

Biofuels- How Impacting the Greenhouse Effect Impacts Power Boilers

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Risk Engineering - Machinery Breakdown

Zurich Services Corporation

Risk Engineering

Biofuels - Power Boilers



- “Green energy “ – sign of the times?
- 2012 - Zurich discusses energy produced by solar boilers
- 2013 - Issues with biogas as a fuel
- 2014 - Biofuels- How Impacting the Greenhouse Effect Impacts Power Boilers

Objectives

Discover available sources of biomass

Use of biomass in power generation

Challenges of using biomass as boiler fuel

Discover some lessons learned as the use of biomass has grown over the last 25 years.

Biofuels – Power Boilers



Future mainstream use of liquid biofuels – transportation

Biofuels in solid form used for boiler fuel are categorized as biomass and is the subject we will explore today.

Biomass- Power Boilers



Current status of biomass power generation in the United States.

- Biomass installed capacity – 16 gigawatts or about 1.4 percent of total installed generating capacity in North America. Data derived from Ventyx Global LLC, Velocity Suite
- The United States added 549 MW of biomass fired power plants in 2013. U.S. Energy Infrastructure Administration

Biomass – Power Boilers

This 58 MW biomass plant in Anderson, CA, produces low-cost electricity from wood by-products. NREL is DOE's lead laboratory for biomass power R & D.

Photo by Warren Getz, NREL, Image #00298



Biomass sources

- Wood chips & pellets
- Wood wastes
- Construction scrap wood and demolition debris
- Agricultural wastes
- Animal processing byproducts
- Forest residues from logging
- Removal of insect damaged trees

Biomass Sources cont'd

- Refuse Derived Fuel (RDF)
- Tire Derived Fuel (TDF)
- Sludge from municipal and process effluent
- Black and Red spent liquors
- Energy crops

Biomass – Power Boilers

Clear, dry wood chips arrive at a wood-fired power plant.

Photo by Warren, Getz, NREL #01766



Biomass – Power Boilers

Municipal Landfill

Photo by David Parsons, NREL #5292



Future biomass sources under development

- Additional varieties of short rotation energy crops.

Biomass Fired Power Boilers

- Input range from 20 tons/hour to over 250 tons/hour
- Most common biomass combustion systems are stoker grates and fluidized beds.
- Co-firing conversions using coal

Biomass Facilities



U.S. BIOMASS FACILITIES



STATE	NAME	OWNER	CITY	MEGAWATT CAPACITY (MW)
ARIZONA	AR1	Stratfield	Wink	24.0
ARIZONA	AR2	Stratfield	Wink	24.0
ARIZONA	AR3	Waters	Polson	8.7
ARIZONA	AR4	Curt Ben Lumber	Guthrie	8.0
CALIFORNIA	CA-1	Burney Forest Power	Burney	91.0
CALIFORNIA	CA-2	Calera One Company	Calera	12.0
CALIFORNIA	CA-3	Calera New Power	Calera	47.0
CALIFORNIA	CA-4	DD Pathways Power	Bunkie	17.5
CALIFORNIA	CA-5	Great Arroyo	Chico	15.5
CALIFORNIA	CA-6	Burney Biomass Power	Burney	91.0
CALIFORNIA	CA-7	OTIE Mill Power Corporation	Salinas	44.0
CALIFORNIA	CA-8	OTIE Energy, LLC	Stockton	45.0
CALIFORNIA	CA-9	Serra Power Corporation	Serra Dela	9.0
CALIFORNIA	CA-10	Chico Station Outcrop	Chico	25.0
CALIFORNIA	CA-11	Red Bluff Power	French	25.0
CALIFORNIA	CA-12	Madira Energy, Inc.	Madira	25.0
CALIFORNIA	CA-13	Red Bluff Power	French	25.0
CALIFORNIA	CA-14	Great Arroyo	Chico	15.5
CALIFORNIA	CA-15	Serra Pacific Lumber Facility	Burney	91.0
CALIFORNIA	CA-16	Serra Pacific Lumber Facility	Linton	6.0
CALIFORNIA	CA-17	Honey Lake Power	Wentworth	36.0
CALIFORNIA	CA-18	Serra Pacific Lumber Facility	Curry	12.5
CALIFORNIA	CA-19	Wendell Cogeneration	Wendell	16.0
CALIFORNIA	CA-20	Covanta Energy	Colusa	65.0
CALIFORNIA	CA-21	Covanta Energy	Merced	50.0
CALIFORNIA	CA-22	OTIE Woodland Biomass Power	Woodland	25.0
CALIFORNIA	CA-23	Shasta Woodland	Anderson	65.0
CALIFORNIA	CA-24	Serra Pacific	Anderson	1.0
CALIFORNIA	CA-25	Chico	Chico	11.5
CALIFORNIA	CA-26	Shasta Renewable Resources	Anderson	12.0
CALIFORNIA	CA-27	Woodland Energy	Woodland	25.0
CALIFORNIA	CA-28	De Luz Power Co.	Scotts	15.0
CALIFORNIA	CA-29	Covanta Energy	Burney	15.0
CALIFORNIA	CA-30	Covanta Energy	Westwood	12.0
CALIFORNIA	CA-31	Covanta Energy	Chico	16.0
CALIFORNIA	CA-32	Serra Pacific Energy Facility	Serra	3.5
CALIFORNIA	CA-33	Red Bluff Plant	French	11.0
CALIFORNIA	CA-34	Serra Pacific Lumber Facility	Linton	6.0
CALIFORNIA	CA-35	Tray Biomass Plant	Tray	21.5
CONNECTICUT	CT-1	Reliance Energy	Shelton	30.0
FLORIDA	FL-1	Ridge Generating Station	Wausatcha	38.8
FLORIDA	FL-2	Chickasaw	South Bay	75.0
FLORIDA	FL-3	Ocala	South Bay	60.0
FLORIDA	FL-4	Orange Power LLC	Orange	14.0
FLORIDA	FL-5	Jefferson Power LLC	Manatee	8.0
FLORIDA	FL-6	US Sugar	Dunn	20.0

