Technical Memorandum

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Date: *October 29, 2010*

Subject: *Statewide Energy Sector Water Demand Forecast*

1.0 Introduction

Presented in this technical memorandum is the Georgia statewide energy sector water demand forecast through 2050. For the purposes of this analysis, forecasted water demands are associated with future energy sector utilities' (NAICS 22) power generation. Water demands associated with power generation by facilities with other industry codes are captured as part of the municipal and industrial water demand forecasts already completed on a regional basis. The intention of this effort is to produce a statewide energy utilities' water demand forecast through 2050. The forecast is designed to support statewide water resources planning and is not intended to support future energy planning needs.

This technical memorandum discusses both water withdrawal requirements and water consumption for energy generation within the state. Information related to water withdrawals is an important consideration in planning for the water needed for energy production. However, water consumption is the more important element when assessing future resources because a large volume of water is typically returned to the environment following the energy production process. The overall water consumption in the state associated with energy production in 2005 was only about 7 percent of total water withdrawals for energy production.

This forecast does not focus specifically on regional demands, but rather is meant to forecast energy sector water demands at the state level. Total statewide demands are geographically disaggregated through the forecast year 2020 based on a set of assumptions applicable to all power generating facilities in the state and according to the location of known and planned power generating facilities confirmed by the Georgia Environmental Protection Division (EPD) and an energy sector ad hoc group. Following 2020, the demands associated with existing and planned facilities can be separated from the demands associated with the power generating capacity assumed to become available based on recent trends in additional capacity statewide and energy sector ad hoc group guidance. No assumptions are made regarding the location of the additional capacity and it is assumed that power generated from this capacity will operate in a manner identical to existing and planned facilities. As such, any geographic disaggregation of statewide demands represents an estimate based upon a detailed set of assumptions.

There are several limitations of assumptions for forecasting energy and water demand. These include, but are not limited to:

- Historical economic conditions that affect electricity demand (i.e. recession periods) influence the forecast and may not reflect future actual performance.
- Historical energy data are not adjusted for weather.
- Future environmental regulatory changes (i.e. CO_2, air and water quality, waste) that may have significant impacts to the electric utility industry and power generation choices are not reflected in this forecast.
- Future electricity usage per capita changes may also have significant impacts on electricity demand and are not reflected in this forecast.
- Estimates for future water needs for power generation do not anticipate technology advancements that may affect water needs.

In addition to this introduction section, this technical memorandum consists of six sections:

- Section 2, Statewide Withdrawal and Consumption Rates for Power Generation – Presents the analysis and calculation of statewide water withdrawal rates and water consumption rates associated with energy generation within the State of Georgia
- Section 3, Future Power Needs – Presents the relationship between historical statewide energy generation and population and how that relationship is used to project future statewide energy needs
- Section 4, Baseline Water Demand Forecast – Presents the assumptions and results of the baseline statewide energy sector water demand forecast through 2050
- Section 5, Alternative Forecast Scenarios – Presents the assumptions and results of the alternative statewide energy sector water demand forecast through 2050
- Section 6, Baseline and Alternative Power Needs Water Demand Forecast Summary – Provides a comparison of the results of both the baseline and alternative water demand forecasts
- Section 7, References

2.0 Statewide Withdrawal and Consumption Rates for Power Generation

Forecasting future energy water needs at the state level requires defensible estimates of the rate at which particular power generating units withdraw and consume water for the production of energy. A literature search revealed three nationally scoped studies (EPRI, 2008; EPRI, 2002; Dziegielewski and Bik, 2006) that offered insight to the range of values likely to be observed. The studies reflect the fact that there is a high degree of inter-annual variability in power production and water demands due to factors such as weather, the price of a particular fuel, and other facility-specific issues; thus there are quite defensible ranges of water withdrawal and consumption rates. With this as context, universally accepted benchmarks are debatable.

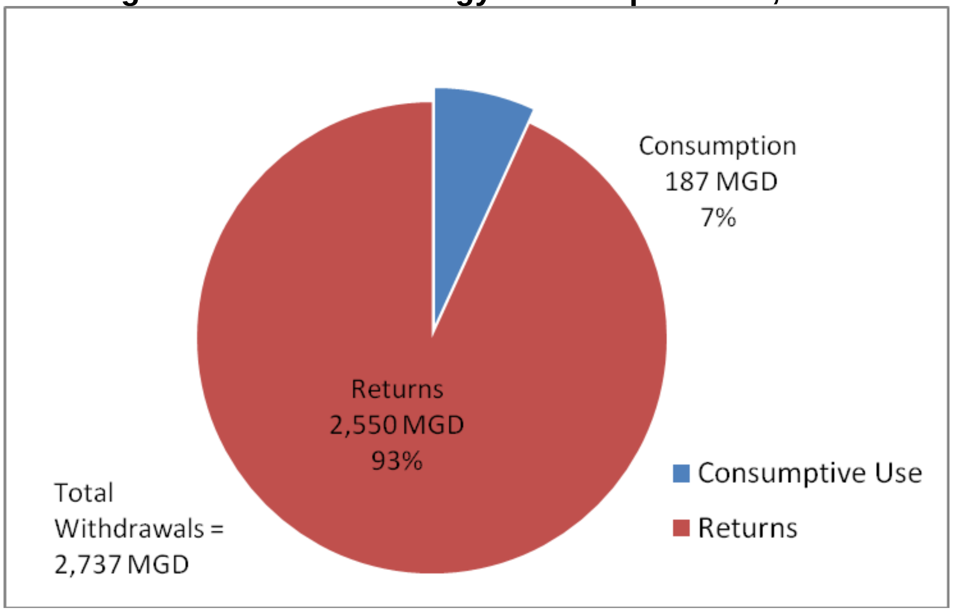
It is important to note the distinction between requirements for water withdrawal and water consumption during the thermoelectric power generation process. The majority of thermoelectric power generation water use occurs as part of a facility's cooling process. Cooling water withdrawal requirements are proportional to the quantity of steam being condensed. Low flow rates are associated with a high temperature differential, and vice versa. Water consumption refers to the water that is lost to the environment mostly as a result of evaporation during the cooling process. While the availability of water for withdrawal is a necessary precursor for most thermoelectric power generation processes, it is the water consumed that drives future potential water resource supply gaps.

Figure 1 shows the proportion of statewide water withdrawals for energy production that is consumed and returned. Statewide, 93 percent of withdrawals are returned and only 7 percent is consumed in energy generation.

The majority of thermoelectric power plants employ either once-through or recirculated cooling. Power plants with once-through cooling (also known as single pass cooling) require large amounts of water withdrawals for the cooling process. These plants consume a relatively small amount of the water they withdrawal. The cooling water is run through a condenser in a single pass and discharged back into the source water body at slightly higher temperatures without ever coming into contact with the air. The once-through cooling process typically consumes less than 1 percent of the water withdrawn (EPRI, 2002).

Power plants using recirculated cooling water have much have lower withdrawal rates than once-through facilities because rather than running the cooling water through the condenser in a single pass in a closed system, warmed cooling water is pumped from the steam condenser to a cooling tower or pond. During this process the warmed cooling water comes into contact with the air, allowing a portion of the water to be evaporated. The cooled water is then recycled back to the condenser. As a result of the recirculation, less water is required for cooling; however, a much greater portion of the cooling water is consumed.

Figure 1 Statewide Energy Consumptive Use, 2005



In addition to a facility's cooling type, its method of power generation is a determinant of its water use characteristics. The prime mover (e.g., steam turbine, gas combustion turbine, and combined-cycle) is a determining factor because water is only required during processes involving steam turbines. The type of fuel used to produce the power is a factor to a lesser degree. For example, the water requirements of a coal-fired generator powering a steam turbine and using cooling towers is not significantly different than a biomass powered steam turbine using cooling towers.

By contrast, the type of prime mover and cooling type does have a significant impact on water requirements when the fuel type is the same. For instance, according to EPRI (2008), a natural gas combined-cycle generator with cooling towers withdraws water at a rate of about 175 to 250 gallons per MWh of power produced. The EPRI 2008 report does not provide estimates of water consumption per MWh produced. According to the EPRI 2002 report, natural gas combined-cycle plants with cooling towers consume about 180 gallons per MWh. On the other hand, a natural gas powered steam turbine with cooling towers requires 20,000 to 35,000 gallons per MWh produced (EPRI, 2008) and consumes approximately 300 gallons per MWh (EPRI, 2002). This is because a natural gas combined-cycle process with cooling towers derives only about one-third to one-half of its net power output from the steam turbine (EPRI, 2008).

Overall there are five fuel type/prime mover/cooling type power generation combinations included in this analysis of water withdrawal and consumption rates, not including hydroelectric power generation. **Table 1** presents the most common fuel type/prime mover/cooling type combinations within the state. Statewide energy water demand is forecasted for each of the power generation combinations in **Table 1**. The last column of **Table 1** shows the combination abbreviation found in many of the tables in this report.

Table 1 Fuel Type/Prime Mover/Cooling Type Combinations in Analysis

Fuel Type	Prime Mover	Cooling Type	Table Abbreviation
Natural Gas	Combined-Cycle	Cooling Tower	NG,CC,CT
Fossil/Biomass[1]	Combustion (gas) Turbine	N/A	FF/Bio,GT
Fossil/Biomass[1]	Steam Turbine	Once-through	FF/Bio,ST,OT
Fossil/Biomass[1]	Steam Turbine	Cooling Tower	FF/Bio,ST,CT
Nuclear	Steam Turbine	Cooling Tower	Nuc,ST,CT

[1] Fossil fuels include coal, fuel oil, and natural gas.

Tables 2 and **3** show estimated withdrawal and consumption rates for some of the common fuel types and cooling system types in Georgia derived from the nationwide studies by EPRI (2002 and 2008) and Dziegielewski and Bik (2006), respectively. These two literature sources do not explicitly identify the prime mover with the exception of natural gas combined-cycle units. It should be noted, however, that steam turbines are the assumed prime mover for all combinations presented in **Tables 2** and **3** with the exception of natural gas combined-cycle units. The only other prime mover examined in this analysis are combustion turbines, which do not have an associated cooling type and require minimal water use. As such, the literature sources presented in **Tables 2** and **3** do not identify water withdrawal and consumption rates for generator units powering combustion turbines.

Table 2 EPRI Withdrawal and Consumption Rates

Fuel Type and Cooling System Type	Water Withdrawal (gal/MWh) EPRI, 2008	Typical Water Consumption (gal/MWh) EPRI, 2002
Fossil/biomass, once-through cooling[1]	20,000 – 45,000	~300
Fossil/biomass, cooling towers[1]	500 – 800	~480
Nuclear, cooling towers	750 - 900	~720
Natural gas, combined-cycle, cooling towers	175-250	~180

[1] Fossil fuels include coal, fuel oil, and natural gas.

Table 3 Dziegielewski and Bik, Regression-based Withdrawal and Consumption Benchmarks

Fuel Type and Cooling System Type	Water Withdrawal Minimum/Avg/Maximum (gal/MWh)	Water Consumption Minimum/Avg/Maximum (gal/MWh)
Fossil/biomass, once-through cooling[1]	N/A / 78,000 / 181,000	1,700 / 3,100 / 4,100
Fossil/biomass, cooling towers[1]	40 / 1,200 / 2,400	500 / 900 / 1,500
Nuclear, cooling towers	900 / 1,500 / 2,300	N/A / 770 / N/A
Natural gas, combined-cycle, cooling towers	N/A	N/A

[1] Fossil fuels include coal, fuel oil, and natural gas.
Source: Dziegielewski and Bik, 2006
N/A – not included in report

2.1 Data Sources

In determining statewide power generation water withdrawal and water consumption rate estimates for Georgia, two primary sources of data were utilized. First, water withdrawal data were obtained from EPD in the form of two Microsoft Access databases. One database contained all permitted surface water withdrawals in the State of Georgia. The second database contained all permitted groundwater withdrawals in the state. In total, there are 15 thermoelectric facilities with surface water withdrawal permits and 9 thermoelectric facilities with groundwater withdrawal permits in the database; additionally there are 10 hydroelectric facilities with surface water withdrawal permits. Nearly all (99.9 percent) of the base year (i.e., 2005) water withdrawals were from a surface water source.

Data and information related to the amount of power generated, fuel type, cooling type, and prime mover for electric utility (NAICS 22) facilities within the state were obtained from the U.S. Energy Information Administration (EIA). All pertinent power facility information was not confined to a single EIA database; rather several EIA "forms" were downloaded in order to gather all the necessary information. **Table 4** summarizes the EIA sources for each specific type of data utilized in the process of determining statewide water withdrawal and consumption rates. Forms were downloaded for all years of analysis.

Table 4 EIA Data Source Forms

EIA Form	Data/Information Contained
EIA-767	Facility cooling system type
EIA-860	Generator unit capacity
EIA-906/920	Generator unit fuel type, prime mover, and power generation

2.2 Methodology

Five years of water withdrawal and power generation data were analyzed in the calculation of statewide water withdrawal and consumption rates. Facility water withdrawal and consumption data, as well as individual generator unit power generation data from 2003 to 2007 were included in the analysis. The facilities included in the analysis are those with water withdrawal permits issued by EPD. These facilities represent more than 95 percent of the overall thermoelectric power generated in the state by power utilities (identified in the EIA-906/920 database as NAICS 22). **Table 5** provides a list of all facilities included as part of this analysis. **Table 6** shows the total power generated (in gigawatt hours) by these 15 facilities from 2003 to 2007, the statewide total thermoelectric NAICS 22 power generated in those years, and the percent of the statewide total thermoelectric NAICS 22 power generated represented by the facilities included in the analysis.

Table 5 Thermoelectric Power Facilities Included in Analysis

Facility Name	County
Plant Bowen	Bartow
Plant Branch	Putnam
Chattahoochee Energy Facility	Heard
H Allen Franklin[1]	Lee (Alabama)
Plant Hammond	Floyd
Plant Hatch	Appling
Plant Jack McDonough	Cobb
Plant McIntosh	Effingham
Plant McManus	Glynn
Plant Mitchell	Dougherty
Plant Scherer	Monroe
Vogtle	Burke
Plant Wansley	Heard
Plant Wentworth (Kraft)	Chatham
Plant Yates	Coweta

[1] Plant is physically located in Alabama; water withdrawal permit from Georgia EPD

Table 6 Analysis Facilities and Total State Electric Utility Power Generation (in Gigawatt Hours)

	2003 GWh	2004 GWh	2005 GWh	2006 GWh	2007 GWh
Analysis Facilities	114,902	119,232	126,820	129,949	136,794
State Total	116,372	121,410	129,582	133,265	141,771
Analysis Facilities % of Total	99%	98%	98%	98%	96%

Withdrawal rates were calculated as the total facility water withdrawals divided by total generator unit power generated for each particular year. Consumption rates were calculated as total facility water consumption divided by total generator unit power generated for each particular year.

Some facilities have multiple power generator units producing energy through processes with different water requirements. For instance the Wansley facility in Heard County has four natural gas combined-cycle units (Unit 6, Unit 7, Unit 8, also known as Chattahoochee, and Unit 9) and two steam turbine, fossil fuel generating units. However, water withdrawal and consumption data were facility specific rather than generator unit specific. Therefore, generator-specific withdrawal and consumption rates had to be calculated at each facility in order to arrive at statewide metrics of water withdrawal and consumption rates for each particular power generation combination.

