RENEWABLE ENERGY IN THE SOUTH

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EXECUTIVE SUMMARY

Transitioning away from increasingly scarce, carbon-intensive and polluting fossil fuels is one of the key challenges facing modern society. Prominent among the energy supply options with inherently low life-cycle CO_2 emissions is a suite of renewable technologies. They also represent an opportunity to diversify energy resources while increasing reliance on domestic fuels.

Government policies can provide a strong impetus for constructing renewable generation facilities. Federal and state tax incentives, government procurement policies, statewide renewable electricity standards (RESs), and regional carbon cap and trade programs all encourage investments in renewable electricity. These policies, however, are not uniformly adopted throughout the country. While 29 states have an RES, only four of these states are located in the South (Delaware, Maryland, North Carolina, and Texas) plus the District of Columbia (Figure ES.1).

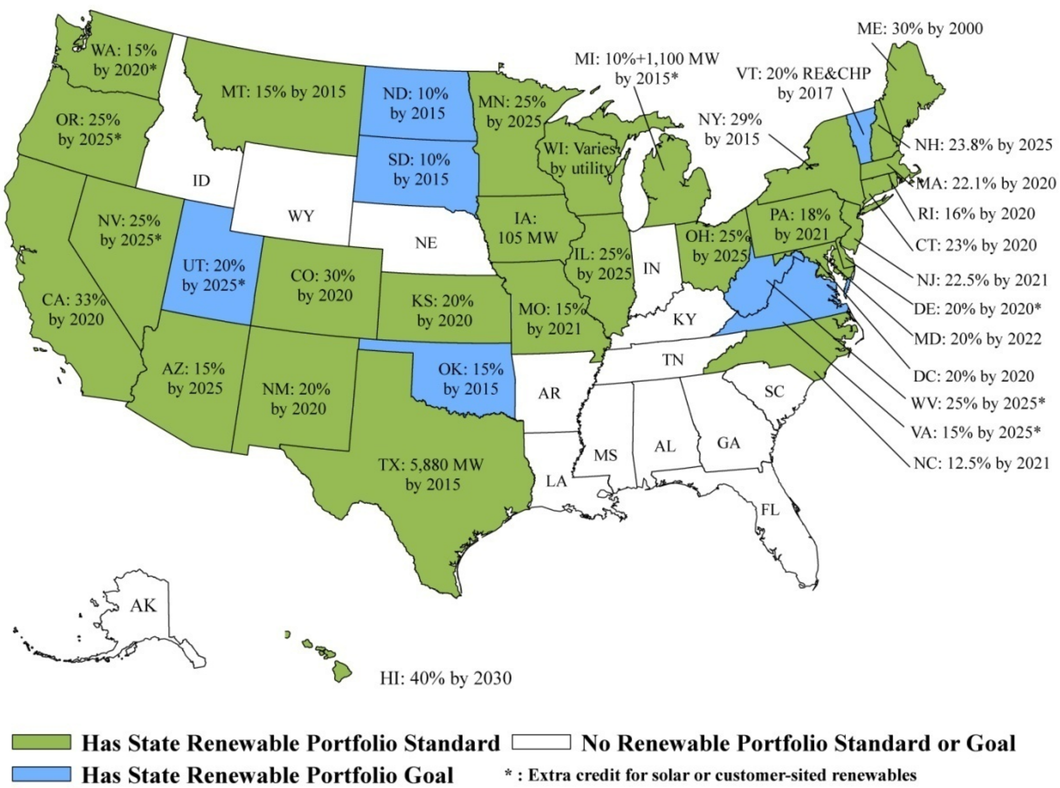

Figure ES.1 States with Renewable Electricity Standards

Source: Database of State Incentives for Renewable Energy (2010) http://www.dsireusa.org/. Accessed August 17, 2010

An RES is particularly influential for renewable markets because it provides a mandate requiring electricity suppliers to employ renewable resources to produce a certain amount or percentage of power by a fixed date. Typically, electric suppliers can either generate their own renewable energy, buy power from independent power producers, or buy renewable energy credits. Thus, this policy blends the benefits of a "command and control" regulatory paradigm with a free market approach to environmental protection.

Policy makers in some Southern states oppose renewable electricity standards because they believe their renewable resources are insufficient. The purpose of this report is to provide an up-to-date assessment of the economic potential for expanding renewable electricity generation in the South. We examine this economic potential by first incorporating new and improved estimates of hydropower and wind resources into our version of the National Energy Modeling System (NEMS). Then we adjust the cost forecast for solar resources to better reflect published estimates. Next we considered several policies – including accelerated R&D and extensions of tax credits – where increased renewable utilization is a policy goal. Finally, we examine the ability of renewable power generation to compete with traditional fossil and nuclear power options under two different federal policy scenarios: a national RES and a carbon-constrained future.