STATE	NAME	OWNER	CITY	MW
FLORIDA, Cont'd.	FL-7	Buckeye Florida Biomass	Buckeye Florida Ltd. Palm Bay	35.0
FLORIDA, Cont'd.	FL-8	Palatka	Georgia Pacific Corp. Palatka	35.0
FLORIDA, Cont'd.	FL-9	Panama City	Serra Corporate Corp. Panama City	20.0
FLORIDA, Cont'd.	FL-10	International Paper Co.	Tallahassee	62.0
FLORIDA, Cont'd.	FL-11	Renegade Mill	Renegade	22.5
FLORIDA, Cont'd.	FL-12	Beach	Beach	25.0
GEORGIA	GA-1	MultiState Station Gap	MultiState Station Gap	17.0
GEORGIA	GA-2	Marion Mill	Georgia Packaging	40.0
MISSISSIPPI	MS-1	Okeefe	Okeefe Sugar Co.	29.0
IDAHO	ID-1	New Meadows	Tamrock Energy	4.5
ID-2	Rummer Cogen	Sisson Lumber Company	Champan	5.0
ILLINOIS	IL-1	Eastern Illinois University	Eastern Illinois University	1.0
IOWA	IA-1	SFO Gas and Electric	SFO Gas and Electric	6.0
IOWA	IA-2	SFO Gas and Electric	Comptchee LLC	2.0
LOUISIANA	LA-1	Batch Ridge	Agriculture Power	15.5
LA-2	Jenarada	Perkins Ltd	Jenarada Sugar	2.0
MAINE	ME-1	Old Town Fuel and Fiber	Reliance Partners	28.0
ME-2	Reliance Lumber Mills	Reliance Holdings	Falls	24.0
ME-3	Reliance Ashland	Reliance Holdings	Falls	24.0
ME-4	SD Warm Waterbrook	SD Warm Co.	Westbrook	65.0
ME-5	Reliance Fort Fairfield	Reliance Holdings	Fort Fairfield	27.0
ME-6	West Enfield	Covanta Energy	West Enfield	24.5
ME-7	Reliance Station	Reliance Holdings	Station	40.0
ME-8	Jonesboro	Covanta Energy	Jonesboro	24.5
ME-9	Central Power (Maine)	Central Power	Central	18.0
ME-10	Deleau	Verdeco Energy	Deleau	22.0

STATE	NAME	OWNER	CITY	MW
MARSHALLS	MA-1	Platt Power Planting Inc.	Gulfport	15.0
MICHIGAN	MI-1	Cadillac Renewable Energy	Alvord Power Corp	34.0
MI-2	Gayling Generating Station	CMO Enterprises/Corcoran Energy/Trillium	Gayling	36.2
MI-3	Genesee Power Station	CMO Enterprises/Trillium	Flint	35.0
MI-4	Wayne Energy of Michigan	GEF Inc.	Madison	17.0
MI-5	Wing Energy of Michigan	GEF Inc.	Lincoln	19.0
MI-6	Holmes Power Co.	Forster	Madison	17.0
MI-7	Wayne Paper	Wayne Paper	Dunnaway	25.0
MI-8	L'Anse-au-Loup Biomass	L'Anse-au-Loup Electric Plant Co. LLC	L'Anse	19.0
MI-9	Central Michigan University	Central Michigan University	Mt. Pleasant	8.0
MINNESOTA	MN-1	Duluth	M.L. Howard	7.0
MN-2	Superior	Alan King	Superior	8.0
MN-3	St. Paul	St. Paul District Heating	St. Paul	35.0
MN-4	Polson Cog	Polson Cog	Polson	13.0
MN-5	City of Maple	City of Maple	Maple	8.0
MN-6	Hobing	Department of Public Utilities	Hobing	13.0
MN-7	Republic Energy Group	Minnesota Power Inc.	Grand Rapids	28.0
MN-8	Flouron Lumber	Flouron Lumber	Benson	65.0
MISSOURI	MO-1	University of Missouri	University of Missouri	10.0
NEW HAMPSHIRE	NH-1	Passaic Power	GEF Inc.	25.0
NH-2	Springwater Power LP	Springwater Power Co. LP	Springwater	15.0
NH-3	Passaic Power Vermont	Passaic Power Vermont	Wentworth	25.0
NH-4	CO Vermont	Maubert Sustainable Energy	Wentworth	15.0
NH-5	Scottie Station	PS&E	Putnam	20.0
NH-6	Danforth Power LLC	Maubert Sustainable Energy	Danforth	18.0