For facilities with multiple generator units with the same prime mover and cooling system reported, the rate of withdrawal and consumption could be calculated for the entire facility rather than by generator unit. Therefore, the combined power generated by those units was used as the denominator in the gallons per megawatt hour calculation and total facility withdrawal and consumption was used as the numerator.

In determining water withdrawal and consumption rates for each year of analysis, two facilities had to be treated uniquely. Plants McIntosh and Wansley both have natural gas combined-cycle generators as well as fossil fuel steam turbine generators associated with the single reported value for water withdrawals and consumption. In order to derive a value for gallons of water withdrawn per megawatt hour generated for individual generator units at these two facilities, the EPRI (2002) estimate for typical withdrawals per MWh generated by natural gas combined-cycle generators was used. The EPRI (2002) value of 230 gallons per MWh was used to estimate the portion of total facility withdrawals attributable to power generated by natural gas combined-cycle units. Total facility withdrawals reported minus the estimated natural gas combined-cycle withdrawals resulted in an estimation of the withdrawals that were attributed to the fossil fuel steam turbine generator units at each facility. These withdrawals were divided by the power generated during that year by the respective unit to derive the withdrawal rate for fossil fuel steam turbine units. The same approach was adopted in determining consumption rates; however, the EPRI (2002) estimated value of 180 gallons per MWh was used.

Once generator-specific withdrawal and consumption metrics were calculated, a weighted average of all units of the same power generation combination was calculated based upon the amount of power generated by unit for each year. The average of the 5-year weighted averages resulted in the final withdrawal and consumption metrics used in forecasting energy water demands for electric utility (NAICS 22) facilities within the state.

2.3 Results

Table 7 shows the result of the 5-year data analysis. As would be expected, there was year-to-year variability observed over the 5-year period. Withdrawal rates for once-through cooling systems fell within the high end of the range developed by EPRI (2008). Withdrawal rates observed for fossil fuel/biomass with cooling towers were above the rates developed by EPRI. Withdrawal rates for natural gas combined-cycle facilities are on target with those developed by EPRI. Rates observed for nuclear facilities with cooling towers were above the range developed by EPRI and slightly below the average developed by Dziegielewski and Bik.

Consumptive use at facilities with once-through cooling is minimal compared to facilities with closed-loop cooling systems. Water consumption at the facility itself is minimal or zero because water does not come in direct contact with the air (Torcellini and Judkoff, 2003). However, the increased temperature of the discharged water increases the evaporation rate of the receiving body of water, indirectly increasing the amount of water consumption associated with the generation of power at the facility.

Results from the analysis show consumption rates for fossil/biomass facilities with once-through cooling as zero. Based on information provided from the ad hoc group and Georgia EPD, it was determined that once-through facilities discharge amounts about equal to their surface water withdrawals and consumption is negligible. Therefore, for the purposes of developing the statewide energy sector water demand forecast, consumptive use at once-through facilities is assumed to be zero. Although there is no regulation currently in place to prevent the construction of plants with once-through cooling, it is unlikely that any new facilities with once-through cooling will be built in Georgia in the future.

Results for consumption rates for fossil/biomass facilities with cooling towers are between the EPRI estimate and average rate developed by Dziegielewski and Bik. Natural gas combined-cycle consumption rates are only slightly higher than EPRI (2002) estimates. Nuclear facilities with cooling towers exhibited consumption rates about 110 to 160 gallons per MWh greater than the estimates by Dziegielewski and Bik and EPRI (2002) respectively.

For the purposes of developing a statewide energy sector water demand forecast, the 5-year withdrawal and consumption rate averages presented in **Table 7** were used.

Table 7 Withdrawal and Consumption Rates Analysis Results

WATER WITHDRAWALS (in gallons) PER MWh

Power Generation Combination	2003	2004	2005	2006	2007	5-Year Avg.	Difference from EPRI (2008) Range Estimate
FF/Bio, ST, OT	43,891	42,301	39,010	39,036	40,785	**41,005**	w/in range
FF/Bio, ST, CT	1,130	1,176	1,244	1,098	1,116	**1,153**	+353
FF/Bio, GT[1]	0	0	0	0	0	**0**	N/A
NG, CC, CT	220	241	228	215	222	**225**	w/in range
Nuc, ST, CT	1,371	1,284	1,435	1,401	1,370	**1,372**	+472

WATER CONSUMPTION (in gallons) PER MWh

Power Generation Combination	2003	2004	2005	2006	2007	5-Year Avg.	Difference from EPRI (2002) Estimate
FF/Bio, ST, OT	0	0	0	0	0	**0**	N/A
FF/Bio, ST, CT[2]	496	595	540	563	643	**567**	+87
FF/Bio, GT[1]	0	0	0	0	0	**0**	N/A
NG, CC, CT	196	209	187	192	205	**198**	+18
Nuc, ST, CT	867	854	914	890	875	**880**	+160

ABBREVIATIONS

Fuel Type:	Prime Mover:	Cooling Type:
FF – Fossil Fuel (includes coal, fuel oil, and natural gas)	ST – Steam turbine	OT – Once-through
Bio – Biomass	CC – Combined-cycle	CT – Cooling Tower
NG – Natural Gas	GT – Combustion (gas) turbine	
Nuc - Nuclear		

[1] Input from the energy sector ad hoc group indicated that there is minimal cooling or water use/consumption associated with simple-cycle gas turbines. EPRI (2002) supports this assumption, stating that gas turbines are virtually all simple-cycle designs and therefore do not involve steam cycles and would be "too small in number to worry about quantifying for freshwater consumption projections." Withdrawal and consumption per megawatt hour was assumed to be zero.

[2] Plant Harlee Branch has a unique cooling system that employs a combination once-through condenser and part-time once-through cooling tower. Consumptive use at Plant Harlee Branch is not incorporated into the water consumption rates for either the fossil fuel/biomass once-through or cooling tower combinations.

2.4 Data Comparisons

Water withdrawal and consumption rates for several facilities fell outside of the ranges developed in the nationwide studies by EPRI and Dziegielewski and Bik. The 5-year average water withdrawal rates for generators at plants Wansley, McManus, Mitchell, and Yates were all above the ranges produced by EPRI and the averages developed by

Dziegielewski and Bik. The 5-year water consumption rate for Harlee Branch is well below both the EPRI and Dziegielewski and Bik rates.

Through dialogue with the energy sector ad hoc group, unique water use issues were identified at the facilities in question where possible. Thus Plants McManus, Mitchell, Wansley, and Yates were included in the analysis. Plant Harlee Branch has an atypical cooling system. Plant Branch requires water withdrawals similar to a once-through facility and consumes more water than a typical once-through facility, but less water than a typical cooling tower facility. As a result, the consumption rates for Plant Branch were removed from the 5-year weighted average of gallons of water consumed per megawatt hour generated.

Hydroelectric Power

The data available for water withdrawals by hydroelectric power facilities did not allow for an analysis that yielded a useful statewide metric for water withdrawal per MWh of hydroelectric generated power. Hydroelectric power facilities are in stream users of water and have no consumption in the actual generation process. Evaporation off the reservoirs is included in the water resource assessments.

There were ten hydroelectric facilities with EPD water withdrawal permit data reporting withdrawals between 2003 and 2007. Many of the large hydroelectric power facilities in Georgia do not have Georgia EPD water withdrawal permits. **Table 8** provides a list of the hydroelectric power facilities in the EPD surface water withdrawal database. Of the ten hydroelectric facilities listed in **Table 8**, the EIA form 906/920 database only contained power generation data for four facilities. EIA form 860 contained capacity data for the same four facilities.

Table 8 EPD Withdrawal Database Hydroelectric Power Facilities, 2003-2007

Facility Name	County
Crisp County Power Comm – Hydro	Worth
Eagle & Phenix Hydroelectric Project, Inc.	Muscogee
Fall Line Hydro Company, Inc	Clarke
Ha-Best, Inc.	Habersham
High Shoals Hydro, Inc.*	Oconee
Homestead Energy Resources, LLC	Early
Milstead Hydroelectric*	Rockdale
Oglethorpe Power Corp, Rocky Mountain Hydro*	Floyd
Porterdale Hydroelectric Assoc.*	Newton
Thomas Brothers Hydro, Inc.	Newton

*Denotes facility with power generation data available in EIA Form 906/920

Analysis of withdrawals per megawatt hour of power generated at these four facilities resulted in a wide range of outcomes. The gallon per megawatt hour withdrawal rate for the four facilities whose annual power generation data was able to be obtained from the EIA ranged from 917,909 gal/MWh in 2007 to 15,339,753 gal/MWh in 2006. The weighted 5-year average withdrawal per megawatt hour for those four facilities was 7,043,543 gal/MWh. The inconsistency of the results has led to the conclusion that the 5-year average of gallons withdrawn per megawatt hour of power generated is not a useful metric for forecasting purposes.

As part of this statewide energy sector water demand forecast, water withdrawals by hydroelectric facilities are not forecasted. Water withdrawals associated with hydroelectric facilities are not an off-stream use, other than a negligible amount of consumption due primarily to evaporation. In addition, it is unlikely that there will be any new growth in the number of major hydroelectric facilities in Georgia and the power generation from existing facilities is expected to remain constant into the future.

A literature review of hydroelectric power water use provided insight regarding a metric for determining hydroelectric power water consumption per megawatt hour of power generated. Torcellini and Judkoff (2003) developed state-level water consumption rates for hydroelectric power generation. According to the study, hydroelectric power generation in Georgia consumes 0.04742 gallons per megawatt hour of power generated. This consumptive use is almost entirely attributable to evaporation. Evaporative loss is accounted for as part of the surface water availability assessment. Therefore, for purposes of forecasting future power sector water demands, the consumptive use rate of 0.04742 gallons per megawatt hour of hydroelectric power generated is not employed in the forecast model.

3.0 Future Power Needs

Future statewide energy sector water demands are dependent upon future statewide power needs. To project the future power generation needs for the State of Georgia through 2050, it was necessary to understand the historical relationship between statewide power generation and state population, the "driver" of future power needs. Examining the relationship between statewide population and total energy utility (NAICS 22) power generation between 1990 and 2008 showed a highly positive correlation. The modeled relationship between statewide population and total megawatt hours generated by energy utilities is shown in **Table 9**. Total annual statewide electric utilities power generation data was obtained from the EIA form 906/920. Total annual state population was obtained from the U.S. Census Bureau.

A similar relationship was observed when examining gross state product as the independent variable and statewide utilities' power generation as the dependent variable. Because there are no available gross state product projections for the State of Georgia that have been developed through 2050 that could be used as a "driver" of statewide power needs, it was not possible to develop statewide power needs projections based upon this variable.

Table 9 Statewide Population and Electric Utilities Power Generation Model, 1990-2008

MODEL PARAMETERS				
Dependent Variable: Power Generation MWh				
Number of Observations				19
Dependent Mean				117,374,269
Coefficient of Variation				3.2303
Root MSE				3,791,485
Adj. R-Square				0.9358
Power Generation Parameter Estimates				
Variable	**Estimate**	**Standard Error**	**T Value**	**Pr > |t|**
Intercept	5,940,658	6,919,220	0.86	0.4025
Population	13.95816361	0.85983	16.23	<0.0001

The historical gross state product and state population data are also highly correlated. Because of this intercorrelation, it is not possible to use both of these variables simultaneously in relationship to power generation.

In early 2010, the Georgia Office of Planning and Budget (OPB) released statewide and county-level population projections through 2050. These projections were used in the development of the municipal demand forecasts and as the driver in projecting future statewide energy needs through 2050. Statewide projected population is shown in **Figure 2**. Statewide population projections show an increase of about 9.6 million between 2010 and 2050, increasing at a rate of 1.69 percent annually.

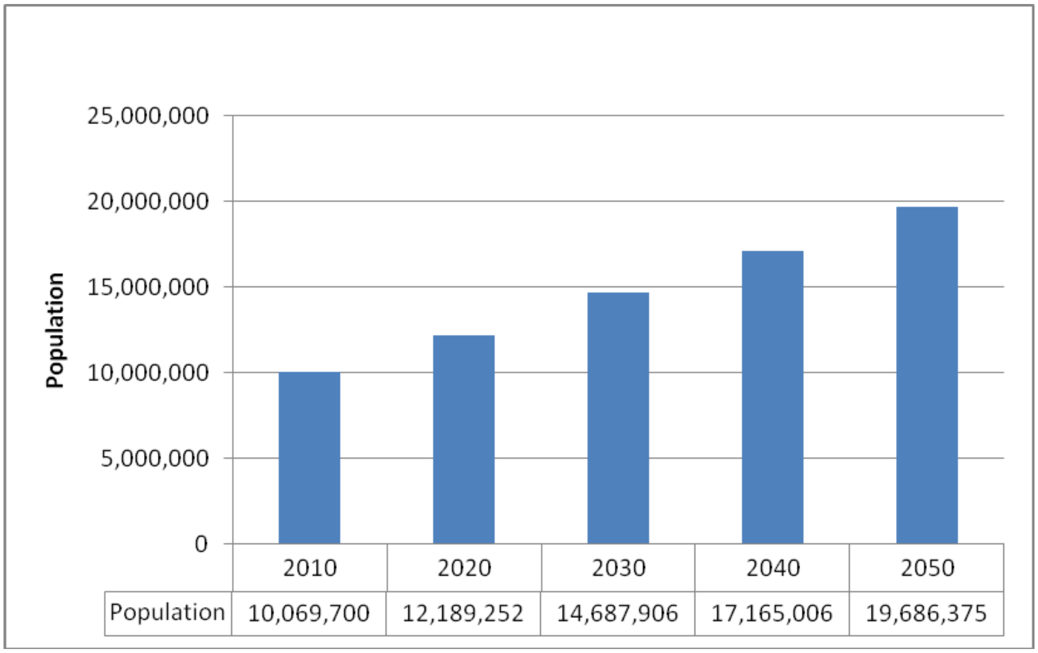
Using the OPB statewide population projections, total statewide power generation needs were projected based on the following equation:

Power Generation = Model Intercept + (Population Parameter * Projected Population)

Figure 3 shows the total projected statewide baseline power generation needs through 2050. Between 2010 and 2050, statewide power generation needs increase by 91.6 percent total, 1.64 percent annually.