Customer-owned renewables are included in this assessment in addition to utility-scale renewables. While they are often not the focus of renewable policy debate, customer-owned renewables can achieve most of the same environmental and sustainability objectives that are the major drivers for increasing utility-scale renewables.

The Current Status of Renewable Power in the South

The South (Figure ES.2), with its strong energy-intensive industrial base, accounts for 44% of the nation's total energy consumption, while it is home to only 36% of the U.S. population. Coal dominates electricity generation in the South, and renewables only provide 3.7% of its electricity generation. No state in the South exceeds the national average of 9.5% renewable electric power.

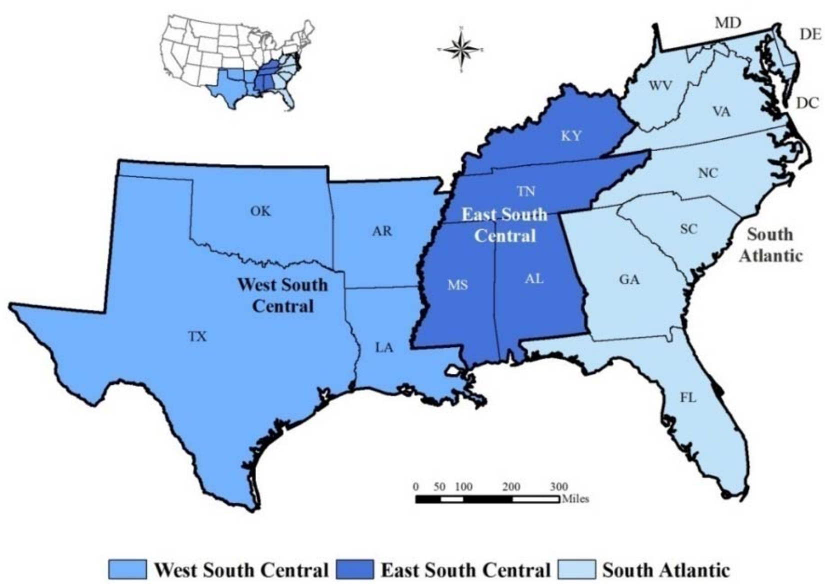

Figure ES.2 The Census South Region and Its Three Divisions[1]

[1] Map and definition from U.S. Census Bureau document on Regions and Divisions of the United States *www.census.gov/geo/www/us_regdiv.pdf*

Hydropower represents nearly two-thirds of U.S. renewables, and it is also the largest renewable resource in the South accounting for 53% of the region's renewable electricity. Many Southern states produce hydropower, with Alabama, Tennessee, and Arkansas most notable among them (Table ES.1). Wind power is the second largest renewable source of electricity in the U.S. and in the South. Among the Southern states, Texas generates the largest quantity of wind power and Oklahoma also has a significant share. West Virginia and Tennessee are the only other two Southern states producing at least 1 TBtu of wind power. Biomass from wood and waste is the third largest renewable source of electricity both in the U.S. and the South. While Florida produces the largest quantity of biopower, other Southern states have significant quantities, as well, including Virginia, Maryland and the Carolinas. No state in the South produces more than 0.5 TBtu of geothermal or solar/PV electricity. In contrast, geothermal electricity comprised 8% of U.S. renewable generation in 2008, and solar power constituted 0.2%.

Table ES.1 Consumption of Electric Power from Renewable Resources, by State in 2008 (Trillion Btu)

	Total Electricity	Renewable Share (%)	Renewable Power	Hydro	Wind	Biomass (Wood & Waste)	Geo-thermal	Solar & Photo-voltaic
Alabama	1404	4.6%	64	61	0	4	0	0
Arkansas	532	9.0%	48	46	0	2	0	0
Delaware	73	2.7%	2	0	0	2	0	0
DC	1	0.0%	0	0	0	0	0	0
Florida	2002	2.6%	52	2	0	50	0	0
Georgia	1302	1.6%	21	21	0	0	0	0
Kentucky	1030	1.9%	20	19	0	1	0	0
Louisiana	701	1.7%	12	11	0	1	0	0
Maryland	486	5.6%	27	20	0	8	0	0
Mississippi	445	0.0%	0	0	0	0	0	0
North Carolina	1253	3.0%	38	30	0	8	0	0
Oklahoma	730	8.4%	61	38	23	0	0	0
South Carolina	1024	1.8%	18	11	0	7	0	0
Tennessee	911	6.2%	56	56	1	0	0	0
Texas	3652	4.8%	175	10	160	5	0	0
Virginia	742	3.5%	26	10	0	16	0	0
West Virginia	907	1.3%	12	8	4	0	0	0
Census South	**17,200**	**3.7%**	**630**	**340**	**188**	**104**	**0**	**0**
(% of the South)			3.7%	2.0%	1.1%	0.6%	0%	0%
United States	**40,200**	**9.5%**	**3,800**	**2,500**	**550**	**440**	**310**	**9**

In sum, the South's wind power is concentrated mostly in the West South Central states, while its biopower comes mostly from the South Atlantic region. Its hydropower is widely dispersed, but is particularly dominant in the East South Central states (Figure ES.3).

