National Regulatory Research Institute

Renewable Energy Availability in the Southeast: Report for the Southeastern Association of Regulatory Utility Commissioners

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http://www.nrri.org/pubs/electricity/NRRI_Southeast_Energy_june11-13.pdf.

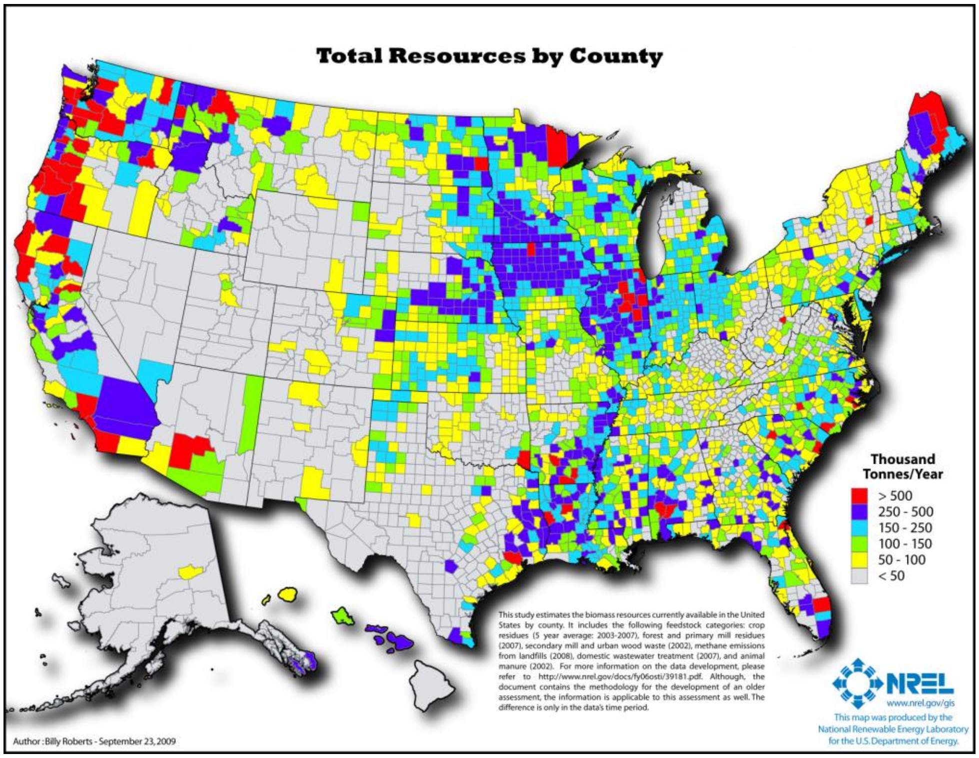
This report summarizes renewable energy production and use in the Southeast and outlines prospects for future renewable energy resource development. The information is compiled from federal data, resource assessments, and academic studies.[1] It presents data on five renewable energy resources: biomass, hydropower, solar, wind, and geothermal.

[1] Additional state energy data is available at http://www.eia.gov/state/.

I. Biomass

Biomass comprises a diverse array of natural resources including forest products, crop residues, urban wood residues, livestock manure, landfills, and energy crops. Biomass is relatively abundant in the Southeast, as can be seen in Figure 1.[2]

Figure 1. Biomass Resources of the United States



Source: http://www.nrel.gov/gis/images/map_biomass_total_us.jpg

Currently, biomass energy accounts for about half of all the renewable electricity produced in the Southeast.[3] Where biomass fuels are readily available in ample quantities and at low cost, biomass is a cost-competitive option for renewable electricity production.[4]

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[2] For maps of each biomass resource type, see http://www.nrel.gov/gis/biomass.html.

[3] *Yes We Can: Southern Solutions for a National Renewable Energy Standard*, Southern Alliance for Clean Energy, February 2009, http://www.cleanenergy.org/images/files/SERenewables022309rev.pdf.

[4] Marilyn Brown, Youngsun Baek, Etan Gummerman, Cullen Morris, and Yu Wang. *Renewable Energy in the South: A Policy Brief*, Georgia Institute of Technology, July 2010, http://www.spp.gatech.edu/faculty/workingpapers/wp58.pdf.

