**Southern Company**

**2023 Integrated Resource Plan Update**

**Resource Mix Study**

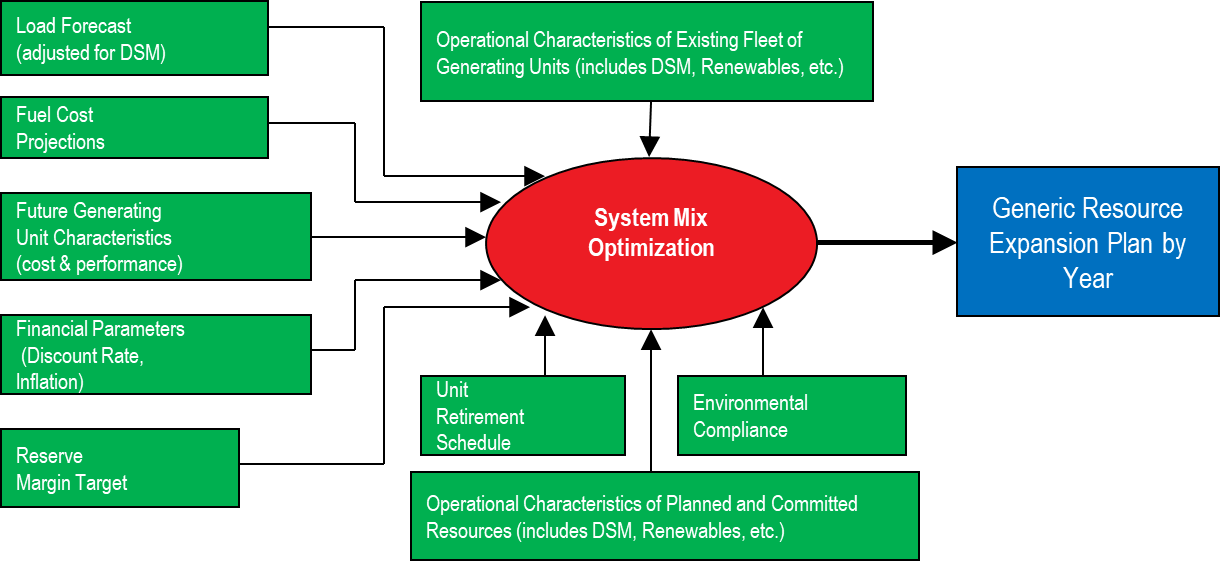
October 2023

# SUMMARY

The primary objective of this study is to provide information regarding the development of an optimal least-cost resource mix or generic expansion plan. The generic expansion plan was selected to minimize revenue requirements while complying with reliability criteria, environmental laws, and regulations, considering risk and flexibility. This study provides an informative roadmap for long-term decisions. The base case contained in this Mix Study does not represent commitments but instead is a generic expansion plan used for planning and to support analyses. Under the framework established in the state of Georgia, when a capacity need is identified through an Integrated Resource Plan (“IRP”), Georgia Power Company (“Georgia Power” or the “Company”) will meet such identified need in accordance with the Georgia Public Service Commission (“Commission”) rules and will utilize Georgia Power specific information, as appropriate.

This report summarizes the results of the 2023 IRP Update Resource Mix Study. The recommendations of the study provide input to an optimum resource addition schedule for the retail operating companies. The base case resource addition schedule is based on maintaining minimum winter and summer reserve margins and minimizing the total operating and capital costs over the planning horizon. While both summer and winter seasons are reviewed, future resource addition schedules will be based on the additions needed to meet the higher of the summer or winter capacity need. For this 2023 IRP Update resource plan, the winter capacity need occurred earlier and was higher than the summer capacity need for the entire planning horizon. Therefore, the system expansion plan includes additions to address the forecasted winter capacity needs. An overview of the expansion plan optimization process is shown in Figure 1 below.

*Figure 1: Expansion Plan Optimization Process Overview*



In developing a resource expansion plan, it is important to consider uncertainties that could impact planning decisions. Key uncertainties affecting planning include the evolution of natural gas prices, future environmental pressure—especially regarding carbon-dioxide (“CO2”), cost and performance of future generating technologies, and future load growth. Therefore, in developing its scenarios, the Company identifies different plausible viewpoints in each of these four areas. These viewpoints are combined to create six scenarios for the 2023 IRP Update. For purposes of this resource mix study, a single scenario is available upon the 2023 IRP Update filing date. However, Georgia Power will file the additional five scenarios in a supplemental filing in the 2023 IRP Update docket. Shown in Figure 2 is the generic capacity expansion plan (cumulative megawatts (“MW”) by 2043) for the moderate gas, zero-dollar carbon (“MG0”) scenario.