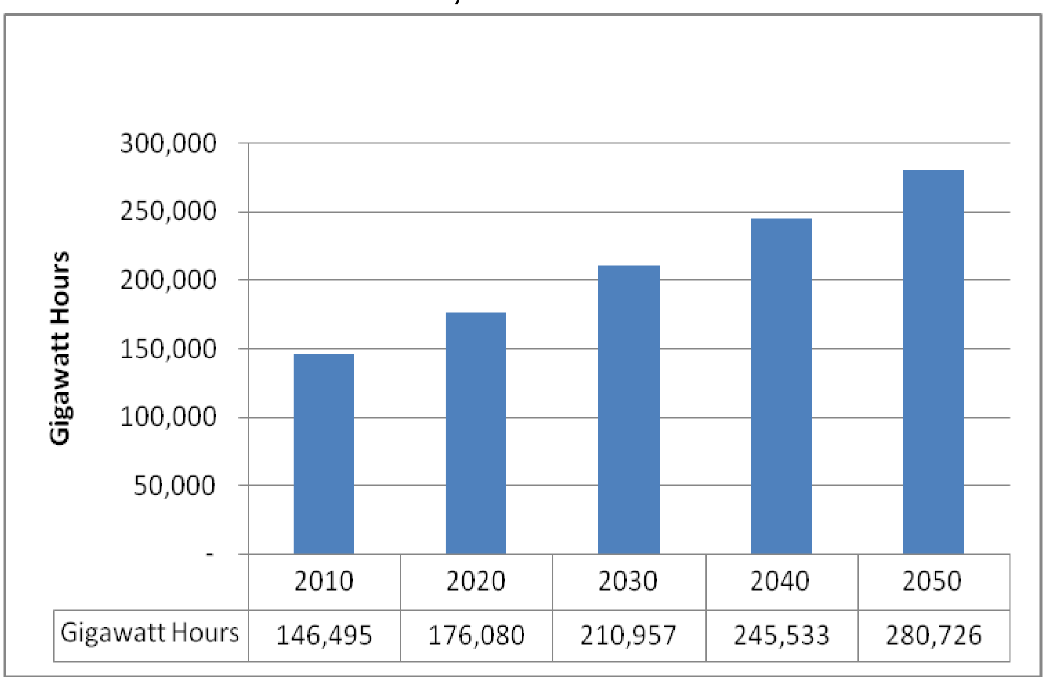
The alternative power needs projection is discussed in Section 5 of this report, following the discussion of water requirements associated with the baseline power generation projection.

Figure 2 Georgia Population Projections, 2010 - 2050



Source: Georgia OPB

Figure 3 Projected Statewide Power Generation Needs in Georgia 2010-2050, Baseline Scenario



4.0 Baseline Water Demand Forecast

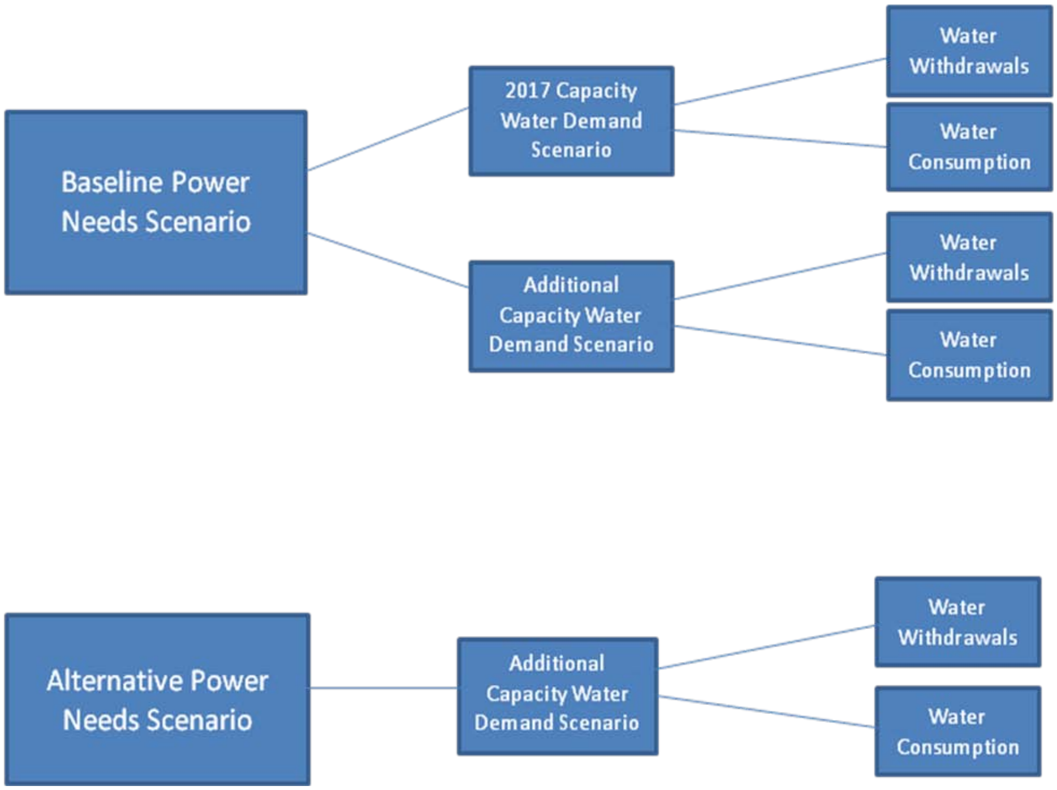
4.1 Water Demand Forecast Scenarios

Two water demand forecast scenarios were developed (2017 Capacity and Additional Capacity). Each scenario involves different assumptions regarding the availability of future power generating capacity in the state. The water demand forecast scenarios are discussed below. For each the additional capacity scenario, forecasts were developed for the baseline statewide power needs projection (discussed in Section 3 above) and an alternative statewide power needs projection. The alternative power needs projection will be discussed in detail in Section 5 of this report. **Figure 4** provides a diagram of the different statewide water demand forecasts developed.

<u>2017 Capacity Scenario</u>

The first water demand scenario involves the assumption that no additional generating capacity will be added beyond what is most likely to be developed through 2017. This scenario is called the *2017 capacity scenario*. The purpose of this scenario is to allow Water Planning Councils (Councils) to assess future water resource demands associated with power generation at current and planned facilities. Under this scenario, Councils can plan for water resources management under a scenario whereby the geographical distribution of water demands is based upon the location of current and planned facilities and those facilities' water demand is forecasted until maximum sustainable capacity factors are reached. This scenario was developed for illustrative purposes based on existing and planned facilities in order to determine how far into the future existing and planned facilities can meet energy needs. It is not a likely scenario because under it forecasted power needs are not met in the future. Maximum sustainable capacity factors for each of the power generation combinations, with the exception of hydropower, were provided by the energy sector ad hoc group. For the purposes of this statewide water demand forecast, hydropower capacity factors were assumed to be 10 percent for all forecast years.

Figure 4 Energy Sector Water Demand Forecast Scenario Diagram



Additional Capacity Scenario

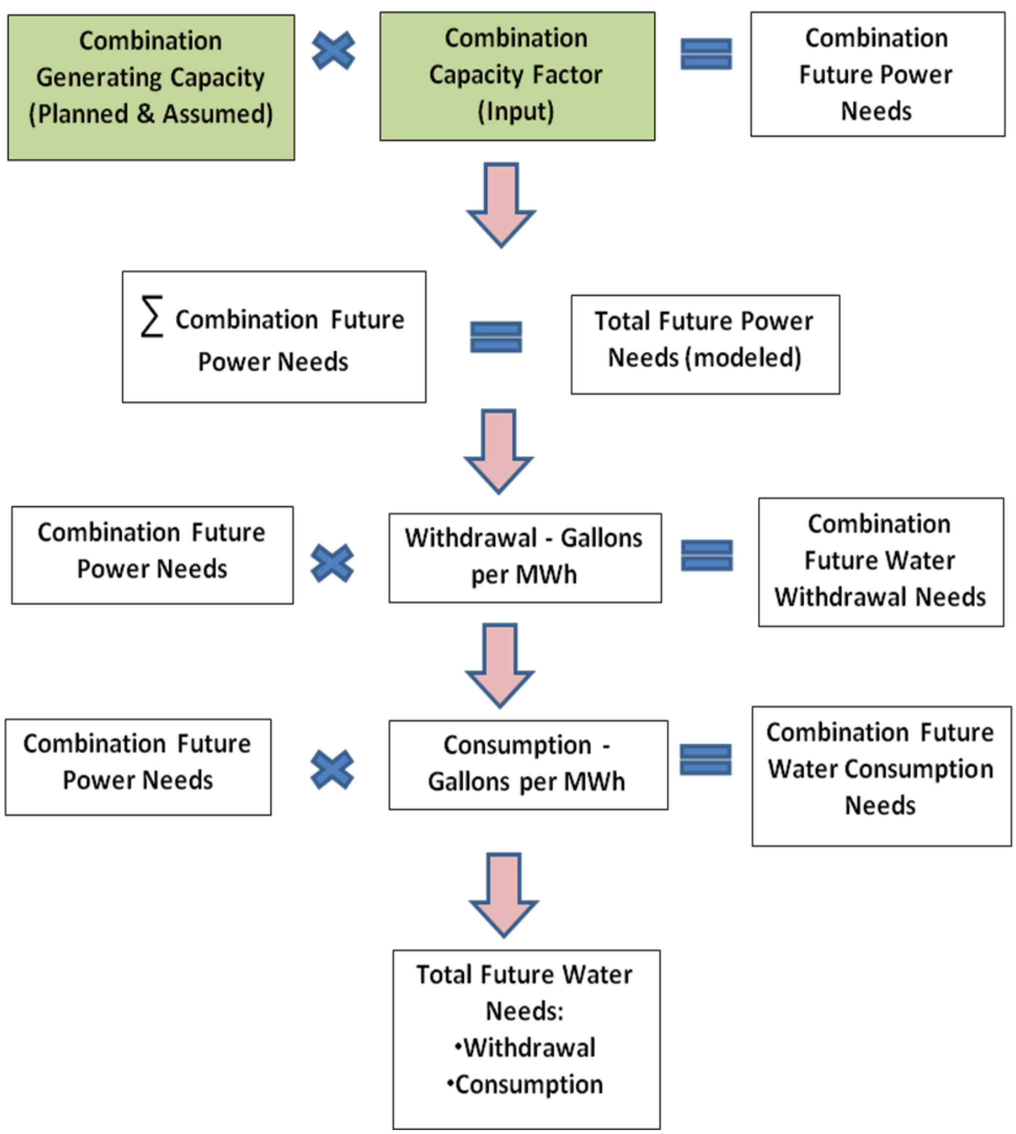
The second water demand scenario involves the assumption that there will be additional capacity added in order to meet future energy needs. This capacity will be added beyond what currently exists and what is planned to be developed through 2017. This scenario is called the *additional capacity scenario*. Under this scenario the location of the additional capacity beyond 2017 is unknown and is not speculated, however, additional accommodating capacity is added into the demand model throughout the forecast planning horizon. The purpose of the *additional capacity scenario* is to determine statewide energy sector water demands associated with existing and planned facility capacity through 2017 and the demands associated with the assumed additional capacity beyond 2017.

4.2 Water Demand Forecast Model Design

Figure 5 provides a diagram of how future energy sector water demands are calculated within the demand forecast model. In the diagram, the generating capacity of a given power generation combination through 2020 is assumed to be equal to its current (i.e.,

2008) capacity unless additional capacity by new or expanding facilities is known. Assumed additional capacity beyond 2017 is discussed in Section 4.3.3. If additional future capacity is assumed for a particular power generation combination, that capacity is added to the total combination capacity for the year the capacity is scheduled to be available. For example, it is known that between 2015 and 2020 the Vogtle nuclear power facility will be adding an additional 2,204 MW of capacity. Therefore, nuclear generating capacity is increased by 2,204 MW in 2020 in the forecast model.

Figure 5 Energy Sector Water Demand Forecast Model Diagram



Forecasted power needs are met by adjusting the capacity factors for each power generation combination. The capacity factor for each power generation combination is multiplied by the total statewide capacity associated with that combination to derive the total power generated by combination. Capacity factors are adjusted so that total power generated equals the total statewide power needs.

The power generated by combination is then multiplied by the appropriate rate of withdrawal/consumption presented in Section 2.3 above to derive the water demand associated with each power generation combination. The total demand of all combinations represents the statewide energy sector water demand forecast total.

4.3 Baseline Demand Forecast Model Assumptions

The development of the two baseline energy water demand forecasts involved formulating an extensive set of assumptions. Many of the characteristics of the energy sector are difficult to predict because of numerous influential variables. Factors such as weather, fuel price, and political and regulatory policy all influence power production characteristics. For the purposes of developing the statewide energy sector water demand forecast, assumptions had to be made regarding the future generating capacity needed statewide and the power generating combinations to receive the additional capacity, the future capacity factors of the various power generating combinations, and the future of non-biomass and non-hydroelectric renewable energy in the state.

4.3.1 Planned Facility Capacity

Georgia EPD provided information regarding planned new electric utility facilities and expansion/conversion of existing facilities that submitted air permit applications with EPD. The list contained multiple facilities whose future is largely unknown. With the assistance of Georgia EPD and the energy sector ad hoc group, the facilities most likely to become operational were identified. **Table 10** shows the planned facilities identified by Georgia EPD and the energy sector ad hoc group, their approximate capacity, fuel type, prime mover, cooling type, and estimated year of operation. The additional capacity associated with these facilities is incorporated into the demand model to allow for a more accurate representation of future generating capacity by power generation combination.

Table 10 Planned Energy Utility Facilities in Georgia

Plant Name	Capacity (MW) approx.	Fuel Source	Prime Mover	Cooling Type	Planned Year of Operation
Plant Mitchell	-59[1]	Biomass	ST	OT	2013
McDonough Unit Retirement	-259	Fossil Fuel	ST	CT	2011
McDonough Units 4&5	1682	Natural Gas	ST	CT	2012
McDonough Unit Retirement	-258	Fossil Fuel	ST	CT	2012
McDonough Unit 6	841	Natural Gas	ST	CT	2013
Vogtle Unit 3	1102	Nuclear	ST	CT	2016
Vogtle Unit 4	1102	Nuclear	ST	CT	2017
Bainbridge Power	170	No. 2 Fuel Oil	Simple-Cycle	N/A	b/w 2010 and 2015
Paul Creek Energy Center, LLC	225	Natural Gas	Simple-Cycle	N/A	b/w 2015 and 2020
Plant Washington	850	Coal	ST	CT	b/w 2010 and 2015
Longleaf Energy Station	1,200	Coal	ST	CT[2]	b/w 2015 and 2020[3]
Oglethorpe Power – Monroe County[4]	1,200	Natural Gas	Combined-Cycle	CT	b/w 2015 and 2020
Warren County Biomass Energy Facility	100	Biomass	ST	CT	2015[5]
Total	**7,896**				

[1] Conversion from 155 MW coal-fired boiler into a 96 MW biomass-fired boiler. Note- work on the conversion of this plant has been suspended pending EPA Industrial Boiler MACT regulations.
[2] Longleaf Air Quality Permit (4911-099-033-P-01-1) dated April 9, 2010 indicates the construction of cooling towers.
[3] Currently under litigation. Air quality permit states that construction shall be completed no later than December 31, 2015. Therefore, additional capacity from the Longleaf facility is assumed to be available between 2015 and 2020.
[4] Additional generating capacity and planned year of operation identified by Oglethorpe Power via the energy sector ad hoc group meeting on 8/3/10.
[5] Planned year of operation identified by Oglethorpe Power via email to author dated 8/11/10.