Table 1. Biomass Capacity and Generation in the Southeastern States

	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	**Total**
Total Current Capacity (MW)	622	374	992	711	110	426	223	367	270	175	4,270
Total Current Generation (GWh)	3,489	1,634	4,128	4,128	458	2,908	1,415	1,759	1,881	404	22,204
Total Potential Capacity (MW)											
Forest Production	7,142	4,853	3,471	9,102	2,218	3,932	5,889	6,887	4,898	3,783	52,175
Crop Residues	197	2,416	1,643	502	893	2,183	1,104	752	167	756	10,613
Urban Wood Residues	243	158	845	465	229	239	155	420	38	309	3,101
Livestock Manure	43	66	9	63	16	3	33	169	14	9	425
Landfills	108	5	209	92	114	76	42	195	83	125	1,049
Energy Crops	3,128	1,135	550	1,950	2,205	1,341	5,914	688	1,303	1,668	19,882
Total	10,861	8,633	6,727	12,174	5,675	7,774	13,137	9,111	6,503	6,650	87,245
Potential Feasible Generation (GWh)											
Forest Production	7,895	5,365	3,837	10,062	2,452	4,347	6,510	7,614	5,415	4,182	57,679
Crop Residues	660	8,094	5,507	1,683	2,991	7,316	3,698	2,521	559	2,533	35,562
Urban Wood Residues	1,449	942	5,034	2,772	1,362	1,422	921	2,499	225	1,842	18,468
Livestock Manure	256	394	52	378	93	16	196	1,007	82	54	2,528
Landfills	642	30	1,243	547	680	451	253	1,161	492	745	6,244
Energy Crops	11,646	4,227	2,048	7,261	8,207	4,991	22,019	2,562	4,851	6,212	74,024
Total	22,548	19,052	17,721	22,703	15,785	18,543	33,597	17,364	11,624	15,568	194,505

SOURCES: Appendix B, *Yes We Can: Southern Solutions for a National Renewable Energy Standard* , Southern Alliance for Clean Energy, February 2009, http://www.cleanenergy.org/images/files/SERenewables022309rev.pdf
EIA, *State Renewable Electricity Profiles, 2008 edition* , http://www.eia.gov/cneaf/solar.renewables/page/state_profiles/r_profiles_sum.html

As shown in Table 1, much potential remains for using biomass energy resources. Additional resource assessment will be needed to: (a) refine estimates of potential biomass resources, (b) ensure sustainable resource development, and (c) identify cost-effective opportunities for converting biomass resources to useful energy.

Whether liquid, gas, or solid, biomass fuels can generate electricity. Biomass can also provide heat energy and transportation fuels.

II. Hydropower

Hydroelectric power is presently the second most prevalent renewable energy resource in the Southeast. It comprises 38% of all renewable energy produced in the region.[5]

Environmental concerns are preventing further development of "large" hydropower facilities (defined by the U.S. Department of Energy as a facility with a capacity over 30 MW). Thus, estimates of hydroelectric potential in the Southeast reflect assessments of small and low-impact hydro resources (defined by the U.S. Department of Energy as facilities with a capacity of 100 kW to 30 MW).[6] In addition, repowering existing dams with more efficient generating equipment and adding generators at dams where none presently exist can both offer cost-effective means of adding more hydroelectric capacity.

Table 2. Hydroelectric Capacity and Generation in the Southeastern States

	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	Total
Total Current Capacity (MW)	3,280	1,309	55	1,932	777	192	-	1,828	1,363	2,418	13,154
Total Current Generation (GWh)	6,980	2,407	235	2,430	2,395	784	-	3,840	704	6,802	26,577
Total Potential Capacity (MW)	4,877	12,714	1,075	4,066	6,467	7,279	6,709	4,231	2,242	8,797	58,457
Total Potential Generation (GWh)	11,018	7,575	918	4,445	6,932	3,464	2,610	6,897	2,560	12,540	58,959

SOURCES: Idaho National Laboratory, *Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants*, January 2006, http://hydropower.inel.gov/resourceassessment/index.shtml

