Yes We Can:
Southern Solutions for a National Renewable Energy Standard

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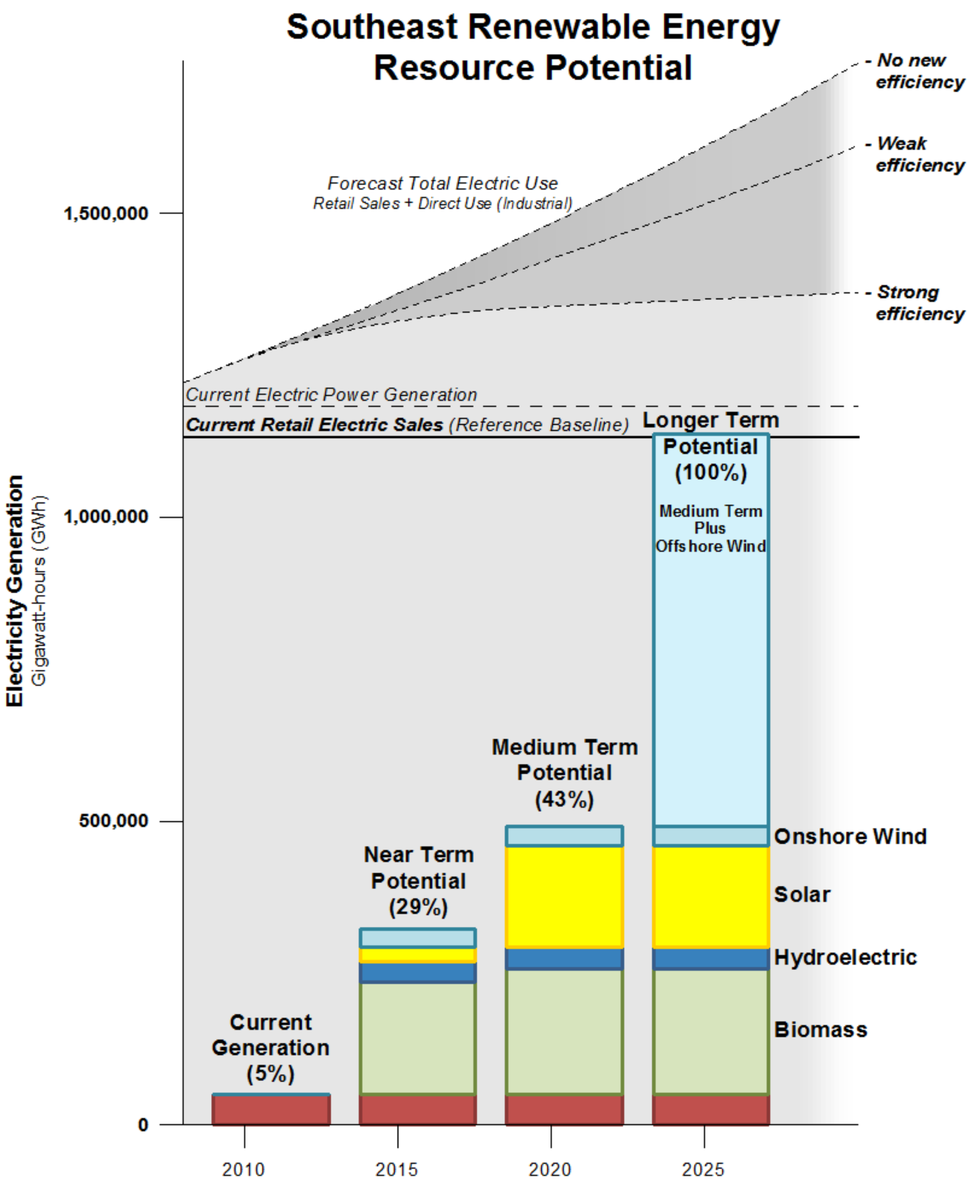
Executive Summary

The Southeast has the ingenuity and renewable energy resources to become more prosperous and energy independent. Utilities across eleven Southeastern states can tap homegrown clean energy resources to meet a significant percentage of electric power demands. Our analysis of renewable energy estimates in the region show sufficient resources to fulfill an aggressive national mandate for renewable energy.

- Today, renewable energy resources generate enough power to serve approximately 5% of retail electric sales in the Southeast.
- Near-term renewable energy resources can generate more than 15% of forecast electricity demand by 2015. If utilized today, these resources would represent about 29% of today's retail sales.
- The Southeast's resources are ample, diverse and widely distributed. Utilities and state regulators will have flexibility in choosing the solutions that are in the public interest.
- With energy efficiency improvements, renewable energy could meet 30% or more of the Southeast's need for electric power.
- One day, renewable energy and energy efficiency may be able to meet nearly all electricity demand.

In summary, the Southeast can meet a national renewable energy standard of at least 15% by 2015, 20% by 2020, and 25% by 2025 with today's technology and tomorrow's jobs.



A National Renewable Energy Standard

A national Renewable Energy Standard (RES) requires that a designated percentage of utilities' electricity production comes from renewable energy sources. The Southern Alliance for Clean Energy assembled data from a large number of regional and national studies to determine whether the Southeast has the resources needed to meet a national RES. Our analysis includes the following assumptions:

- The standard would escalate gradually from today's 5% generation level to:
  - A near-term goal of 15% generation by 2015,
  - A medium-term goal of 20% generation by 2020, and
  - A longer-term goal of 25% generation by 2025.
- Supplemental federal and state policies will support an RES.
- All utilities will be required to comply.

