demand (MW) | | Demand Response (MW) | | Net Internal Demand (MW) | | Anticipated Resource (MW) | | Prospective Resource (MW) | | Anticipated Reserve Margin | | Prospective Reserve Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter |
| 2022 | 32,870 | 29,759 | 1,062 | 934 | 31,808 | 28,825 | 41,042 | 41,624 | 41,042 | 41,624 | 29% | 44% | 29% | 44% |
| 2023 | 33,049 | 29,499 | 1,062 | 934 | 31,987 | 28,565 | 41,753 | 42,364 | 41,753 | 42,364 | 31% | 48% | 31% | 48% |
| 2024 | 33,015 | 30,495 | 1,062 | 968 | 31,953 | 29,527 | 41,753 | 42,364 | 41,753 | 42,439 | 31% | 43% | 31% | 43% |
| 2025 | 33,193 | 30,655 | 1,062 | 968 | 32,131 | 29,687 | 41,753 | 42,364 | 41,753 | 42,439 | 30% | 43% | 30% | 43% |
| 2026 | 33,355 | 30,618 | 1,062 | 968 | 32,293 | 29,650 | 41,753 | 42,364 | 41,753 | 43,439 | 29% | 43% | 29% | 43% |
| 2027 | 33,429 | 30,733 | 1,062 | 968 | 32,367 | 29,765 | 41,753 | 42,364 | 41,753 | 43,439 | 29% | 42% | 29% | 42% |
| 2028 | 33,531 | 30,858 | 1,062 | 968 | 32,469 | 29,890 | 41,753 | 42,364 | 41,753 | 43,439 | 29% | 42% | 29% | 42% |
| 2029 | 33,642 | 30,999 | 1,062 | 968 | 32,580 | 30,031 | 41,753 | 42,364 | 41,753 | 43,439 | 28% | 41% | 28% | 41% |
| 2030 | 33,748 | 31,193 | 1,062 | 968 | 32,686 | 30,225 | 41,753 | 42,364 | 41,753 | 43,439 | 28% | 40% | 28% | 40% |
| 2031 | 33,925 | 31,168 | 1,062 | 968 | 32,863 | 30,200 | 41,753 | 42,364 | 41,753 | 43,439 | 27% | 40% | 27% | 40% |




| Existing On-Peak Generation (Summer) | | |
|---|---|---|
| Type | MW | Percent |
| Gas | 27,768 | 68.1% |
| Coal | 5,725 | 14.0% |
| Nuclear | 5,353 | 13.1% |
| Oil | 1,074 | 2.6% |
| Hydro | 383 | 0.9% |
| Wind | 300 | 0.7% |
| Sun | 100 | 0.2% |
| Other | 57 | 0.1% |
| Pumped Storage | - | 0.0% |
| Biomass | - | 0.0% |




## LOCATION - SERC MISO-SOUTH

The SERC MISO-South subregion includes all or parts of the states of Arkansas, Texas, Louisiana, and Mississippi.

## MEMBER ENTITIES - SERC MISO-SOUTH

The Midcontinent Independent System Operator, Inc. is the Planning Coordinator for this subregion. Other SERC members include the City of Lafayette, Louisiana, Cleco Corporate Holdings, LLC, Cleco Power, Cooperative Energy, East Texas Electric Cooperative Inc., Entergy, Entergy Arkansas, Entergy Mississippi, Entergy Louisiana, Entergy Texas, Entergy New Orleans, and Louisiana Energy & Power Authority.

## LOAD DEMAND AND GROWTH - SERC MISO-SOUTH

SERC MISO-South is summer peaking. The total internal demand for the SERC MISO-South subregion is expected to grow annually at the rate of 0.35% over the 10-year planning horizon.

## RESERVE MARGIN - SERC MISO-SOUTH

MISO is one BA. To evaluate the resources, transmission adequacy, and anticipated reserves for the SERC MISO-South subregion, SERC only considers the areas of the SERC MISO-South subregion, which lies within the BA area of MISO. The Anticipated Reserve Margins for the SERC MISO-South subregion will remain above the Reference Reserve Margin of 15% for the next 10 years.

## RESOURCE ADEQUACY - SERC MISO-SOUTH

Natural gas makes up about 68% as the largest generation fuel type, followed by coal (14%), and nuclear (13%). Oil, hydroelectric, solar, and wind energy sources round up the remaining 5% of the capacity resources.

Reported demand-side management response in the SERC MISO-South subregion is roughly 3% of the total internal demand through the forecast period.

There are no scheduled retirements during the planning horizon. The SERC MISO-South subregion expects to add 570 MW of natural gas generation in the next 5 years. The MISO GI queue indicates a significant amount of IBR additions in the SERC MISO-South subregion. Depending on the completion of these projects, the subregion could see anywhere between 2 GW and 19 GW of additional IBRs in the next 5 years.

The 2020 SERC Probabilistic Assessment observed less than 15% planning reserve margins in the subregion for the study years 2022 and 2024. The sensitivity analysis showed that the loss of load metrics would increase for a reduction in reserves of 2/3 or due to increasing levels of outages which can be triggered by extreme weather events.

Interest in developing solar resources in the subregion is increasing and is beginning to emerge from the MISO Definitive Planning Phase (DPP) processes but has not caused a noticeable change to the net internal demand or anticipated capacity additions in the subregion at this time. Both transmission and distribution planning engineers in the subregion are preparing for increased solar and other IBR development.

MISO is moving to a seasonal capacity market starting next year, PY 2023-24, which will shed further light on seasonality and resource adequacy in non-peak times.

