WISCONSIN LEGISLATIVE COUNCIL
STAFF MEMORANDUM

Memo No. 2

TO: MEMBERS OF THE SPECIAL COMMITTEE ON DOMESTIC BIOFUELS

FROM: David L. Lovell, Senior Analyst

RE: Assessment of Biomass in Wisconsin Available for Biofuels Production

DATE: October 8, 2008

This Memo discusses the availability of biomass in Wisconsin for the production of transportation biofuels. It first identifies major categories of biomass and then presents some of the factors considered in assessing the amount of available biomass. It concludes with a brief discussion of studies of biomass availability in Wisconsin.

SOURCES OF BIOMASS

This part of the Memo identifies categories of biomass. It distinguishes between types of biomass for production of transportation biofuels, the subject of your committee's study, and those for production of biogas, primarily methane. Note that many of these materials can also be used as solid fuels for combustion in boilers or furnaces. Also, there are nonfuel uses for many of these materials. The most obvious example is food crops. Other examples include the use of wood chips in papermaking, the use of crop residues as animal bedding or landscaping mulch, and the potential use of various forms of biomass to produce chemical feedstocks.

Sources of Biomass for Liquid Biofuel Production

Food Crops. The principal food crops currently used for biofuels production are corn (for ethanol production) and soybeans (for biodiesel production). In tropical and subtropical regions, sugar cane is used to produce ethanol and palm oil is used to produce biodiesel, as well.

Dedicated Biomass Crops. Various nonfood crops can be grown specifically for biofuels production. These include agronomic crops such as switchgrass and forestry crops such as poplar.

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Crop Residues. Crop residues are the portion of a crop plant other than the primary product of the crop. While crop residues are often thought of as the portion of a crop plant that is left in the field after harvesting, in fact much of these "residues" are currently collected for various uses. The most abundant of crop residue in Wisconsin is corn stover, as the nongrain part corn plants is called. Another example is straw from small grains.

Forest Residues. Forest residues can be divided into logging residues and other removals. Logging residues are the unused part of trees cut or killed by logging. Other removals includes trees cut or killed by silvicultural operations, such as stand thinning, and those cut or killed in the course of land clearing and other forest uses not directly associated with the production and harvesting of round wood.

Primary Mill Residues. Primary mills are facilities where round wood is processed into wood products – in lay terms, sawmills. Residues from such mills include coarse and fine wood materials (wood scraps and sawdust) and bark.

Secondary Mill Residues. Secondary mills are facilities that use the products of primary mills for manufacturing, such as furniture manufacturers or woodworking shops. Their residues include wood scraps and sawdust.

Other Industrial Residues. Some industries produce organic wastes that can be used as feedstocks for biofuels production. Examples include the paper making and food processing industries.

Urban Wood Residues. There are a number of urban sources of wood residues, which include mixed municipal solid waste, tree trimmings, and construction and demolition waste.

Sources of Biomass for Biogas (Methane) Production

Animal Waste. The use of digesters to produce methane from animal waste is growing as both an energy source and a means of waste management.

Landfills and Wastewater Treatment Facilities. The decomposition of organic wastes in landfills produces methane, which can be captured and used. The same is true with regard to the secondary treatment of sewage in wastewater treatment facilities.

ASSESSMENT OF AVAILABLE BIOMASS

Assessments of available biomass can vary greatly in their purpose and scope. They can vary with regard to the number and types of sources they consider, their geographic scope (the region covered) and resolution (the fineness with which that region is subdivided), the time frame of their analysis (i.e., whether they attempt to predict future conditions), and the use of technical, cost-based, and market-based analyses. Studies range from an assessment of the availability of the particular types of biomass needed for a particular manufacturing process in a particular location, to a state-wide assessment of one type of biomass, to a comprehensive assessment of all types of biomass across the United States.

Assessment of the availability of biomass can be viewed as a stepped process, with each step adding a layer of refinement to the assessment. The following is one view of the levels of analysis that can be applied to an assessment.

Inventory

The first level is an inventory of the resource. The following are questions that are part of such an inventory:

- How much biomass is produced on land in current production?
- How much biomass could be produced on land not currently in production?
- How much are biomass yields expected to increase over time with improved crop genetics, tillage practices, etc.?

An inventory may take into account the amount of biomass currently produced that is already used for other purposes. Similarly, when evaluating the potential for dedicated energy crop production, an inventory may account for land that is already in use for other purposes.

Technical or Cost-Based Analysis

The second level considers how much of the total inventory of biomass is actually available. Such an analysis may focus on technical constraints to availability, cost-based constraints, or both. The two analyses are closely related. Since technical constraints affect the cost of obtaining biomass and cost constraints affect what technologies can be used to obtain biomass, analysis of one can provide some insight into the other, as well.