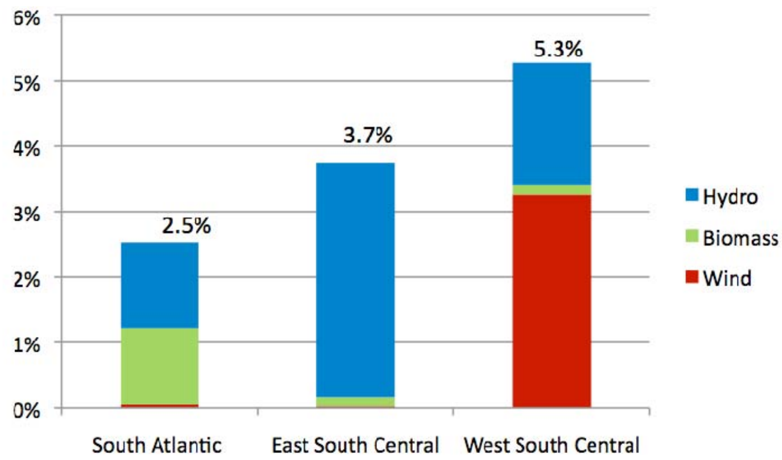

Figure ES.3 Consumption of Electric Power from Renewable Resources, by Census Division in 2008 (as a Percent of Electric Power Consumption)

Source: Energy Information Administration. 2010b. *State Energy Data System*. Retrieved on July 2, 2010 from: http://www.eia.doe.gov/emeu/states/_seds.html

Notable Renewable Energy Projects in the South

The scarcity of renewable electricity standards in the South should not suggest that the region lacks renewable power activity. In fact, the potential for expansion of renewable energy in the South is being demonstrated by the growth of investments in renewable power projects throughout the region. SACE (2009) listed approximately a dozen activities in its report on renewable resources in the Southeast. Additional projects have been initiated recently with funding from the American Recovery and Reinvestment Act (ARRA). Solar projects have received the biggest financial boost from the ARRA, with more than $60 million spending on 14 programs. In addition, more than $10 million of ARRA funding supports biomass development, and about $20 million is being spent on hydropower projects. When these projects are completed, the South will have an additional 120 MW of solar power, more than doubling its current solar capacity. Investments in wind farms in the West South Central states have been significant, and Florida Power and Light is planning a 14 MW wind farm on Hutchinson Island.

METHODOLOGY

Unlike most previous assessments of renewable electricity alternatives, this report includes ***both***: 1) utility-scale renewable generation and 2) customer-owned renewable resources. Utility-scale generators use wind, biomass, hydro, or solar energy to produce electricity. Customer-owned renewable resources include rooftop solar panels, industrial facilities that produce electricity from waste heat (called "combined heat and power" or CHP), and demand-side technologies such as heat pumps that use heat in the air, water, or ground to produce energy services that reduce the requirement to consume electricity.

Our assessment of renewable electricity resources in the South uses a version of NEMS, the U.S.

Department of Energy's premier energy forecasting tool.[2] NEMS models U.S. energy markets and is the principal modeling tool used by the Energy Information Administration (EIA) to produce "reference forecasts" that are published each year in its *Annual Energy Outlook*. In this analysis, three scenarios of expanded renewables in the South are compared with the Reference forecast reflecting EIA's analysis of the Stimulus Bill and the 2008 economic downturn (EIA, 2009a):

- **Expanded Renewables:** Uses updated estimates of renewable resources in the South detailed in Volume II and other sources. In addition, it assumes a number of renewable policies such as an extension of R&D and tax subsidies, but no new state or Federal carbon pricing or renewable energy portfolio policies are enacted.
- **Expanded Renewables + Renewable Electricity Standard (RES):** Uses all of renewable policies and updated estimates of renewable resources from the **Expanded Renewables Scenario** along with a Federal requirement of 25% renewable electricity production by 2025. The scenario exempts small retailers from the RES mandate and excludes hydroelectric power and municipal solid waste from the sales baseline. An RES only scenario was also created in order to compare results.
- **Expanded Renewables + Carbon-Constrained Future (CCF):** Uses all of the renewable policies and updated estimates of renewable resources from the **Expanded Renewables Scenario** along with a carbon price of $15 (in $2005) per metric ton of carbon dioxide in 2012 growing annually at 7%. Allowances are redistributed to load serving entities as described above, and there are no carbon offsets. A CCF only scenario was also created in order to compare results.