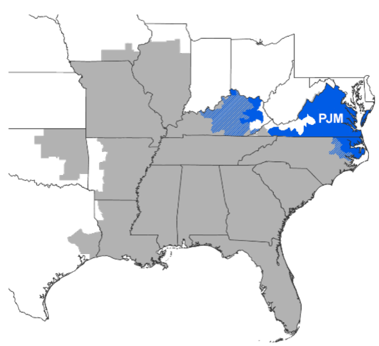
## TRANSMISSION ADEQUACY - SERC MISO-SOUTH

SERC conducted a planning study with a focus on the future projection of load, generation, and transmission system readiness for the 2027 summer peak season along with a heavy power transfer scenario from PJM to MISO areas. No thermal or voltage constraints were observed in the 2027 summer peak study for this subregion.

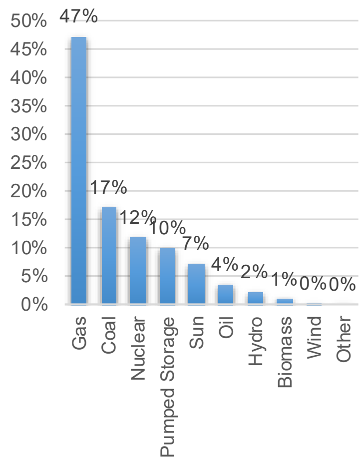
The heavy power transfer scenario identified some potential thermal overloads in the SERC MISO-South subregion. Most of the potential overloads are due to the loss of significant generation along the Gulf Coast of Louisiana and Texas, which forced this power transfer across previously loaded facilities in Arkansas and Mississippi. These potential overloads can be managed by the MISO market by re-dispatching generation near the potential overloads and increasing the output of available generation along the Gulf Coast.

The SERC MISO-South subregion continues to make the necessary investments in transmission to ensure that reliability needs are met over the 10-year horizon. More than 370 miles of new transmission lines in the SERC MISO-South assessment area are in the design and construction phases. They are projected to enhance system reliability, interconnect new generators, and meet the growing load demand. Per projection, the majority (360 miles) of the new transmission lines will go into service in the first 5 years of the planning horizon.

# F. SERC PJM SUBREGION

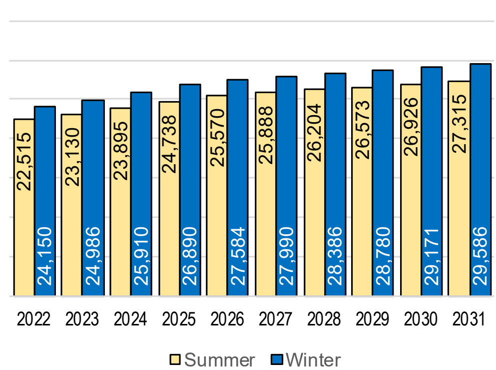



| Year | Total Internal Demand (MW) Summer | Total Internal Demand (MW) Winter | Demand Response (MW) Summer | Demand Response (MW) Winter | Net Internal Demand (MW) Summer | Net Internal Demand (MW) Winter | Anticipated Resource (MW) Summer | Anticipated Resource (MW) Winter | Prospective Resource (MW) Summer | Prospective Resource (MW) Winter | Anticipated Reserve Margin Summer | Anticipated Reserve Margin Winter | Prospective Reserve Margin Summer | Prospective Reserve Margin Winter |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2022 | 22,515 | 24,150 | 805 | 803 | 21,710 | 23,347 | 30,158 | 28,782 | 30,158 | 28,824 | 31% | 46% | 31% | 46% |
| 2023 | 23,130 | 24,986 | 826 | 824 | 22,304 | 24,162 | 30,916 | 28,710 | 42,510 | 31,185 | 37% | 48% | 63% | 65% |
| 2024 | 23,895 | 25,910 | 853 | 850 | 23,042 | 25,060 | 31,457 | 28,754 | 54,860 | 37,152 | 40% | 49% | 88% | 79% |
| 2025 | 24,738 | 26,890 | 881 | 878 | 23,857 | 26,012 | 31,550 | 28,754 | 59,081 | 37,464 | 39% | 46% | 107% | 86% |
| 2026 | 25,570 | 27,584 | 908 | 905 | 24,662 | 26,679 | 31,550 | 28,754 | 60,999 | 38,190 | 39% | 46% | 115% | 89% |
| 2027 | 25,888 | 27,990 | 919 | 916 | 24,969 | 27,074 | 31,550 | 28,754 | 61,266 | 38,458 | 39% | 45% | 117% | 89% |
| 2028 | 26,204 | 28,386 | 930 | 927 | 25,274 | 27,459 | 31,550 | 28,754 | 61,429 | 38,621 | 38% | 44% | 118% | 89% |
| 2029 | 26,573 | 28,780 | 941 | 938 | 25,632 | 27,842 | 31,550 | 28,754 | 61,429 | 38,621 | 38% | 44% | 118% | 89% |
| 2030 | 26,926 | 29,171 | 953 | 950 | 25,973 | 28,221 | 31,550 | 28,754 | 61,578 | 38,770 | 37% | 43% | 117% | 88% |
| 2031 | 27,315 | 29,586 | 966 | 963 | 26,349 | 28,623 | 31,550 | 28,754 | 61,578 | 38,770 | 37% | 42% | 117% | 87% |