4.3.2 Power Generation Combination Capacity Factors Through 2020

Holding current (i.e., 2008, the most recent year of available data from EIA) power generation combination capacity factors constant results in an underestimation of overall power needs in future years. This is because current capacity factors are associated with current power generation.

There is a high degree of variability that exists year-to-year with respect to the power generated by a particular power generation combination. For example, between 2003 and 2007, fossil fuel once-through cooling power generation units in the state produced energy at between 45 and 65 percent of capacity on average. Future power needs will be higher and capacity factors will need to keep pace with increasing power demands. Thus, assumptions regarding the changes in future capacity factors are required. The future generating capacity factor assumptions made were informed by recent historical data and trends and by guidance of the energy sector ad hoc group.

Within the forecast model, the assumed capacity factors for each power generation combination determine the power generated by that combination. It is assumed that all facilities with a common power generating combination will operate at the same statewide capacity factor. Therefore the statewide combination capacity factor is applied to the total statewide available capacity for the power generation combination to derive the total power generated for each power generation combination.

Tables 11 and **12** show power generation combination capacity factors from 2003-2007 in blue as well as the assumed capacity factors for every five-year increment between 2010 and 2050 in red for the *baseline 2017 capacity scenario* and the *baseline additional capacity scenario,* respectively. In **Table 11**, the capacity factors are the same for the years 2045 and 2050 because the maximum sustainable capacity factors are assumed to have reached their reasonable upper limits. The capacity factors in red can be adjusted within the water demand forecast model.

Table 11 Power Generation Capacity Factors, Actual and Assumed, Baseline 2017 Capacity Scenario

	ACTUAL					ASSUMPTIONS								
Power Generation Combination	2003	2004	2005	2006	2007	2010	2015	2020	2025	2030	2035	2040	2045*	2050*
NG, CC, CT	10.8%	15.3%	16.8%	22.5%	27.8%	26.8%	22.2%	19.4%	25.0%	30.0%	36.1%	47.5%	50.0%	50.0%
FF/Bio, GT[1]	0.6%	0.4%	0.7%	1.2%	1.9%	3.8%	4.0%	2.0%	5.0%	8.0%	11.0%	15.0%	15.0%	15.0%
FF/Bio, ST, OT[1]	49.3%	45.3%	55.1%	54.2%	64.7%	57.0%	56.0%	53.0%	57.6%	65.0%	72.0%	85.0%	85.0%	85.0%
FF/Bio, ST, CT[1]	64.5%	67.8%	72.2%	71.4%	72.1%	74.0%	73.0%	68.0%	74.0%	79.9%	85.0%	85.0%	85.0%	85.0%
Nuc, ST, CT	93.9%	95.3%	89.1%	90.4%	91.9%	90.0%	89.0%	89.0%	90.0%	91.0%	92.0%	93.0%	93.0%	93.0%
Hydro	13.3%	10.1%	13.6%	7.7%	6.5%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%

*Maximum sustainable capacity factors do not meet projected statewide power needs.
[1] Fossil fuels include coal, fuel oil, and natural gas.

Table 12 Power Generation Capacity Factors, Actual and Assumed, Baseline Additional Capacity Scenario

	ACTUAL					ASSUMPTIONS								
Power Generation Combination	2003	2004	2005	2006	2007	2010	2015	2020	2025	2030	2035	2040	2045	2050
NG, CC, CT	10.8%	15.3%	16.8%	22.5%	27.8%	26.8%	22.2%	19.4%	19.0%	17.0%	17.5%	17.0%	17.0%	17.0%
FF/Bio, GT[1]	0.6%	0.4%	0.7%	1.2%	1.9%	3.8%	4.0%	2.0%	2.0%	2.0%	3.0%	2.5%	3.0%	2.0%
FF/Bio, ST, OT[1]	49.3%	45.3%	55.1%	54.2%	64.7%	57.0%	56.0%	53.0%	53.0%	53.0%	53.0%	53.0%	53.0%	53.0%
FF/Bio, ST, CT[1]	64.5%	67.8%	72.2%	71.4%	72.1%	74.0%	73.0%	68.0%	69.1%	67.0%	67.0%	65.7%	66.3%	65.3%
Nuc, ST, CT	93.9%	95.3%	89.1%	90.4%	91.9%	90.0%	89.0%	89.0%	90.0%	89.0%	89.0%	89.0%	89.0%	89.0%
Hydro	13.3%	10.1%	13.6%	7.7%	6.5%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%

[1] Fossil fuels include coal, fuel oil, and natural gas.

4.3.3 Additional Capacity Beyond 2020

For the purposes of developing the *additional capacity scenario* water demand forecast, it was assumed that there will be additional power generation capacity added beyond 2020 to accommodate the projected statewide power generation needs. It is unknown as to which power generation combination will receive the additional capacity. Discussions with energy sector stakeholders have indicated that it is unlikely that significant additional power generation capacity will be added for generator units using once-through cooling processes due to environmental regulations and policy promoting closed cycle cooling. Discussions with EPD indicate that it is unlikely that additional major hydropower generation capacity will be developed in the future.

There are plans for nine biomass-powered electric utility facilities in Georgia, however, the expected year of capacity availability is known for only two facilities (Plant Mitchell in 2012 and Warren County Biomass in 2015). According to an EPD list of planned power generating facilities in Georgia, among all planned biomass facilities, there is an additional 472 MW of new biomass derived energy production capacity that is planned to become available. Because of uncertainty regarding if and when those facilities will come online, their additional capacity is not incorporated into the forecast model with the exception of Plant Mitchell and the Warren County Biomass facility.

For power generation combinations excluding fossil/biomass once-through and hydropower, it is reasonable to assume that additional capacity will become available in years beyond 2020. A Governor's Energy Policy Council Staff Research Brief (GEFA) indicates projected growth in statewide energy demand of approximately 1,000 MW per year. For this analysis, the authors assume that 1,000 MW of additional capacity per year is added after 2020. No specific guidance was identified pertaining to the disaggregation by power generation combination temporally. Per the energy sector ad hoc group's suggestion, for planning purposes, no additional capacity for fossil fuel/biomass generators with once-through cooling will be added over the planning horizon. **Table 13** shows the assumptions made for additional capacity by generation combination between 2020 and 2050. The assumptions for additional capacity apply to forecasts developed for both the baseline power needs and alternative power needs scenarios. These assumptions can be adjusted within the forecast model.

Table 13 Assumed Additional Generating Capacity Beyond 2020, in Megawatts

Power Generation Combination	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
NG, CC, CT	2,000	1,000	2,000	1,000	2,000	1,000
FF/Bio, GT[1]	1,000	1,000	1,000	1,000	1,000	1,000
FF/Bio, ST, CT[1]	2,000	2,000	2,000	2,000	2,000	2,000
Nuc, ST, CT[1]	0	1,000	0	1,000	0	1,000
Total	5,000	5,000	5,000	5,000	5,000	5,000

[1] Fossil fuels include coal, fuel oil, and natural gas.

4.3.4 Non-Hydro Renewable Energy Production

In addition to the assumptions made regarding future capacity factors, an assumption was made for future power generation by "non-traditional" power sources such as wind, solar, and geothermal. It is likely that non-hydro renewable energy sources will become a greater contributor to statewide power generation in the future. According to EPRI (2009), it is assumed that by 2030, 15 percent of total U.S. electricity generation will come from non-hydro renewable sources and that the majority of that electricity (74 percent) will be generated by wind power, 15 percent will be generated by biomass, and 11 percent will come from "other technologies, including solar."

In Georgia, biomass is the predominant renewable resource. Therefore, it may be reasonable to assume that the State of Georgia will be behind the national projections of 15 percent non-hydro renewable energy in 2030. Based on information of planned energy utility facilities in Georgia, it is known that biomass will become a contributor to statewide utility energy production in the near future. The future contribution of non-biomass and non-hydro renewable energy production is unknown.

The energy sector ad hoc group acknowledged that the majority of the future renewable energy in the State of Georgia will be derived from biomass. The capacity associated with biomass facilities is assumed to be incorporated into the fossil fuel/biomass, steam turbine, cooling tower power generation combination and will exhibit water withdrawal and consumption characteristics according to the analysis results shown in **Table 7**. While the future contribution of non-hydro and non-biomass renewable energy in the state is unknown, the group concluded that it would be a negligible amount likely not to exceed 1 percent by 2030. Therefore, for the purposes of generating a statewide energy sector water demand forecast, it is assumed that by 2030 one percent of energy production in the State of Georgia will come from non-biomass and non-hydro renewable sources. This assumption applies only to the *additional capacity scenario* because no additional capacity beyond 2020 is assumed for the *2017 capacity scenario*.

4.3.5 Projected Power Generation by Combination

The percent of projected power generated by each power generation combination was derived based upon the capacity factor assumptions in **Table 11** (*baseline 2017 capacity scenario*) and **Table 12** (*baseline additional capacity scenario*). The percent of power generated by each generation combination for forecast years between 2010 and 2020 and for every ten year increment through 2050 is shown in **Table 14** for the *baseline 2017 capacity scenario* and in **Table 15** for the *baseline additional capacity scenario*. The projected power generation by each combination is shown in **Tables 16** and **17** for the two scenarios. The maximum sustainable capacity factors for each power generation combination are exceeded between 2040 and 2045 under the *2017 capacity scenario*. Therefore power generation no longer meets the projected demand after 2040 under this scenario.

Table 14 Power Generation by Combination, Baseline Power Needs, 2017 Capacity Forecast Scenario

Power Generation Combination	2010	2020	2030	2040	2050*
NG, CC, CT	12.6%	8.7%	11.2%	15.3%	
FF/Bio, GT[1]	2.4%	1.1%	3.7%	5.9%	
FF/Bio, ST, OT[1]	12.2%	9.3%	9.5%	10.7%	
FF/Bio, ST, CT[1]	48.9%	51.4%	50.5%	46.1%	
Nuc, ST, CT	21.8%	27.7%	23.6%	20.7%	
Hydro	2.2%	1.8%	1.5%	1.3%	
Other Renewable	0.0%	0.0%	0.0%	0.0%	
Total	100%	100%	100%	100%	

*Maximum sustainable capacity factors do not reach projected statewide power needs.
[1] Fossil fuels include coal, fuel oil, and natural gas.

Table 15 Power Generation by Combination, Baseline Power Needs, Additional Capacity Forecast Scenario

Power Generation Combination	2010	2020	2030	2040	2050
NG, CC, CT	12.6%	8.7%	8.5%	9.1%	9.6%
FF/Bio, GT[1]	2.4%	1.1%	1.1%	1.3%	1.3%
FF/Bio, ST, OT[1]	12.2%	9.3%	7.7%	6.6%	5.8%
FF/Bio, ST, CT[1]	48.9%	51.4%	53.4%	54.4%	55.5%
Nuc, ST, CT	21.8%	27.7%	26.8%	26.2%	25.7%
Hydro	2.2%	1.8%	1.5%	1.3%	1.1%
Other Renewable	0.0%	0.0%	1.0%	1.0%	1.0%
Total	100.%	100%	100%	100%	100%

[1] Fossil fuels include coal, fuel oil, and natural gas.

Table 16 Projected Power Generation by Combination (in GWh), Baseline Power Needs, 2017 Capacity Forecast Scenario

Power Generation Combination	2010	2020	2030	2040	2050*
NG, CC, CT	18,403	15,353	23,732	37,559	
FF/Bio, GT[1]	3,548	1,932	7,729	14,493	
FF/Bio, ST, OT[1]	17,839	16,313	20,006	26,162	
FF/Bio, ST, CT[1]	71,645	90,593	106,505	113,241	
Nuc, ST, CT	31,866	48,695	49,789	50,883	
Hydro	3,195	3,195	3,195	3,195	
Other Renewable	0	0	0	0	
Total[2]	146,495	176,080	210,957	245,533	
Total Required	146,495	176,080	210,957	245,533	

[1] Fossil fuels include coal, fuel oil, and natural gas.
[2] Total may not equal the sum of individual combination power generation due to rounding.
*Maximum sustainable capacity factors do not reach projected statewide power needs.

Table 17 Projected Power Generation by Combination (in GWh), Baseline Power Needs, Additional Capacity Forecast Scenario

Power Generation Combination	2010	2020	2030	2040	2050
NG, CC, CT	18,403	15,353	17,916	22,384	26,851
FF/Bio, GT[1]	3,548	1,932	2,283	3,291	3,729
FF/Bio, ST, OT[1]	17,839	16,313	16,313	16,313	16,313
FF/Bio, ST, CT[1]	71,645	90,593	112,650	133,607	155,747
Nuc, ST, CT	31,866	48,695	56,491	64,288	72,084
Hydro	3,195	3,195	3,195	3,195	3,195
Other Renewable	0	0	2,110	2,455	2,807
Total[2]	146,495	176,080	210,957	245,533	280,726
Total Required	146,495	176,080	210,957	245,533	280,726

[1] Fossil fuels include coal, fuel oil, and natural gas.
[2] Total may not equal the sum of individual combination power generation due to rounding.

Figures 6 and **7** show the projected power generation in Georgia by power generation combination that results from the set of assumptions described above for the *baseline 2017 capacity* and *baseline additional capacity* scenarios respectively. As the graphs show, power generation needs are projected to increase steadily throughout the planning horizon and fossil fuel/biomass generators with cooling towers and nuclear generators with cooling towers are projected to be the primary sources of the power generated to meet those needs.