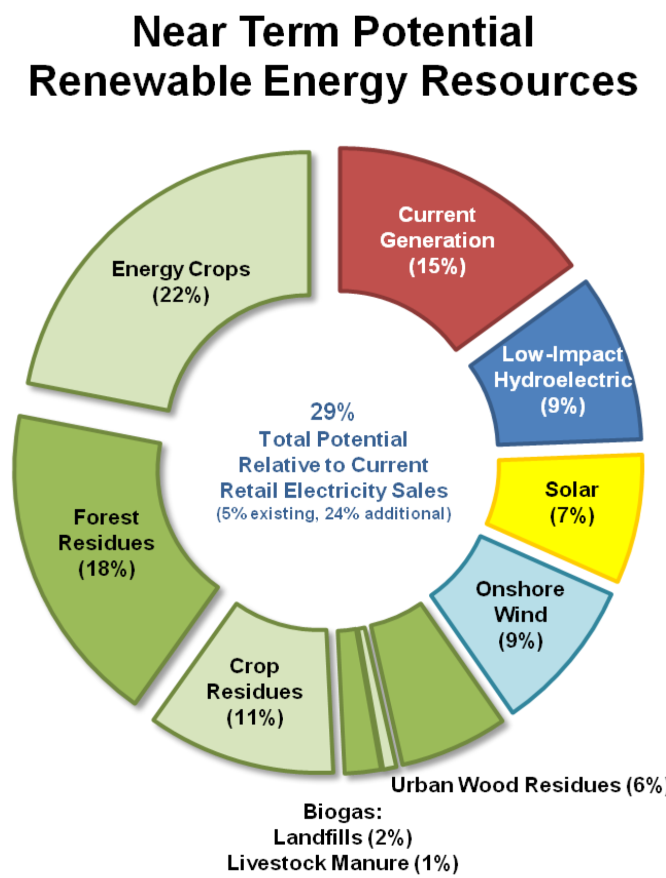
The Southeast has been portrayed as a region that will face significant cost and difficulty meeting a national RES due to scarce access to renewable energy resources. *__This assertion is simply inaccurate__*. The Southeast has sufficient renewable energy resources to comply with a strong RES. Developing our region's renewable energy potential and meeting an RES will actually benefit the region.

Renewable Resources Ready in the Near-Term

The Southeast possesses a variety of renewable energy resources, but biomass is the region's most important near-term option. Today, biomass and hydroelectric power are equally responsible for nearly all of the Southeast's renewable energy generation. Biomass represents about two-thirds of the Southeast's near-term potential for expanding renewable energy. Realizing the Southeast's vast potential for homegrown renewable energy starts with the thoughtful use of our biomass resources.

Today, biomass generation is mainly associated with the use of mill and agricultural processing wastes. Tomorrow's opportunities for using biomass to generate electricity in the Southeast include a diverse assortment of options, particularly energy crops and wood resources.

Energy crops are typically thought of as agricultural crops planted and harvested explicitly for energy generation. However, certain fast-growing trees that can be planted on marginal forest acreage not currently under good stewardship also fit into this category. Energy crops, which can be grown on disused land in poor condition, can provide auxiliary benefits as wildlife habitat. Our analysis builds on



regional stakeholder research as well as scientific expertise at federal laboratories to set out an ambitious goal for energy crops. Nevertheless, developing our resources to this extent would make a major contribution to energy production using only four percent of today's farmland.

The Southeast's wood resources include forest residues – underutilized portions of felled trees – and urban wood waste from landscaping and other such activities. Some industrial users of forest products express understandable concern about new competitors for critical resources. However, the resources cataloged in this analysis are not currently utilized for high-value purposes. Furthermore, the use of wood residues would not directly add to the considerable ecological problems affecting southeastern forests, as only about 0.2% of forest stocks are included in the biopower component of the medium-term feasible resource potential.

The potential for biogas energy generation in this region remains modest. As biogas projects capture methane that would otherwise contribute to global warming, they should not be neglected.

Biomass is a widely available resource in the Southeast, but it is not the only resource that is ready to rely upon. Southeastern utilities are also beginning to develop the region's solar and wind resources. In response to new state renewable energy policies in Florida and North

Carolina, as well as improved cost-effectiveness, several new solar, biomass and wind projects are underway.

- Duke Energy contracted with SunEdison for a 16 MW solar generation facility in Davidson County, North Carolina.
- North Carolina issued Duke Energy regulatory approval to install 10 MW of solar panels on residential and business rooftops.
- Progress Energy has announced three 1 MW solar PV projects in North Carolina.
- Vanir Energy announced a 1.5 MW solar heating and cooling project to serve a Henderson County, North Carolina business park without utility involvement.
- Georgia Power is seeking regulatory approval to convert its coal-fired Plant Mitchell to a 96 MW wood waste biomass plant with reduced fuel and operating costs. The utility has contracted for half the output of a similar privately-built 110 MW plant.
- Oglethorpe Power is planning two to three 100 MW biomass power plants in Georgia.
- Florida Power and Light (FPL) is planning a 14 MW wind farm on Hutchinson Island.
- FPL is planning the world's first hybrid solar / natural gas power plant with a 75 MW solar thermal facility.

Also of note, Gainesville Regional Utilities has developed a solar photovoltaic "feed in tariff" (GRU 2008). The analysis supporting this approach is particularly relevant to questions regarding appropriate rates to pay for solar power.

Of the different types of near-term potential resources, only low-impact hydroelectric power has failed to attract much attention from Southeastern utilities. However, this proven technology is getting a fresh look around the world as low-impact projects that do not require dams or other major structures are proving to be a useful addition to the power system.

Renewable Energy Opportunities Across the Southeast

State	Electric Power Generation (avg GWh, 2005-07)	Renewable Share of Generation	Feasible Renewable Resource Potential (Relative to 2006 retail sales)				Breakthrough Technologies
			Current	Near-Term	Medium-Term	Longer-Term	
Alabama	137,694	8 %	12 %	41 %	61 %	61 %	Geothermal
Arkansas	51,113	8 %	9 %	75 %	112 %	112 %	Geothermal
Florida[i]	220,931	2 %	2 %	11 %	20 %	21 %	Ocean current
Georgia	139,597	4 %	4 %	25 %	39 %	78 %	Ocean current
Kentucky	97,094	3 %	3 %	26 %	39 %	39 %	
Louisiana	91,475	4 %	5 %	32 %	51 %	51 %	Geothermal
Mississippi	47,098	3 %	3 %	77 %	113 %	113 %	Geothermal
North Carolina	126,974	4 %	4 %	29 %	42 %	250 %	Ocean current
South Carolina	101,129	3 %	3 %	21 %	33 %	242 %	Ocean current
Tennessee	93,669	8 %	7 %	31 %	44 %	44 %	
Virginia	76,087	3 %	2 %	20 %	31 %	179 %	Ocean current
Southeastern States	**1,182,861**	**4 %**	**5 %**	**29 %**	**43 %**	**100 %**	

Crafting State-Specific Solutions

Near-term renewable energy resources in the Southeast are *ample, widely distributed and diverse*. Because of the wide availability of resources, initial investments in renewable energy will not require special changes to the Southeast's transmission system. As most major Southeastern utilities operate across state lines, the specific resources available in each state are only a useful indication of regional resource distribution.

Mississippi and Arkansas have a special opportunity to develop and *export* biomass resources or the electricity they generate. Other Southeastern states have enough homegrown resources to meet 10-25% of electricity demand in the near-term without crossing state lines. With these resources, the Southeast can meet a near-term national RES target of 15% by 2015.

Even without considering untapped resources like offshore wind, ocean energy or geothermal resources, the medium-term outlook for the Southeast is also promising. Every Southeastern state has the potential to meet a goal of 20% by 2020.