STATE	NAME	OWNER	CITY	MW
NEW HAMPSHIRE, Cont'd.	NH-7	Black Associates Energy Co.	Black Energy/Associates LLC	15.0
NH-8	Concord Steam	Concord Steam	Concord	6.0
NEW YORK	NY-1	Reliance Chatsaugay	Reliance Holdings	33.0
NY-2	Reliance Lynbrook	Reliance Holdings	Lynbrook	22.0
NY-3	Niagara Generation LLC	U.S. Renewable Group	Niagara Falls	28.0
NY-4	Reliance Black River	Reliance Holdings	Black River	45.0
NORTH CAROLINA	NC-1	Cowan County Wood Energy LP	Duke Energy International	40.0
NC-2	Conestoga Clean Power	Reliance Holdings	Kannapolis	30.0
NC-3	Biomass One	Biomass One LP	Wade City	50.0
NC-4	Warm Springs Fibre	Warm Springs Fibre	Madison	36.0
NC-5	Engers BioPower LLC	Engers BioPower Co.	Sumter	15.0
NC-6	Reliance Forest Products	Reliance Forest Products	Dillon	40.0
NC-7	Rough & Ready	Rough & Ready Lumber Co.	Clear Junction	1.5
NC-8	Douglas County Lumber Co.	Douglas County Lumber Co.	Waynesville	8.4
NC-9	Flora City	D.J. Johnson	Flora City	10.0
PENNSYLVANIA	PA-1	Koppers Susquehanna Plant	Koppers Inc./Susquehanna	7.5
PA-2	Spring Grove	RA Graduate	Spring Grove	24.0
SOUTH CAROLINA	SC-1	Beaufort River	American/COE	31.0
TENNESSEE	TN-1	Sevier Industries	Sevier Industries	30.0
TN-2	Apex Power	Apex Capital Management	Memphis	30.0
TN-3	Napicoles Power	South Power	Napicoles	105.0
VERMONT	VT-1	Joseph O. Melzer Generating Station	City of Burlington/Deleau	80.0
VT-2	Pyrgote Power Station	GEF Inc.	East Pyrgote	22.0
VIRGINIA	VA-1	Pittsylvania Power Station	Dominion Virginia Energy	101.0
VA-2	Albana Power Station	Dominion Virginia Energy	Albana	20.0
VA-3	Nights Old Field Energy Co.	Nights Old Field Energy Co.	Nights City	107.0
VA-4	South Bottom Energy Project	North Va. Dev. Co-op	South Bottom	85.0
WASHINGTON	WA-1	Kelle Falls	Astoria	47.0
WA-2	Serra Pacific Aberdeen	Serra Pacific Industries Inc.	Aberdeen	12.0
WA-3	Serra Pacific Burlington	Serra Pacific Industries Inc.	Burlington	22.0
WA-4	Simpon Tacoma	Simpon Tacoma	Tacoma	24.0
WA-5	Naselle Strine Lumber	Naselle	Coakley	5.0
WA-6	Hampton Arkilas	Hampton Arkilas	Dungeness	7.0
WISCONSIN	WI-1	Bay Front Power Plant	Just Energy	73.0