Factors affecting the technical availability include harvesting and residue collection technologies, terrain, and road access. A technical analysis may also address the issue of sustainability: how much biomass can be removed on an on-going basis without causing adverse effects to soil and other resources?

A cost-based analysis may evaluate the amount of biomass available at or below the maximum cost necessary for a particular facility or it may estimate the amount of one or more biomass types available over a range of costs. Factors that affect cost include:

- The cost to harvest and collect the material.
- The cost to process and store the material.
- The cost to transport the material from the site of harvesting to the processing or storage site and to the site of final use.

Market-Based Analysis

The third level of analysis recognizes that the various forms of biomass are commodities and that markets exist for each of these commodities. For any type of biomass for which there is more than one use, the highest price that one of the competing users is willing to pay will set the market price for the commodity. If a competing use places a higher value on the commodity than biofuels producers, that use will out-bid biofuels producers in the market and the commodity will flow first to that competing

use. On the other hand, if a biofuels producer out-bids competing users, the commodity will flow to that biofuels producer.

Just as there are competing uses for biomass commodities, there are also competing uses for the land on which biomass is grown, principally using the land to grow other crops or keeping the land out of production for conservation purposes. A market-based analysis of biomass availability should consider these competing uses, also.

In addition to providing a sophisticated assessment of biomass availability, a market-based analysis can shed light on various issues of concern to policy makers. For example, if a biomass commodity is essential to an established industry, a market-based analysis can be used to determine whether a state policy that promotes the use of that commodity for energy production will have an adverse effect on the existing industry. A real-life example of this is the potential for competition between the pulp and paper industry and energy producers for wood chips and other forest products.

Interplay With Renewable Resources Policies

Certain state and federal policies require the use of renewable resources, including biomass resources, and so may warrant consideration in a biomass assessment. In particular, renewable portfolio standards for electric generation and renewable fuel standards for motor vehicle fuels require the use of minimum amounts of renewable resources. Each such policy will include a definition of "renewable resource" or a similar term to establish what resources can be used to meet the requirements of the policy. In the case of the federal renewable fuel standard, the definition of "renewable biomass" excludes crops and crop residues from land that had not been cleared or cultivated prior to the establishment of the standard; it also excludes slash and pre-commercial thinnings from federal lands. Biomass assessments typically do not make these distinctions. However, it is apparent that, for purposes of developing new policies and complying with existing policies, such distinctions are very pertinent.

ASSESSMENTS OF WISCONSIN BIOMASS RESOURCES

U.S. Department of Energy Biomass Assessment Program

The U.S. Department of Energy (DOE), primarily through its Oak Ridge National Laboratory (ORNL), has produced a number of studies assessing the national availability of biomass.

1999 ORNL Report

An early study published by ORNL[1] provided a cost-based analysis of the availability of biomass. It evaluated broad categories of residues or wastes and dedicated energy crops, estimating the amounts available at delivered costs of $20, $30, $40, and $50 per dry ton. It presented its findings aggregated by state. Findings for Wisconsin are shown in the following table. The agricultural residue estimated was almost entirely (97%) corn stover; the energy crop evaluated was switchgrass.

[1] M.E. Walsh, et al., *Biomass Feedstock Availability in the United States: 1999 State-Level Analysis*, ORNL, April 1999, updated January 2000.

Biomass Available (thousand dry tons) by Delivered Cost, Wisconsin, 1999

Cost	Agricultural Residues	Dedicated Energy Crops	Forest Residues	Mill Residues	Urban Wood Waste	TOTAL
$20/dry ton	0	0	0	42	383	425
$30/dry ton	0	0	609	1,202	639	2,450
$40/dry ton	5,180	3,596	886	1,202	639	11,502
$50/dry ton	5,180	6,114	1,138	192	639	14,963

"Billion-Ton Study"

Perhaps the best known study by ORNL is the so-called "billion-ton study."[2] The purpose of this study was to determine whether the land resources of the United States are capable of producing a sustainable supply of biomass sufficient to displace 30% or more of the country's current petroleum consumption. The amount of biomass needed for this was estimated at approximately 1 billion tons. The study considered all biomass sources, including food crops, on a national scale. The study did not include an explicit cost-based analysis, but applied a technical feasibility filter through the use of limitations and assumptions, such as excluding forestlands that are inaccessible or on sensitive sites, considering equipment recovery limitations, and assuming various residue recovery rates. The study also excluded biomass that is currently used for another purpose. The report presents findings as aggregate national figures. The study concluded that more than 1 billion tons of biomass potentially would be available for biofuels production by the middle of the 21st Century, at which time, the report states, large-scale bioenergy and biorefining industries are likely to exist.