Because the Southeast's renewable energy resources are ample, widely distributed, and diverse, the Southeast has many paths to meeting a renewable energy standard. Because most proposals for a renewable energy standard incorporate market-based flexibility, utilities can reach across state lines if that is in the interests of their customers and consistent with state policy. Furthermore, efforts to accelerate use of offshore wind and "breakthrough" technologies could bring forward additional opportunities not accounted for in our estimates.

The Southeast will need to look to offshore wind and ocean energy to meet a goal of 25% by 2025, and a variety of coastal energy projects are already underway. For example:

- University of North Carolina is studying the feasibility of wind energy in the state's sounds.
- South Carolina is studying the feasibility of offshore wind energy in state waters.
- Georgia is studying regional transmission infrastructure for ocean-based renewable energy.
- Southern Company has received a federal government lease to collect site-specific wind data in waters off of Georgia's coast.
- Florida Atlantic University's Center for Ocean Energy Technology receives state funds to explore ocean energy by placing a turbine in the Gulf Stream and studying the generation of energy from extreme temperature differences that naturally occur in the ocean.

While the Southeast has not demonstrated widespread national leadership on renewable energy, utilities and state governments throughout the region are exploring the renewable energy potential with creative and dynamic projects. Effective policies like a national RES can help accelerate renewable energy development across the Southeast.

21st Century Challenges, 21st Century Solutions

In less than a century, the United States succeeded in building a network of electric utilities that provide reliable, universal electric service to America. Sustained policy action supported that remarkable achievement and addressed the challenges of that period. Today a new set of laws, regulations and practices are needed to deploy renewable energy and energy efficiency while rebuilding our economy in the rural South.

Twenty-first century policies must prioritize actions that will achieve energy independence *and* minimize global warming pollution. In addition to a national Renewable Energy Standard (RES), the following policies are needed (and assumed in this analysis) to help achieve these goals:

- National carbon dioxide "cap-and-trade" or equivalent policy.
- Third party suppliers of electricity paid at market-based cost of service, reflecting off-peak and peak system value.
- A solar "carve-out," feed-in tariff, or other policy that provides a premium value for investment in solar energy (to the extent that this value is not already reflected in payments at a market-based cost of service).
- Complementary government biofuel policies.

- Responsible and predictable permitting for low-impact hydro, onshore wind, offshore wind and biomass power plants.
- Extension and expansion of state and federal tax credits for renewable energy and efficiency through 2020.

These assumptions are implicit in the primary references used to inform this analysis (see Navigant 2008 for example). In addition, the following conditions (assumed in this analysis) will contribute to or provide an incentive for achieving energy independence while minimizing global warming pollution:

- Moderately high fossil fuel costs.[ii]
- Relatively low capital costs for renewable energy projects that are sustained from recent experience.
- Biomass resources proven to be available at the higher end of resource potential range.
- Relatively rapid rate of technology adoption.

Notably, high electricity rates are not among the conditions needed to support renewable energy development. Renewable energy can be developed at a moderate cost of electricity (relative to future expectations). High electricity rates are more likely to occur if utilities continue to build high-cost baseload generation (expensive coal and nuclear) power plants and neglect inexpensive energy efficiency opportunities.

Tomorrow's Energy, Tomorrow's Jobs

A national Renewable Energy Standard (RES) that reaches a target of 25% by 2025 can play an important role in strengthening our region's economy. Developing the Southeast's renewable energy potential will create new economic opportunities and spur demand for a variety of skilled trades and professional careers.

For example, in 2007 the University of Florida partnered with the USDA Forest Service and other organizations to study the economic impact of a 20 or 40 MW wood-fueled power plant. The study looked at the impact in counties and states throughout the South, including 15 counties in Tennessee, Georgia, Florida and the Carolinas, and found that one 20 MW plant could create an average of 177 full-time, part-time and seasonal jobs while a 40 MW plant could create an average of 393 jobs. Furthermore, the analysis revealed that a 20 MW facility would generate average additional economic activity of $11.07 million and a 40 MW facility would produce nearly $23 million in economic activity (University of Florida 2007).

A 2008 analysis of North Carolina's state-level RES also shows economic benefits. Accounting for job loss and the economic consequences of potential rate increases, the analysis indicated that the RES would result in a net job gain of nearly 2,050 jobs per year over 20 years by the year 2021 (La Capra 2008).

The Bureau of Labor Statistics reports that the Southeast lost more than 612,000 jobs in 2008. Currently, the average unemployment in Southeastern states is 8.5% compared to a national unemployment rate of 7.2%. While we cannot expect a national RES to reverse the unemployment trends completely, the resulting increase in economic and employment opportunities prove beneficial.