EIA, *State Renewable Electricity Profiles, 2008 edition*, http://www.eia.gov/cneaf/solar.renewables/page/state_profiles/r_profiles_sum.html

Table 2 shows current and potential hydroelectric resources in SEARUC states. Hydropower is poised to expand beyond conventional facilities, too: New technologies can harness the hydrokinetic energy of falling water, without the need for dams and impoundments. Technologies to convert ocean currents, waves, and tides to usable energy are also in the works.[7] Ocean current energy conversion is being developed at the Florida Atlantic University Center for Ocean Energy Technology. Though in its beginning stages, ocean current energy shows promise for the Southeast, at least off the Florida coast where Gulf Stream currents could be tapped.[8]

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[5] *U.S. Solar Industry Year in Review 2009*, Solar Energy Industries Association, April 2010, http://www.seia.org/galleries/default-file/2009%20Solar%20Industry%20Year%20in%20Review.pdf.

[6] Marilyn Brown, Youngsun Baek, Etan Gummerman, Cullen Morris, and Yu Wang. *Renewable Energy in the South: A Policy Brief*, Georgia Institute of Technology, July 2010, http://www.spp.gatech.edu/faculty/workingpapers/wp58.pdf.

[7] See http://ocsenergy.anl.gov/guide/index.cfm.

[8] Personal communication, John Wilson, Research Director, Southern Alliance for Clean Energy, March 28, 2011.

III. Solar

Solar energy, particularly solar photovoltaic (PV) technology, is a fast-growing industry. In 2009, U.S. total solar electric capacity was 2,108 MW—up from 494 MW in 2000. From 2008 to 2009 alone, U.S. solar industry revenue increased by 36%.[9] Of all the electricity generated by renewable means in the U.S. in 2009, solar power accounted for 2.9%. By contrast, in the Southeast solar power comprised a negligible portion (less than 0.01%) of renewable generated electricity.[10]

The Southeast does have solar capacity. Seven out of ten of the SEARUC states have solar radiation levels higher than the national average. The largest solar photovoltaic (PV) farm in the country is located in Florida, and another solar PV plant was finished in North Carolina in 2011.[11] Table 3 displays existing and estimated potential solar generation and capacity for the SEARUC states.

In most applications, solar electricity is presently more expensive than power from other sources. The cost of solar electricity production is declining, though, as technologies and economies of scale in manufacturing and deployment improve.[12] Solar energy can also provide heating, cooling, and domestic hot water. Many such applications can be cost-effective today.

Table 3. Solar Photovoltaic Capacity and Generation in Southeastern States

	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	Total
Total Current Capacity (MW)	0	0	0	0	0	0	0	0	0	0	0
Total Current Generation (GWh)	0	0	0	0	0	0	0	0	0	0	0
Total Potential Capacity (MW)	48,567	42,136	90,516	65,817	38,282	41,271	39,768	55,628	32,022	45,815	499,822
Total Potential Generation (GWh)	17,821	16,550	21,532	18,668	11,546	14,632	15,609	15,798	9,895	12,824	154,875

Source: *Yes We Can: Southern Solutions for a National Renewable Energy Standard,* Knoxville, TN: Southern Alliance for Clean Energy, February 2009, http://www.cleanenergy.org/images/files/SERenewables022309rev.pdf

9 *U.S. Solar Industry Year in Review 2009*, Solar Energy Industries Association, April 2010, http://www.seia.org/galleries/default-file/2009%20Solar%20Industry%20Year%20in%20Review.pdf.

10 Joyce McLaren, *Southeast Regional Clean Energy Policy Analysis*, National Renewable Energy Laboratory, January 2011, http://www.nrel.gov/docs/fy11osti/49192.pdf.

11 Marilyn Brown, Youngsun Baek, Etan Gummerman, Cullen Morris, and Yu Wang. *Renewable Energy in the South: A Policy Brief*, Georgia Institute of Technology, July 2010, http://www.spp.gatech.edu/faculty/workingpapers/wp58.pdf.

12 U.S. Department of Energy, *2008 Solar Technologies Market Report*, January 2010, http://www1.eere.energy.gov/solar/pdfs/46025.pdf. See especially Part 3.