The first scenario seeks to provide an improved forecast of the future growth of renewable energy. The two additional scenarios estimate what might happen to the future of renewable power in the South if a national RES or a national price on carbon were enacted.

Updated Estimates of Renewable Resources

Recent assessments of renewable resources provide updated, more precise, and more expansive estimates of available renewable resources across the country. The updated estimates shown in Table ES.2 show potentials for five specific renewable resources in each of the 16 Southern states and the District of Columbia. These resource potentials are the basis for modeling the hydro and the wind power in the Expanded Renewables scenario described above, since they identify a greater physical resource than previous estimates. For the biomass, landfill gas, and solar, we use other data sources that provide more detailed supply curve estimates that are consistent with the averages shown in Table ES.2, as described in the full report.

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[2] SNUG-NEMS: Southeastern NEMS User Group version of NEMS.

Table ES.2 Renewable Resource Potential, by State					
	Low-Power and Small Hydro (MW of Feasible Projects)	**Wind (km^2 of Developable Land)**	**Biomass Wood & Waste (Thousand tons/year)[3]**	**Methane from Waste (Thousand tons/year)[4]**	**Solar Radiative Forcing ($kWh/m^2/day$)**
Alabama	460	24	12,000	340	4.9
Arkansas	590	1,840	12,590	190	5.1
Delaware	6	1.9	420	60	4.6
DC	N/A	N/A	56	1	4.6
Florida	79	0.1	9,210	500	5.2
Georgia	230	26	14,450	350	5.1
Kentucky	520	12	7,540	290	4.5
Louisiana	310	82	12,880	180	5.0
Maryland	91	300	1,910	220	4.6
Mississippi	300	0.0	15,790	170	5.0
North Carolina	350	160	9,920	810	5.0
Oklahoma	350	103,400	3,740	210	5.0
South Carolina	210	37	6,100	220	5.0
Tennessee	660	62	6,440	300	4.7
Texas	330	380,300	13,260	940	5.4
Virginia	420	360	6,230	310	4.8
West Virginia	480	380	2,390	50	4.3
South Total	**5,370**	**486,900**	**134,900**	**5,140**	**-**
U.S. Total	**29,400**	**2,091,800**	**408,000**	**15,030**	**-**

Note: Numbers may not add up due to rounding. Source: Hall, et al. (2006) *Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants,* INL, Table B-1; NREL (2010) *Wind Powering America. Wind Resource Potential*. Retrieved on July 18, 2010 from: http://www.windpoweringamerica.gov/wind_maps.asp; Energy Information Administration. (2010b). *State Energy Data System*. Retrieved on July 2, 2010 from: http://www.eia.doe.gov/emeu/states/_seds.htm; Milbrandt, A. (2005)*A Geographic Perspective on the Current Biomass Resource Availability in the United States*,NREL,TP-560-39181,pg.49 (Table 10), December 2005.

The hydro resource data suggest the availability of significant small conventional and low-power hydro resources, above and beyond those previously modeled in NEMS. These resources are available across many states in the East South Central and South Atlantic regions, and they total more than five GW, or the equivalent of approximately five new coal or nuclear plants. The

[3]Biomass Wood & Waste in Table 2 includes crop residues, switch grass, forest residues, mill residues, urban wood waste.
[4]Methane from Waste includes methane from landfills, manure waste, and domestic wastewater management.

latest wind resource data measured at 80-meter heights show a broader geography of wind resources relative to the resources previously modeled in NEMS. Prior estimates suggested more limited wind power resources in the South. The estimates of biomass resources and methane from waste broadly reflect the magnitudes modeled in NEMS, which recently updated its bioenergy supply curves. These resource estimates exceed those of other models that are not as current.

RESULTS

Utility-Scale and Customer-Owned Renewables

This section compares a Reference forecast with the three modeled scenarios previously described. Figure ES.4 displays the results in terms of the proportion of total electricity generation in the South that would come from renewable resources over the next twenty years. In the Expanded Renewables Scenario, renewable electricity generation doubles the output of the Reference forecast for the South. If a Federal RES is adopted or the policies represented by our CCF scenario are implemented, we estimate that 15% to 30% of the South's electricity could be generated from renewable sources.