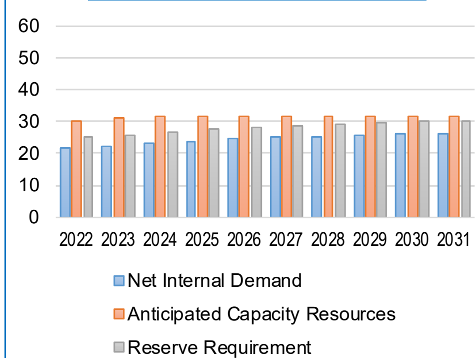



| Existing On-Peak Generation (Summer) | | |
|---|---|---|
| Type | MW | Percent |
| Gas | 14,347 | 47.2% |
| Coal | 5,195 | 17.1% |
| Nuclear | 3,576 | 11.8% |
| Pumped Storage | 3,015 | 9.9% |
| Sun | 2,187 | 7.2% |
| Oil | 1,076 | 3.5% |
| Hydro | 654 | 2.2% |
| Biomass | 271 | 0.9% |
| Wind | 54 | 0.2% |
| Other | - | 0.0% |

Annual Total Internal Demand (MW)




Net Internal Demand vs. Anticipated Capacity (GW)




## LOCATION - SERC PJM

The SERC PJM subregion includes all or parts of the states of North Carolina, Virginia, and Kentucky.

## MEMBER ENTITIES - SERC PJM

The PJM Interconnection, LLC is the Planning Coordinator for this subregion. Other SERC members include Dominion Virginia Power and East Kentucky Power Cooperative.

## LOAD DEMAND AND GROWTH - SERC PJM

The SERC PJM subregion is winter peaking. The total internal demand for the SERC PJM subregion is expected to grow annually at the rate of 2.17% over the 10-year planning horizon.

## RESERVE MARGIN - SERC PJM

The Anticipated Reserve Margins for the SERC PJM subregion will remain above the Reference Margin Level of 15% for the next 10 years. It is important to note that the Anticipated and Prospective Reserve Margin values shown are for the entire PJM area, not just the area of PJM that is within the SERC footprint.

## RESOURCE ADEQUACY - SERC PJM

Natural gas makes up about 47% as the primary generation fuel type, followed by coal at 17%, and nuclear at 12%. Hydroelectric and pumped storage make up 12% of the resources in PJM. Solar generation contributes about 7% of the total capacity. Oil, biomass, and wind energy sources contribute the remaining 5% of the capacity resources within the SERC PJM subregion.

The SERC PJM subregion differs from other subregions in SERC in that Demand Response resources can participate in all PJM Markets: Capacity, Energy, and Ancillary Services.

SERC PJM expects to add more than 5,200 MW of IBRs over the 10-year planning horizon. PJM requires that PJM member Third-Party Suppliers (Curtailment Service Providers - CSPs) bring these resources to PJM Markets; it is the responsibility of these CSPs to act as Market Operating Centers, relaying PJM instructions for load reductions (in any of the markets) to these resources.

SERC PJM accounts for DERs in the load forecast. For the long-term load forecast, PJM defines distributed solar generation as any solar resource that is not interconnected to the PJM markets. These resources do not go through the full interconnection queue process and are not offered as capacity or as energy resources. Furthermore, the output of these resources is netted directly with the load. PJM does not receive metered production data from any of these resources. There have been no current or anticipated operational impacts of DERs noted in PJM.

PJM's Regional Transmission Expansion Process (RTEP) continues to manage an unprecedented capacity shift driven by federal and state public policy and broader fuel economics. They include new generating plants powered by Marcellus and Utica shale natural gas, new wind and solar units driven by federal and state renewable incentives, and market impacts introduced by demand resources and energy efficiency programs.

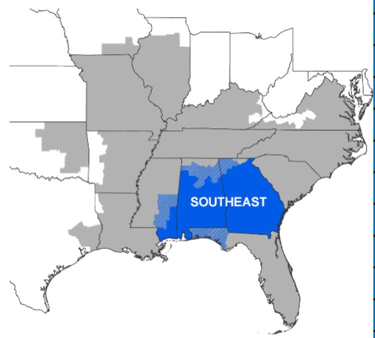
The 2020 SERC Probabilistic Assessment did not observe resource adequacy issues in the SERC-PJM subregion for the study years 2022 and 2024.

## TRANSMISSION ADEQUACY - SERC PJM

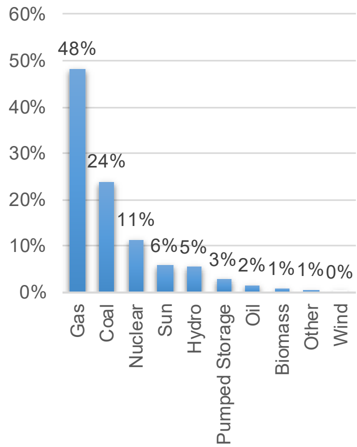
SERC conducted a planning study with a focus on the future projection of load, generation, and transmission system readiness for the 2027 summer peak season along with a heavy power transfer scenario from PJM to MISO areas. No thermal or voltage constraints were observed in the 2027 summer peak study or the heavy power transfer scenario for this subregion.

Approximately 30 miles of new transmission lines in the SERC PJM subregion are in the design and construction phases. They are projected to enhance system reliability, interconnect new generators, and meet the growing load demand.