IV. Wind

U.S. wind power capacity and generation is growing rapidly. In 2009 alone, U.S. installed wind capacity increased by 39%.[13] Wind power development in the Southeast, shown in Table 4, has been scarce so far. Among the SEARUC states, only Arkansas and Tennessee report installed wind generation.

Table 4. Wind Capacity and Generation in Southeastern States

Compiled on March 24, 2011 by Rachel Gelman, National Renewable Energy Laboratory

Capacity (MW)

	AL	AR	GA	FL	KY	LA	MS	NC	SC	TN
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.8
2004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.8
2008	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0
2009	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0
2010	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	29.0

2003-07 data: EIA, http://www.eia.doe.gov/cneaf/electricity/page/capacity/capacity.html
2008 data: AWEA, *Annual Wind Industry Report, Year Ending 2008,* http://www.awea.org/learnabout/publications/loader.cfm?csModule=security/getfile&PageID=5094
2009 data: AWEA, *Year End 2009 Market Report,* http://www.awea.org/learnabout/publications/loader.cfm?csModule=security/getfile&PageID=5090
2010 data: AWEA, *U.S. Wind Industry Year-End 2010 Market Report,* January 2011, http://www.awea.org/documents/reports/4Q10_market_outlook_public.pdf

Generation (MWh)

	AL	AR	GA	FL	KY	LA	MS	NC	SC	TN	TN Capacity Factor
2001	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
2002	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4,068.0	
2003	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,933.0	24.9%
2004	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,813.0	1.5%
2005	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3,339.0	1.3%
2006	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	54,598.0	21.6%
2007	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	49,937.0	19.8%
2008	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50,117.0	19.7%
2009	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	51,747.0	20.4%
2010	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40,570.0	16.0%

Source: EIA *Form 923 Database*, http://www.eia.doe.gov/cneaf/electricity/page/eia906_920.html
Note: The EIA Form 923 database only captures utility scale wind. 2010 generation is estimated by EIA.

[13] Marilyn Brown, Youngsun Baek, Etan Gummerman, Cullen Morris, and Yu Wang. *Renewable Energy in the South: A Policy Brief*, Georgia Institute of Technology, July 2010, http://www.spp.gatech.edu/faculty/workingpapers/wp58.pdf

The Southeast does have some wind resources capable of supporting commercial, utility-scale wind power development. Table 5 displays estimated onshore wind energy potential in the Southeast states at 80 meters above the ground.

Presently, the U.S. Department of Energy estimates that wind power development is economically viable at or above a threshold average annual wind speed of 6.5 meters per second (m/s) at a turbine hub height of 80 meters. As wind-generating technology improves, turbines can be sited in areas with lower average wind speeds. Also, taller towers enable turbine placement in some areas that are not commercially viable for turbines on 80-meter towers.

Current large-scale mapping procedures tend to underestimate wind resources in hilly areas like the Appalachian Mountains. The mapping procedures focus on contiguous areas, measured in megawatts of capacity per square kilometer, and thus underestimate wind potential in areas where linear development, adjacent to mountain ridges, will take place.[14]

Table 5. Potential On-Shore Wind Capacity and Generation in the Southeast

	Windy Land Area >= 30% Gross Capacity Factor at 80m					Wind Energy Potential	
State	Total (km^2)	Excluded (km^2)	Available (km^2)	Available % of State	% of Total Windy Land Excluded	Installed Capacity (MW)	Annual Generation (GWh)
Alabama	80.4	56.7	23.6	0.02%	70.6%	118.2	333
Arkansas	4,663.2	2,823.2	1,840.1	1.34%	60.5%	9,200.3	26,906
Florida	9.6	9.5	0.1	0.00%	99.2%	0.4	1
Georgia	281.3	255.3	26.0	0.02%	90.7%	130.1	380
Kentucky	48.7	36.6	12.1	0.01%	75.1%	60.6	173
Louisiana	125.5	43.6	82.0	0.07%	34.7%	409.8	1,100
Mississippi	0.0	0.0	0.0	0.00%	N/A	0.0	0
North Carolina	1,155.6	994.1	161.5	0.13%	86.0%	807.7	2,395
South Carolina	102.8	65.8	37.0	0.05%	64.0%	185.0	504
Tennessee	359.9	298.1	61.9	0.06%	82.8%	309.3	900
TOTAL	6,827.1	4,582.8	2,244.3			11,221.4	32,693
SOURCE: DOE, WindPowering America, March 2011, http://www.windpoweringamerica.gov							