Appendix A: Summary of Southeast Renewable Energy Resource Potential

Total Potential Capacity (MW)	**SE 11**	**SE 8**	**AL**	**AR**	**FL**	**GA**	**KY**	**LA**	**MS**	**NC**	**SC**	**TN**	**VA**
Onshore Wind	70,911	60,950	-	9,655	186	4,728	306	-	-	15,777	924	4,395	34,940
Offshore Wind	494,047	494,047	-	-	40,300	71,472	-	-	-	140,097	149,768	-	92,410
Biomass	92,906	70,825	10,861	8,634	6,727	12,175	5,674	7,773	13,137	9,111	6,502	6,651	5,660
Hydroelectric	63,274	36,785	4,877	12,714	1,075	4,066	6,497	7,279	6,709	4,231	2,242	8,797	4,789
Geothermal	1,058,703	589,848	102,865	214,522	39,114	39,018	60,051	194,281	200,743	49,716	69,226	50,733	38,433
Solar	545,476	423,787	48,567	42,136	90,516	65,187	38,282	41,271	39,768	55,628	32,022	45,851	46,249
Total	**2,325,317**	**1,676,243**	**167,170**	**287,660**	**177,918**	**196,645**	**110,810**	**250,604**	**260,357**	**274,561**	**260,684**	**116,427**	**222,481**
Maximum Feasible Capacity (MW)	**SE 11**	**SE 8**	**AL**	**AR**	**FL**	**GA**	**KY**	**LA**	**MS**	**NC**	**SC**	**TN**	**VA**
Onshore Wind	14,106	10,819	-	3,186	49	1,560	101	-	-	4,857	305	2,089	1,959
Offshore Wind	179,390	179,390	-	-	612	17,180	-	-	-	73,789	43,360	-	44,450
Biomass	27,515	20,346	3,028	2,559	2,380	3,049	2,120	2,490	4,512	2,332	1,561	2,091	1,393
Hydroelectric	9,031	5,926	1,053	1,402	181	525	976	727	708	766	453	1,296	944
Geothermal	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar	79,298	58,951	8,256	7,747	9,826	8,790	5,843	6,758	7,397	7,691	4,664	6,438	5,888
Total	**309,341**	**275,432**	**12,337**	**14,894**	**13,047**	**31,104**	**9,040**	**9,975**	**12,618**	**89,435**	**50,344**	**11,914**	**54,634**
Maximum Feasible Generation (GWh)	**SE 11**	**SE 8**	**AL**	**AR**	**FL**	**GA**	**KY**	**LA**	**MS**	**NC**	**SC**	**TN**	**VA**
Onshore Wind	33,166	25,682	-	7,256	86	3,635	228	-	-	11,882	679	4,645	4,753
Offshore Wind	644,902	644,902	-	-	2,069	52,788	-	-	-	262,557	169,252	-	158,236
Biomass	204,878	151,496	22,548	19,053	17,721	22,703	15,785	18,544	33,597	17,364	11,624	15,569	10,371
Hydroelectric	36,046	23,660	4,038	5,168	683	2,015	4,538	2,681	2,610	3,057	1,856	5,738	3,662
Geothermal	-	-	-	-	-	-	-	-	-	-	-	-	-
Solar	166,799	124,071	17,821	16,550	21,532	18,668	11,546	14,632	15,609	15,798	9,895	12,824	11,924
Total	**1,085,792**	**969,810**	**44,407**	**48,027**	**42,091**	**99,809**	**32,098**	**35,856**	**51,817**	**310,659**	**193,306**	**38,777**	**188,945**
Total excluding offshore wind	***440,889***	***324,908***	***44,407***	***48,027***	***40,022***	***47,021***	***32,098***	***35,856***	***51,817***	***48,101***	***24,054***	***38,777***	***30,709***
Current Renewable Generation (2005-2007 avg)	51,333	40,748	10,468	4,041	5,169	5,824	2,853	3,692	1,415	5,599	2,585	7,242	2,446
Total Generation (2005-2007 avg)	1,182,861	943,179	137,694	51,113	220,931	139,597	97,094	91,475	47,098	126,974	101,129	93,669	76,087

Data are summarized as "SE 11" (referring to all states studied) and "SE 8" (referring to all states except Arkansas, Louisiana, and Kentucky.) The details for each of these resource estimates are provided in the following appendices.

This report was revised on February 23, 2009 to address requests for clarification. The major change is to include retail sales in addition to in-state generation as a baseline for comparing renewable energy generation. In-state generation resources are used to meet retail sales demand and direct use (by industrial facilities, for example), as well as covering losses during transmission and (for some states) net power exports to other states. Because renewable resources are used to generate a substantial percentage of electricity classified as "direct use" in some states, there can be substantial differences at the state level when comparing various renewable energy generation rates to various estimates of electricity generation or use. All of these data are available in the accompanying workbook available on our website.

Additional revisions include revisions to the discussion of forest resources to clarify potential impacts to forest ecosystems, and the following explanation of resource potential classifications that was inadvertently omitted from the original publication.

Characterization of Resource Potential
Resources are presented in the appendix using three classifications.

Total potential capacity indicates the potential maximum peak output (in megawatts) if all resources identified in this study were used to generate power. For each resource, the number presented reflects the maximum power output prior to the application of any constraints. In some studies, this figure was not provided. If a similar study provided this figure for similar resource characteristics (say, for a nearby state), then the total potential capacity was calculated assuming that a similar share of the resource base is feasible. Because the total potential capacity includes resources that cannot be developed under any likely scenario, this figure is useful only as an indication of how the feasibility criteria affected the resource. Furthermore, because there is no potential generation from many of these resources due to unsuitability for generation, it is not meaningful to calculate a "total potential generation" estimate and none is attempted.

Total feasible capacity indicates the potential maximum peak output (in megawatts) of resources that may feasibly be developed. Because the data in this analysis are drawn from a variety of studies, the feasibility criteria used vary somewhat from resource to resource, and state to state. In general, a feasible resource is one that can be developed without compromising an obvious restriction or and under a reasonable (but perhaps aggressive) policy scenario. Examples of obvious restrictions include no wind development in national parks or offshore in shipping lanes. Examples of policy scenario restrictions include the exclusion of geothermal resources due to high cost even under aggressive policy scenarios and the exclusion of unsustainable forest resource extraction. Examples of policy scenario incentives that result in including resources are the state and federal policy scenarios from Navigant (2008).

Total feasible generation indicates the potential annual energy output (in megawatt-hours) of the development of the resources identified as within the total feasible capacity. In other words, capacity (MW) and generation (MWh) are two ways of measuring the utilization of the same energy resources. For purposes of load planning, capacity is the critical measure. However, for purposes of studying the implications of a national renewable energy standard (RES), the important quantity is the generation potential of the resources.

Energy Demand Scenarios
Unless a scenario is clearly specified, all calculations of renewable energy potential as a percentage of electricity sales are relative to average state retail sales for in 2006. These sales figures are obtained from the Energy Information Administration.

Where noted in the report, renewable energy potential is compared to future demand. For this purpose, three scenarios of electricity demand are considered. Because most Southeastern states have minimal energy efficiency programs (Florida achieves annual savings of 0.2% and other states achieve far less), the analysis considers the various levels of effort made to reduce electricity demand.

- *No energy efficiency* – All states experience 1.7% retail sales growth per year. This assumption is based on our informal review of recent planning assumptions (see, for example, Navigant 2008).
- *Weak energy efficiency* – Annual retail sales growth is reduced by 25% (approximately 1.3%) beginning in 2011. Relative to the *no energy efficiency* scenario, the cumulative impact of these annual results is about 4% overall energy savings by 2020 and 6% in 2025.
- *Strong energy efficiency* – Energy efficiency programs are assumed to be phased in gradually, reaching a performance target of 1% annual energy savings in 2015 and 1.5% annual energy savings in 2020. Relative to the *no energy efficiency* scenario, these annual results create a cumulative impact of nearly 11% overall energy savings in 2020 and 19% in 2025.

In all scenarios, direct use is assumed to remain flat. This assumption is based on the approximation that growth in the efficiency of direct use is balanced by overall economic growth in these sectors. Because direct use is a relatively small share of total electrical end use, the overall trends are not particularly sensitive to this assumption.

For the generation forecast in each scenario, the state's overall end use growth rate is applied to the generation baseline (average of 2005-2007 generation) to provide an estimate of total in-state generation.