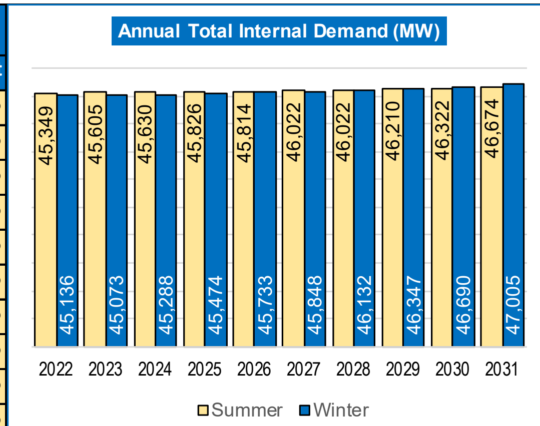
# G. SERC SOUTHEAST SUBREGION

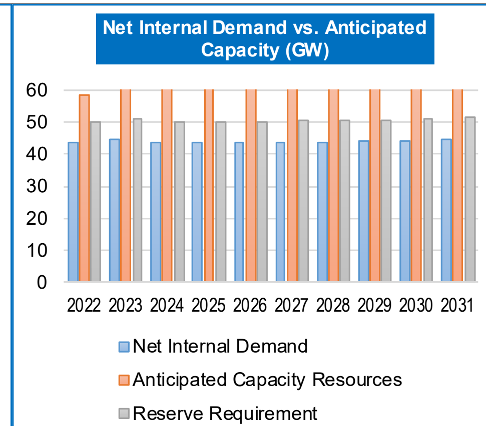



| | Total Internal Demand (MW) | | Demand Response (MW) | | Net Internal Demand (MW) | | Anticipated Resource (MW) | | Prospective Resource (MW) | | Anticipated Reserve Margin | | Prospective Reserve Margin | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter | Summer | Winter |
| 2022 | 45,349 | 45,136 | 1,946 | 1,954 | 43,403 | 43,182 | 58,631 | 58,668 | 58,631 | 58,668 | 35% | 36% | 35% | 36% |
| 2023 | 45,605 | 45,073 | 1,197 | 1,206 | 44,408 | 43,867 | 62,755 | 61,067 | 63,287 | 61,067 | 41% | 39% | 41% | 39% |
| 2024 | 45,630 | 45,288 | 2,118 | 2,127 | 43,512 | 43,161 | 65,045 | 62,263 | 65,638 | 62,263 | 49% | 44% | 49% | 44% |
| 2025 | 45,826 | 45,474 | 2,129 | 2,138 | 43,697 | 43,336 | 65,066 | 62,348 | 65,659 | 62,348 | 49% | 44% | 49% | 44% |
| 2026 | 45,814 | 45,733 | 2,223 | 2,233 | 43,591 | 43,500 | 65,175 | 62,398 | 65,768 | 62,398 | 50% | 43% | 50% | 43% |
| 2027 | 46,022 | 45,848 | 2,222 | 2,231 | 43,800 | 43,617 | 65,175 | 62,398 | 65,768 | 62,398 | 49% | 43% | 49% | 43% |
| 2028 | 46,022 | 46,132 | 2,222 | 2,231 | 43,800 | 43,901 | 65,175 | 62,398 | 65,768 | 62,398 | 49% | 42% | 49% | 42% |
| 2029 | 46,210 | 46,347 | 2,213 | 2,222 | 43,997 | 44,125 | 65,176 | 62,399 | 65,769 | 62,399 | 48% | 41% | 48% | 41% |
| 2030 | 46,322 | 46,690 | 2,090 | 2,100 | 44,232 | 44,590 | 65,134 | 62,357 | 65,727 | 62,357 | 47% | 40% | 47% | 40% |
| 2031 | 46,674 | 47,005 | 2,091 | 2,101 | 44,583 | 44,904 | 65,130 | 62,353 | 65,723 | 62,353 | 46% | 39% | 46% | 39% |




| Existing On-Peak Generation (Summer) | | |
|---|---|---|
| Type | MW | Percent |
| Gas | 29,489 | 48.2% |
| Coal | 14,642 | 23.9% |
| Nuclear | 6,918 | 11.3% |
| Sun | 3,500 | 5.7% |
| Hydro | 3,288 | 5.4% |
| Pumped Storage | 1,632 | 2.7% |
| Oil | 929 | 1.5% |
| Biomass | 449 | 0.7% |
| Other | 314 | 0.5% |
| Wind | - | 0.0% |




## LOCATION - SERC SOUTHEAST

The SERC Southeast subregion includes all or parts of Alabama, Florida, Georgia, and Mississippi.

## MEMBER ENTITIES - SERC SOUTHEAST

The Planning Coordinators in this subregion include Georgia Transmission Corporation, Municipal Electric Authority of Georgia, PowerSouth Energy Cooperative, and Southern Company.

## LOAD DEMAND AND GROWTH - SERC SOUTHEAST

SERC Southeast is dual peaking. The total internal demand for the SERC Southeast subregion is expected to grow annually at the rate of 0.32% over the 10-year planning horizon.

## RESERVE MARGIN - SERC SOUTHEAST

The Anticipated Reserve Margins for the SERC Southeast subregion will remain above the Reference Reserve Margin of 15% for the next 10 years.

## RESOURCE ADEQUACY - SERC SOUTHEAST

Natural gas makes up about 48% as the largest generation fuel type, followed by coal (24%), and nuclear (11%). Solar, hydroelectric, pumped storage, oil, biomass, and energy storage systems round up the remaining 17% of the capacity resources.

SERC Southeast expects to add approximately 4,800 MW, predominantly in nuclear, variable energy resources, and some natural gas generation.

The 2020 SERC Probabilistic Assessment observed adequate resources for the study years 2022 and 2024. The sensitivity analysis showed that the loss of load metrics would increase for a reduction in reserves of 1/3 or due to increasing levels of outages, which can be triggered by extreme weather events.