[14] Personal communication, John Wilson, Research Director, Southern Alliance for Clean Energy, March 28, 2011. A better metric for hilly areas would be MW of capacity per linear kilometer of ridges. Wind turbine siting on ridge tops can prove problematic, though, because of aesthetic concerns and potential harm to avian species.

Georgia, Louisiana, North Carolina, and South Carolina do possess significant offshore wind resources, as shown in Table 6. Offshore wind power will not produce cost-competitive energy for Southeastern states for at least several years.[15]

Table 6. Offshore Wind Resource Capacity Estimates for Southeastern States

	Wind Speed at 90 meter hub height (in meters per second)							
	7.0 - 7.5	7.5 - 8.0	8.0-8.5	8.5 - 9.0	9.0 - 9.5	9.5 - 10.0	>10.0	Total >7.0
State	Area (MW)	Area (MW)	Area (MW)	Area (MW)	Area (MW)	Area (MW)	Area (MW)	Area (MW)
GA	3,820	7,741	523	0	0	0	0	12,085
	(19,102)	(38,706)	(2,617)	(0)	(0)	(0)	(0)	(60,425)
LA	48,043	15,032	0	0	0	0	0	63,075
	(240,214)	(75,162)	(0)	(0)	(0)	(0)	(0)	(315,376)
NC	1,847	4,098	13,655	39,875	16	0	0	59,491
	(9,237)	(20,491)	(68,274)	(199,374)	(80)	(0)	(0)	(297,456)
SC	1,457	8,202	10,384	6,007	0	0	0	26,049
	(7,283)	(41,010)	(51,919)	(30,033)	(0)	(0)	(0)	(130,244)
Note:	Area is measured in square kilometers.							
Source:	DOE, WindPowering America, March 2011,							
	http://www.windpoweringamerica.gov/windmaps/offshore.asp							

[15] Marilyn Brown, Youngsun Baek, Etan Gummerman, Cullen Morris, and Yu Wang. *Renewable Energy in the South: A Policy Brief*, Georgia Institute of Technology, July 2010, http://www.spp.gatech.edu/faculty/workingpapers/wp58.pdf.

