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RENEWABLE ENERGY IN THE SOUTH: A Policy Brief

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ABSTRACT

This working paper assesses the economic potential of renewable electricity generation in the South under alternative policy scenarios. Using a customized version of the National Energy Modeling System (NEMS), we examine the impact of 1) expanded and updated estimates of renewable resources, 2) a Renewable Portfolio Standard (RPS), and 3) a Carbon-Constrained Future (CCF). Under the Expanded Renewables Scenario, renewable electricity generation doubles the output of the Reference forecast for the South. If a Federal RPS is imposed 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. Among the renewable resources, wind, biomass, and hydro are anticipated to provide the most generation potential. As the integration of renewable sources expands through the modeled time horizon, wind gradually out-competes biomass in the renewable electricity market. Cost-effective customer-owned renewables could also contribute significantly to electricity generation by 2030 in the South, under supportive policies.

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1. INTRODUCTION

Transitioning away from increasingly scarce, carbon-intensive and polluting fossil fuels is one of the key challenges facing the United States and indeed the globe. Prominent among the energy supply options with inherently low life-cycle CO_2 emissions is a suite of renewable technologies. They also present an opportunity to diversify energy resources while increasing reliance on domestic fuels with greater benefits for employment and economic growth relative to imported energy supplies.

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

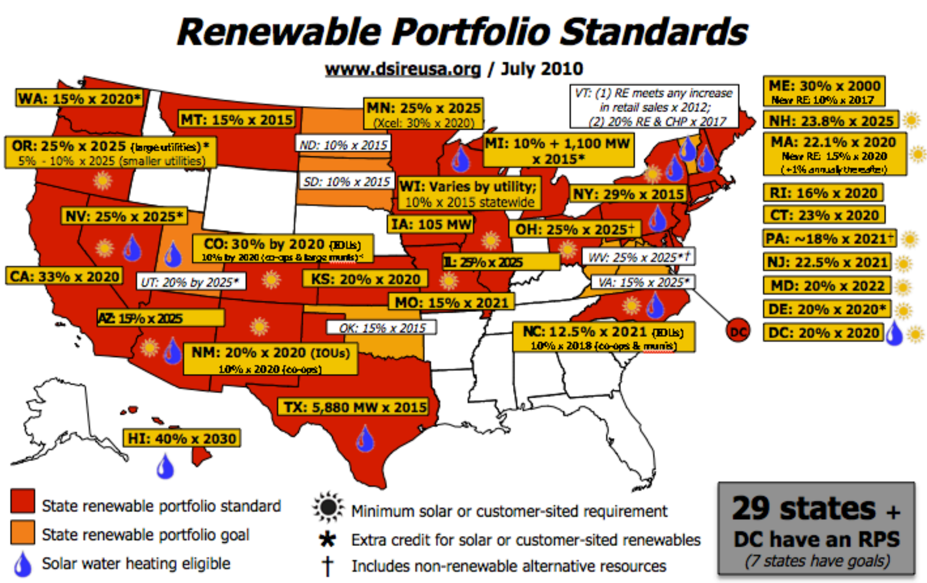

Figure 1. States with Renewable Portfolio Standards

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

Many southern states oppose renewable portfolio 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 hydro, wind, and biopower resources. Next we considered several policies – including accelerated R&D and extensions of tax credits – where increased renewable utilization is a policy goal. We then examine the ability of renewable power generation to compete with traditional fossil and nuclear power options under two different federal policy scenarios: a national RPS and a carbon-constrained future. Customer-owned renewables are included in this assessment because even though they are not typically part of the renewable policy debate, increased use of customer-owned renewables can achieve many of the same objectives as increasing utility-scale renewables.

1.1 The Current Status of Renewable Power in the South

The South, defined as the 16 states plus D.C., shown in Figure 2, with its strong energy-intensive industrial base, accounts for 44% of the nation's total energy consumption, while it only accounts for 36% of the U.S. population. Coal dominates electricity generation in the South, and renewables provide only 3.7% of its electricity generation. No state in the South exceeds the national average of 9.5% renewable electric power.