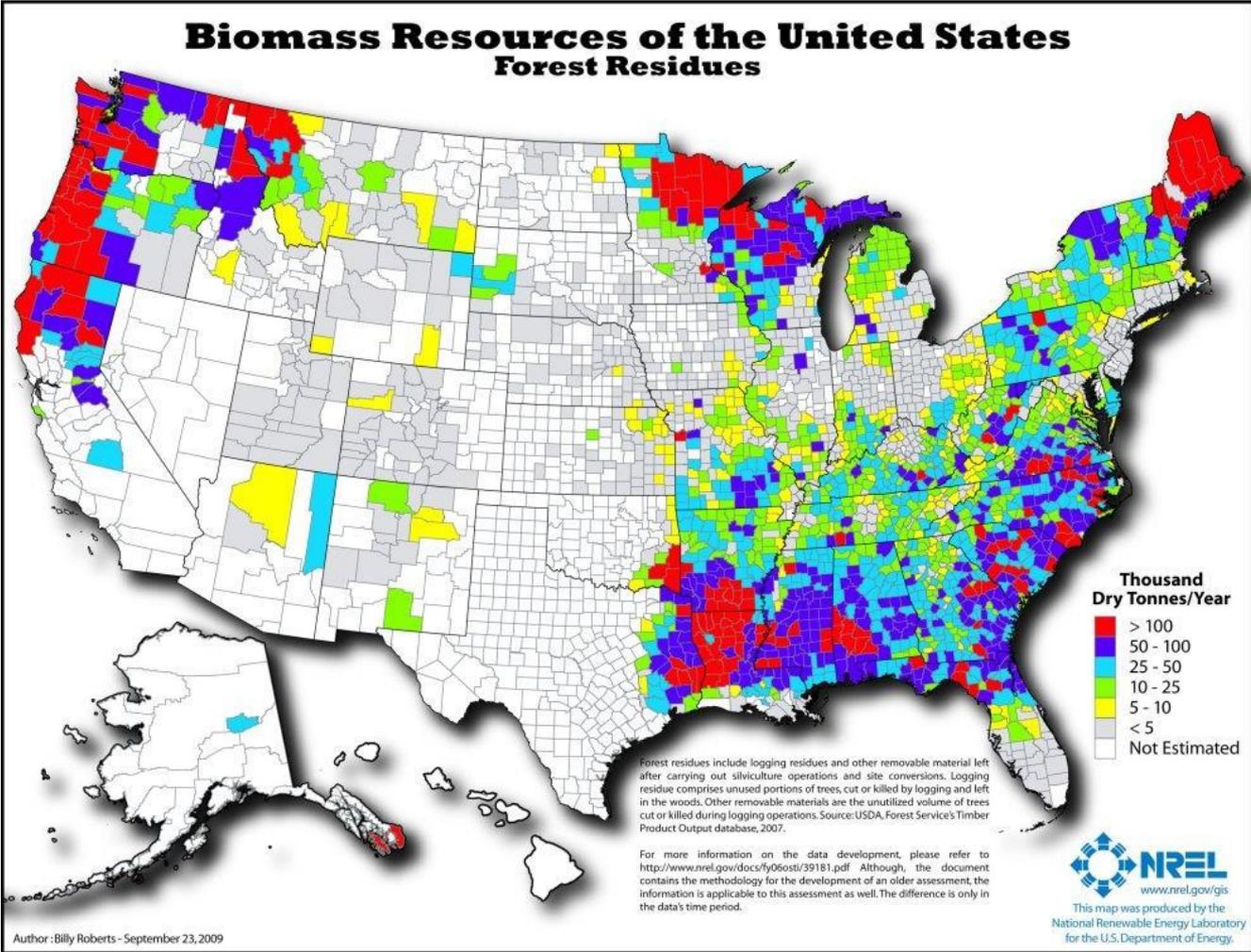
Natural Energy, Naturally

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Biomass Sources – Forests



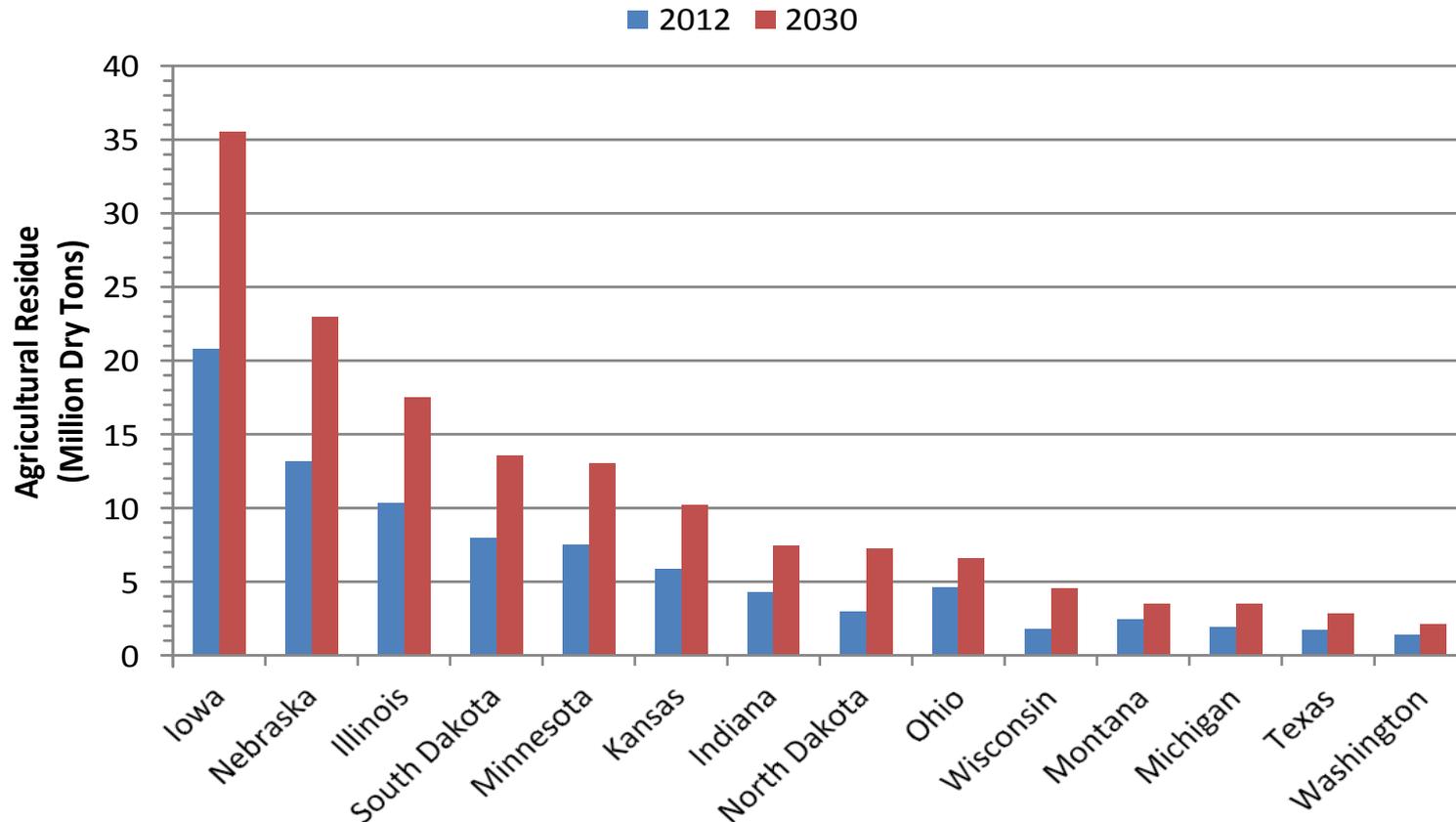
Source: USDA, Forest Service's Timber Product Output database, 2007



Biomass Sources - barley straw, corn stover, oat straw, sorghum stubble, and wheat straw.



- Projections of Agricultural Residues at \$50/dry ton (ORNL, 2011)