*Figure 2: 2023 IRP Update MG0 Expansion Plan – Cumulative MW by 2043*

**REDACTED**

# ASSUMPTIONS

The key inputs to the study are the cost of capital and escalation rates, a reliability criterion represented by the Target Reserve Margin, the operating data and retirement or projected unavailability dates of existing and committed generating units, projected demand side options (“DSOs”), load forecasts, fuel forecasts, and costs and performance characteristics of candidate generating technologies. The following provides details for each of these key inputs.

## *FINANCIAL ASSUMPTIONS*

Cost of capital rates are based on the Markit June 2023 forecast. Table 1 details the capital structure and weighted costs used in the Mix Study.

*Table 1: Capital Structure*

| **Component** | **Ratio** | **Cost** | **Weighted** | **After Tax Hurdle Rate** | **Revenue Requirement Rate** |
| --- | --- | --- | --- | --- | --- |
| Debt | 45% | **REDACTED** | **REDACTED** | **REDACTED** | **REDACTED** |
| Equity | 55% | **REDACTED** | **REDACTED** | **REDACTED** | **REDACTED** |
| Weighted Cost | | | **REDACTED** | **REDACTED** | **REDACTED** |

## *RESERVE MARGIN*

The 2023 IRP Update reflects a 16.25% Summer Target Reserve Margin and 26% Winter Target Reserve Margin for long-term resource planning purposes, consistent with the Commission’s final order in GPC’s 2022 IRP.

## *EXISTING CAPACITY MIX*

The Company’s current generating capacity consists of 18% coal, 48% gas and oil, 11% nuclear, 5% hydro, and 18% other[[1]](#footnote-2) (Solar, Solar + Storage, Wind, DSO, and Biomass). Over the course of the planning horizon, the capacity mix will change due to many factors, including, but not limited to, unit rating changes, resource additions, nuclear license expirations, power purchase agreement expirations, and retirements. For planning purposes, discrete retirement dates of Company-owned generating units were utilized in the base case. Please refer to Technical Appendix Resource Mix Study (Georgia Power Territorial Base Case Load vs. Existing Capability Table) for more details.

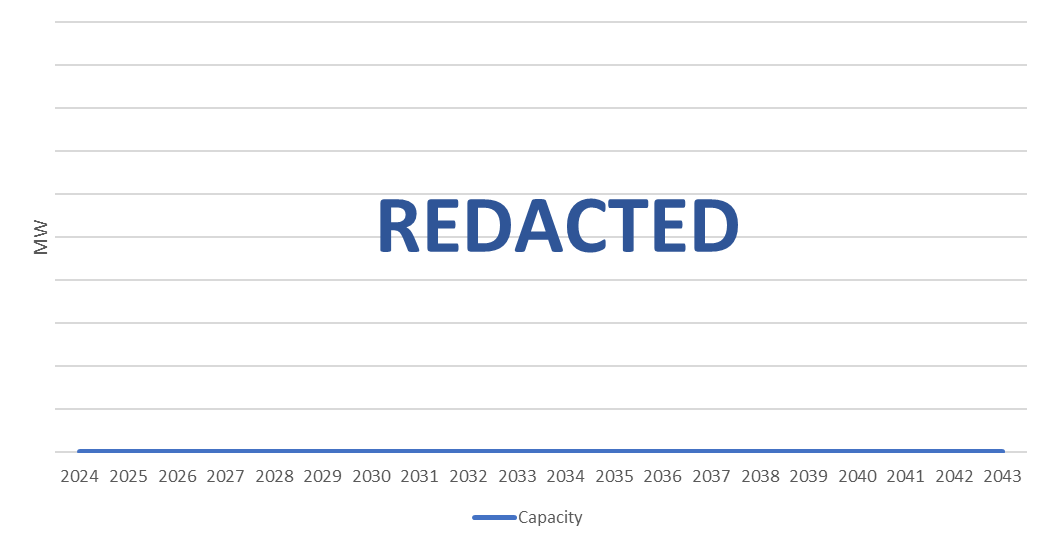
### *DEMAND-SIDE OPTIONS*

Demand-side options are either “dispatchable” or “non-dispatchable.” Examples of dispatchable DSO include interruptible load and other options that can be controlled and dispatched by a utility. Examples of non-dispatchable DSO include options such as insulation or end-use equipment efficiency, which are not directly controllable by a utility.