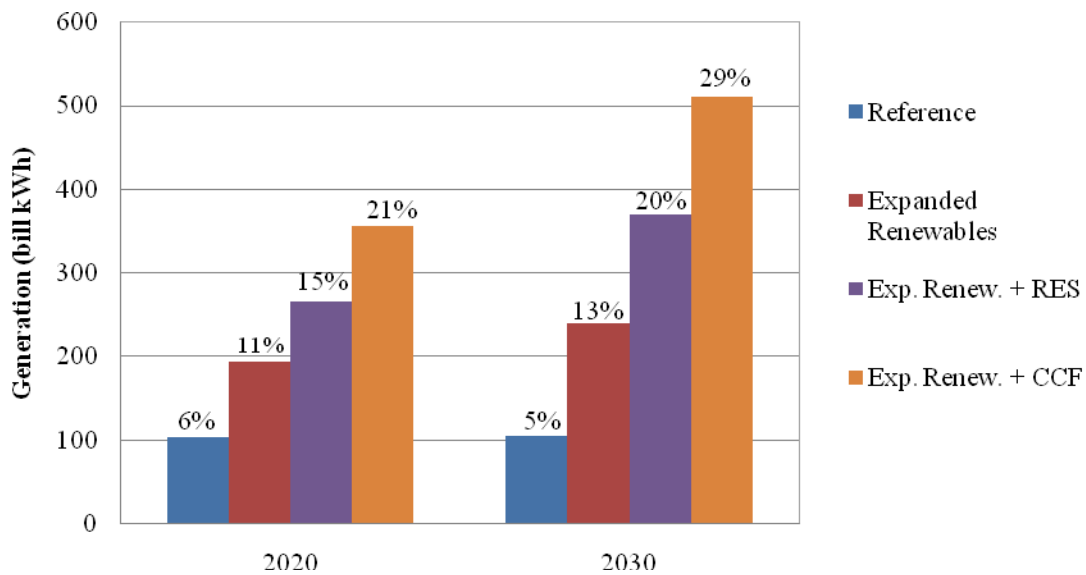

Figure ES.4 Utility-Scale Renewable Generation in the South
(% of total generation)

Table ES.3 shows the amounts of renewable electricity (in billion kilowatt hours –TWh), that would be generated under the three renewable-enhancing scenarios compared to the same scenarios without Expanded Renewables, including displaced electricity from customer-owned renewables. Most of the growth comes from wind, CHP and distributed solar as well as biomass.

The modeled scenarios reflect an environment in which renewable sources are increasingly economically competitive or mandated, as in the case of an RES. Of the utility-scale renewable sources, wind and biomass not only provide the most generation potential, but are also the least expensive. It appears that wind out-competes biomass as the integration of renewable sources expands through the modeled time horizon.

Table ES.3 Renewable Generation and Customer-Owned Renewables in the South in 2030 (billion kWh)

	Utility-Scale Renewables						
	Wind	Biopower	Municipal Waste	Hydro	Solar PV	**Total**	**% above Reference**
Reference Forecast	39	19	4.3	42	0.2	104	-
Expanded Renewables	151	24	3.8	60	0.3	239	129%
Renewable Electricity Standard	54	238	4.3	42	0.2	339	224%
+ Renewable Electricity Standard	224	82	3.8	60	0.3	370	254%
Carbon Constrained Future	59	83	4.3	43	0.2	190	81%
+ Carbon Constrained Future	362	83	4.3	61	0.3	511	389%
	Customer-Owned Renewables						
	CHP	Distributed Biopower	Heat Pump Water Heaters*	Solar Water Heaters*	Distributed Solar PV	**Total**	**% above Reference**
Reference Forecast	102	37	-	-	10	149	-
Expanded Renewables	151	34	34	21	68	308	107%
Renewable Electricity Standard	85	32	-1.8	0	13	128	-14%
+ Renewable Electricity Standard	145	32	33	21	69	300	101%
Carbon Constrained Future	210	39	12	0.3	9	270	81%
+ Carbon Constrained Future	288	42	42	23	69	464	211%

+ RES and + CCF include the Expanded Renewables scenario assumptions in addition to the RES and CCF scenarios.
*The heat pump and solar water heater numbers are the incremental difference between the reference forecast and each scenario. These numbers, though presented in billion kWh, differ from the other values presented in the table. Since the water heater technologies do not generate electricity, these numbers are the energy savings these technologies avoid. They can be interpreted as the avoided fossil-fuel generation attributed to heat pump and solar water heaters.

By definition, an RES must meet an increased renewable target by 2030. Placing a price on carbon, represented by our Exp. Renew. + CCF Scenario, unsurprisingly leads to marked increases in renewable uptake. Interestingly, the Exp. Renew. + CCF Scenario has about 150% more utility-scale renewable generation than the CCF only Scenario. These results suggest there is large, economically viable utility-scale renewable potential that is close in costs with the other major GHG emission free technology, nuclear. Table ES.3 also points out that customer-owned renewable sources are significant. This is particularly true in the case of CHP. Our study suggests that by 2030 CHP may displace as much as 288 TWh of electricity generation in the South.