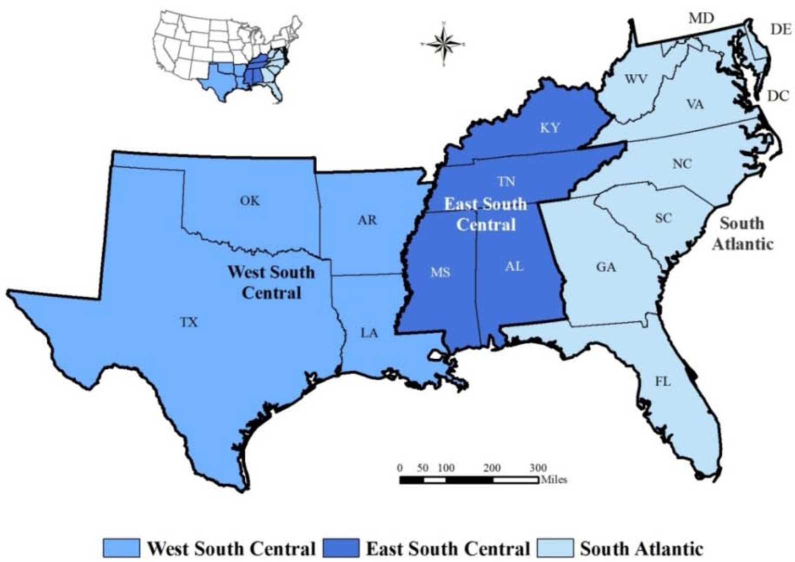

Figure 2. The Census South Region and Its Three Divisions[1]

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 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%.

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

[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*

particularly dominant in the East South Central states (Figure 3).

Table 1. Electric Power Consumption of Renewables, by State in 2008 (Trillion Btu)

	Total Electricity	Renewable Share (%)	Renewable Power	Hydro	Wind	Biomass (Wood & Waste)	Geo-thermal	Solar & Photo-voltaic
Alabama	1,404	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	2,002	2.6%	52	2	0	50	0	0
Georgia	1,302	1.6%	21	21	0	0	0	0
Kentucky	1,030	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	1,253	3.0%	38	30	0	8	0	0
Oklahoma	730	8.4%	61	38	23	0	0	0
South Carolina	1,024	1.8%	18	11	0	7	0	0
Tennessee	911	6.2%	56	56	1	0	0	0
Texas	3,652	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	**17,195**	**3.7%**	**630**	**340**	**188**	**104**	**0**	**0**
(% of South)			**3.7%**	**2.0%**	**1.1%**	**0.6%**	**0%**	**0%**
United States	**40,200**	**9.5%**	**3800**	**2500**	**550**	**440**	**310**	**9**

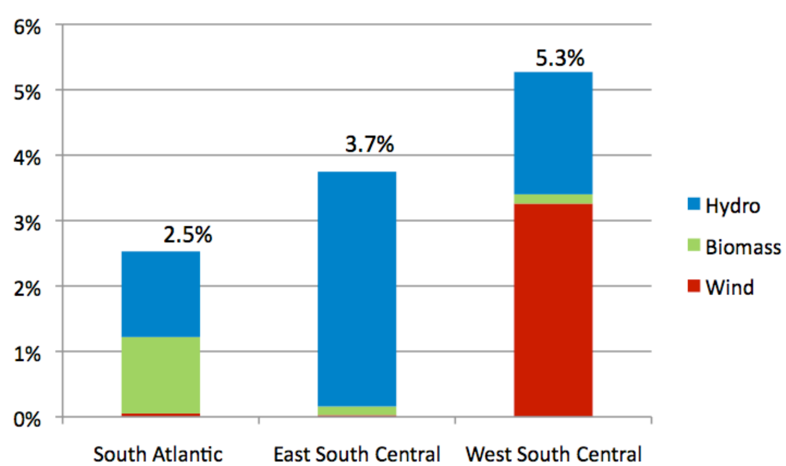

Figure 3. Renewable Generation Shares in the South, in 2008

Source: Energy Information Administration. (2010).

1.2 Notable Renewable Energy Projects in the South

There is substantial development activity for renewables in the South in spite of the relative scarcity of renewable portfolio standards. 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 in 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 and 300-500 MW of biopower, more than doubling the current capacity of both. 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.

2. 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, geothermal, 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 the National Energy Modeling System (NEMS)[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,* as well as being used widely for policy analysis. In our study, three scenarios of expanded renewables in the South are compared with the Reference forecast consistent with EIA's (2009) *Annual Energy Outlook,* which takes into account stimulus spending:

- **Expanded Renewables:** Uses updated estimates of renewable potential in the South drawn from McConnell, Hadley, and Xu (2010) and other sources. In addition, it assumes an extension of R&D and tax subsidies, but no new state or Federal carbon pricing or renewable energy portfolio policies are enacted.
- **+ Renewable Portfolio Standard (RPS):** Uses the updated estimates of renewable resources 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.
- **+ Carbon-Constrained Future (CCF):** Uses the updated estimates of renewable resources 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 and there are no carbon offsets.

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

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 RPS or a national price on carbon were enacted.