The energy contribution of DERs in this assessment area is small but is expected to grow over the assessment period. Entities account for distributed generation and behind-the-meter generation by modeling the net of the load and generation. A distributed or behind-the-meter generation facility will be shown explicitly only if an agreement is in place for that generation to be utilized (i.e., controlled) by a BA in the SERC Southeast subregion. Although entities in SERC Southeast continue to monitor and engage in committee forums related to the issue, entities are not anticipating operational impacts due to these resources.

## TRANSMISSION ADEQUACY - SERC SOUTHEAST

SERC conducted a planning study with a focus on the future projection of load, generation, and transmission system readiness for the 2027 summer peak season along with a heavy power transfer scenario from PJM to MISO areas. No thermal or voltage constraints were observed in the 2027 summer peak study for this subregion.

The heavy power transfer scenario revealed a negative impact on the SERC Southeast subregion. Based on the study findings it was recommended that requests for large interregional transfers between BA areas or energy markets must be planned, analyzed, and coordinated, such as through an affected system review, before being approved or confirmed by a Transmission Service Provider (TSP).

The SERC Southeast subregion expects approximately 700 miles of new transmission additions over the assessment period that are in the design and construction phases. They are projected to enhance system reliability, interconnect new generators, and meet the growing load demand. Other projects include adding new transformers, existing transmission line updates, and other system reconfigurations/additions to support transmission system reliability.

# 10. RELIABILITY RISKS

Grid Reliability is an essential component of our national security and society. SERC's mission is to assure effective and efficient reduction of risks to the reliability and security of the BPS. To accomplish this mission SERC works with its stakeholders through technical committees and working groups to develop risk-based solutions to address reliability and security concerns. The development of the Regional risk report is a key deliverable to support that effort.

In the review of SERC Reliability Risks the Engineering Committee (EC), Operations Committee (OC), and Critical Infrastructure Protection Committee (CIPC) separately identified the top Reliability risks to the SERC Region from their perspectives. The groups then collaborated to consider those risks that were significant for two or more of the technical committees and to determine the overall ranking for the most significant risks for the SERC Region.

TABLE 3: 2022-23 RANKED REGIONAL RISK ELEMENTS

| | | | |
|---|---|---|---|
| Manage | 1. Supply Chain | Manage | 6. Legacy Architecture |
| Manage | 2. Exploitation of Vulnerabilities | Manage | 7. Extreme Physical Events (Man-Made): Sabotage & Attacks |
| Manage | 3. Shortage of Required Skillsets | Manage | 8. Fuel Diversity/Fuel Availability |
| Manage | 4. Resource Uncertainty | Monitor | 9. Variable Energy Resource Integration |
| Monitor | 5. Extreme Weather | Monitor | 10. Parallel/Loop Flow Issues |

Table 3 displays the top identified SERC Reliability risks and their risk status for the SERC Region. Each risk is given a status based on the Manage and Monitor definitions below.

- The **Manage** status group includes emerging risks where mitigation plans need to be developed and implemented, through SERC, NERC, or other industry engagements, or additional mitigation plans need to be considered.
- The **Monitor** status group includes risks for which mitigation plans and guidance are already in progress, and for which time is needed to allow mitigation actions to be implemented and evaluate the effectiveness of reducing risk.

Continuing focus on the interdependent nature of the highest risks going forward, as well as the continuing commitment to mitigation and regularly evaluating the effectiveness of implemented mitigation strategies, are key to reducing risks across the SERC Region. SERC has published the 2022 Regional Risk Report on the SERC website.[5]

[5] https://www.serc1.org/docs/default-source/committee/ec-reliability-risk-working-group/2022-23-serc_regional_risk_report_final.pdf

# 11. SEASONAL STUDIES AND ASSESSMENTS

In addition to conducting a ten-year long-term outlook for the Region, SERC performs seasonal assessments for the summer and winter months in order to inform the leaders, planners, operators, and policymakers with responsibility for or interest in the BPS in the SERC Region and prepare them to take necessary actions to ensure the reliability of the SERC BPS.

## SERC 2022 SUMMER AND 2022-2023 WINTER RELIABILITY ASSESSMENTS

The annual reliability assessments for the 2022 summer and the 2022-23 winter seasons performed in 2022 included a more in-depth look at the weather, resource, and transmission adequacy assessment specific to the SERC Region. The assessment of the SERC Region also includes parts of areas in MISO and PJM. SERC performs assessments of the area within the SERC Region only. SERC evaluated the resource adequacy of the SERC Region and the subregions based on a comparison of expected peak demand and resource capacity for each season. In recent years, large numbers of generators have experienced planned and forced outages during peak times. The BPS has also experienced fuel and generation availability issues as well as challenges outside of peak times. SERC identified resource uncertainty, fuel diversity and availability, and variable energy resources integration among the top SERC Regional risks to reliability and security. To expand the consideration of resource adequacy beyond the peak hour, SERC considered probabilistic analysis on a seasonal basis to better understand the resource adequacy in the Region across a range of hours, load levels, and outage conditions. The SERC Regional 2022 summer and 2022-23 winter assessments are posted on the SERC website.[6] Here are some of the key takeaways from the seasonal assessments performed in 2022:

- SERC MISO Central reported insufficient firm resources to meet their expected summer peak forecast with typical historical generation outages. Under normal summer conditions, SERC MISO Central would rely on emergency resources, non-firm energy imports, and Demand Side Management to maintain system reliability. More extreme scenarios, (e.g., higher than projected loads, more extreme temperatures, higher generation outages, or low wind conditions) would potentially require MISO to enact emergency procedures, including temporary operator-initiated load shedding.
- With the increase in electrification of transportation and the continued transition to electric heating and appliances, some SERC subregions are seeing an increase in winter peak load.
- Fuel availability remains a concern for the winter months. The SERC footprint contains a large amount of natural gas generation, and disruptions to gas supply would have immediate and substantial impact. Coal transportation is another area where uncertainty exists, and it directly affects fuel supply at those generating stations that rely upon coal.
- The potential for extreme weather is a concern. While SERC registered entities have improved winterization plans, and they continue to focus on preparedness activities, the threat of a prolonged cold weather event remains a risk to reliability.