Figure ES.5 portrays the generation results of the Expanded Renewables Scenario across the four National Energy Reliability Council regions that broadly cover the South:

- Electric Reliability Council of Texas (ERCOT),
- Florida Coordinating Council (FRCC),
- Southeast Electricity Reliability Council (SERC), and
- Southwest Power Pool (SPP).

We see that the western part of the region is dominated by wind. Wind is also heavily represented in Florida, due principally to wind imports. The contribution of biopower, while not insignificant, is attenuated by its higher cost when compared to wind.

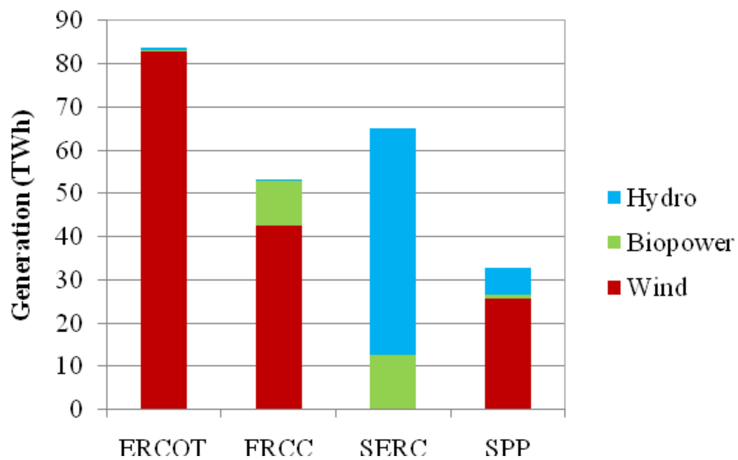

Figure ES.5 Southern Renewable Distribution by NERC region in 2030 (Expanded Renewables Scenario)

Figure ES.6 illustrates how much total renewable potential could be realized by 2030, considering both utility-scale and customer-owned renewables. Combined heat and power systems as well as solar and heat pump water heaters are classified as customer-owned resources that avoid fossil fuel generation. (The category "Demand-Side Solar" in Figure ES.6 includes distributed solar PV and solar water heating.) Adding customer-owned renewables to utility-scale renewables nearly doubles the potential of renewable generation in the South.

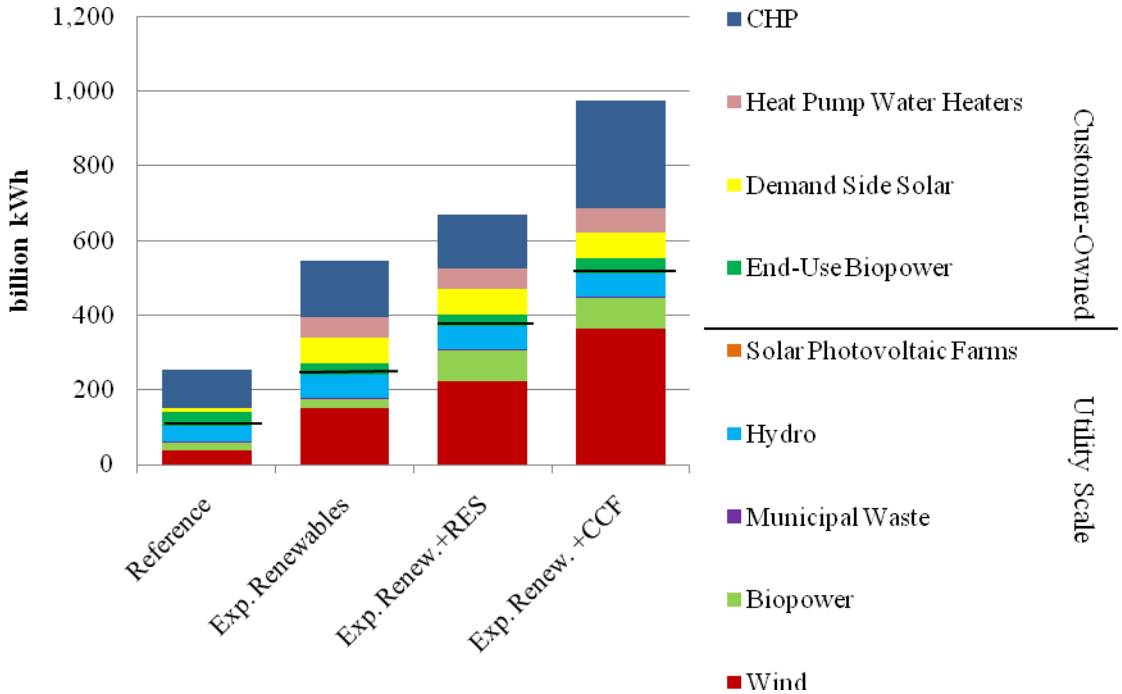

Figure ES.6 Economic Potential for Utility-Scale and Customer-Owned Renewable Generation in 2030