Figure 6 State of Georgia Projected Power Needs by Combination, Baseline Power Needs, 2017 Capacity Forecast Scenario

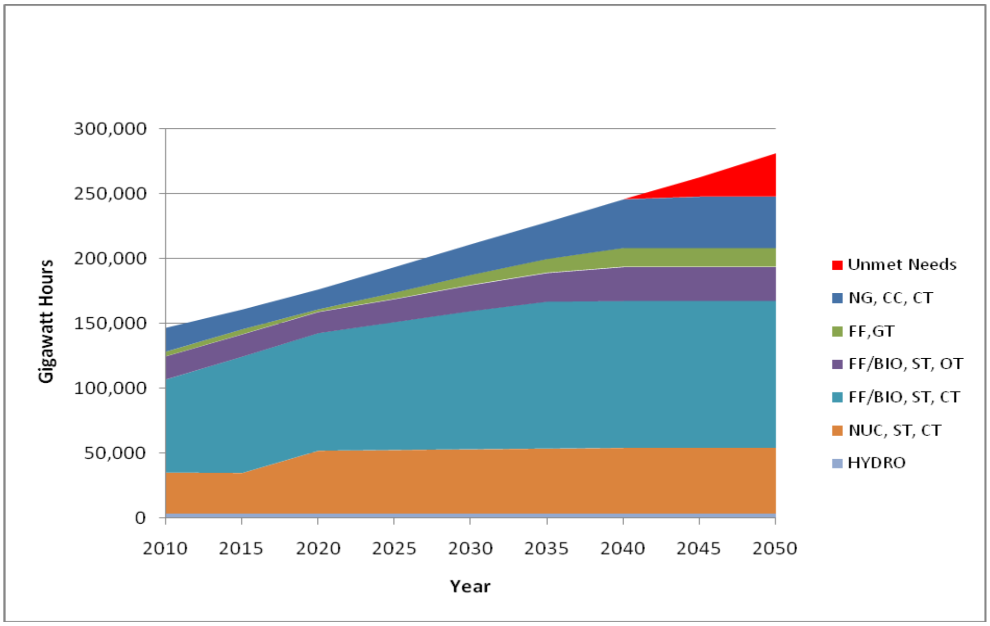
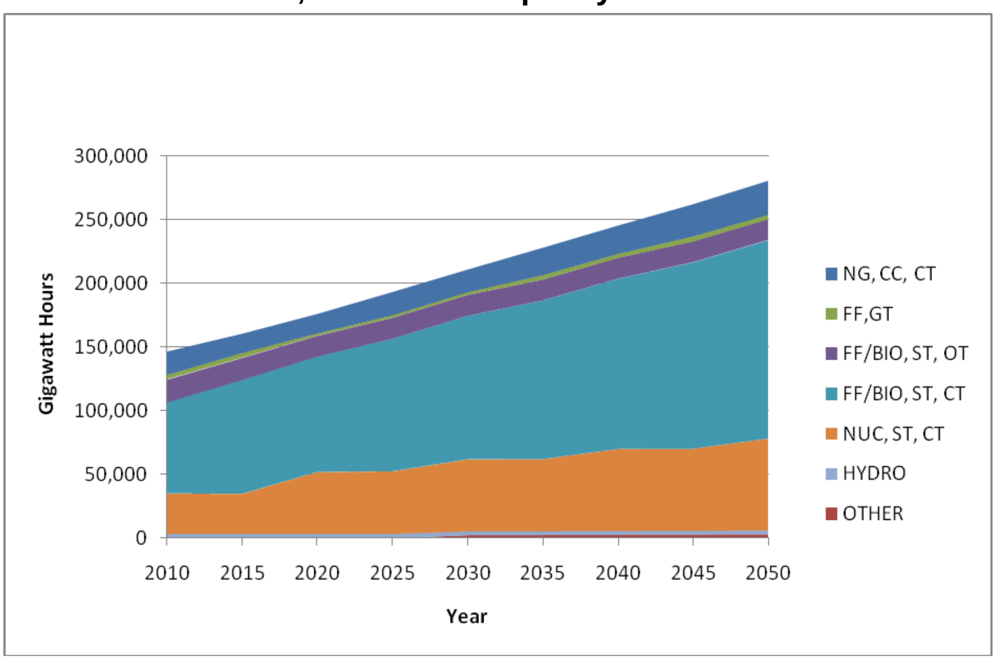


Figure 7 State of Georgia Projected Power Needs by Combination, Baseline Power Needs, Additional Capacity Forecast Scenario



Note: "OTHER" refers to power generation from non-hydro and non-biomass renewable energy and fossil fuels include coal, fuel oil, and natural gas.

4.4 Baseline Water Demand

The baseline water demands are derived using the water withdrawal and consumption rates described in Section 2.3 and the model assumptions described in Section 4.3. **Tables 18 and 19** show the forecasted water withdrawal and consumption demand respectively for each power generation combination beginning in 2010 and incrementally every 10 years through 2050. Under the *baseline 2017 capacity scenario,* the maximum sustainable capacity factors are reached between 2040 and 2045. Thus, no information is presented beyond the year 2040.

Overall, total energy sector water withdrawal demands increase at a rate of 1.33 percent annually from 2010 to 2040 for the *baseline 2017 capacity* scenario and at a rate of 0.25 percent annually from 2010 to 2050 for the *baseline additional capacity scenario*.

Table 18 Baseline Power Needs Water Withdrawal Demands, MGD

Power Generation Combinations	2010	2020	2030	2040	2050*
Baseline 2017 Capacity Scenario					
NG, CC, CT	11	9	15	23	
FF/Bio, GT[1]	0	0	0	0	
FF/Bio, ST, OT[1]	2,004	1,833	2,248	2,939.12	
FF/Bio, ST, CT[1]	226	286	336	358	
Nuc, ST, CT	120	183	187	191	
Hydro	0	0	0	0	
Other Renewable	0	0	0	0	
Total[2]	2,361	2,311	2,786	3,511	
Baseline Additional Capacity Scenario					
NG, CC, CT	11	9	11	14	17
FF/Bio, GT[1]	0	0	0	0	0
FF/Bio, ST, OT[1]	2,004	1,833	1,833	1,833	1,833
FF/Bio, ST, CT[1]	226	286	356	422	492
Nuc, ST, CT	120	183	212	242	271
Hydro	0	0	0	0	0
Other Renewable	0	0	0	0	0
Total[2]	2,361	2,311	2,412	2,510	2,612

*Projected generation does not meet projected demand for Baseline 2017 Capacity Scenario
[1] Fossil fuels include coal, fuel oil, and natural gas.
[2] Sum may not equal total due to rounding.

Table 19 Baseline Power Needs Water Consumption Demands, MGD

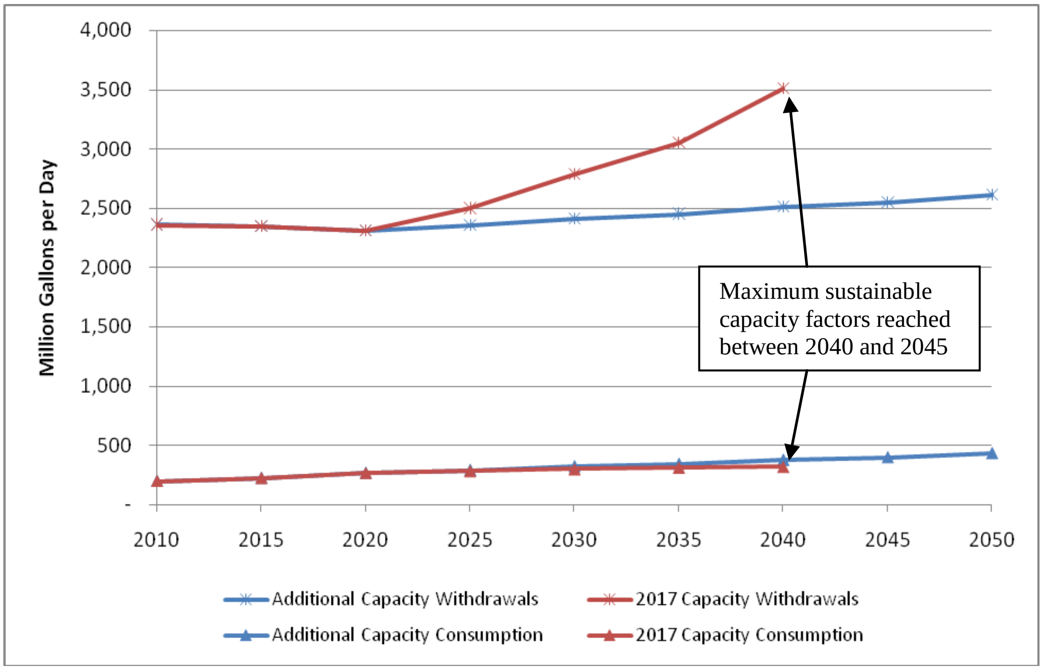
Power Generation Combinations	2010	2020	2030	2040	2050*
Baseline 2017 Capacity Scenario					
NG, CC, CT	10	8	13	20	
FF/Bio, GT[1]	0	0	0	0	
FF/Bio, ST, OT[1]	0	0	0	0	
FF/Bio, ST, CT[1]	111	141	166	176	
Nuc, ST, CT	77	117	120	123	
Hydro	0	0	0	0	
Other Renewable	0	0	0	0	
Total[2]	198	267	298	319	
Baseline Additional Capacity Scenario					
NG, CC, CT	10	8	10	12	15
FF/Bio, GT[1]	0	0	0	0	0
FF/Bio, ST, OT[1]	0	0	0	0	0
FF/Bio, ST, CT[1]	111	141	175	208	242
Nuc, ST, CT	77	117	136	155	174
Hydro	0	0	0	0	0
Other Renewable	0	0	0	0	0
Total[2]	198	267	321	375	430

*Projected generation does not meet projected demand for Baseline 2017 Capacity Scenario
[1] Fossil fuels include coal, fuel oil, and natural gas.
[2] Sum may not equal total due to rounding.

As **Table 18** and **Figure 8** show, there is a decrease in withdrawal demand between 2010 and 2020 under both baseline forecast scenarios. This decrease is predominately attributable to the increase in power generation between 2010 and 2020 by less water withdrawal intensive power generation combinations using steam turbines and cooling towers. The transition from once-through cooling to cooling towers will result in a decrease in water withdrawals. Consumptive use associated with cooling towers is greater than that associated with once-through cooling. Therefore consumptive use is forecasted to increase statewide.

Water withdrawals and consumption associated with nuclear power production increases significantly between 2010 and 2020 under both baseline scenarios. Nuclear power generation increases from 19.6 percent of total statewide power generation in 2015 to 25.5 percent in 2025 as a result of additional capacity at Vogtle and a relatively stable statewide capacity factor.

Figure 8 State of Georgia Energy Sector Withdrawals and Consumption, Baseline Power Needs Scenario



Under the *baseline 2017 capacity scenario*, following 2020, water withdrawal demand increases sharply due to the steady increase in production by fossil/biomass once-through facilities necessary to meet statewide power needs without additional capacity. By 2040 all power generation combinations have maximized their sustainable capacity factors and total withdrawals level out at about 3,500 mgd.

As shown in **Table 18**, the majority of the sector's water withdrawals are attributed to once-through cooling facilities. Thus, estimates of future energy sector water withdrawals are highly sensitive to policies regulating once-through cooling. A phase-out of once-through cooling would significantly reduce total statewide water withdrawals. Due to a general uncertainty regarding the future of once-through cooling facilities, no assumptions are made concerning the timing of a phase-out of those facilities in Georgia for the purposes of generating and statewide energy sector water demand forecast.

Table 19 and **Figure 8** show a steady increase in statewide energy sector water consumption from 2010 to 2050. The overall increase in energy production by facilities with cooling tower systems is driving this steady increase in consumptive water demands under both baseline scenarios.

4.4.1 Geographic Distribution of Baseline Water Demand Forecast

This section is an effort to evaluate water needs by Water Planning Region (region) among current and planned facilities. Geographically disaggregating the estimated withdrawals and consumption by region involves some generalized assumptions:

- All facilities of a particular power generation combination are assumed to exhibit the same rates of withdrawal and consumption per megawatt hour of power generated.
- The assumed statewide capacity factors apply to all facilities of a particular power generation combination.
- Only demands associated with existing and planned facilities are regionally disaggregated through 2050. Existing and planned facilities' demands are forecasted by region through 2050 according to the proportion of available capacity in the region in 2020.
- The geographic disaggregation of water withdrawals and consumption associated with a particular power generation combination (with the exception of once-through facilities) is assumed to occur based upon the ratio of available combination generating capacity within the regional boundary. As capacity for planned facilities and existing facility expansion is added, the ratio of the available combination generating capacity will fluctuate among planning regions. For instance, the addition of planned nuclear capacity in the Savannah Upper Ogeechee Region will increase that region's percentage of overall nuclear capacity and decrease other regions' percentages.

Some power plants in Georgia with once-through cooling only typically produce power a few days a year. Therefore, water withdrawal and consumption demands are disaggregated by facility according to their five year (2003-2007) average percent of withdrawals among all once-through cooling facilities in the state. If multiple once-through facilities are located within a particular region, the percent of average withdrawals are summed for each facility within the region.

This approach does not capture the water use idiosyncrasies of each particular facility; it is a simplified way of geographically disaggregating the statewide water demand forecast through 2020 for planning purposes and does not reflect actual operating conditions.

The baseline water demand can be geographically disaggregated by region for each of the baseline forecast scenarios through the year 2020 because the location of the facilities responsible for the demand for water withdrawals and consumption are known. After 2020, the withdrawals and consumption associated with existing and planned facilities must be isolated in order to geographically disaggregate demands by region. Because the location of the additional capacity is unknown and is not speculated, the demands associated with any assumed additional capacity cannot be geographically disaggregated.

Current and future electric utility (NAICS 22) facilities have been identified in nine of the eleven Georgia Water Planning Regions throughout the state. Only the Suwannee-Satilla and Upper Flint Regions do not contain existing or planned facilities through 2017. **Table 20** shows the base year withdrawals by region as well as the forecasted withdrawals by region through 2020. **Table 21** shows the base year consumption as well as the forecasted consumption by Region through 2020. Forecasted withdrawals and consumption are identical for both baseline water demand scenarios through 2020 because power generation capacity and capacity factors are identical through 2020. The forecast base year (i.e., 2005) thermoelectric water consumption data available from EPD shows that withdrawals are highest in the Upper Oconee Region due to the withdrawals associated with Plant Harlee Branch and consumption is highest in the Metro North Georgia Region due to the consumption associated with Plants Bowen and Yates.

Table 20 Base Year and Forecasted Withdrawals by Region (in MGD), Baseline Power Needs Scenario

Region	2005	2010	2020
Altamaha	58	51	51
Coastal Georgia	309	341	311
Coosa-North Georgia	535	560	512
Lower Flint-Ochlockonee	121	135	146
Metro North Georgia[1]	433	114	144
Middle Chattahoochee	64	42	39
Middle Ocmulgee	59	73	69
Savannah-Upper Ogeechee	65	69	133
Suwannee-Satilla	0	0	0
Upper Flint	0	0	0
Upper Oconee	1,092	973	906
Other[2]	1	3	2
Total	2,737	2,361	2,311

[1] Plant McDonough in Cobb County converted from a once-through cooling system to a cooling tower system in 2008. As a result, the water withdrawal per MWh generated at Plant McDonough will align with the characteristics of a cooling tower facility in all forecasted years.

[2] Water demand in the "Other" Region is associated with demands at the Franklin Combined-Cycle facility located in Lee County, Alabama and with a water withdrawal and consumption permit with the State of Georgia.

Table 21 Base Year and Forecasted Consumption by Region (in MGD), Baseline Power Needs Scenario

Region	2005	2010	2020
Altamaha	36	33	32
Coastal Georgia	4	3	2
Coosa-North Georgia[1]	0	1	1
Lower Flint-Ochlockonee	0	0	11
Metro North Georgia[2]	44	56	71
Middle Chattahoochee	22	22	20
Middle Ocmulgee	35	36	35
Savannah-Upper Ogeechee	43	44	85
Suwannee-Satilla	0	0	0
Upper Flint	0	0	0
Upper Oconee[3]	3	0	8
Other[4]	1	3	2
Total	187	198	267

[1] The Coosa North Georgia Region contains one combined-cycle facility. The EPD permit withdrawal/consumption database did not contain water use data for this facility. For the purposes of the statewide energy sector water demand forecast, consumptive use at the combined-cycle facility is assumed to be 198 gallons per MWh.
[2] Plant McDonough in Cobb County converted from a once-through cooling system to a cooling tower system in 2008. As a result the water consumption per MWh generated at Plant McDonough will align with the characteristics of a cooling tower facility in all forecasted years explaining the increase in consumption in the Metro North Georgia Region.
[3] Plant Harlee Branch in Putnam County is not a typical cooling tower facility. It exhibits much smaller consumption per MWh generated than typical cooling tower facilities. Thus, using a statewide rate of consumption for cooling tower facilities may overestimate the consumptive demand and assuming zero consumption may underestimate consumptive demand for Plant Harlee Branch and the Upper Oconee Region. For planning purposes, consumptive use at Plant Harlee Branch is assumed to be zero. Consumptive use in 2020 is attributable to the planned Plant Washington facility.
[4] Water demand in the “Other” Region is associated with demands at the Franklin Combined-Cycle facility located in Lee County, Alabama which has a water withdrawal and consumption permit with the State of Georgia.