[6] https://www.serc1.org/program-areas/reliability-assessments/reliability-assessments

## SERC REGIONAL NEAR-TERM AND LONG-TERM TRANSMISSION ANALYSES

SERC NTWG completed its studies of the 2022 summer season in June 2022 and the 2022-23 winter season in November 2022. Additionally, the SERC LTWG completed its analysis of the 2027 summer season in August of 2022. These studies evaluated the performance of the interconnected electric transmission systems within the SERC Region under normal and extreme conditions with large power transfers across the SERC footprint. The studies considered the seasonal operation of the interconnected systems based on the projections of expected customer demands, generation dispatch, scheduled maintenance, interconnected transmission network configuration, and the firm electric power transfers in effect among the interconnected systems for the season. The analyses included the simulation of single event contingencies throughout the SERC Region and the evaluation of the impacts of these contingencies on both individual SERC and neighboring systems. The coordinated contingency evaluation identified no impacts on the reliability of individual SERC entities or neighboring systems for the local transmission contingencies tested. Overall, these transmission analyses did not show any transmission adequacy concerns that cannot be mitigated by existing operating guides or other mitigation strategies. SERC member companies can receive a copy of the SERC studies upon request via the SERC website.[7]

[7] https://www.serc1.org/contact-us

# 12. FOCUS ON INVERTER-BASED RESOURCES

Federal and state policymakers continue to emphasize the importance of moving to decarbonized energy generation in the future. In response to these policies, many states and utilities within the SERC Region have established, or have proposals to establish, carbon reduction goals and promote the integration of greater levels of renewable resources such as solar, wind, and battery energy storage. The electric utility industry is working to meet the new technical challenges associated with generator retirements, increased levels of IBRs, and the associated planning and operating needs to ensure the transition occurs reliably. Even as industry experience grows, and as effective modeling and engineering study techniques are developed into guidelines and reliability standards to meet those challenges, IBR commissioning practices for utilities remain an area of challenge and are still to be addressed.

## SERC GUIDANCE DOCUMENT FOR IBR COMMISSIONING PROCESS

SERC is experiencing an increasing trend in the growth of IBRs throughout the Region. Some members are seeing higher growth of IBRs than others. Regardless of the level of IBRs, SERC members need to learn from each other's experience of commissioning new IBRs into their systems. An effective commissioning process will identify technical issues, reduce interconnection project delays, and facilitate safe and effective entry into commercial operation.

To that end, the SERC VERWG has developed a guidance document for commissioning practices for IBRs connecting to the Bulk Electric System. This document provides general guidance to SERC member utilities for the development of their commissioning procedures and contributes to the industry knowledge base. It provides insight into the different phases of commissioning an IBR facility—from construction through commercial operation—with a focus on utility activities. It addresses the Pre-Testing, Testing, Post Testing, and Ongoing Monitoring Phases of the IBR commissioning process. The guidelines are informed by the collective experience of SERC contributors and present the insights in a way that allows selective application and incorporation into a utility's commissioning process. A copy of this document is available to SERC member companies upon request via the SERC website.[8]

[8] https://www.serc1.org/contact-us

## SERC GUIDANCE DOCUMENT FOR IBR INTERCONNECTION PRACTICES

As the IBRs continue to grow throughout SERC, SERC members learn from each other as they work with the owners of IBRs to reliably add new inverter-based generating resources in their systems. A guidance document showing the interconnection processes respective to SERC member companies will allow the stakeholders to learn from each other.

The SERC VERWG took a very important step forward by documenting the participating SERC stakeholder practices for the integration and interconnection of IBRs into their transmission grid. The participating SERC member utilities were first surveyed to understand their internal practices regarding the IBR points of interconnections, design and technical requirements, voltage, generator performance, metering, telecommunications, and testing and implementation requirements. The members of the working group update this document annually and host numerous discussions on various technical materials. A copy of this document is available to SERC member companies upon request via the SERC website.[9]

[9] https://www.serc1.org/contact-us

# 13. DATA CONCEPTS AND ASSUMPTIONS

## LOAD FORECAST

Load forecasting is a technique used by power companies to predict power or energy consumption. The information is also needed to balance the supply and load demand at all times.

## TOTAL INTERNAL DEMAND

The peak hourly load for the summer[10] and winter[11] of each year. Projected Total Internal Demand is based on normal weather (50/50 distribution[12]) and includes the impacts of distributed resources, energy efficiency, and conservation programs.

## NET INTERNAL DEMAND

Total Internal Demand, reduced by the amount of Controllable and Dispatchable Demand Response projected to be available during the peak hour. Net Internal Demand is used in all Reserve Margin calculations.