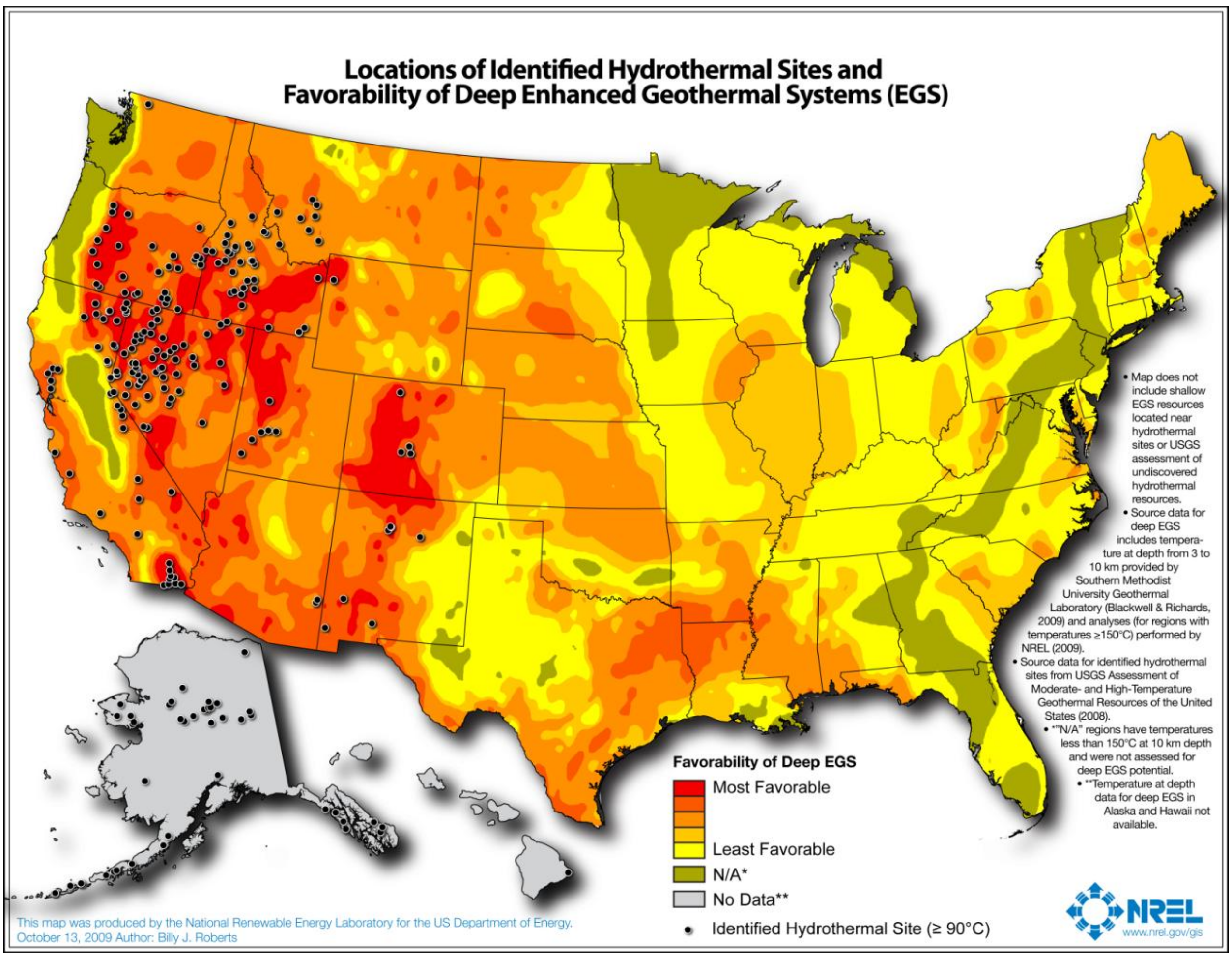
V. Geothermal

Figure 2 depicts a high-level geothermal resource assessment for the U.S. This map identifies geological sources of heat, at depths from 3 to 10 kilometers below the surface, capable of generating steam for electricity production. The map shows some moderately favorable geothermal resources in Arkansas, Louisiana, and Mississippi.

An additional source of renewable energy is the steady temperature of the earth and ground water at much shallower depths. This energy can be tapped by earth-coupled, water-source heat pumps, to provide energy for use in heating, cooling, and domestic hot water. Such heat pumps are often called geothermal. Figure 3 presents a high-level assessment of such resources that might be used for commercial-scale development.