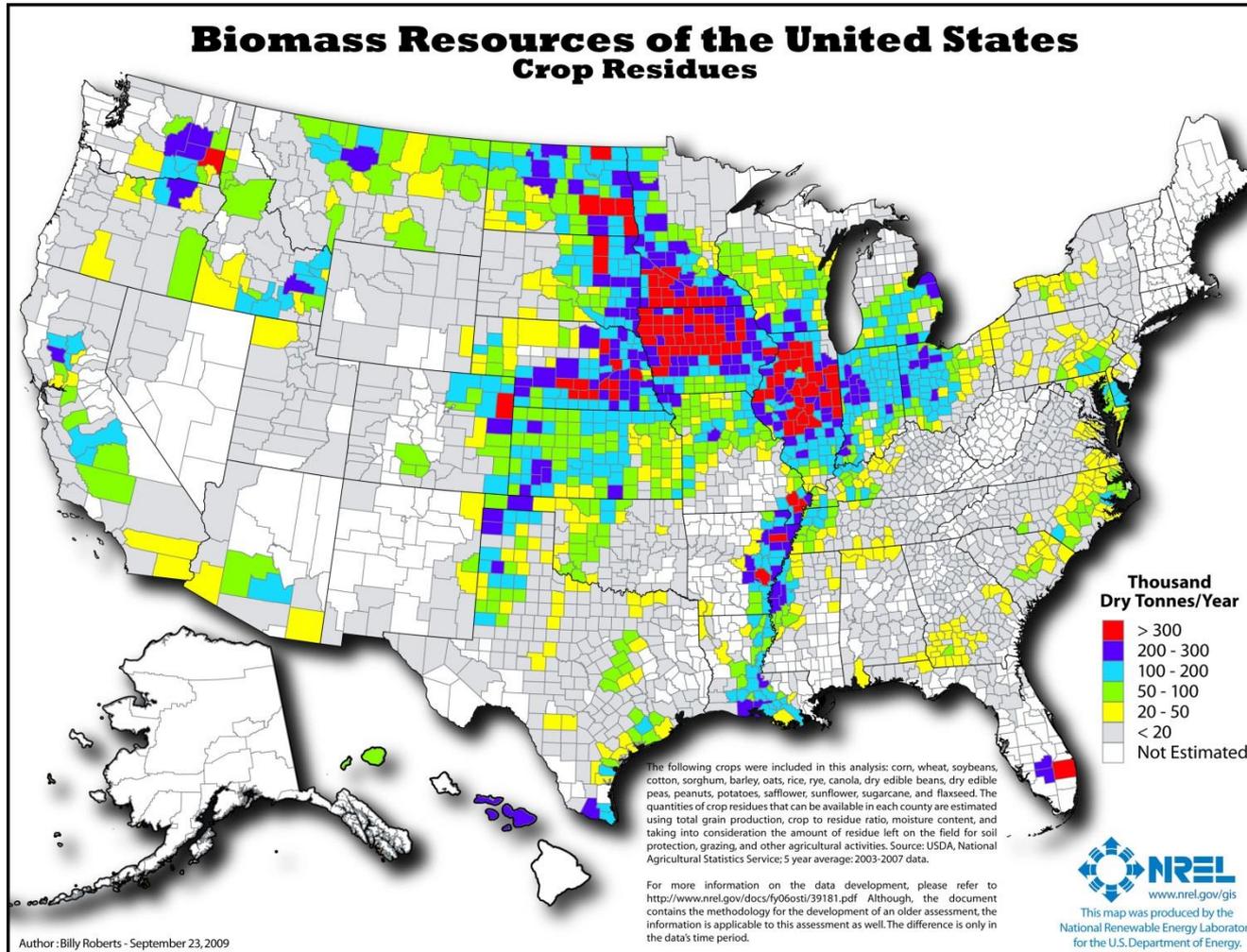


Biomass Sources – Domestic Distribution of Agricultural Wastes



ZURICH®

Source: USDA, National Agricultural Statistics Service; five-year average: 2003-2007



Biomass Facilities



U.S. BIOMASS FACILITIES



STATE	NAME	OWNER	CITY	MW	
ARIZONA	AR1	Stratfield	Wink Stratfield Power, L.L.O.	24.0	
ARIZONA	AR1	Waters	Polson	8.7	
	AR2	Curt Ben Lumber	Curt Ben Lumber	61.0	
CALIFORNIA	CA-1	Burney Forest Power	Burney Forest Power	94.0	
	CA-2	Calera One Company	Calera Company	12.0	
	CA-3	Casec New Power	Casec	47.0	
	CA-4	CG Refractive Power	Waste East-West Power (EMF)	17.5	
	CA-5	Great Arguswood	Waste Capital Management	15.0	
	CA-6	Burns Biomass Power	Central Energy Corp.	Renfro Carbon	19.6
	CA-7	OTI Mt. Pico Cogeneration	OTI Energy	Salinas	44.0
	CA-8	OTI Spokane, L.L.O.	OTI Energy	Spokane	45.0
	CA-9	Sierra Power Corporation	Sierra Forest Products	Terra Bella	9.0
	CA-10	Chilena Station Outcrop	Coveris Inc.	garrison	25.0
	CA-11	Red Bluff Energy	WMAA American Power Group	Firearm	26.0
	CA-12	Machina Energy, Inc.	Community Recycling	Frederick	28.0
	CA-13	Red Bluff Energy	WMAA American Power Group	Rockwell	26.0
	CA-14	Great Arguswood	Waste Capital Management	El Nido	12.5
CA-15	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Burney	9.0	
CA-16	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Linton	6.0	
CA-17	Honey Lake Power	Overseer	Wentworth	36.0	
CA-18	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Curtney	12.5	
CA-19	Waste Capital	Refractive Power Products	Wendell	16.0	
CA-20	Coveris Energy	Coveris	65.0		
CA-21	Coveris Energy	Coveris	28.0		
CA-22	OTI Woodland Biomass Power	OTI Energy	Woodland	25.0	
CA-23	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Anderson	65.0	
CA-24	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Anderson	1.0	
CA-25	Chilena	Community Recycling	Chilena	11.6	
CA-26	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Anderson	12.0	
CA-27	Wentworth Energy	Wentworth	36.0		
CA-28	CG Refractive Power	Overseer	Scotts	16.0	
CA-29	Coveris Energy	Coveris	28.0		
CA-30	Coveris Energy	Coveris	28.0		
CA-31	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Sonoma	3.5	
CA-32	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	But Lake	11.0	
CA-33	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Linton	6.0	
CA-34	Sierra Pacific Lumber Facility	Sierra Pacific Industries Inc.	Tracy	21.5	
CONNECTICUT	CT-1	Refinery Siting	Refinery Holdings	30.0	
FLORIDA	FL-1	Ridge Generating Station	Wasteboard	Auburnville	38.8
	FL-2	Chickasaw	Florida Cypress	South Bay	75.0
	FL-3	Chickasaw	Florida Cypress	South Bay	60.0
	FL-4	Trigge Power L.L.O.	Green Hunter Energy	Trigge	14.0
	FL-5	Chickasaw	Jefferson Power L.L.O.	Manvelto	8.0
FL-6	US Sugar	US Sugar	Dunnell	20.0	