## CONTROLLABLE AND DISPATCHABLE DEMAND RESPONSE

The projected amount of unique MW counted toward resource adequacy planning by an entity for activities or programs that are directly controlled or dispatched by a System Operator. These programs are designed to modify the amount of electricity used during the peak hour and may include any demand response called as part of an emergency operating procedure.

## TOTAL INSTALLED NON-UTILITY PHOTOVOLTAIC

Non-utility scale photovoltaic generation. This includes single-phase installed units that are considered “behind-the-meter,” “rooftop solar,” or part of a “building-integrated system.”

[10] The summer season represents June–September.

[11] The winter season represents December–February.

[12] There is a 50% probability that actual demand will be higher and a 50% probability that actual demand will be lower than the value provided for a given season/year.

## RESOURCE CATEGORIES

SERC collects projections for existing and planned capacity and net capacity transfers (between subregions) that will be available during the forecast hour of peak demand for the summer and winter seasons of each year. Resource planning methods vary throughout the Region. SERC uses the following categories to provide a consistent approach for collecting and presenting resource adequacy:

| Resource Type | Anticipated | Prospective |
|---|---|---|
| **Existing-Certain Generating Capacity**<br>Includes operable capacity expected to be available to serve load during the peak hour with firm transmission | √ | √ |
| **Existing-other capacity**<br>Includes operable capacity that could be available to serve load during the peak hour, but lacks firm transmission and could be unavailable during the peak for many reasons | | √ |
| **Tier 1 Capacity Additions**<br>Includes capacity that is either under construction or has received approved planning requirements | √ | √ |
| **Tier 2 & Tier 3 capacity additions**<br>Includes capacity that has been requested but has not received approval for planning requirements | | √ |
| **Firm Capacity Transfers**<br>(Imports Minus Exports)<br>Includes transfers with firm contracts | √ | √ |
| **Expected (non-firm) Capacity Transfers**<br>(Imports Minus Exports)<br>Includes transfers without firm contracts, but a high probability of future implementation | | √ |
| **Confirmed Retirements**<br>Generators that have formally announced retirement plans. These units must have an approved generator deactivation request where applicable. | √ | √ |
| **Unconfirmed Retirements**<br>Generation capacity that is expected to retire based on the result of a subregion generator survey or analysis. | | √ |

**Note blank cells indicate the resource type is not within the specified category. Whereas a √ indicates the resource type is a part of this category.*

## RESERVE MARGIN - PLANNING RESERVE MARGIN

Planning reference margins are reserve margin targets based on each area's load, generating capacity, and transmission characteristics. The primary metric used to measure resource adequacy is defined as the difference in resources (Anticipated or Prospective) and Net Internal Demand, divided by Net Internal Demand, shown as a percentile.

| Anticipated | Prospective |
|---|---|
| $\dfrac{\text{(Anticipated Resources – Net Internal Demand)}}{\text{Net Internal Demand}}$ | $\dfrac{\text{(Prospective Resources – Net Internal Demand)}}{\text{Net Internal Demand}}$ |

## RESERVE MARGIN - REFERENCE MARGIN

The assumptions and naming convention of this metric vary by subregion. The Reference Margin Level can be determined by using both deterministic and probabilistic (based on a 0.1/year loss of load study) approaches. In both cases, system planners use this metric to quantify the amount of reserve capacity in the system above the forecasted peak demand needed to ensure sufficient supply to meet peak loads. A reserve margin of 15%, for example, means that 15% of a region's electric generating capacity would be available as a buffer to supply unexpected changes in the summer's peak hourly load. Establishing a Reference Margin Level is necessary to account for long-term factors of uncertainty involved in system planning, such as unexpected generator outages and extreme weather impacts that could lead to increased demand beyond what was projected in the 50/50 load forecasted. In many subregions, a Reference Margin Level is established by a state, provincial authority, ISO/RTO, or other regulatory body. In some cases, the Reference Margin Level is a requirement. Reference Margin Levels can fluctuate for the assessment period or may be different for the summer and winter seasons.

# 14. GLOSSARY

| Acronym | Definition |
|---|---|
| BA | Balancing Authority |
| BES | Bulk Electric System |
| BESS | Battery Energy Storage System |
| CAGR | Compound Annual Growth Rate |
| DERs | Distributed Energy Resources |
| DSM | Demand Side Management |
| DWG | SERC Dynamics Working Group |
| EC | SERC Engineering Committee |
| EMS | Energy Management System |
| ERAG | Eastern Interconnection Reliability Assessment Group |
| ERO | Electric Reliability Organization |
| FERC | Federal Energy Regulatory Commission |
| GI | Generation Interconnection |
| IBRs | Inverter-based Resources |
| ISO | Independent System Operator |
| LOLE | Loss Of Load Expectation |
| LTRA | NERC Long-Term Reliability Assessment |
| LTWG | SERC Long-Term Working Group |
| MISO | Midcontinent Independent System Operator |
| MISO DPP | MISO Definitive Planning Phase |
| MISO LRTP | MISO Long Range Transmission Plan |
| MMWG | Multiregional Modeling Working Group |
| NERC | North American Electric Reliability Corporation |
| NERC PAWG | NERC Probabilistic Assessment Working Group |
| NTWG | SERC Near-Term Working Group |
| PC | Planning Coordinator |
| PJM | Pennsylvania-New Jersey-Maryland Pool |
| PJM CSPs | PJM Curtailment Service Providers |
| PJM RTEP | PJM Regional Transmission Expansion Process |
| PLCS | SERC Planning Coordination Subcommittee |
| PSS/E | Power System Simulator for Engineering |
| PV | Photovoltaic |
| PY | Planning Year |
| RAWG | SERC Resource Adequacy Working Group |
| RC | Reliability Coordinator |
| RDT | Regional Directional Transfer |
| RE | Regional Entity |
| RRS | SERC Reliability Review Subcommittee |
| RTO | Regional Transmission Organization |
| SCADA | Supervisory Control and Data Acquisition |
| SERC | SERC Reliability Corporation |
| SERC CIPC | SERC Critical Infrastructure Protection Committee |
| SERC DWG | SERC Dynamics Working Group |