2.1 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 2 – compiled by McConnell, Hadley, and Xu (2010) – show potentials for four specific renewable resources in each of the 16 southern states and the District of Columbia. These resource potentials are the basis for the Expanded Renewables scenario described above.

Table 2. Renewable Resource Potential, by State

	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]**
Alabama	460	24	12,000	340
Arkansas	590	1,840	12,590	190
Delaware	6	1.9	420	60
DC	N/A	N/A	56	1
Florida	79	0.1	9,210	500
Georgia	230	26	14,450	350
Kentucky	520	12	7,540	290
Louisiana	310	82	12,880	180
Maryland	91	300	1,910	220
Mississippi	300	0.0	15,790	170
North Carolina	350	160	9,920	810
Oklahoma	350	103,400	3,740	210
South Carolina	210	37	6,100	220
Tennessee	660	62	6,440	300
Texas	330	380,300	13,260	940
Virginia	420	360	6,230	310
West Virginia	480	380	2,390	50
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

[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.

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 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 current magnitudes modeled in NEMS, which recently updated its bioenergy supply curves. These resource estimates exceed those of other models that are not as current.

3. RESULTS

3.1 Utility-Scale and Customer-Owned Renewables

This section compares a Reference forecast with the three modeled scenarios previously described. Figure 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 RPS is imposed 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.

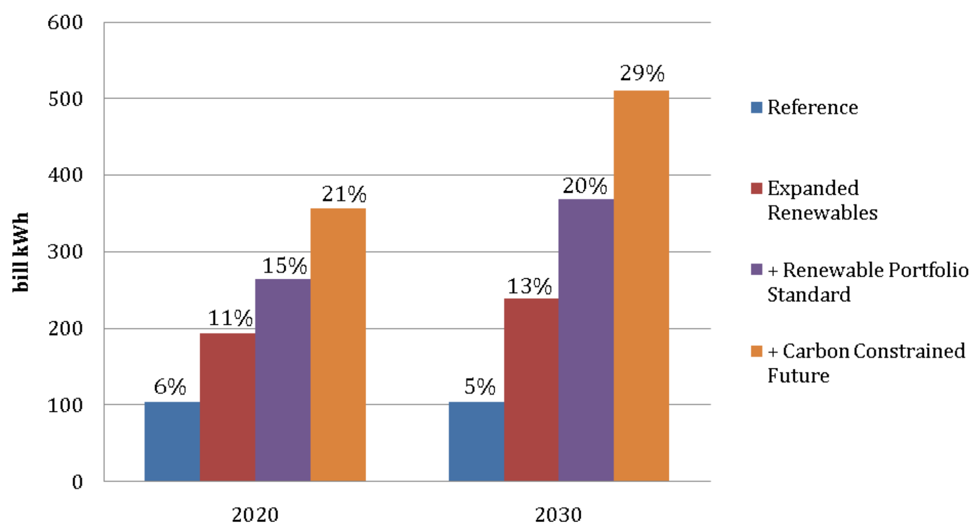

Figure 4. Utility-Scale Generation in the South (with % of total generation)

Table 3 shows the amounts of electricity (in billion kWh), that would be generated under the three renewable-enhancing scenarios, as well as the 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 RPS. 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.

By definition, an RPS must meet an increased renewable target by 2025. Placing a price on carbon, represented by our +CCF Scenario, unsurprisingly also leads to marked increases in renewable uptake. Interestingly, the +CCF Scenario has about 150% more utility-scale renewable generation than a standalone CCF Scenario[5]. These results suggest there is large, economically viable utility-scale renewable potential that is close in costs to the other major GHG emission free technology, nuclear. Table 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.

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

	Utility-Scale Renewables						
	Wind	Biomass	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	130%
+ Renewable Portfolio Standard	224	82	3.8	60	0.3	370	256%
+ Carbon Constrained Future	362	83	4.3	61	0.3	510	390%
	Customer-Owned Renewables						
	Biopower	CHP	Heat Pump Water Heaters	Solar PV	Solar Water Heaters	**Total**	**% above Reference**
Reference Forecast	37	102	9	9	0.9	158	-
Expanded Renewables	34	151	50	68	0.8	304	92%
+ Renewable Portfolio Standard	32	145	50	67	1.5	296	87%
+ Carbon Constrained Future	42	288	48	68	1.7	448	184%

The distribution of renewable generation within the South is not uniform. The western part of the region is dominated by wind. The southeast contains most of the hydropower, currently generating about 40 billion kWh per year. Notably, in the scenarios, wind generation becomes cost competitive in Florida but not compared to rest of the Southeast, so Florida purchases imported wind. The contribution of biomass, while not insignificant, is attenuated by its higher cost when compared to wind.