STATE	NAME	OWNER	CITY	MW	
FLORIDA, Cont'd.	FL-7	Buckeye Florida Biomass	Buckeye Florida Ltd. Partners	Flory	35.0
	FL-8	Palatka	Georgia Pacific Corp.	Palatka	4.0
	FL-9	Palatka City	Sierra Corporate Corp.	Palatka City	20.0
	FL-10	International Paper Co.	International Paper Co.	Denmark	62.0
	FL-11	Renfroville Mill	Reynolds	Renfroville	22.5
	FL-12	Beach	Beach	Beach	15.0
GEORGIA	GA-1	MultiState Refinap Gap	MultiState Refinap Gap	Refinap Gap	17.0
	GA-2	Marion Mill	Graphic Packaging	Marion	43.0
IDAHO	ID-1	Oakdale	Oakdale Sugar Co.	Idaho	29.0
IOWA	I-1	New Meadows	Tamrock Energy	New	4.6
	I-2	Rummur Cogen	Silvaco Lumber Company	Champion	6.0
ILLINOIS	IL-1	Eastern Illinois University	Eastern Illinois University	Champaign	2.1
IOWA	IOWA	SFO Gas and Electric	SFO Gas and Electric	Oedar Rapids	6.0
LOUISIANA	LA-1	Batch Ridge	Agriculture Power	Lake Charles	15.6
LA-2	Jenarada	Parhous Ltd	Jenarada Sugar	Jenarada	2.0
MAINE	ME-1	Old Town Fuel and Saw	Refinery Holdings	Old Town	28.0
	ME-2	Refinery Lumber Mills	Refinery Holdings	Lewiston	24.0
	ME-3	Refinery Ashland	Refinery Holdings	Falls	29.0
ME-4	SD Warm Waterbrook	SD Warm Co.	Waterbrook	65.0	
ME-5	Refinery Fort Fairfield	Refinery Holdings	Fort Fairfield	27.0	
ME-6	West Enfield	Coversa Energy	West Enfield	24.5	
ME-7	Refinery Station	Refinery Holdings	Station	40.0	
ME-8	Jonestown	Coversa Energy	Jonestown	24.5	
ME-9	Central Power	Central Power	Central	18.0	
ME-10	Delebo	Verdeco Energy	Delebo	22.0	

STATE	NAME	OWNER	CITY	MW	
MASSACHUSETTS	MA-1	Platt River Power Plant	GDF Suez	Worcester	15.0
	MA-2	Cadillac Renewable Energy	Atlantic Power Corp	Cadillac	34.0
MICHIGAN	MI-1	Grayling Generating Station	CMO Enterprises/Corcoran Energy/Trillium	Grayling	36.2
MI-2	Grayling Generating Station	CMO Enterprises/Corcoran Energy/Trillium	Grayling	36.2	
MI-3	Wing Energy of Michigan	GDF Suez	Michigan	17.0	
MI-4	Wing Energy of Michigan	GDF Suez	Michigan	17.0	
MI-5	Wing Energy of Michigan	GDF Suez	Michigan	17.0	
MI-6	Wing Energy of Michigan	GDF Suez	Michigan	17.0	
MI-7	Wing Paper	Wing Paper	Durand	28.0	
MI-8	Locke-Walton Biomass Plant	Locke-Walton Electric Plant Co. L.L.C.	Locke	19.8	
MI-9	Central Michigan University	Central Michigan University	Mt. Pleasant	8.0	
MINNESOTA	MN-1	Duluth	M.L. Howard	Duluth	7.0
MN-2	Sooport	Alan King	Sooport	8.0	
MN-3	St. Paul	St. Paul District Heating	St. Paul	35.0	
MN-4	Polston Cogen	Polston Cogen	Bemidji	13.0	
MN-5	City of Maple	City of Maple	Maple	8.0	
MN-6	Hobing	Department of Public Utilities	Hobing	13.0	
MN-7	Republic Energy Center	Minnesota Power Inc.	Grand Rapids	28.0	
MN-8	Flouron Lumber Power Plant	Flouron L.L.C.	Flouron	65.0	
MISSOURI	MO-1	University of Missouri	University of Missouri	Columbia	10.0
NEW HAMPSHIRE	NH-1	Platt River Power	GDF Suez	Worcester	15.0
NH-2	Springwater Power LP	Springwater Power Co. LP	Springwater	15.0	
NH-3	Platt River Power	Manitou Sustainable Energy	Worcester	15.0	
NH-4	CG Vermont	Manitou Sustainable Energy	Worcester	15.0	
NH-5	Scituate Station	PSNH	Scituate	20.0	
NH-6	Danbury Power L.L.O.	Manitou Sustainable Energy	Danbury	16.0	