Dispatchable DSOs were included as capacity resources in this study. Each interruptible contract load was appropriately adjusted to equate it to the supply side by one or more of the following corresponding factors: availability factor, loss factor, and Effective Load Carrying Capability (“ELCC”). For all operating companies, non-dispatchable DSOs are accounted for in the load forecast. Please see Technical Appendix Resource Mix Study (Georgia Power and System DSO Data) for additional information regarding DSO assumptions used in the 2023 IRP Update.

Figure 3 below shows the existing, planned, and committed system capacity changes for the 2024 – 2043 period.

*Figure 3: Retail Operating Companies’ Existing and Planned Capacity Forecast*



## *LOADS*

Load forecasts were provided by each retail operating company. The System peak demand is the sum of each retail operating companies’ non-coincident peak demand multiplied by a load diversity factor. The diversity percentages are based on a historical ten-year average of monthly diversities from 2013 through 2022. More information on the Company’s load forecasts can be found in the 2023 IRP Update Main Document and the Load and Energy Forecast presented in the Technical Appendix.

To address the uncertainty of future electricity consumption across a range of scenarios, the Company produces specific load forecasts for multiple scenario views. The Company’s reference load forecast uses annually updated forecasts of electricity consumption throughout the planning horizon assuming the US Energy Information Administration’s (“EIA”) 2023 Annual Energy Outlook (“AEO”) “Reference” gas price forecast and a $0 carbon view. The forecast is done separately for each of the three types of customers—residential, commercial, and industrial. For each scenario, this reference load forecast is adjusted to include the impacts of the changing fuel or carbon forecast used in that scenario.

The state of Georgia has seen historic growth in economic development activity, specifically new load related to data centers, clean energy technology, and manufacturing. Due to the speed in which economic development customers are growing, the Company has produced a load scenario that captures the increased speed and magnitude in which these customers are growing. This load scenario (“2023 IRP Update Load Forecast”) is specific to the 2023 IRP Update and will be used as the reference load forecast in this Mix Study. Additionally, the Company produces two other load forecast views used in the scenarios that include additional electrification-influenced load growth and end-use efficiency and customer generation with varying degrees of added carbon pressure (“Alt 1” and “Alt 2”).

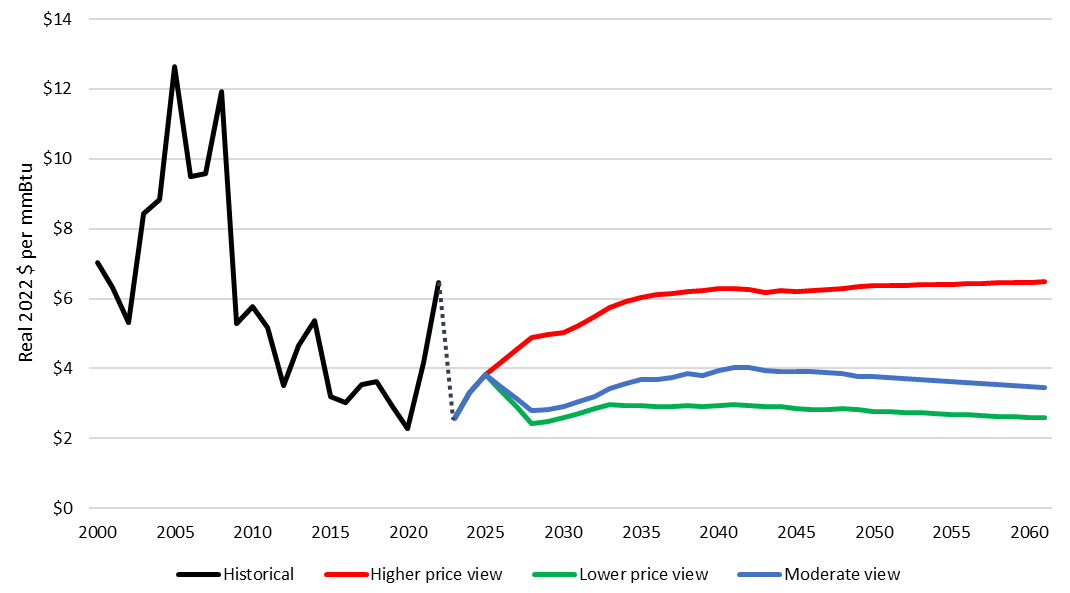
* Alt 1 Load Forecast: The Alt 1 load view reflects the Company’s view of how a moderate amount of CO2 pressure would have two generally opposing effects on load growth. First, CO2 pressure would be consistent with increased electrification of transportation, thus increasing load growth. Second, CO2 pressure would be consistent with increased efficiency of electricity end-use either because of improved energy efficiency of devices or because of income and substitution effects associated with more expensive electricity, which would have the effect of reducing load growth.
* Alt 2 Load Forecast: The Alt 2 load view reflects a similar forecast to Alt 1, except that it reflects the effects of a large degree of CO2 pressure, rather than a moderate degree.