Figure 5 illustrates how much total renewable potential is likely to be realized by 2030, considering both utility-scale and customer-owned renewables. Adding customer-owned renewables substantially enhances the potential of renewable generation in the South.

[5] CCF only Scenario, without Expanded Renewables, is not shown in this mini-report, but is discussed in the full report Renewable Energy in the South.

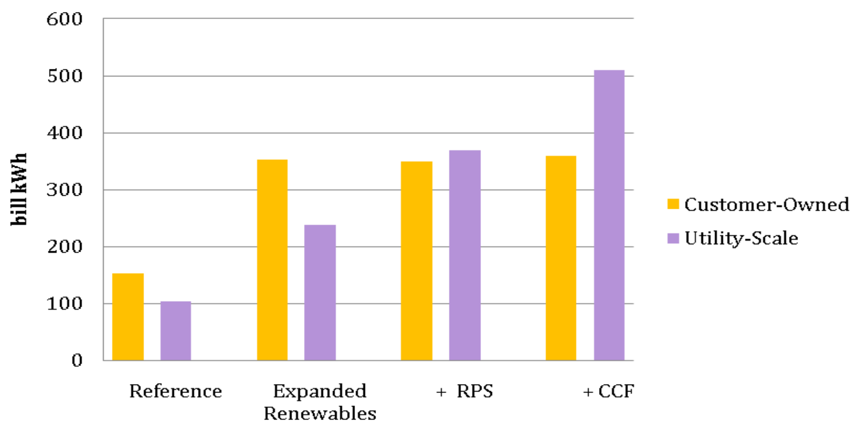

Figure 5. Economic Potential for Renewable Generation and Avoided Generation, 2030

A preliminary assessment shows that the price changes resulting from the four scenarios are modest. For example, in the South Atlantic region the average electricity price for all users in 2030 goes from $0.10/kWh in the Reference forecast to $0.09/kWh for both the Expanded Renewables and +RPS scenarios. The +CCF scenario shows a price increase in 2030 to $0.11/kWh[6].

3.2 Greenhouse Gas Emission Reductions

Figure 6 below shows the projected greenhouse gas emissions from electricity generation for the South, for each of the modeled scenarios. Not surprisingly, the carbon constrained future scenario results in the greatest reduction in emission. The avoided emissions from electricity shown in Figure 6 are similar to the overall avoided emissions for the South (shown in Table 4).

Table 4. Emissions Reductions from Reference (mill tonnes CO2 Equiv)

	Expanded Renewables	+ RPS	+ CCF
2020 Avoided	52	99	280
2030 Avoided	92	167	675

Notably, renewable sources could be expected to help reduce emissions from electricity generation in the South in 2030 between 7% (in the Expanded Renewables Scenario) and 55% (in the +Carbon Constrained Future Scenario).

[6] A large expansion of inexpensive wind serves to reduce prices. Biomass incentives and second order effects of customer-owned renewables have not been captured in this Policy Brief. Further analysis of these costs will be provided in the forthcoming full report.

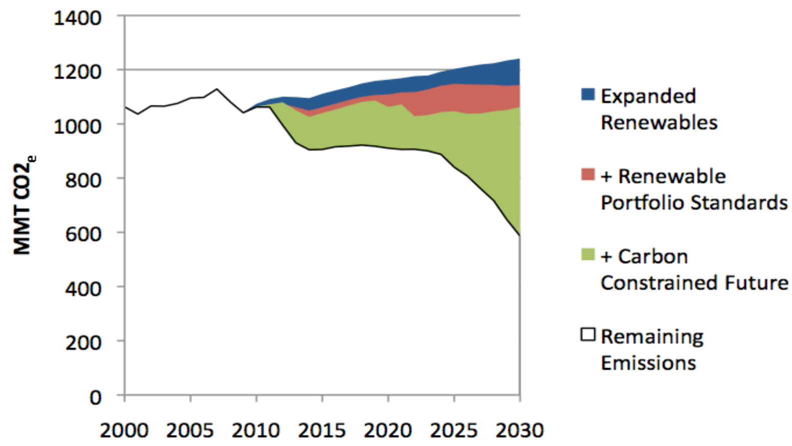

Figure 6. Southern Electricity Carbon Dioxide Emissions Reductions, by Scenario

4. 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. 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.

4.1 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 NEMS modeling estimates.

4.2 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 +CCF Scenario, solar PV provides significant renewable energy. These 'demand-side' renewables are not usually evaluated for meeting RPS targets; nevertheless, the modeling shows that they would be significant low-cost contributors to the South's clean energy portfolio.

4.3 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.

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