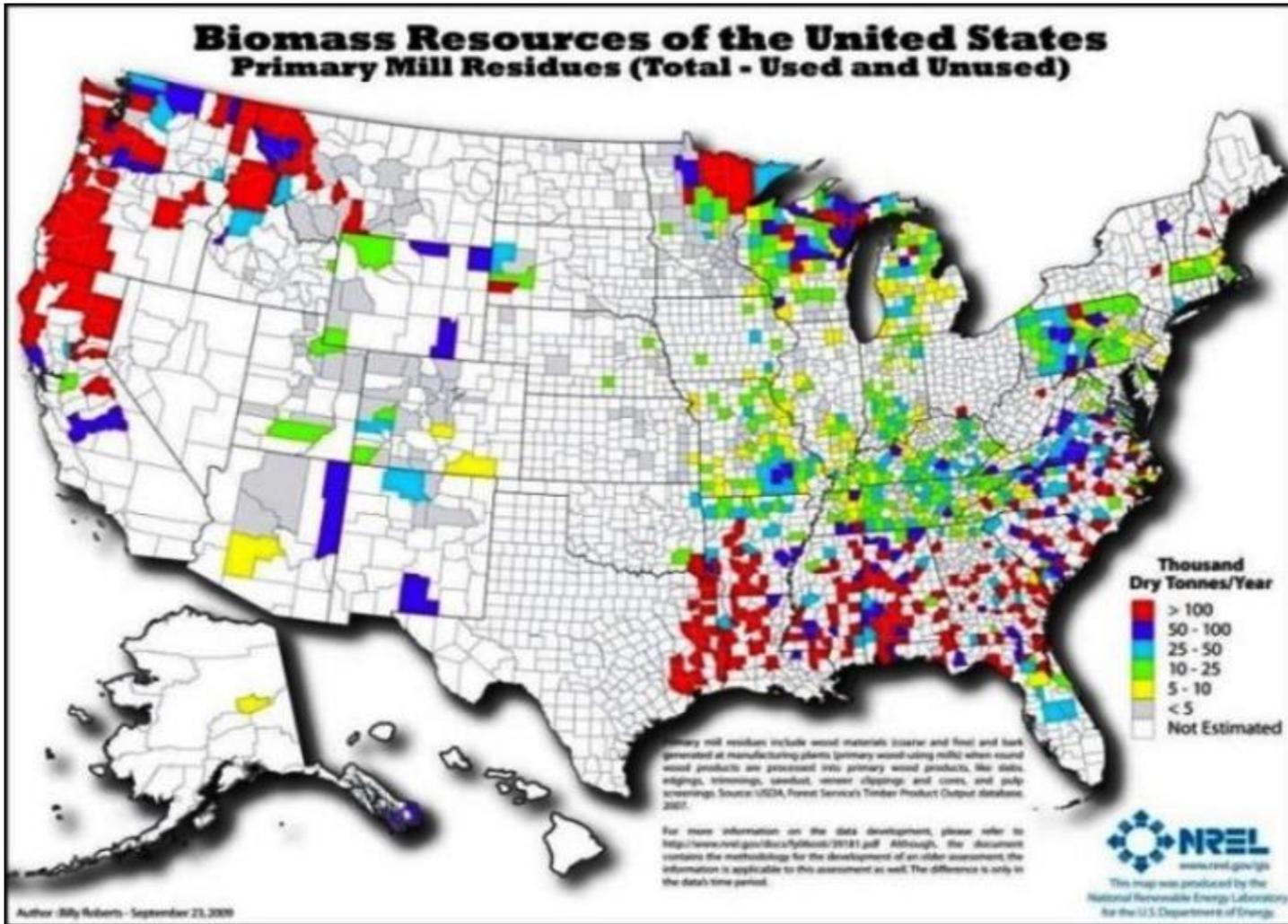
STATE	NAME	OWNER	CITY	MW	
NEW HAMPSHIRE, Cont'd.	NH-7	Edison Associates Energy Co.	Edison Associates Energy, L.L.C.	Albany	15.0
	NH-8	Concord Steam	Concord Steam	Concord	6.0
NEW YORK	NY-1	Refinery Chateaugay	Refinery Holdings	Chateaugay	33.0
	NY-2	Refinery Lyncoln	Refinery Holdings	Lyncoln	22.0
	NY-3	Niagara Generation L.L.C.	U.S. Renewable Group	Niagara Falls	28.0
	NY-4	Refinery Black River	Refinery Holdings	Black River	45.0
NORTH CAROLINA	NC-1	Coveris County Wood	Coveris Energy International	New Ben	49.0
	NC-2	Coveris County Wood	Coveris Energy International	New Ben	49.0
OHIO	OH-1	Central Ohio Clean Power	Refinery Holdings	Kennel	30.0
OHIO, Cont'd.	OH-2	Biomass One	Biomass One LP	Wilde City	50.0
	OH-3	Sierra Sustainable Energy	Sierra Sustainable Energy	Expire	18.0
	OH-4	Warm Springs Fibre	Warm Springs Fibre	Madras	30.0
	OH-5	Engeman BioPower L.L.C.	Engeman BioPower Co.	Summa	15.0
	OH-6	Refinery Forest Products	Refinery Forest Products	Blain	49.0
	OH-7	Rough & Ready	Rough & Ready Lumber Co.	Clear Junction	1.5
NORTH CAROLINA, Cont'd.	NC-3	Douglas County Lumber Co.	Douglas County Lumber Co.	Waynesville	8.4
NC-4	Flora City	D.J. Johnson	Flora City	10.0	
PENNSYLVANIA	PA-1	Koppers Susquehanna Plant	Koppers Inc./Susquehanna PA	Montgomery	7.5
PA-2	Spring Drive	RA Graduate	Spring Drive	24.0	
SOUTH CAROLINA	SC-1	Sierra Sustainable Energy	American/COE	Aiken	20.0
TEXAS	TX-1	Sierra Industries	Sierra Industries	Marshall	30
TX-2	Apex Power	Apex Capital Management	Lubbock	62.0	
TX-3	Nacogdoches Power	South Power	Nacogdoches	102.0	
VERMONT	VT-1	Joseph O. Melzer Generating Station	City of Burlington Electric	Burlington	82.0
	VT-2	Pyrgote Power Station	GDF Suez	East Pyrgote	22.0
VIRGINIA	VA-1	Pittsylvania Power Station	Dominion Virginia Energy	Hull	80.0
	VA-2	Albana Power Station	Dominion Virginia Energy	Albana	55.0
	VA-3	Nights City Wood Energy Co.	Nights City Wood Energy Co.	Nights City	107.0
	VA-4	South Bottom Energy Project	Northwest Va. Dec Co-op	South Bottom	87.0
WASHINGTON	WA-1	Kelle Falls	Astoria	Kelle Falls	47.0
	WA-2	Sierra Pacific Aberdeen	Sierra Pacific Industries Inc.	Aberdeen	12.0
	WA-3	Sierra Pacific Burlington	Sierra Pacific Industries Inc.	Burlington	28.0
	WA-4	Sierra Pacific Tacoma	Sierra Pacific Industries Inc.	Tacoma	24.0
	WA-5	Wagner Brothers Lumber	Wagner Brothers Lumber	Coulee	6.0
WASHINGTON, Cont'd.	WA-6	Hampton Allstate	Hampton Allstate	Dungeness	7.0
WISCONSIN	WI-1	Bay Front Power Plant	Just Energy	Island	73.0