Greenhouse Gas Emission Reductions

Figure ES.7 below shows the projected greenhouse gas emissions from electricity generation for the South, for each of the Expanded Renewable. scenarios. Not surprisingly, the carbon constrained future scenario results in the greatest reduction in emission. The avoided emissions from electricity shown in Figure ES.7 are similar to the overall avoided emissions for the South (shown in Table ES.4).

Table ES.4 Emission Reductions from Reference (million tonnes CO_{2e})

	Expanded Renewables	Renewable Electricity Standard	Exp. Renew. + RES	Carbon Constrained Future	Exp. Renew. + CCF
2020 Avoided	54	69	100	169	300
2030 Avoided	84	160	160	553	710

Notably, renewable sources could be expected to help reduce electricity emissions in the South in 2030 between 7% (in the Expanded Renewables scenario) and 55% (in the Expanded Renewables + CCF).

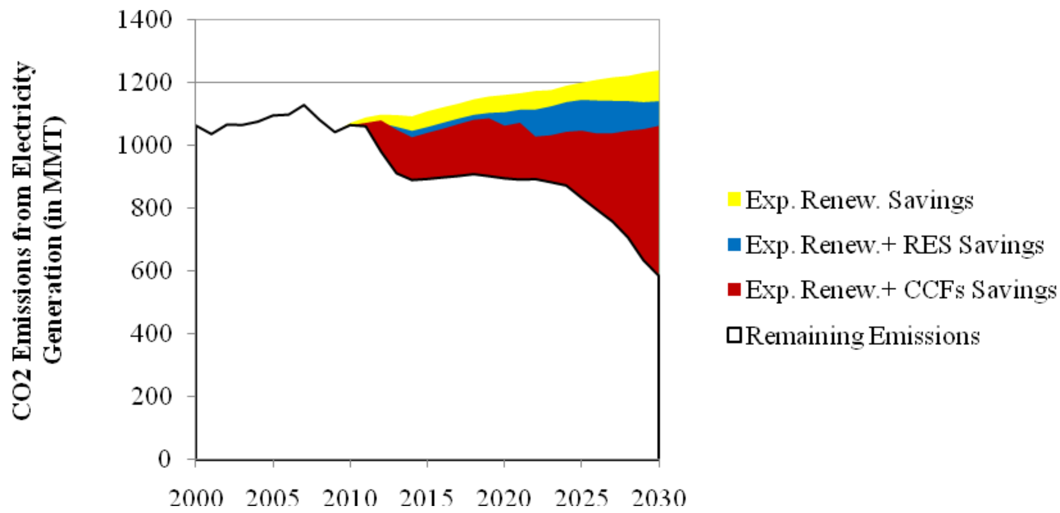

Figure ES.7 Southern Electricity Carbon Dioxide Emissions Reductions, by Scenario

ECONOMICS OF RENEWABLE ENERGY IN THE SOUTH

The expanded tax credits, technology improvements, and updated renewable resource estimates that comprise the "Expanded Renewables" scenario would have favorable impacts on electricity rates and utility bills. As shown in Figure ES.8, average electricity rates in the South are forecast to rise for all users by 23% in the EIA Reference case (from 7.9¢/kWh in 2010 to 9.7¢/kWh in 2030). In contrast, the average electricity rate in the region in the Expanded Renewables scenario would rise by only 16% over the two decades, to 9.0¢/kWh. The escalation of rates associated with the RES and CCF policies is similarly dampened with the addition of the Expanded Renewables assumptions.