Additional scenario analyses, including those based on the Alt 1 and Alt 2 load forecasts, will be provided in a supplemental update.

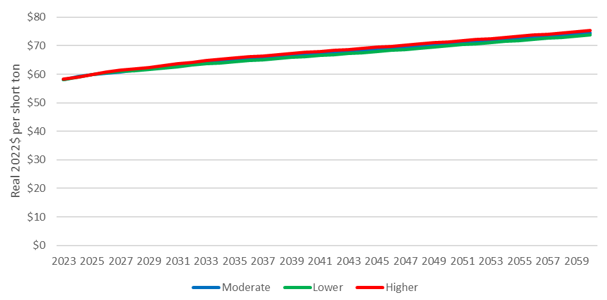
## *FUEL FORECASTS*

Near term base fuel costs are based on the Southern Company fuel budgeting process. For the 2023 IRP Update, the Company adopted and adapted paths produced by EIA for its 2023 AEO for the long-term fuel costs. The following illustrations give the fuel price paths that the Company has used in the 2023 IRP Update scenario analysis. Only the moderate fuel price views are used for the Mix Study, but additional analyses including the other fuel price views will be provided in a supplemental update.

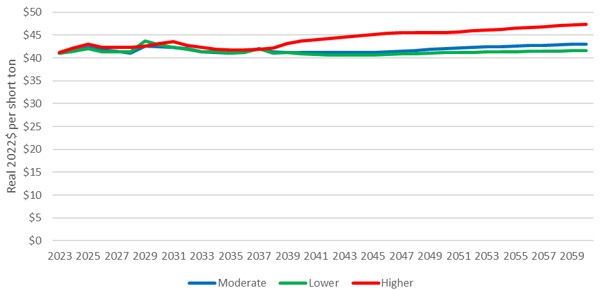
*Figure 4: Views of future price of Natural Gas at Henry Hub*



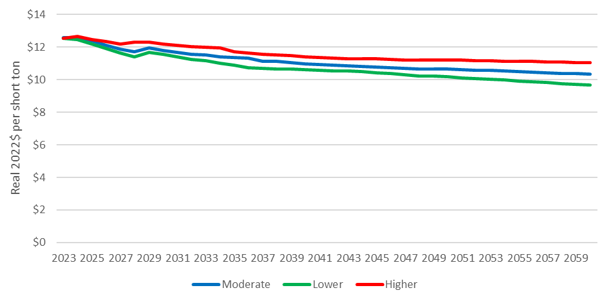
*Figure 5: Views of future price of coal at mine, by scenario, Central Appalachia*



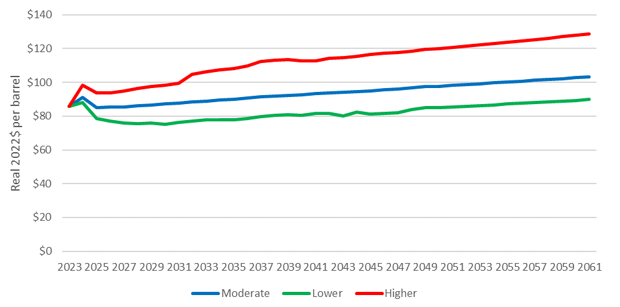
*Figure 6: Views of future price of coal at mine, by scenario, Illinois Basin*



*Figure 7: Views of future price of coal at mine, by scenario, Powder River Basin*