Timeframes for Renewable Energy Development Potential
Not all renewable energy resources can be developed quickly. In addition to considerations of cost and the availability of technology, some projects take longer to design and construct. Furthermore, suppliers' ability to hire skilled managers and laborers, then manufacture and distribute key components at substantially higher volumes might require time to develop. For these reasons, renewable energy resources are categorized into three categories.

Near-term resources are resources that could be developed in significantly less than a decade, potentially within six years. Near-term resources include current generation and partial implementation of other resources as follows:

- Current generation data are from the Energy Information Administration, except for Florida (Navigant 2008).
- Biomass resources, assuming 90% implementation of feasible renewable energy resources (Appendix B)
  - Achieving this rate of implementation would require significant development of the supply chain for forest, crop and urban wood residues. However, since the amount of forest residues required (0.2% of total forest stock) and crop residues (1% of total crop production) is relatively small, the impact on the scale of forest and agricultural operations will be modest.
  - Approximately 4 million acres of energy crops would be needed. This represents conversion or addition of farmland representing about 4% of 2007 farmland (Perlack 2005, USDA-NASS 2008). This figure varies from 1% of farmland in Florida and Virginia to 11% of farmland in Mississippi due to varying soil suitability and existing land uses in those states.
  - Co-firing at existing coal plants could provide a substantial amount of the generation (reducing the use of coal), but some new power plants would be needed (Southern Alliance for Clean Energy 2008).
  - Since biogas from livestock manure and landfills represents less than 5% of total biomass energy potential, there is flexibility in how quickly these resources are developed. However, since these resources currently represent ongoing sources of methane emissions to the atmosphere, addressing these concerns quickly is a necessary and effective strategy to reduce global warming pollution.
- Solar resources, assuming 15% implementation (Appendix C)
  - Utility and private sector commitments have already been announced. This implementation rate reflects the region's current cautious attitude towards the cost of solar energy as well as its suitability to provide electricity in the current utility management paradigm for reliability. However, the total potential for solar energy resources does reflect the impact of a broad range of supportive state and federal policies (see Appendix C).
- Onshore wind resources, assuming 90% implementation (Appendix D)
  - Our organization is aware of private energy developers pursuing an interest in wind development projects. This aggressive implementation rate reflects the maturity of this technology and the availability of data to target developments to the suitable locations. Although projects can be developed in under

two years, onshore wind projects typically require three to five years to accomplish all phases of development. Given the challenges of development on ridgelines, immediate policy signals would be needed to achieve 90% implementation in five to six years.

- Hydroelectric resources, assuming 90% implementation (Appendix E)
    - Achieving this rate of implementation would require significant development by an industry that does not currently exist at scale in the Southeast. However, the technology and its means of production are relatively simple and could be expanded rapidly. The major obstacle to this technology is the current lack of interest in small-scale distributed renewable energy resources.

For purposes of comparison to electricity sales scenarios (above), near-term resources are benchmarked to 2015.

Medium-term resources are those resources that could be developed in approximately one decade. Medium-term resources are 100% implementation of near-term resources.

Longer-term resources are medium-term resources, plus offshore wind resources. While pilot projects for offshore wind could feasibly be developed in much less than a decade, planning for large scale projects is unlikely to begin for several years. As a consequence, development is unlikely to reach levels much beyond pilot project levels until at least 2020. Although there are substantial engineering challenges to offshore wind development in addition to unresolved policy questions, these obstacles could be resolved to enable major development by 2025.

In addition to offshore wind, longer-term resources could conceivably include breakthrough technologies, particularly geothermal and ocean current power generation. Current technology projections for geothermal electricity generation (Appendix F) do not indicate cost-effectiveness without cost improvements. Ocean current generation remains a conceptual energy resource and is currently undergoing active research and development. If engineering research and development are successful, manufacturing and deployment of these technologies is likely to be feasible on a reasonable timescale; potentially by 2025 but perhaps much sooner.

Appendix B: Southeast Biomass Energy Resource Potential

Biomass	SE 11	SE 8	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	VA
Total Potential Capacity (MW)	92,906	70,825	10,861	8,634	6,727	12,175	5,674	7,773	13,137	9,111	6,502	6,651	5,660
Projected Feasible Capacity (MW)	27,515	20,346	3,028	2,559	2,380	3,049	2,120	2,490	4,512	2,332	1,561	2,091	1,393
Projected Feasible Generation (GWh)	204,878	151,496	22,548	19,053	17,721	22,703	15,785	18,544	33,597	17,364	11,624	15,569	10,371
Current Generation (GWh)	23,925	18,925	3,489	1,634	4,128	3,394	458	2,908	1,415	1,759	1,881	404	2,455
Total Potential Generation (GWh)	228,803	170,421	26,036	20,687	21,849	26,097	16,243	21,452	35,012	19,123	13,504	15,973	12,826
Total Potential Capacity (MW)													
Forest Production	56,694	45,691	7,142	4,853	3,471	9,102	2,218	3,932	5,889	6,887	4,898	3,783	4,518
Crop Residues	10,866	5,374	197	2,416	1,643	502	893	2,183	1,104	752	167	756	253
Urban Wood Residues	3,510	2,884	243	158	845	465	229	239	155	420	38	309	409
Livestock Manure	435	350	43	66	9	63	16	3	33	169	14	9	11
Landfills	1,174	979	108	5	209	92	114	76	42	195	83	125	126
Energy Crops	20,227	15,546	3,128	1,135	550	1,950	2,205	1,341	5,914	688	1,303	1,668	344
Total	**92,906**	**70,825**	**10,861**	**8,634**	**6,727**	**12,175**	**5,674**	**7,773**	**13,137**	**9,111**	**6,502**	**6,651**	**5,660**
Projected Feasible Capacity (MW)													
Forest Production	8,417	6,783	1,060	721	515	1,351	329	584	874	1,023	727	562	671
Crop Residues	4,890	2,418	89	1,087	740	226	402	983	497	339	75	340	114
Urban Wood Residues	2,808	2,308	195	127	676	372	183	191	124	336	30	247	328
Livestock Manure	348	280	34	53	7	51	12	2	26	135	11	7	8
Landfills	939	783	86	4	167	73	91	61	34	156	66	100	100
Energy Crops	10,113	7,773	1,564	568	275	975	1,102	670	2,957	344	652	834	172
Total	**27,515**	**20,346**	**3,028**	**2,559**	**2,380**	**3,049**	**2,120**	**2,490**	**4,512**	**2,332**	**1,561**	**2,091**	**1,393**
Projected Feasible Generation (GWh)													
Forest Production	62,673	50,509	7,895	5,365	3,837	10,062	2,452	4,347	6,510	7,614	5,415	4,182	4,994
Crop Residues	36,408	18,008	660	8,094	5,507	1,683	2,991	7,316	3,698	2,521	559	2,533	847
Urban Wood Residues	20,909	17,182	1,449	942	5,034	2,772	1,362	1,422	921	2,499	225	1,842	2,439
Livestock Manure	2,590	2,086	256	394	52	378	93	16	196	1,007	82	54	63
Landfills	6,994	5,832	642	30	1,243	547	680	451	253	1,161	492	745	748
Energy Crops	75,304	57,878	11,646	4,227	2,048	7,261	8,207	4,991	22,019	2,562	4,851	6,212	1,279
Total	**204,878**	**151,496**	**22,548**	**19,053**	**17,721**	**22,703**	**15,785**	**18,544**	**33,597**	**17,364**	**11,624**	**15,569**	**10,371**