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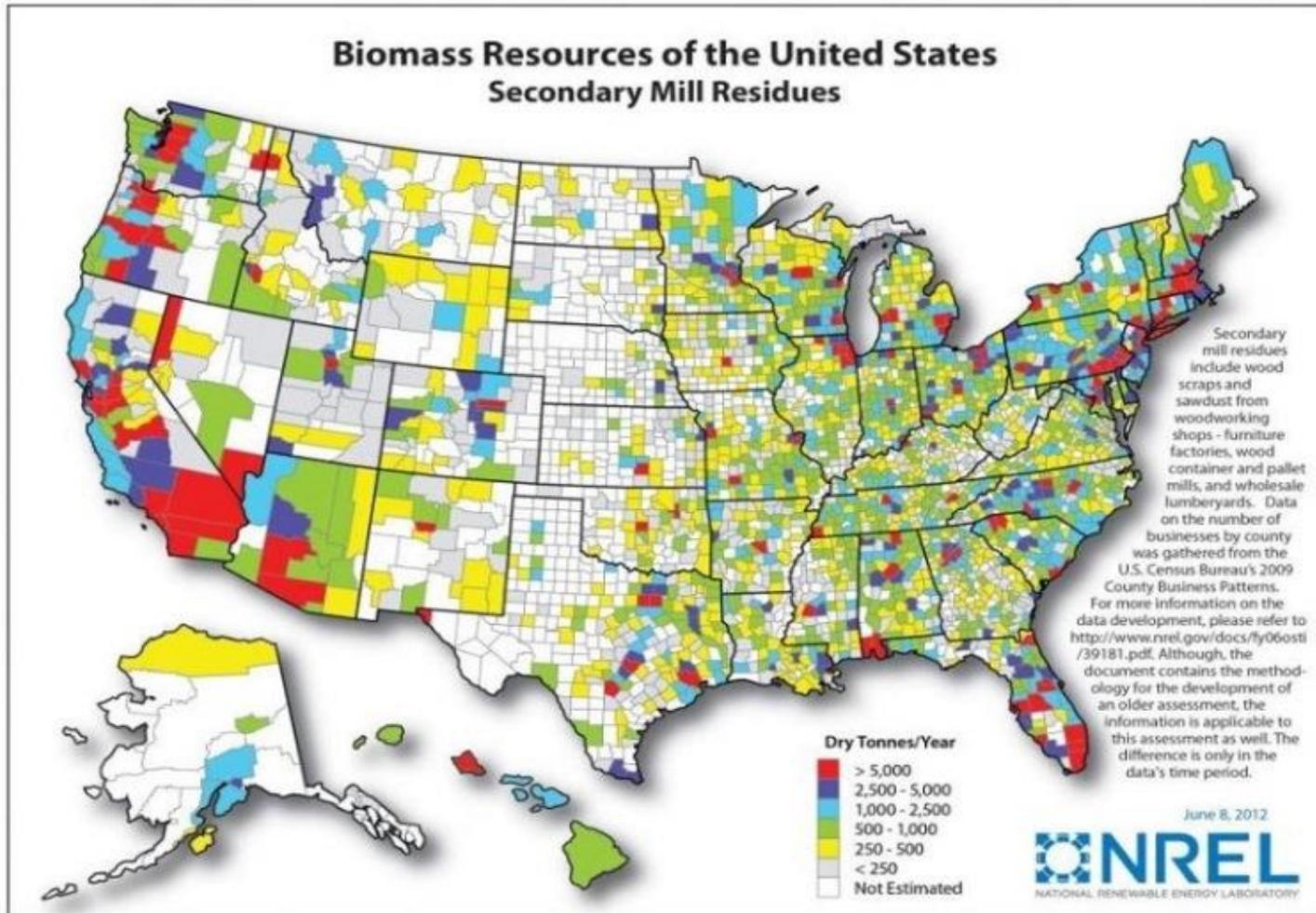
Biomass - Primary Mill Sources

Source: USDA, Forest Service's Timber Product Output database, 2007



Biomass – Secondary Mill Sources

Source: U.S. Census Bureau, 2009 County Business Patterns



Biomass – Power Boilers



So we see Biomass resources are available throughout the United States.

Why use biomass for fuel?

- Saves valuable landfill space
- Provides an end use for waste products
- Assists in forest management hazard reduction programs
- Contributes to the local economy
- Provides an alternative to fossil fuels

Biomass – Power Boilers



Why use biomass for fuel?

- Environmental regulations

Biomass - Power Boilers



The CO₂ emitted from biomass-based fuels combustion does not increase atmospheric CO₂ concentrations, assuming the biogenic carbon emitted is offset by the uptake of CO₂ resulting from the growth of new biomass." The United States Environmental Protection Agency, 74 Fed. Reg. 24,904, 25,039 (May 26, 2009).

Biomass - Power Boilers



"The record shows that electric generation using biomass that would otherwise be disposed of under a variety of conventional methods (such as open burning, forest accumulation, landfills, composting) results in a substantial net reduction in GHG emissions." California Public Utilities Commission, January 2007, Decision 07-01-039

Challenges of using Biomass in boilers.

- Variable physical properties of biomass must be accounted for in boiler design.
- Abrasive characteristics of some biomass fuels.
- Increased operator interaction controlling the combustion process.
- Co firing with coal
- Transportation costs
- Increasing competition for low priced biomass sources.

Methods to help reduce problems.

- Select proven fuel feed systems
- Use dedicated feeder systems for specific biomass sources or,
- Consider blending differing biomass fuels into a homogeneous mixture before the fuel enters the boiler.
- Loader operator training in proper handling of biomass fuels.
- Adding processing equipment to handle a variety of fuels

Methods to help reduce problems.

- Abrasive characteristics of some biomass fuels.

Use cladding or shielding to extend boiler tube life in high wear areas.

Biomass- Power Boilers



- Emerging / Maturing Technologies

Biomass – Power Boilers



Future studies recently awarded involve:

- The use of flue gas to dry wood chips
- Development of a solid biofuel that has potential for direct, stand-in use at power generation facilities.
- Development of distributed generation in rural environments using rural biomass as fuel.

Biomass - Power Boilers



- As our scientists and engineers seek new ways to generate power for our growing population centers, one of our responsibilities is to learn new technologies and adaptations of existing technologies to identify adverse trends and conditions impacting boilers we inspect.

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