*Figure 8: Views of future price of oil, West Texas Intermediate*



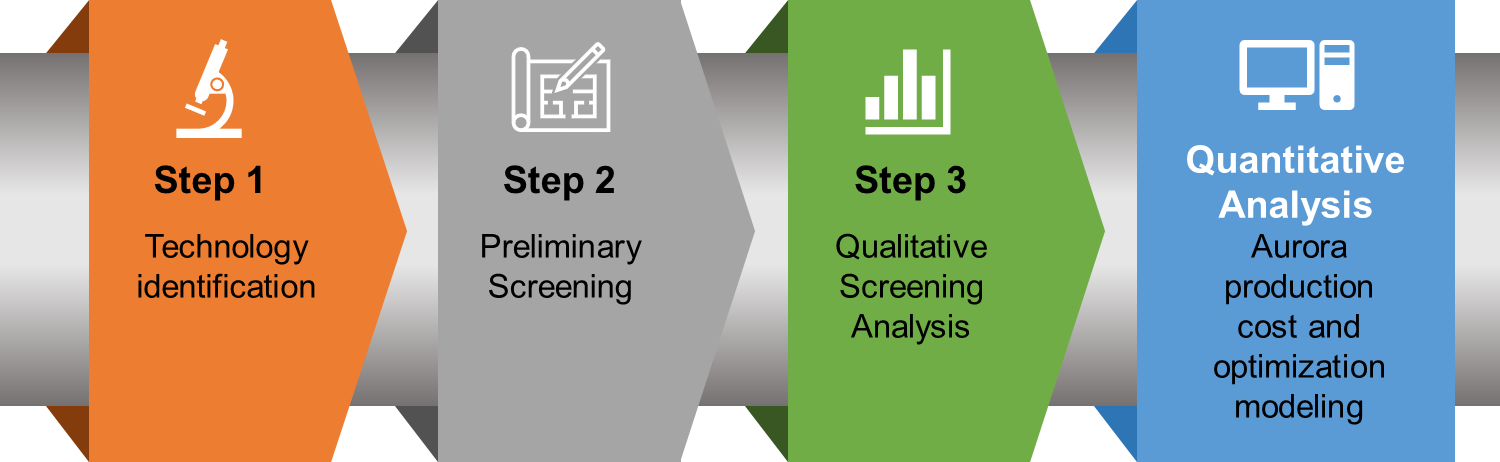
The candidate expansion unit gas price is a capacity need weighted average, by retail operating company, of several potential plant locations throughout the Southern Company System. Combined cycle additions include the cost of contracting for firm annual natural gas delivery, and combustion turbine additions include the cost of contracting for firm summer only natural gas delivery.

## *TECHNOLOGY SCREENING & CANDIDATE EXPANSION UNITS*

The Company performs detailed expansion planning and production cost analysis during each IRP. This detailed analysis requires extensive and complex computational analysis. Therefore, the Company completes a technology screening assessment of new generation technologies to reduce the potential list of new supply-side options to a manageable list of technologies that are likely to be economically competitive. This technology screening assessment evaluates both established and emerging generating technologies. The objective is to assess the cost, maturity, safety, operational reliability, flexibility, economic viability, environmental acceptability, fuel availability, construction lead times, and other relevant factors of new supply-side generation options.

The technology screening process includes three main steps: (i) the Technology Identification, (ii) Preliminary Screening, and (iii) Detailed Qualitative Screening Analysis, as illustrated in Figure 9. Supply-side options retained after these steps are then considered in the more detailed expansion plan modeling.

*Figure 9: Technology Screening Process*



The screening process is useful for comparing costs of resource types but cannot be solely utilized for determining a long-term resource plan because future units must be optimized with an existing system containing various resource types. Results from the screening analysis provide guidance for the technologies to be further considered in the more detailed quantitative analysis phase of the planning process. All resources that passed Steps 1-3 of the technology screening process were offered to the model to be optimized with the existing system.

### *CANDIDATE EXPANSION UNITS*

For 2023 IRP Update analyses, the technologies that screened as potentially cost-effective included natural gas combined cycle (with and without carbon capture and sequestration), dual-fuel combustion turbine with Selective Catalytic Reduction (“SCR”), reciprocating internal combustion engine, solar photovoltaic, wind, advanced nuclear, and battery storage (short- and medium-duration).