The major source for biomass data is the *Bioenergy Roadmap for Southern United States* (Alavalapati 2009). However, this report provides the technical potential in terms of resource volume and potential energy value for forest biomass (USDA-FS), crop residues (USDA-NASS 2007), urban wood residues (Milbrandt 2005), livestock manure (Barker 2001) and methane from landfills (Milbrandt 2005). Since energy crops were not included, an alternate source was selected (Milbrandt 2005).

Additional analysis was necessary to convert these data into potential electric capacity and develop feasible capacity and generation estimates. The conversion to electricity resources assumes an 85% capacity and uses conversion factors from government or national laboratories. To determine feasible resource use, factors from a Florida study (Mulkey 2008) were adapted to the resource categories used in this analysis.

Appendix C: Southeast Solar Energy Resource Potential

Solar	SE 11	SE 8	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	VA
Total Potential Capacity (MW)	545,476	423,787	48,567	42,136	90,516	65,187	38,282	41,271	39,768	55,628	32,022	45,851	46,249
Projected Feasible Capacity (MW)	79,298	58,951	8,256	7,747	9,826	8,790	5,843	6,758	7,397	7,691	4,664	6,438	5,888
Projected Feasible Generation (GWh)	166,799	124,071	17,821	16,550	21,532	18,668	11,546	14,632	15,609	15,798	9,895	12,824	11,924
Current Generation (GWh)	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potential Generation (GWh)	166,799	124,071	17,821	16,550	21,532	18,668	11,546	14,632	15,609	15,798	9,895	12,824	11,924
Rooftop PV													
Total Potential Capacity (MW)	190,757	163,595	12,500	6,128	52,000	24,921	10,079	10,955	6,846	21,545	11,042	16,053	18,689
Projected Feasible Capacity (MW)	3,057	2,834	276	3	1,047	130	111	108	292	489	136	267	197
Projected Feasible Generation (GWh)	4,819	4,480	442	5	1,730	202	163	171	455	746	213	398	293
Ground Mounted PV													
Total Potential Capacity (MW)	346,127	253,256	34,816	35,725	37,000	39,730	27,258	29,888	32,184	33,421	20,659	28,280	27,166
Projected Feasible Capacity (MW)	74,391	54,624	7,709	7,683	8,458	8,544	5,528	6,557	6,946	7,059	4,458	5,843	5,606
Projected Feasible Generation (GWh)	159,481	117,517	17,010	16,462	19,263	18,307	11,169	14,334	14,936	14,856	9,587	12,030	11,527
Large Scale Solar Water Heating													
Total Potential Capacity (MW)	8,212	6,556	1,251	283	1,136	535	945	428	738	662	321	1,518	394
Projected Feasible Capacity (MW)	1,775	1,417	270	61	246	116	204	93	160	143	69	328	85
Projected Feasible Generation (GWh)	2,348	1,923	369	84	387	158	215	127	218	195	95	397	103
CSP - feasibility limited to Florida due to need for direct incidence of sunlight													
Total Potential Capacity (MW)	380	380			380								
Projected Feasible Capacity (MW)	75	75			75								
Projected Feasible Generation (GWh)	151	151			151								

The most authoritative analysis of solar energy potential in the Southeast is the *Florida Renewable Energy Potential Assessment* (Navigant Consulting 2008). All Florida data for the solar energy resource are derived from this study, which used three policy and forecast scenarios that resulted in different levels of renewable energy potential. In response to this study in January 2009, the Florida Public Service Commission recommended a renewable energy standard of 20% by 2020. Using a weighted average of two scenarios, the solar resource potential for Florida was estimated for an overall 20% renewable energy potential as recommended by the commission; these data are used in this report.

Since there is no comparable data for any other Southeastern state, the Florida study findings were extended to other states using technology-specific adjustment factors.

- *Rooftop PV* – The total potential capacity for all Southeastern states (using somewhat less robust methods) has been estimated as 223 thousand GWh on a state by state basis (Paidipati 2008). The newer Florida estimate is approximately 15% less than the prior estimate; accordingly, the total potential for each state is reduced by the same factor. The feasible potential capacity for states other than Florida is extended from the same study (2015 cumulative best case, SAI pricing scenario). The newer Florida estimate is roughly three times larger than the prior estimate, which is reasonable considering that the newer estimate includes five additional years of opportunity to install solar resources as well as different policy and forecast assumptions. The feasible potential generation was determined using the same approach except that the energy output per unit of capacity is reduced relative to Florida based on the relative energy density of each state (Denholm and Margolis 2007).

- *Ground Mounted PV* - The Florida study determined the total potential capacity based primarily on an in-depth land use analysis using GIS technology; less than 1% of Florida land area was identified as suitable. Because other Southeastern states appear generally less intensively developed, and have fewer acres in wetlands or other restricted land uses, it is likely that a larger percentage of land in those states might fit the same criteria developed for Florida. For that reason, adjusting the total potential capacity across the Southeast based on the land area of each state relative to Florida provides a fairly conservative assumption. The feasible potential capacity was reduced based on the energy density of each state relative to Florida, using this factor as a proxy for the slightly less attractive economic opportunity to develop solar in those states. The feasible potential generation was reduced in the same way to account for the economic opportunity, and the energy density factor was reapplied to also account for the difference in energy output per unit of capacity.
- *Large Scale Solar Water Heating* – Although solar water heating does not generate electricity per se, it does tend to displace electricity used to generate hot water. The Florida study considered opportunities to generate the equivalent of greater than 2 MW of water heating capacity. The total and feasible potential capacity for each state was determined by adjusting the Florida estimate based on the state's large commercial roof area relative to Florida (Chaudhari 2004) because most large solar water heating opportunities would be at major commercial sites (e.g., hospitals, hotels). The feasible potential generation for each state was derived from the Florida data adjusted for both the roof area data and the state's solar fraction relative to Florida (Denholm 2007).
- *Concentrated Solar Power* – A literature review indicates that this technology depends on a high incidence of direct sunlight to be successful. These conditions do not occur in the Southeast anywhere north of approximately Gainesville, Florida. Accordingly, we assume no potential for other Southeastern states.