5.0 Alternative Forecast Scenarios

Due to the high degree of uncertainty regarding the future of statewide energy demand and production, two alternative energy sector water demand forecast scenarios have been developed. These scenarios have been produced to develop a range of possible future statewide power needs, and subsequently, statewide energy sector water needs. Both scenarios represent a future in which statewide power needs are greater than the baseline projections. As presented in Section 4, the baseline 2017 capacity scenario did not meet projected energy needs through 2050. Therefore, only the results of the additional capacity scenario are presented below, assuming additional capacity beyond what is planned through 2017 follows the schedule of additional capacity presented in **Table 13**.

Under the baseline forecast scenarios presented in Sections 3 and 4 of this report, statewide power needs are projected based upon the historical (1990-2008) relationship between state population and statewide electric utility power generation using Georgia Office of Planning and Budget population projections as the driver for calculating future statewide power needs. Along with those projections, a set of assumptions regarding the likely future production of energy by power generation combination and the amount of water used by those combinations was made to forecast energy sector water needs through 2050. Under the alternative scenarios, the historical relationship between population and statewide power projection also determines future power needs, however the variance of the model relationship is used to project a "high" statewide power needs scenario. The assumptions regarding power generation combination capacity factors also change to account for the higher projected statewide energy needs.

5.1 Alternative Scenario Statewide Power Needs

Three sources of future power generation projections were analyzed for comparison to the baseline statewide power needs projections discussed in Section 3 of this report and for consideration as potential alternative statewide power needs scenarios. These sources included the Department of Energy 2010 EIA energy outlook report, the SERC[1] Reliability Corporation net energy for load projections, and the Georgia Governor's Energy Policy Council annual coincident peak demand projections.

5.1.1 EIA Annual Energy Outlook Projections

The EIA Annual Energy Outlook for 2010 includes projections of energy consumption by fuel type and by sector (e.g., residential, industrial, and transportation) for low, reference, and high economic growth scenarios through 2035. Projections are developed nationally and for nine sub-national regions. Future energy consumption projections for the State of Georgia are included in the South Atlantic Regional projections. The South Atlantic Region includes the states of Delaware, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, and West Virginia.

Table 22 shows the projected rates of growth in total delivered energy for the South Atlantic Region and the U.S. under the low, reference, and high economic growth scenarios. As the table shows, total delivered energy through 2035 in the South Atlantic Region is projected to grow slightly faster than the national projections under all three economic growth scenarios.

[1] SERC is a nonprofit corporation responsible for promoting and improving the reliability and adequacy, and critical infrastructure of the bulk power system in all or portions of 16 central and southeastern states.

Table 22 EIA Projected Average Annual Growth in Total Delivered Energy (2007-2035)

	Low Economic Growth	Reference Case	High Economic Growth
South Atlantic	0.2%	0.6%	1.0%
U.S.	0.1%	0.5%	0.9%

5.1.2 SERC Net Energy for Load Projections

The SERC Reliability Corporation Information Summary (July 2010) provides projected seasonal peak-hour demand and net energy load through 2019 for the combined SERC region. The SERC region includes all of Alabama, Georgia, Mississippi, North Carolina, and South Carolina, and portions of Arkansas, Illinois, Kentucky, Louisiana, Missouri, Texas, and Virginia. SERC projects that seasonal peak-hour demand will increase by 1.74 percent annually between 2010 and 2019 and net energy load will increase by 1.5 percent annually through 2019. While SERC is divided geographically into five sub-regions, no projections were available at the sub-regional level.

5.1.3 Georgia Governor's Energy Policy Council

At the request of the Governor, the Georgia Environmental Finance Authority (GEFA) and the Georgia Environmental Protection Division developed a research brief in 2006 that includes a ten-year coincident peak demand forecast for Georgia from 2007 to 2016. The annual coincident peak demand refers to the single hour of the year with the highest statewide system peak demand. According to the report, the average annual growth in coincident peak demand from 2007 to 2016 is 2.9 percent.

5.1.4 Summary of Statewide Power Projections

Analysis of the three sources of future power generation needs led to the conclusion that the sources were not adequate for developing alternative future statewide total power generation needs scenarios through 2050. Geographic inconsistency was of particular concern. Only the Georgia Governor's Energy Policy research provided projections pertaining strictly to the State of Georgia. Both the EIA and SERC projections were produced for a multi-state region. Further, the three sources do not use the same metric of power to project total electric utility power generation. The EIA data projects total delivered energy consumption through 2035, SERC projects seasonal peak-hour demand and net energy load through 2019, and the Georgia Governor's Energy Policy Council projects coincident peak demands through 2016.

Because it was determined that the available sources of future power needs projections were inadequate to develop alternative statewide power needs scenarios, a methodology utilizing the 95 percent confidence intervals associated with the modeled relationship between state population and total state electric utility power generation between 1990 and 2008 was developed[2]. Using these confidence intervals, the statistically significant upper and lower limits of the modeled projections of statewide power generation needs could be calculated through 2050. This method is presented in Section 5.2.

5.2 Alternative Statewide Power Needs Projections Methodology

The principle behind the use of confidence intervals is to use the variance of the model to form an upper and lower range of dependent variable estimates that are within the 0.05 level of statistical significance. The variance of the model estimates are shown as the standard error in **Table 9**. The modeled relationship yields estimates of the mean value for y (i.e., state power generation needs) given the independent variable x (i.e., projected statewide population). Since it is known that the estimated value for statewide power generation needs will not always be exactly equal to the mean, one can consider the model variability to estimate a range of values around the mean (both higher and lower) that are within the 0.05 level of statistical significance. At the 95 percent confidence interval, the upper and lower coefficients are the model coefficients plus or minus about two times the standard error. **Table 23** shows the model results including the lower and upper intercepts and parameter coefficients.

Table 23 1990-2008 Statewide Population and Electric Utility Power Generation Regression Model Results

	Model Coefficient*	Lower 95% Coefficient	Upper 95% Coefficient
Intercept	5,940,658	-8,657,621	20,538,937
Population	13.95816361	12.14409	15.77224

*See Table 11.

The following equation shows how the upper and lower limits of the 95 percent confidence interval estimates are calculated:

$$Y^{95}_k = (\beta_0 \pm 1.96\ se_0) + (\beta_x \pm 1.96\ se_x)\ X_k$$

Where:
Y^{95}_k = estimated value of the dependent variable at 95th confidence interval
β_0 = model intercept
β_x = population model coefficient
se_0 = standard error of intercept
se_x = standard error of population
X_k = projected statewide population during year k

[2] The confidence interval is the confidence associated with the ability of an interval estimate to contain the value of the parameter of interest. For example, if an interval estimation procedure provides intervals that include 95 percent of all possible values of the population parameter, the interval estimate is said to be constructed at the 95 percent confidence level, and 0.95 is referred to as the confidence coefficient.

5.3 Alternative Scenario Assumptions

For developing the *alternative additional capacity scenario* forecast, it was determined that a statewide energy needs scenario projecting the potential statistically significant high statewide power needs be examined to envision a situation with higher than likely sector water demands. By projecting statewide power needs at the 95 percent confidence upper limit, Councils could consider a future where demand for water resources may be greater than those projected using the mean (average) historical relationships.

Using the model relationship for the upper 95 percent coefficient shown in **Table 23** and the equation shown in Section 5.2, the alternative high statewide power needs were projected. **Figure 9** shows the alternative high statewide power needs projection compared to the baseline statewide power needs projection. Statewide power needs under the baseline scenario exceed 280,000 GWh by 2050 and grow at an average annual rate of 1.74 percent between 2008 and 2050[3]. Under the high projection scenario, statewide power needs exceed 330,000 GWh by 2050 and grow at an average annual rate of 2.14 percent between 2008 and 2050.

In order to meet the high statewide energy needs projections, the capacity factors for the different power generation combinations must be higher than under the baseline projections. As a result, capacity factors begin to approach their maximum sustainable levels sooner in the forecast time horizon in order to meet the projected needs.

5.4 Alternative Scenario Water Demand Forecast

Incorporating the statewide power needs projections and forecast assumptions discussed above, this section presents the results of the alternative high scenario water demand forecast. **Table 24** shows statewide forecasted water withdrawal demands by each power generation combination beginning in 2010 and incrementally every 10 years through 2050 for the *alternative additional capacity* scenario. Total withdrawals increase at a rate of 0.20 percent annually from 2010 to 2050 under the *alternative additional capacity scenario*.

[3] 2008 is the most recent year of data on statewide electric utility energy production available through the EIA Form 906/920.

Figure 9 Comparison of Baseline and Alternative Statewide Energy Needs Projections, 2010 - 2050

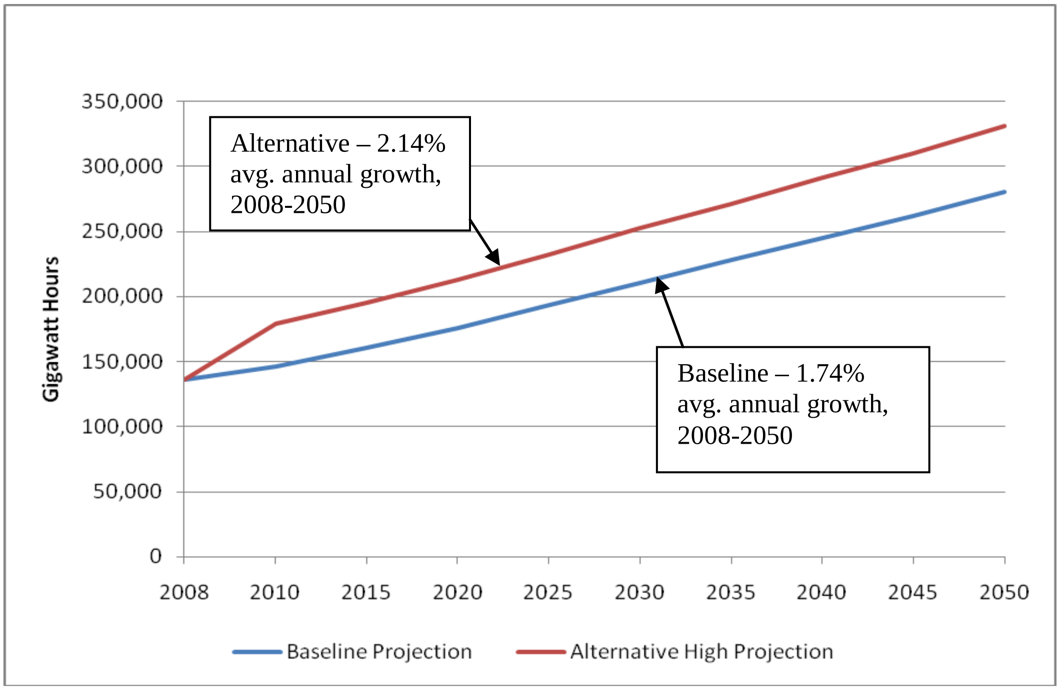


Table 24 Alternative Power Needs Water Withdrawal Demands, in MGD, Alternative Additional Capacity Scenario

Power Generation Combinations	2010	2020	2030*	2040*	2050*
NG, CC, CT	19	18	21	24	29
FF/Bio, GT[1]	0	0	0	0	0
FF/Bio, ST, OT[1]	2,461	2,420	2,248	2,248	2,248
FF/Bio, ST, CT[1]	254	316	397	475	549
Nuc, ST, CT	124	187	215	244	274
Hydro	0	0	0	0	0
Other Renewable	0	0	0	0	0
Total Withdrawals2	2,858	2,941	2,880	2,991	3,100

[1] Fossil fuels include coal, fuel oil, and natural gas.
[2] Sum may not equal total due to rounding.

Statewide water withdrawals are particularly sensitive to power generation by facilities with once-through cooling because those facilities withdrawal water at a rate nearly 30 times greater than the next most water withdrawal intensive power generation combination (nuclear facilities with cooling towers). Under the *alternative additional capacity scenario,* there is no additional capacity assumed to become available for the fossil fuel/biomass with once-through cooling power generation combination and the capacity factor for that combination stays relatively stable. As a result, there is little growth in the overall statewide energy sector water withdrawal demands.

Table 25 shows forecasted water consumption demand by each power generation combination beginning in 2010 and incrementally every 10 years through 2050. Total energy sector water consumption increases by 1.91 percent annually from 2010 to 2050 under the *alternative additional capacity scenario*. Overall, consumption demand increases by 251 mgd from 2010 to 2050 under the *alternative additional capacity scenario*. Because the majority of the assumed additional capacity that will meet the higher projected statewide power needs is for facilities with cooling towers which consume more water than facilities with once-through cooling, statewide water consumption is forecasted to steadily increase under the *alternative additional capacity scenario*.

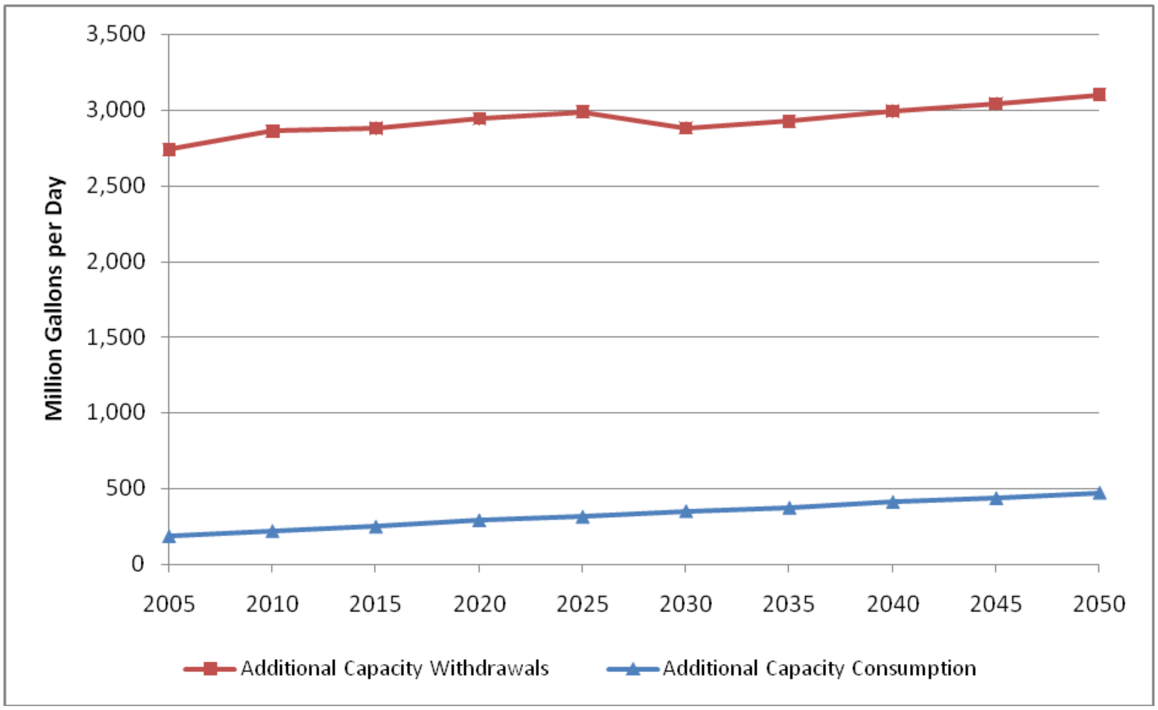
Figure 10 summarizes the withdrawal and consumption forecasts for the *alternative additional capacity scenarios*.