* **Natural Gas Combined Cycle (“CC” and “CC with CCS”)**: The Company’s current assumption for planning purposes is that CC plants without carbon capture facilities are available for fleet expansion beginning in 2030 and only through 2039 ($0 CO2 view) or 2034 (all other CO2 views). This is due to a corresponding planning assumption that beginning in 2035 or 2040, depending on the CO2 view, new CC plants must capture at least 90% of their carbon dioxide emissions. The timing of this requirement is based on the Company’s understanding of the existing Clean Air Act and its statutory requirements for review of abatement technologies (New Source Performance Standards and Best Available Control Technology). With a carbon capture facility, CC plants are referred to as natural gas combined cycle with carbon capture and storage (“CC with CCS”). The Company assumes that CC with CCS that is online by end of 2038 will receive the 12-year 45Q tax credit for each ton of carbon that is captured and stored.
* **Dual-Fuel Combustion Turbines (“CT with SCR”)**: The Company’s current assumption for planning purposes is that dual-fuel combustion turbines with SCR are available for fleet expansion beginning in the year of capacity need for each scenario and assumed to operate with oil as a primary fuel source. CTs must significantly reduce their NOx emissions by installing an SCR device. This assumption comes from recent deployments of this technology across the industry and the Company’s understanding of the existing Clean Air Act and its statutory requirements for review of abatement technologies and requirements.
* **Reciprocating Internal Combustion Engine (“RICE”)**: Reciprocating internal combustion engines are available as an expansion resource beginning in the year of capacity need for each scenario.
* **Solar PV**: Solar PV with single-axis tracking is available as an expansion resource beginning in 2027. The Company’s view is that its costs will continue to decline in real terms, meaning it will become increasingly cost-effective throughout the study timeframe. The Company assumes that solar will receive the 10-year clean electricity production tax credit as part of the Inflation Reduction Act (“IRA”).
* **Southeast Wind**: Wind is available as an expansion resource beginning in 2032. The Company assumes that wind will receive the 10-year clean electricity production tax credit as part of the IRA. Wind has been limited to 8,100 MW total within the Southern Company footprint based on expected wind resource potential and land availability.
* **Battery energy storage systems (“BESS”)**: Battery storage (4-hour option) is available as an expansion resource beginning in the year of capacity need for each scenario. The Company’s view is that its costs will continue to decline into the middle of the planning horizon, before leveling off in real terms, meaning that it will become increasingly cost-effective throughout the study timeframe. The Company assumes that battery storage is able to take advantage of a 40% investment tax credit as part of the IRA.
* **Medium duration energy storage systems (“MDESS”)**: MDESS (12-hour option) is available as an expansion resource beginning in 2033. MDESS is assumed to be representative of pumped thermal energy storage. The Company assumes that MDESS is able to take advantage of a 40% investment tax credit as part of the IRA.
* **Nuclear**: Advanced nuclear options including Small Modular Reactors and Generation IV Nuclear technology are considered as part of the technology screening. Small Modular Reactor cost and performance metrics are modeled and available as an expansion resource. The Company assumes that nuclear will receive the 10-year clean electricity production tax credit as part of the IRA.
* **Power Purchase Agreement between Georgia Power Company and Mississippi Power Company**:Due to the significant increase in economic development load that the Company has seen, the Company’s first capacity need falls in Winter of 2027. Many of the technology options are not assumed to be available as early as Winter 2027. Because of this, for planning purposes, the Company has included the Georgia Power Company and Mississippi Power Company PPA as a resource option within the model. It is modeled to assume the capacity and energy costs per the executed PPA in the Technical Appendix to the 2023 IRP Update.

### *GENERIC UNIT COSTS AND PERFORMANCE*

Table 2 shows the technology assumptions for the candidate units offered in the 2023 IRP Update Mix Study.