In addition to these resources, smaller scale solar water heating is also a widely available resource in the Southeast. Although these resources could be considered eligible for a renewable energy standard, they are often omitted due to difficulties in incorporating them into a market-based trading framework. Accordingly, we have not included these smaller resources in our inventory of renewable energy potential. This approach follows the Florida study.

Appendix D: Southeast Wind Energy Resource Potential

Wind (Total)	SE 11	SE 8	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	VA
Total Potential Capacity (MW)	564,959	554,998	-	9,655	40,486	76,200	306	-	-	155,874	150,693	4,395	127,350
Projected Feasible Capacity (MW)	193,496	190,209	-	3,186	661	18,740	101	-	-	78,646	43,665	2,089	46,409
Projected Feasible Generation (GWh)	678,068	670,584	-	7,256	2,155	56,423	228	-	-	274,440	169,931	4,645	162,989
Current Generation (GWh)	36	36	-	-	-	-	-	-	-	-	-	36	-
Total Potential Generation (GWh)	678,104	670,620	-	7,256	2,155	56,423	228	-	-	274,440	169,931	4,681	162,989

Onshore Wind Resources

Onshore	SE 11	SE 8	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	VA
Total Potential Capacity (MW)	70,911	60,950	-	9,655	186	4,728	306	-	-	15,777	924	4,395	34,940
Projected Feasible Capacity (MW)	14,106	10,819	-	3,186	49	1,560	101	-	-	4,857	305	2,089	1,959
Projected Feasible Generation (GWh)	33,166	25,682	-	7,256	86	3,635	228	-	-	11,882	679	4,645	4,753

A variety of resources were used to estimate onshore wind energy resource potential. (Note that the totals above include offshore wind energy resource potential, presented in Appendix E.)

- *Appalachian State University* (North Carolina, Tennessee) – Using data from NREL and AWS Truewind, along with their own field and GIS analysis, wind resource experts maintain an ongoing assessment of potential wind energy development sites in western North Carolina (Raichle 2007). For eastern North Carolina, data were obtained from a study of North Carolina's renewable energy resources (La Capra Associates 2006). For Tennessee, extensive data were provided to the Tennessee Valley Authority (Carson and Raichle 2005); these data required some analysis for purposes of summarization following methods used for North Carolina (Raichle 2007).
- *AWS Truewind* (Georgia) – AWS Truewind assessed the wind resource potential for Georgia (Bailey 2006). The total potential capacity was obtained from this report. Based on North Carolina results, feasible potential capacity is assumed to be 33% of total potential capacity; generation is derived from that figure using a capacity factor appropriate to the wind class (Raichle 2007).
- *AWS Truewind* (South Carolina) – Using data from AWS Truewind, a research team at University of South Carolina assessed the wind resource potential for South Carolina (Beacham 2008). The feasible potential capacity and generation were obtained from this report. The total potential capacity is derived from these data assuming that the feasible potential is 33% of total potential capacity based on North Carolina results (Raichle 2007).
- *WindDS* (Arkansas, Kentucky) – The National Renewable Energy Laboratory maintains a national model of wind energy potential (Denholm and Short 2006). The total potential capacity was obtained from these data. Feasible potential capacity is assumed to be 33% of total potential capacity; generation is derived from that figure using a capacity factor appropriate to the wind class (Raichle 2007).
- *Virginia Center for Coal and Energy Research* (Virginia) – All necessary data were available in a study of Virginia renewable energy resources and via personal communication with the study author, although some calculations were required to present the data in a consistent framework for this analysis (Virginia Center 2005, Hagerman 2007).
- *Navigant Consulting* (Florida) - The most authoritative analysis of wind energy potential in Florida is the *Florida Renewable Energy Potential Assessment* (Navigant Consulting 2008), which relied on unpublished data from NREL. The Florida study used three policy and forecast scenarios that resulted in different levels of renewable energy potential. Acting on findings in this study in January 2009, the Florida Public Service Commission recommended a

renewable energy standard of 20% by 2020. Using a weighted average of two scenarios, the onshore wind resource potential for Florida was estimated for an overall 20% renewable energy potential as recommended by the commission; these data are used in this report.

No studies have identified significant onshore wind resources for Alabama, Louisiana or Mississippi. Small, specialized wind generation opportunities might exist in these states, and there might be limited opportunity for utility-scale generation on ridgelines in northeast Alabama.

Offshore Wind Resources

Offshore	SE 11	SE 8	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	VA
Total Potential Capacity (MW)	494,047	494,047	-	[redacted]	40,300	71,472	[redacted]	-	-	140,097	149,768	[redacted]	92,410
Projected Feasible Capacity (MW)	179,390	179,390	-	[redacted]	612	17,180	[redacted]	-	-	73,789	43,360	[redacted]	44,450
Projected Feasible Generation (GWh)	644,902	644,902	-	[redacted]	2,069	52,788	[redacted]	-	-	262,557	169,252	[redacted]	158,236

A variety of resources were used to estimate offshore wind energy resource potential. (Note that the totals above include onshore wind energy resource potential, presented in Appendix D.)

- *AWS Truewind* (Georgia) – AWS Truewind assessed the wind resource potential for Georgia (Bailey 2006). The total potential capacity was obtained from this report. Feasible potential capacity is assumed to be 25% for Class 4-5 and 60% for Class 6 (based on Virginia findings, see below). Capacity factors are from the WinDS documentation.
- *AWS Truewind* (South Carolina) – Using data from AWS Truewind, a research team at University of South Carolina assessed the wind resource potential for South Carolina (Beacham 2008). The feasible potential capacity and generation were obtained from this report. The total potential capacity is derived from these data assuming that the feasible potential capacity is 25% for Class 4-5 and 60% for Class 6 (based on Virginia findings, see below).
- *WindDS* (North Carolina) – The National Renewable Energy Laboratory maintains a national model of wind energy potential (Denholm and Short 2006). The total potential capacity was obtained from these data. Feasible potential capacity is assumed to be 25% for Class 4-5 and 60% for Class 6 (based on Virginia findings, see below). Capacity factors are from the WinDS documentation. (Note that offshore wind has been excluded from North Carolina specific resource studies for policy or program reasons.)
- *Virginia Center for Coal and Energy Research* (Virginia) – All necessary data were available in a study of Virginia renewable energy resources and via personal communication with the study author, although some calculations were required to present the data in a consistent framework for this analysis (Virginia Center 2005, Hagerman 2007).
- *Navigant Consulting* (Florida) – The most authoritative analysis of wind energy potential in Florida is the *Florida Renewable Energy Potential Assessment* (Navigant Consulting 2008), which relied on unpublished data from NREL. The Florida study used three policy and forecast scenarios that resulted in different levels of renewable energy potential. In response to this study in January 2009, the Florida Public Service Commission recommended a renewable energy standard of 20% by 2020. Using a weighted average of two scenarios, the offshore wind resource potential for Florida was estimated for an overall 20% renewable energy potential as recommended by the commission; these data are used in this report.