Table 25 Alternative Power Needs Water Consumption Demands, in MGD - Alternative Additional Capacity Scenario

Power Generation Combinations	2010	2020	2030	2040	2050
NG, CC, CT	17	16	19	21	26
FF/Bio, GT[1]	0	0	0	0	0
FF/Bio, ST, OT[1]	0	0	0	0	0
FF/Bio, ST, CT[1]	125	155	195	234	270
Nuc, ST, CT	79	120	138	157	176
Hydro	0	0	0	0	0
Other Renewable	0	0	0	0	0
Total Consumption[2]	221	291	352	412	472

[1] Fossil fuels include coal, fuel oil, and natural gas.
[2] Sum may not equal total due to rounding.

Figure 10 Alternative Power Needs Scenario Withdrawal and Consumption Forecasts, Additional Capacity Scenario



5.4.1 Geographic Distribution of Alternative Water Demand Forecasts

The alternative water demand can be geographically disaggregated by Georgia State-wide Water Planning Region for the alternative forecast through the year 2020 because the location of the facilities responsible for the demand for water withdrawals and consumption are known. Withdrawals and consumption can't be geographically disaggregated through 2050 because the location of the additional capacity is unknown.

Tables 26 and **27** show the base year (i.e., 2005) and forecasted alternative demands by Region through 2020 for withdrawals and consumption respectively.

Table 26 Base Year and Forecasted Withdrawals by Region (in MGD), Alternative Power Needs Scenario

Region	2005	2010	2020
Altamaha	58	53	52
Coastal Georgia	309	419	412
Coosa-North Georgia	535	689	677
Lower Flint-Ochlockonee	121	166	188
Metro North Georgia[1]	433	128	159
Middle Chattahoochee[2]	64	49	44
Middle Ocmulgee	59	83	77
Savannah-Upper Ogeechee	65	71	136
Suwannee-Satilla	0	0	0
Upper Flint	0	0	0
Upper Oconee	1,092	1,195	1,193
Other[3]	1	5	4
Total[4]	2,737	2,858	2,941

[1] Plant McDonough in Cobb County converted from a once-through cooling system to a cooling tower system in 2008. As a result, the water withdrawal per MWh generated at Plant McDonough will align with the characteristics of a cooling tower facility in all forecasted years.
[2] Plant Wansley in Heard County exhibited unusually high water withdrawal rates over the five-year period of analysis. As such, using the statewide rate of water withdrawal per megawatt hour generated for fossil fuel cooling tower facilities may underestimate the withdrawals in the Middle Chattahoochee Region.
[3] Water demand in the “Other” Region is associated with demands at the Franklin Combined-Cycle facility located in Lee County, Alabama and with water withdrawal and consumption permit with the State of Georgia.
[4] Sum may not equal total due to rounding.

Table 27 Base Year and Forecasted Consumption by Region (in MGD), Alternative Power Needs Scenario

Region	2005	2010	2020
Altamaha	36	34	33
Coastal Georgia	4	4	3
Coosa-North Georgia[1]	0	3	2
Lower Flint-Ochlockonee	0	0	12[2]
Metro North Georgia[3]	44	63	78
Middle Chattahoochee	22	27	24
Middle Ocmulgee	35	41	39
Savannah-Upper Ogeechee	43	46	87
Suwannee-Satilla	0	0	0
Upper Flint	0	0	0
Upper Oconee[4]	3	0	9
Other[5]	1	4	4
Total[6]	187	221	291

[1] The Coosa North Georgia Region contains one combined-cycle facility. The EPD permit withdrawal/consumption database did not contain water use data for this facility. For the purposes of the statewide energy sector water demand forecast, consumptive use at the combined-cycle facility is assumed to be 198 gallons per MWh.
[2] The increase in consumption in the Lower Flint-Ochlockonee Region is associated with the additional capacity of the planned Longleaf facility in Early County.
[3] Plant McDonough in Cobb County converted from a once-through cooling system to a cooling tower system in 2008. As a result, the water consumption per MWh generated at Plant McDonough will align with the characteristics of a cooling tower facility in all forecasted years explaining the increase in consumption in the Metro North Georgia Region.
[4] Plant Harlee Branch in Putnam County is not a typical cooling tower facility. It exhibits much smaller consumption per MWh generated than typical cooling tower facilities. Thus, using a statewide rate of consumption for cooling tower facilities may overestimate the consumptive demand and assuming zero consumption may underestimate consumptive demand for Plant Harlee Branch and the Upper Oconee Region. For planning purposes, consumptive use at Plant Harlee Branch is assumed to be zero. Consumptive use in 2020 is attributable to the planned Plant Washington facility.
[5] Water demand in the "Other" Region is associated with demands at the Franklin Combined-Cycle facility located in Lee County, Alabama and with a water withdrawal and consumption permit with the State of Georgia.
[6] Sum may not equal total due to rounding.

6.0 Baseline and Alternative Power Needs Water Demand Forecast Summary

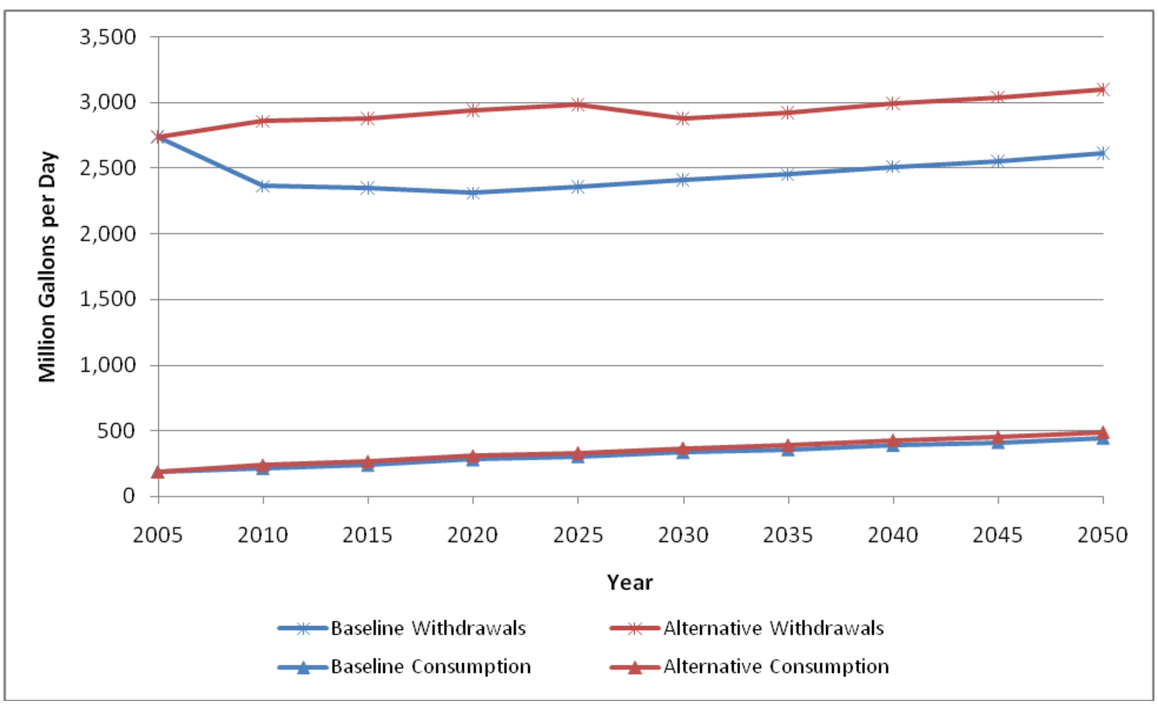
Section 4 presented the baseline energy sector water withdrawal and consumption forecast results for the two capacity scenarios. Section 5 presented the alternative forecast results for the two capacity scenarios. This section will compare and contrast the water demand forecasts under the baseline and alternative power generation needs scenarios.

Table 28 and **Figure 11** compare the baseline and alternative withdrawal and consumption forecasts for the *additional capacity scenario*.

Table 28 Additional Capacity Scenario Water Demand Forecast Comparison, Baseline and Alternative Power Needs

Scenario	2010	2020	2030	2040	2050
Withdrawals (MGD)					
Baseline Additional Capacity	2,361	2,311	2,412	2,510	2,612
Alternative Additional Capacity	2,858	2,941	2,880	2,991	3,100
Consumption (MGD)					
Baseline Additional Capacity	198	267	321	375	430
Alternative Additional Capacity	221	291	352	412	472

Figure 11 Additional Capacity Scenario Water Demand Forecast Comparison, Baseline and Alternative Power Needs



As shown in **Table 28** and **Figure 11**, forecasted withdrawals are higher under the alternative statewide power needs scenario although both scenarios forecast relatively stable withdrawals through 2050. Under the baseline power needs scenario, forecasted withdrawals decrease between the base year and 2020. The decrease is attributable to a lower available capacity for facilities with once-through cooling in 2010 compared to 2005 because of the conversion of Plant McDonough from a once-through facility to a cooling tower facility. Under the baseline scenario, withdrawals do not return to base year levels until around 2030.

Under the alternative power needs scenario, withdrawals increase slightly through 2025 and decrease slightly between 2025 and 2030. Following 2030, withdrawals increase relatively slowly. The decrease between 2025 and 2030 and relative stability of withdrawals thereafter is attributable to the increase in available capacity of less water withdrawal intensive (i.e., natural gas combined-cycle, simple-cycle, and fossil fuel with cooling tower) power generation and relatively stable capacity factors.

Consumptive use under both the baseline and alternative power needs scenarios increases steadily over the forecast horizon, increasing by 1.96 percent annually from 2010 to 2050 under the baseline power needs scenario and 1.91 percent annually under the alternative power needs scenario. As the available capacity for more water consumption intensive (i.e., fossil fuel with cooling towers) power generation increases and capacity factors remain relatively stable, the overall statewide water consumption increases. Forecasted 2050 consumption is 42 mgd greater under the alternative power needs scenario.

Next, forecasted demands associated with existing and planned facilities were isolated from demands associated with assumed additional capacity by separating the available capacity by power generation combination of existing and planned facilities from the available capacity by power generation combination associated with assumed additional capacity. The statewide capacity factors for each power generation combination used to meet statewide forecasted power needs were applied uniformly to the capacity of existing and planned facilities and to the capacity of the assumed additional capacity to derive the power generated by existing and planned facilities and by the assumed capacity. The power produced by power generation combination was then multiplied by the appropriate water use rate to derive the forecasted demand for existing and planned facilities and for the assumed additional capacity. The sum of the demands attributable to existing and planned facilities and the demands attributable to the assumed additional capacity represent the statewide total energy sector water demands.

The 2020 demand from existing and planned facilities does not remain unchanged through 2050. It is assumed that these facilities will continue to operate through the planning horizon. Therefore, under the assumptions laid out in this report, they will be assumed to be operating at the same percent of capacity as all other facilities with the same power generation combination. For example, if the statewide capacity factor for fossil fuel cooling tower facilities increases to meet statewide power needs, the capacity factor is applied to all of the available capacity of that type in the state, including existing and planned and any assumed additional capacity. As those capacity factors fluctuate, power generation fluctuates.

Figures 12 and 13 show the withdrawals associated with existing and planned facilities (blue portion) as well as the withdrawals associated with the facilities represented by the assumed additional capacity (red portion) (see **Table 13** above for additional capacity assumptions). **Figure 14** shows withdrawals under the *baseline scenario* for statewide power generation needs and **Figure 15** shows withdrawals under the *alternative scenario* for statewide power generation needs.

In **Figure 12**, the decline in withdrawals from 2010 to 2020 is due to a growing statewide power needs forecast and the addition of capacity for planned nuclear and fossil fuel/biomass facilities with cooling towers. The additional capacity allows these facilities, which require significantly less water withdrawals compared to facilities with once-through cooling, to meet a larger portion of statewide power needs with very little change in the facilities' operating capacity factors. As a result, a growing portion of the statewide power needs from 2010 to 2020 are being met by facilities requiring relatively small amounts of water withdrawals. The effect is a 50.2 mgd (2.1 percent) decrease in statewide energy sector water withdrawals from 2010 to 2020. Withdrawals begin to increase after 2020 even as additional capacity is added and overall higher forecasted statewide power needs translate into higher energy sector water withdrawal demands.

The energy sector withdrawal forecast in **Figure 13** is higher overall when compared to the forecast in Figure 12 because the water demands in Figure 13 are associated with the alternative (i.e., higher) statewide power needs forecast. Under this scenario, all facilities statewide, including those with once-through cooling, need to operate at higher capacity factors relative to the baseline power needs scenario in order to meet the higher statewide power needs. As a result, the general trend is that of increasing statewide energy sector water withdrawal demand (8.5 percent from 2010 to 2050). There is a decline in statewide energy sector withdrawal demand from 2025 to 2030. This is a situation whereby the statewide energy sector withdrawal forecast is particularly sensitive to the operational characteristics of facilities with once-through cooling because of their high rate of withdrawal per megawatt hour generated. In 2030, because of the growth in the available capacity, a decrease in the capacity factors for all combinations from 2025 to 2030 still allows for the alternative statewide power needs to be met. From 2025 to 2030, the statewide capacity factor for once-through facilities decreases from 70 percent to 65 percent while the combination experiences no additional capacity. The change in capacity factor results in a 173 mgd (5.8 percent) decrease in withdrawals for that combination from 2025 to 2030 and is responsible for the decrease in statewide energy sector water withdrawal demands shown in **Figure 14**.