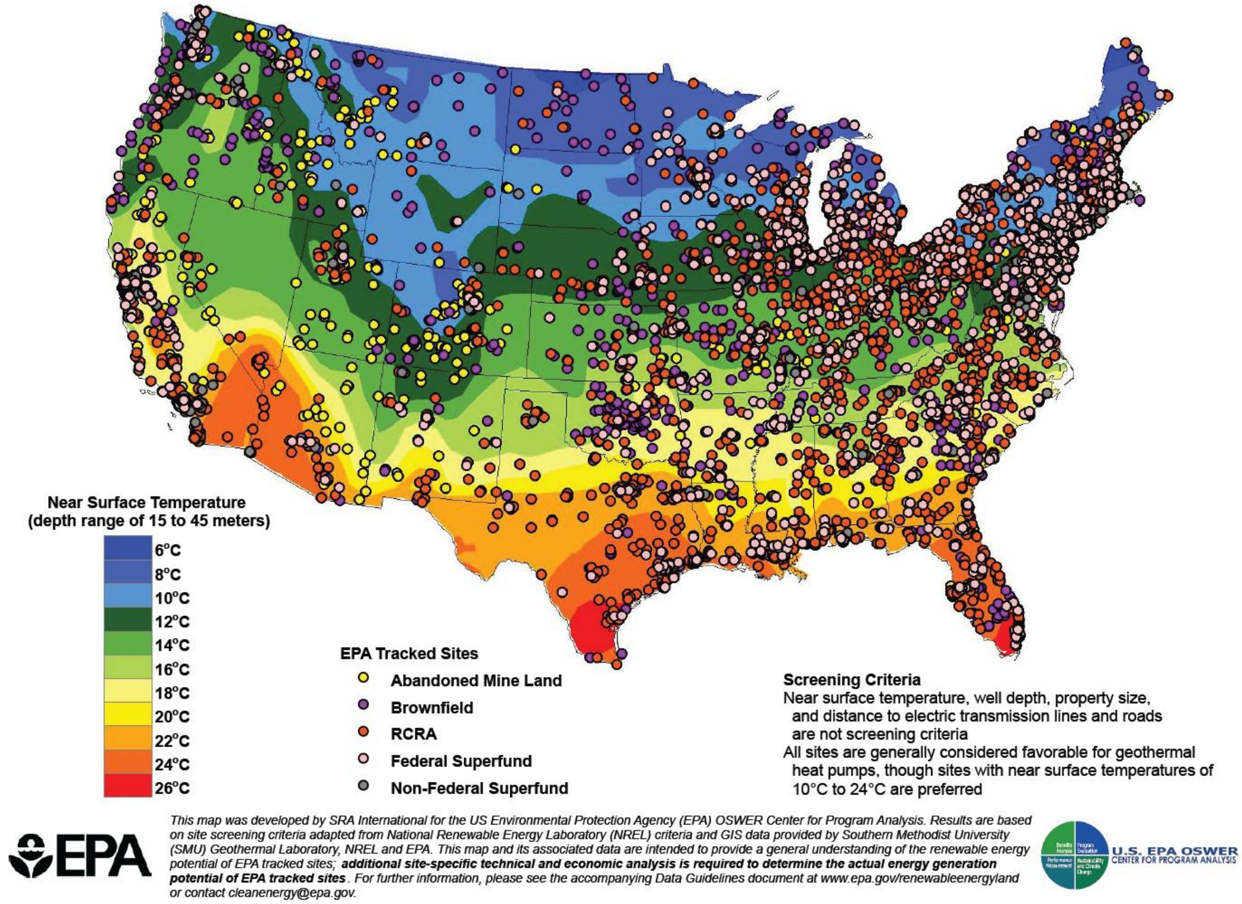
With both types of geothermal energy, additional prospecting will be needed to determine whether cost-effective energy conversion is possible in SEARUC states.

Figure 2. Geothermal Resources of the United States



Source: http://www1.eere.energy.gov/geothermal/maps.html.

Figure 3. EPA Tracked Sites with Geothermal Heat Pump Siting Potential



Source: http://www.epa.gov/oswercpa/maps/pdfs/geo_heatpump_us.pdf. For individual state summaries, see http://www.epa.gov/oswercpa/maps.htm#incentives.

About the Authors

Thomas Stanton is a Principal with the National Regulatory Research Institute. Prior to his work at NRRI, he served as Manager of the Michigan Public Service Commission's Renewable Energy Section, working in the fields of electric utility regulation, energy efficiency, and renewable energy for the Michigan Public Service Commission for 21 years. Mr. Stanton was Coordinator of the MPSC's Michigan Renewable Energy Program and played a major role in developing *Michigan's 21st Century Electric Energy Plan*. He has been an expert witness on energy efficiency, renewable energy, and electric utility restructuring policy issues in cases before the MPSC. He worked for the State Energy Office for 10 years, where he was Director of the state's Energy Information Clearinghouse and Energy Hotline; directed the state Solar Tax Credit program; designed, developed and managed one of the state's first industrial energy analysis programs; and managed the Michigan Biomass Energy and Michigan Resource Recovery Development Programs. Mr. Stanton has also been an Adjunct Professor in the Department of Resource Development and an associate of the Institute of Public Utilities at Michigan State University. He earned a B.A. in Communications and an M.A. in Journalism, both at Michigan State University, and earned an M.S. in Public Administration at Western Michigan University.

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