These studies use generally consistent methods and data sources, except that North Carolina and Florida data are derived from NREL data that represent potential at 50 meters above the surface. AWS Truewind data represent conditions at 90-100 meters–a height more representative of the wind conditions that a modern offshore wind turbine might experience. No studies have identified significant offshore wind resources for Alabama, Louisiana or Mississippi. Data from Florida and Texas suggest that it is highly unlikely that those states have significant offshore wind resource potential.

Appendix E: Southeast Hydroelectric Energy Resource Potential

Hydroelectric	SE 11	SE 8	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	VA
Total Potential Additional Capacity (MW)	63,274	36,785	4,877	12,714	1,075	4,066	6,497	7,279	6,709	4,231	2,242	8,797	4,789
Projected Feasible Additional Capacity (MW)	9,031	5,926	1,053	1,402	181	525	976	727	708	766	453	1,296	944
Projected Feasible Additional Generation (GWh)	36,046	23,660	4,038	5,168	683	2,015	4,538	2,681	2,610	3,057	1,856	5,738	3,662
Current Generation (GWh)	26,567	20,982	6,980	2,407	235	2,430	2,395	784	-	3,840	704	6,802	(9)
Total Potential Generation (GWh)	62,613	44,641	11,018	7,575	918	4,445	6,932	3,464	2,610	6,897	2,560	12,540	3,653
Low Power and Small Hydro Class Plants													
Total Potential Hydro (MWa)	32,334	19,795	3,171	5,697	464	2,061	3,754	3,088	2,823	2,329	1,378	5,295	2,274
Total Developed Hydro (MWa)	3,725	3,048	1,036	347	-	281	305	25	-	402	328	848	153
Total Potential (MWa) (Total minus developed)	28,609	16,747	2,135	5,350	464	1,780	3,449	3,063	2,823	1,927	1,050	4,447	2,121
Annual capacity factor			0.4378	0.4208	0.4316	0.4378	0.5309	0.4208	0.4208	0.4555	0.4691	0.5055	0.4429
Convert MWa to MW (Total Potential Capacity)	63,271	36,781	4,877	12,714	1,075	4,066	6,497	7,279	6,709	4,231	2,238	8,797	4,789
Available High Power (MWa)	2,808	1,714	311	405	51	101	441	248	194	199	153	481	224
Available Low Power (MWa)	1,306	986	150	185	27	129	77	58	104	150	58	174	194
Feasible Capacity (MW)	9,028	5,923	1,053	1,402	181	525	976	727	708	766	450	1,296	944
Feasible Generation (GWh)	36,039	23,652	4,038	5,168	683	2,015	4,538	2,681	2,610	3,057	1,848	5,738	3,662

The potential hydroelectric generation is from an Idaho National Laboratory study (INL 2006). The total potential generation (in average megawatts or MWa) is estimated as the difference between total potential hydroelectric energy and the total developed hydroelectric resource in the state. Using a state-specific capacity factor (INL 2003), the total potential capacity is derived from this figure. The potential feasible resource is derived from the available high and low power generation using the same state-specific capacity factor. Converting available power from MWa to GWh is a straightforward conversion by definition.

The INL report is specifically limited to technologies with low or no environmental impact. In South Carolina, a small additional increment of conventional generation is included (3.5 MW, 7.7 GWh, La Capra and GDS 2007).

Appendix F: Southeast Geothermal Energy Resource Potential

Geothermal	SE 11	SE 8	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	VA
Total Potential Capacity (MW)	1,058,703	589,848	102,865	214,522	39,114	39,018	60,051	194,281	200,743	49,716	69,226	50,733	38,433
Projected Feasible Capacity (MW)	-	-	-	-	-	-	-	-	-	-	-	-	-
Projected Feasible Generation (GWh)	-	-	-	-	-	-	-	-	-	-	-	-	-
Current Generation (GWh)	-	-	-	-	-	-	-	-	-	-	-	-	-
Total Potential Generation (GWh)	-	-	-	-	-	-	-	-	-	-	-	-	-
Total recoverable energy (MW)			102,865	214,522	39,114	39,018	60,051	194,281	200,743	49,716	69,226	50,733	38,433
Developable - lowest cost resource (MW)			135	418	39	126	3,588	58,202	211	205	3,594	436	1,636
Cost (cents / kWh)			29	22	39	58	67	28	22	38	57	48	48
Developable w/cost improvements < 13 c/kWh (MW)			212	37,029				30,800	7,247				
Developable w/cost improvements < 13 c/kWh (GWh)			1,671	291,940	-	-	-	242,824	57,136	-	-	-	-

There is currently no report that identifies significant geothermal electric generation potential in the Southeast. Although isolated locations may have the potential for relatively small utility-scale generation projects, no such opportunities were catalogued in the most recent study (MIT 2006). However, with cost improvements, sites in Arkansas, Louisiana, Mississippi and Alabama could become potential sites for geothermal electric generation at costs that are similar to those being proposed for nuclear and coal generation facilities. (Note that this technology is different from a geothermal heat pump, which is considered an energy efficiency technology, not a renewable energy technology.)

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Endnotes

[i] The 2% figure cited for Florida’s current generation differs from the approximately 5% figure reported in a recent Florida study (Navigant 2008). The difference can be accounted for by differences in the baselines. The Florida study considered renewable energy relative to a sales baseline of the four largest investor-owned utilities, rather than a statewide total sales baseline. Another distinction in the Florida study is the addition of sulfuric acid waste heat recovery, which is defined by statute in Florida as a renewable energy resource.

[ii] Typical assumptions would be natural gas at $11-14 per MMBtu, coal $2.5-3.5 per MMBtu, biomass $60 per dry ton, electricity rates increase from 9¢ to 17¢ per kWh, MSW tipping fee $70 per ton (Navigant 2008).