Figure 12 Statewide Water Withdrawal Forecast, Baseline Power Needs Scenario

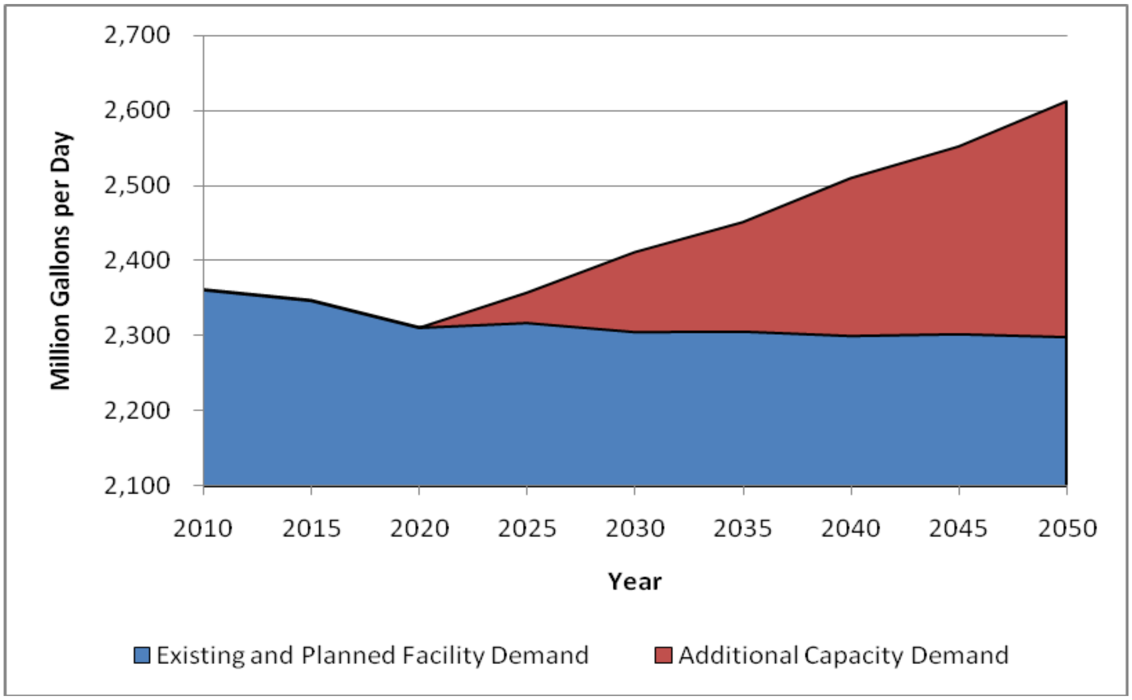
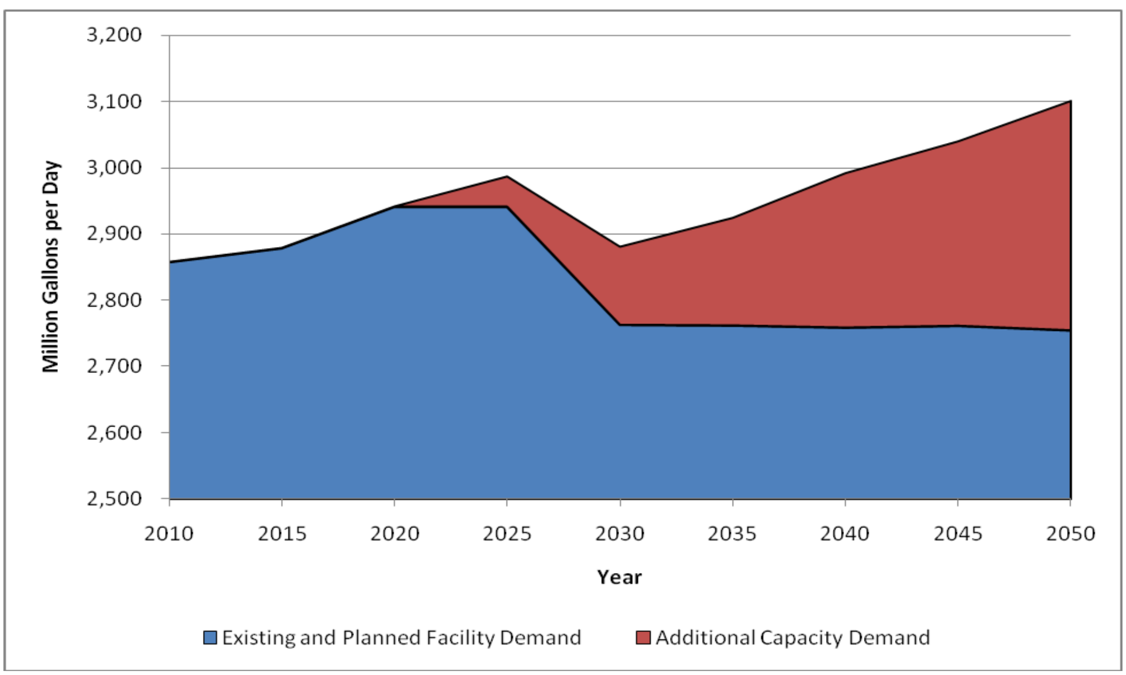


Figure 13 Statewide Water Withdrawal Forecast, Alternative Power Needs Scenario



Figures 14 and 15 show the consumption associated with existing and planned facilities (blue portion) as well as the consumption associated with facilities represented by the assumed additional capacity (red portion). **Figure 14** shows consumption under the *baseline scenario* for statewide power generation needs and **Figure 15** shows consumption under the *alternative scenario* for statewide power generation needs.

Statewide energy sector water consumption demands are not sensitive to a single power generation combination to the degree that statewide energy withdrawals are sensitive to the level of power generated by facilities with once-through cooling. Under the baseline power needs scenario, the capacity factors for each power generation combination stay relatively steady because the assumed additional capacity is able to cover the growing statewide power needs. As a result, statewide consumption shown in **Figure 14** increases at a steady rate. Statewide energy sector consumption under the alternative statewide power needs scenario shown in **Figure 15** exhibit the same steady increase in consumption. However, total statewide consumption is higher because higher statewide power needs require greater amounts of water to produce that amount of energy.

Figure 14 Statewide Water Consumption Forecast, Baseline Power Needs Scenario

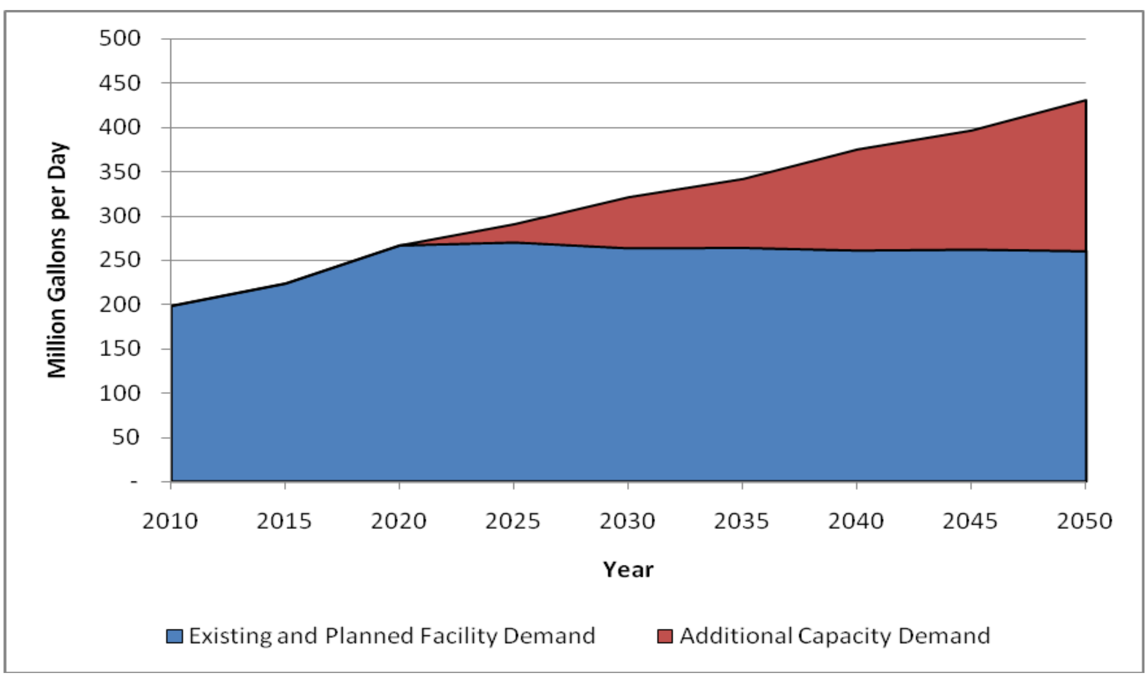
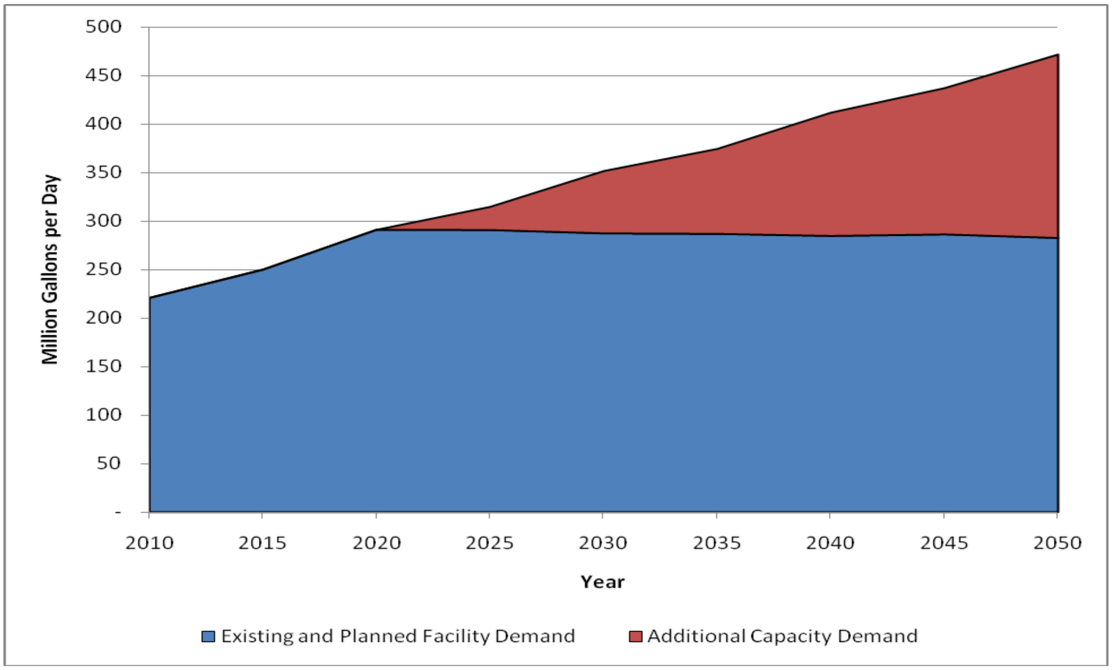


Figure 15 Statewide Water Consumption Forecast, Alternative Scenario



Tables 29 and 30 show the regional and statewide forecasts for water withdrawals and water consumption. **Table 29** shows regional and statewide withdrawals under both the baseline and alternative power generation needs scenarios while **Table 30** shows regional and statewide consumption under the baseline and alternative power generation needs scenarios. Regional demands through 2050 pertain only to existing facilities and facilities planned to become operational by 2017. The demand associated with the assumed additional capacity is also shown as the additional water needed to meet forecasted statewide power demand. The additional water needs are not region specific due to the speculative nature of assigning the demands geographically as discussed above.

Table 29 Existing/Planned Facility and Additional Capacity Forecasted Withdrawals, Baseline and Alternative Power Needs Scenario, in MGD

Region	Power Needs Scenario	2010	2020	2030	2040	2050
Existing and Planned Facilities						
Altamaha	Baseline	51	50	50	50	50
	Alternative	53	52	51	51	51
Coastal Georgia	Baseline	341	311	311	311	311
	Alternative	419	412	382	382	382
Coosa-North Georgia	Baseline	560	512	512	512	512
	Alternative	689	677	628	628	628
Lower Flint-Ochlockonee	Baseline	135	146	146	145	145
	Alternative	166	188	176	176	176
Metro North Georgia	Baseline	114	144	141	139	138
	Alternative	128	159	158	156	154
Middle Chattahoochee	Baseline	42	39	38	37	37
	Alternative	49	44	44	43	43
Middle Ocmulgee	Baseline	73	69	68	67	66
	Alternative	83	77	77	76	75
Savannah-Upper Ogeechee	Baseline	69	133	133	133	133
	Alternative	71	136	134	134	134
Suwannee-Satilla	Baseline	-	-	-	-	-
	Alternative	-	-	-	-	-
Upper Flint	Baseline	-	-	-	-	-
	Alternative	-	-	-	-	-
Upper Oconee	Baseline	973	906	906	905	905
	Alternative	1,195	1,193	1,109	1,109	1,109
Existing and Planned Facilities						
Other[1]	Baseline	3	2	2	2	2
	Alternative	5	4	4	3	3
Total of Existing and Planned Facilities	Baseline	2,361	2,311	2,306	2,300	2,299
	Alternative	2,858	2,941	2,763	2,759	2,754
Additional Water Need to Meet Power Demand (Additional Capacity Demand)						
No Assigned Region	Baseline	-	-	106	210	313
	Alternative	-	-	118	233	346
Total						
State Total[2]	Baseline	2,361	2,311	2,412	2,510	2,612
State Total[2]	Alternative	2,858	2,941	2,880	2,991	3,100

[1] Other represents withdrawal associated with the H Allen Franklin facility. The plant is in Alabama but holds a Georgia withdrawal permit.
[2] Numbers may not sum due to rounding.

Table 30 Existing/Planned Facility and Additional Capacity Forecasted Consumption, Baseline and Alternative Power Needs Scenario, in MGD

Region	Power Needs Scenario	2010	2020	2030	2040	2050
Existing and Planned Facilities						
Altamaha	Baseline	33	32	32	32	32
	Alternative	34	33	33	33	33
Coastal Georgia	Baseline	3	2	2	2	2
	Alternative	4	3	3	3	3
Coosa-North Georgia	Baseline	1	1	1	1	1
	Alternative	3	2	2	2	2
Lower Flint-Ochlockonee	Baseline	0	11	11	11	11
	Alternative	0	12	12	12	12
Metro North Georgia	Baseline	56	71	70	69	68
	Alternative	63	78	78	77	76
Middle Chattahoochee	Baseline	22	20	19	19	19
	Alternative	27	24	23	23	22
Middle Ocmulgee	Baseline	36	35	34	33	33
	Alternative	41	39	39	38	38
Savannah-Upper Ogeechee	Baseline	44	85	85	85	85
	Alternative	46	87	86	86	86
Suwannee-Satilla	Baseline	-	-	-	-	-
	Alternative	-	-	-	-	-
Upper Flint	Baseline	-	-	-	-	-
	Alternative	-	-	-	-	-
Upper Oconee	Baseline	0	8	8	8	8
	Alternative	0	9	9	9	9
Existing and Planned Facilities						
Other[1]	Baseline	3	2	2	2	2
	Alternative	4	4	3	3	3
Total of Existing and Planned Facilities	Baseline	198	267	263	261	260
	Alternative	221	291	288	285	283
Additional Water Need to Meet Power Demand (Additional Capacity Demand)						
No Assigned Region	Baseline	-	-	58	114	170
	Alternative	-	-	64	127	189
Total						
State Total[2]	Baseline	198	267	321	375	430
State Total[2]	Alternative	221	291	352	412	472

[1] Other represents withdrawal associated with the H Allen Franklin facility. The plant is in Alabama but holds a Georgia withdrawal permit.
[2] Numbers may not sum due to rounding.

7.0 References

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