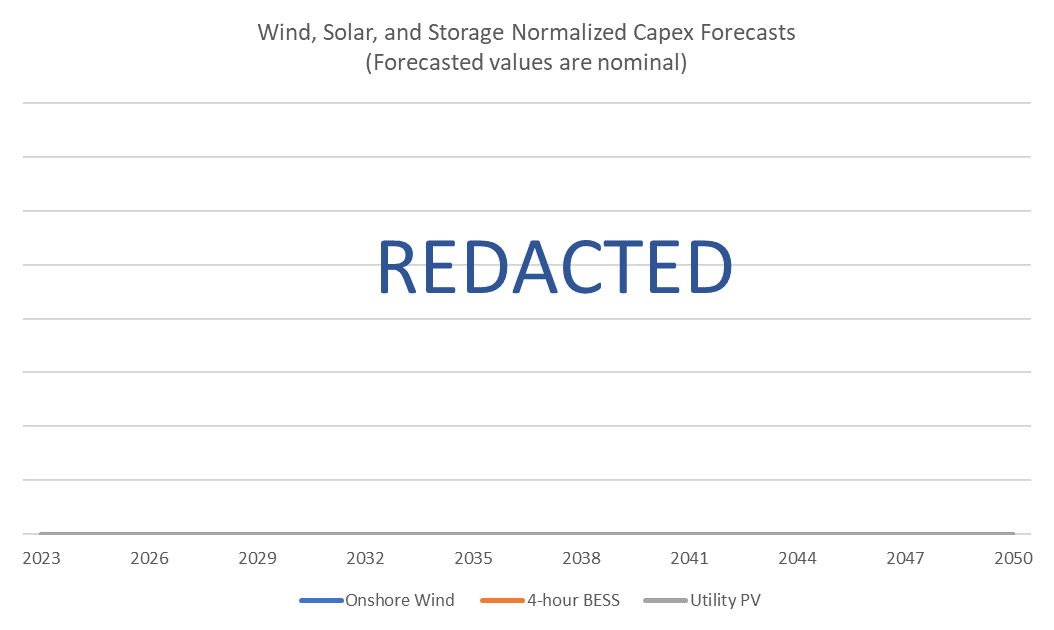
*Table 2: Candidate Technology Assumptions*

| **Technology** | **Capacity Winter** (MW) | **ICE Factor** | **Average Heat Rate** (Btu/ kWh) | **Round Trip Efficiency** | **Fixed Capacity Factor** | **Overnight Cost** (2023$/ kW) | **Recurring Fixed Cost[[2]](#footnote-3)** (2023$/ kW-yr) | **Variable O&M** ($/MWh) | **Asset Life** (Yrs) |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Combined Cycle (CC) | **REDACTED** | **REDACTED** | **REDACTED** |  |  | **REDACTED** | **REDACTED** | **REDACTED** | **REDACTED** |
| Combined Cycle with Carbon Capture & Storage (CC w CCS) | **REDACTED** | **REDACTED** | **REDACTED** |  |  | **REDACTED** | **REDACTED** | **REDACTED** | **REDACTED** |
| Combustion Turbine with Future Emission Controls (CT w SCR) | **REDACTED** | **REDACTED** | **REDACTED** |  |  | **REDACTED** | **REDACTED** | **REDACTED** | **REDACTED** |
| Reciprocating Internal Combustion Engines (RICE) | **REDACTED** | **REDACTED** | **REDACTED** |  |  | **REDACTED** | **REDACTED** | **REDACTED** | **REDACTED** |
| Solar Photovoltaic (PV) - Single Axis Tracker (SAT) | **REDACTED** | **REDACTED** |  |  | **REDACTED** | **REDACTED** | **REDACTED** |  | **REDACTED** |
| Onshore Wind Power | **REDACTED** | **REDACTED** |  |  | **REDACTED** | **REDACTED** | **REDACTED** |  | **REDACTED** |
| Lithium-ion Battery Energy Storage System (BESS) - 4 Hr | **REDACTED**  **REDACTED** | **REDACTED**  **REDACTED**  **REDACTED**  **REDACTED** |  | **REDACTED** |  | **REDACTED** | **REDACTED** | **REDACTED** | **REDACTED** |
| Medium Duration Energy Storage System | **REDACTED**  **REDACTED** | **REDACTED** |  | **REDACTED** |  | **REDACTED** | **REDACTED** | **REDACTED** | **REDACTED** |
| Small Modular Reactors (SMRs) | **REDACTED** | **REDACTED** |  |  |  | **REDACTED** | **REDACTED** |  | **REDACTED** |

Construction cost escalation rates for all technologies except solar, wind, and BESS are based on the Producer Price Index (“PPI”) from the IHS Markit June 2023 Forecast, which is   
**REDACTED**% for the duration of the planning period.

Figure 10 shows the normalized cost projections for Southeast Wind, Solar, and BESS, which show the escalation trajectory used in the Resource Mix study.