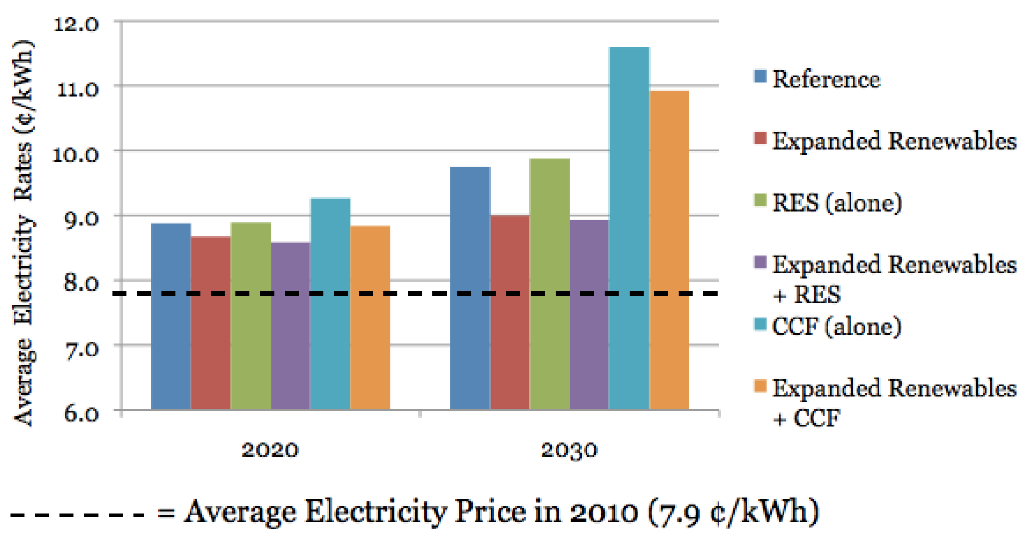

Figure ES.8 Average Electricity Rates in the South under Alternative Scenarios

The Expanded Renewable scenario has a similarly favorable impact on energy bills. In the Reference Case, the South's energy bill (across all fuels) would total $306 billion in 2020, and would rise to $341 billion in 2030 (in $2007). In the Expanded Renewables scenario, electricity bills would increase less—reaching an estimated $292 billion in 2020 and $318 billion in 2030 (7% less). Part of this reduced increase in energy bills is due to lower electricity rates (discussed above), but it is also a result of the inclusion of significant customer-owned renewables – especially CHP and solar and heat pump water heaters – that displace energy consumption in the industrial and residential sectors, in particular.

CONCLUSIONS

By including a full-suite of renewable electricity sources, this report identifies a broad and diversified portfolio of renewable resources available for electric power generation in the South. Under realistic renewable expansion and policy scenarios, the region could economically supply a large proportion of its future electricity needs from both utility-scale and customer-owned renewable energy sources. The growth of customer-owned renewable generation in the South could well match that of utility generation. Additional renewable potential is likely to materialize over the next several decades, when solar becomes more cost-competitive, intermittent transmission barriers are overcome, and emerging technologies mature.

Utility-Scale Renewables

With the inclusion of up-to-date data on wind resource availability (using 80-meter data), wind's lower levelized cost favors it in a regional analysis of utility power generation. As a result, our analysis suggests that wind will overwhelm biopower as a preferred renewable resource for the electric utility sector in the South. Onshore wind in the western part of the South is a low-cost resource that will make resolving transmission issues associated with wind highly desirable.

Previous EIA analysis using NEMS and lower altitude wind potential measurements found biopower to be the preferred renewable resource over wind (EIA, 2009). The real-world adjustments to these assumptions in our modeling resulted in the shift of emphasis between the two sources. In end-use applications, however, biopower continues to be cost-effective and has the potential to grow. Hydropower resources in the South are also shown to be significant with the potential for significant expansion.

While utility-scale solar resources are not forecast to meet even one percent of the South's electricity requirements over the next 20 years, solar projects have received more than $60 million of funding from the ARRA. These resources will be used to build an additional 120 MW of new solar capacity, which will expand its current capacity by more than 200%, and will bring solar workforce skills and supply chain infrastructure to the region. Future growth should be spawned from these investments, exceeding the SNUG-NEMS modeling estimates.

Customer-Owned Renewables

On the customer side, CHP, for example, is a highly cost-effective source of electricity defined as renewable in the sense that it produces electric power from waste heat that would otherwise be vented to the atmosphere. Similarly, solar water heating offers a relatively inexpensive means of displacing the need for electricity production, as do heat pump water heaters. Under the Exp. Renew. + CCF Scenario, “distributed solar” provides 6.3% of total renewable electricity generation. These ‘demand-side’ renewables are not usually evaluated for meeting RES targets; nevertheless, the modeling shows that they would be significant low-cost contributors to the South’s clean energy portfolio.

Translating Renewable Energy Potential into Reality

Given the magnitude of the environmental and energy security challenges facing the nation, many different renewable resources and technologies need to be exploited, and every region of the country needs to contribute. Success will involve transforming and modernizing energy systems in fundamental ways. These transformations in many cases will involve more than just the next generation of technology. They will require paradigm shifts in how we generate and use energy today as well as acceptance of entirely new concepts such as complex integrated systems that optimize suites of technologies. Federal, state, and local public policies can accelerate this transition. The South has an abundance of renewable energy resource potential to help transition the nation away from increasingly scarce, carbon-intensive and polluting fossil fuels. With the commitment of policymakers, utilities, regulators, entrepreneurs, capital markets, and other stakeholders, this potential could be translated into a reality.