| Acronym | Definition |
|---|---|
| *SERC EC* | SERC Engineering Committee |
| *SERC LTWG* | SERC Long-Term Working Group |
| *SERC NTWG* | SERC Near Term Working Group |
| *SERC OC* | SERC Operating Committee |
| *SERC RAWG* | SERC Resource Adequacy Working Group |
| *SERC VERWG* | SERC Variable Energy Resources Working Group |
| *TLR* | Transmission Loading Relief |
| *TP* | Transmission Planner |
| *TSP* | Transmission Service Provider |

# 15. SERC MEMBERSHIP

SERC is a membership corporation. SERC membership is voluntary and free of charge. The current list of members is as follows:

### Investor-Owned Utilities (19)

Alabama Power Company (S)

Ameren Services Company (M-C)

Cleco Corporate Holdings LLC (M-S)

Dominion Energy South Carolina, Inc. (E)

Duke Energy Carolinas, LLC (E)

Duke Energy Florida, LLC (F)

Duke Energy Progress, LLC (E)

Entergy (M-S)

Florida Power & Light Company (F)

Florida Public Utilities Company (F)

Georgia Power Company (S)

Gridforce Energy Management, LLC (M-C)

GridLiance Holdco, LLC (M-C)

Gulf Power Company (F)

LG&E and KU Services Company (C)

Mississippi Power Company (S)

Southern Company Services, Inc. (S)

Tampa Electric Company (F)

Virginia Electric and Power Company (DP, TO) (P)

### Marketers (2)

ACES

Tenaska Power Services Co.

### Municipal (27)

Alabama Municipal Electric Authority (S)

Beaches Energy Services of Jacksonville Beach (F)

City of Bartow (F)

City of Columbia, MO (M-C)

City of Homestead (F)

City of Key West (Keys Energy) (F)

City of Leesburg (F)

City of Ocala Electric Utility (F)

City of Springfield, IL – CWLP (M-C)

City of Tallahassee (F)

City of Winter Park (F)

ElectriCities of North Carolina, Inc. (E)

Fayetteville Public Works Commission (E)

Florida Municipal Power Agency (F)

Fort Pierce Utilities Authority (F)

Gainesville Regional Utilities (F)

Illinois Municipal Electric Agency (M-C)

JEA (F)

Kissimmee Utility Authority (F)

Lakeland Electric (F)

Memphis Light, Gas, and Water Division (C)

Municipal Electric Authority of Georgia (S)

Nashville Electric Service (C)

Orlando Utilities Commission (F)

Owensboro, KY Municipal Utilities (C)

Reedy Creek Improvement District (F)

Utilities Commission of New Smyrna Beach (F)

| Cooperatives (19) |
|---|
| Arkansas Electric Cooperative Corporation (M-S) |
| Associated Electric Cooperative, Inc. (C) |
| Big Rivers Electric Corporation (M-C) |
| Cooperative Energy (M-S) |
| East Kentucky Power Cooperative (P) |
| Florida Keys Electric Cooperative Assn (F) |
| Georgia System Operations Corporation (S) |
| Georgia Transmission Corporation (S) |
| Lee County Electric Cooperative, Inc (F) |
| Louisiana Generating, LLC (M-S) |
| North Carolina Electric Membership Corporation (E) |
| Oglethorpe Power Corporation (S) |
| Old Dominion Electric Cooperative (E) |
| Piedmont Electric Membership Corporation (E) |
| PowerSouth Energy Cooperative (S) |
| Prairie Power, Inc. (M-C) |
| Seminole Electric Cooperative (F) |
| Southern Illinois Power Cooperative (M-C) |
| Wabash Valley Power Association, Inc. (M-C) |

| RTO/ISO/RC (3) |
|---|
| Florida Reliability Coordinating Council, Inc (F) |
| Midcontinent Independent System Operator, Inc. (M-S, M-C) |
| PJM Interconnection, LLC (P) |

| Federal/State Systems (3) |
|---|
| South Carolina Public Service Authority (E) |
| Southeastern Power Administration (S) |
| Tennessee Valley Authority (C) |

| Merchant Electricity Generators (11) |
|---|
| BayWa.r.e. Operation Services LLC |
| Brookfield Smoky Mountain Hydropower LLC (C) |
| Calpine Corporation (C, M-S) |
| Capital Power (E) |
| Cogentrix Energy Power Management, LLC (E) |
| Consolidated Edison Clean Energy Business (S) |
| Cube Hydro Carolinas, LLC (E) |
| Electric Energy, Inc. (C) |
| Northern Star Generation Services Company, LLC (F) |
| Occidental Chemical Corporation (M-S) |
| Vistra Energy Corp. (M-C, P) |

| Subregional Affiliation |
|---|
| (C) SERC Central Subregion |
| (M-C) - SERC MISO-Central Subregion |
| (M-S) - SERC MISO-South Subregion |
| (F) - SERC Florida Peninsula Subregion |
| (E) - SERC East Subregion |
| (P) -SERC PJM Subregion |
| (S) - SERC Southeast Subregion |