*Figure 10: Normalized Cost Projections for Southeast Wind, Solar, and BESS*



Aurora selects new units based on minimizing total operating and capital costs. In order to minimize potential size bias, a unit size of 300 MW was considered for all technologies. The model adds resources in multiples of 300 MW.

### *INFLATION REDUCTION ACT*

The IRA was passed in August of 2022, providing tax incentives to various clean energy technology options. These tax incentives have been incorporated into various technology options that are eligible for selection in the Mix Study. Section 2.6.1 on the candidate expansion technologies references how the IRA credits are incorporated for each eligible technology.

The IRA has various provisions for when incentives are set to end. Many tax credits are set to phase out at the later of 2032 or when the nation-wide electric sector reaches 75% carbon emission reduction from 2022 levels. Due to the progression of current carbon emission reductions, the IRA incentives are assumed to extend through the planning horizon for all $0 CO2 scenarios. For CO2 scenarios, the IRA incentives are assumed to phase out earlier, due to the additional greenhouse gas pressure. The phase out is assumed to begin in 2045 for the $20 CO2 view and in 2035 for the $50 CO2 view.

# BASE CASE GENERIC EXPANSION PLAN

The following base case capacity addition schedule was used as an input to the integrated resource planning process for the retail operating companies. The base case scenario reflects the moderate gas, zero-dollar carbon (“MG0”) scenario. Figure 11 below shows the recommended capacity and energy addition schedule for generic expansion.

*Figure 11: 2023 IRP Update MG0 Expansion Plan*



The conclusion of this study, based upon the results of the base case, is that additional generation capacity requirements may involve a mixture of natural gas combined cycle, dual-fuel combustion turbine with SCR, advanced nuclear, solar photovoltaic, wind, and battery storage. Additionally, the study concludes that a market option, such as the Mississippi Power Company PPA, will be needed to meet near term capacity needs. At the appropriate time, actual resource selection will occur in accordance with Commission rules. Additional conclusions will be drawn upon completion of all scenarios and sensitivities to be filed in the supplemental update.

Please see Technical Appendix Resource Mix Study (GPC and System IRP Summary Data) for additional summary information regarding the Georgia Power and System capacity, peak demands and energies, actual and target reserve margins, and capacity needs.

# SCENARIO ANALYSIS AND DISCUSSION OF RESULTS

## *PLANNING SCENARIO CASES*

Due to the uncertainty related to long term fuel cost, carbon pressure, technology cost and performance, and future electricity consumption, the Company considers multiple views of the future price of natural gas, multiple views of future pressure on the Company’s CO2 emissions, multiple views of future cost and performance of generating technologies, and multiple views of future electricity consumption. For the 2023 IRP Update, the Company assembled these multiple views in those four areas into six planning scenario cases to explore the potential impacts. This resulted in six outlooks of capacity and energy mixes, as reflected in Table 3 below. For purposes of the 2023 IRP Update, only the MG0 scenario with the 2023 IRP Update Load Forecast is available upon the filing date. Georgia Power will file a supplemental filing at a later date to support all six scenarios.

*Table 3: Planning Scenarios*

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Scenario** | **GHG pressure view** | **Technology view** | **Load view** | **Fuel view** | **Label** |
| 1 | Lower | Tech  Portfolio | 2023 IRP Update | Lower | LG0 |
| 2 | Lower | Tech  Portfolio | 2023 IRP Update | Moderate | MG0 |
| 3 | Lower | Tech  Portfolio | 2023 IRP Update +  HG0 delta | Higher | HG0 |
| 4 | Moderate ($20) | IRA 2045 | Alt 1 | Moderate | MG20 |
| 5 | Higher ($50) | IRA 2035 | Alt 2 | Moderate | MG50 |
| 6 | Emissions Limit | IRA 2035 | Alt 2 | Moderate | EL |

## *RESULTS SUMMARY*

Please see Technical Appendix Resource Mix Study (Capacity Expansion Plans) for a summary of results for analyses around the MG0 scenario.

1. A portion of the renewable nameplate generation capacity included in this value includes capacity where the renewable generator retains the related Renewable Energy Credits (“RECs”). [↑](#footnote-ref-2)
2. Recurring fixed costs includes Fixed O&M, Maintenance Capital, and Natural Gas Firm Transportation. [↑](#footnote-ref-3)