ORNL is in the process of updating the billion-ton study. Lab personnel indicate that they are currently applying cost-based analysis, and are developing models to use market-based analysis. The current analysis continues to exclude biomass that is already used for another purpose.

In a related development, the DOE and the U.S. Department of Agriculture (USDA) have established the SunGrant Initiative. With regional centers on the campuses of five land grant universities, this initiative is gathering existing data sets from ground level surveys and satellite data of biomass, focusing primarily on standing biomass. As this information is assembled, ORNL will use it to verify the models it is using for biomass assessment.

ORNL researchers have provided preliminary findings for Wisconsin from their ongoing biomass assessment work. These findings, summarized in the following tables, project to the years

[2] R.D. Perlack, et al., *Biomass as Feedstock for a Bioenergy and Bioproducts Industry : The Technical Feasibility of a Billion-Ton Annual Supply*, ORNL TM-2005/66, April 2005.

2017, 2030, and 2050 but do not estimate biomass availability at varying costs. Comparing these findings to those from the 1999 study, the total crop residue figures are fairly similar, but the 1999 study projected considerably more production from dedicated energy crops than do the more recent findings. In contrast, the more recent findings project considerably more forest residues than did the 1999 study. It appears that the large difference in projected mill residue is because the more recent findings are based on only mill residues that are not currently used for another purpose.

Estimated Wisconsin Cropland Biomass Resource Availability (thousands of dry tons)

Year	Crop Residues					Dedicated Energy Crops	Total
	Corn Stover	Wheat Straw	Oats	Barley	Total Crop Residues		
2007	3,868	85	47	5	4,017	0	4,017
2017	5,442	107	76	9	5,651	308	5,959
2030	7,771	133	76	9	7,989	1,681	9,670
2050	10,991	181	136	22	11,330	8,839	20,169

Estimated Wisconsin Forestland Biomass Resource Availability (thousands of dry tons)

Year	Primary Forest Residues			Unused Primary Mill Residues	Urban Wood Residues	Total
	Logging and Other Removals Residue	Fuel Treatment Thinnings	Total Primary Forest Residues			
2007	1,577	1,241	2,818	46	484	3,348
2017	1,776	1,241	3,017	47	506	3,570
2030	2,047	1,241	3,288	50	564	3,902
2050	2,456	1,241	3,697	58	655	4,410

ORNL researchers indicate that they are developing county-by-county databases that use geographic information system (GIS) techniques to overlay detailed data on the location of biomass sources with transportation infrastructure, utilities, and other resources. They intend to develop an interactive web-based mapping utility to allow individuals to use the databases to evaluate sites for potential biofuels production facilities.

2005 NREL Report

The National Renewable Energy Laboratory (NREL) published a study in 2005,[3] which looked primarily at the geographic distribution of biomass resources. In addition to the types of biomass used to produce transportation fuels, the report addressed the availability of methane from manure management, landfills, and wastewater treatment. While the report includes state-level estimates of biomass availability, perhaps most useful are national maps showing the availability of the various types of biomass by county.

Maps 1 to 6, at the end of this Memo, are taken from the report. Map 1 shows that, while there are significant amounts of crop residue in Southern Wisconsin, the greatest amount of this resource is in the neighboring states of Iowa, Illinois, and Minnesota. Map 2 shows a large forest residue resource in Northern Wisconsin, with other concentrations of this resource in Northern Minnesota and several northeastern, southeastern, and western states. Map 3 shows a similar distribution of primary mill residues, but Map 4 shows that very little of this resource is not already used. Maps 5 and 6 show the distribution of secondary mill residues and urban wood residues.

Maps 7 to 9, which were prepared by NREL researchers for this Memo, bring the geographic distribution of biomass resources in Wisconsin into sharper focus. More so than Maps 1 and 2, Maps 7 and 8 show that forest biomass resources are limited almost exclusively to the far northern portion of the state, while agricultural residues are found in the entire remainder of the state.

Other Studies

Researchers at the University of Wisconsin-Extension (UW-Extension) are developing a GIS-based utility similar to that being developed at ORNL. Like the ORNL project, this utility will allow users to determine the availability of biomass resources, including agricultural, forest, and mill residues found in municipal waste, at specific locations in the state and to overlay infrastructures, political boundaries, and other information on this inventory. The project managers indicate that the utility will be available online sometime this month and that the databases will be updated and refined over time, as new information becomes available.

In addition to the UW-Extension project, various studies have been conducted in Wisconsin looking at parts of this broader picture. The Department of Natural Resources (DNR) is required to prepare a report to the Legislature biennially regarding the extent of forestlands in the state and their potential to produce various fuels. Also, a group of researchers at the UW-Madison are in the design

[3] A. Milbrandt *A Geographic Perspective on the Current Biomass Resource Available in the United States*, NREL TP-560-39181, December 2005.

stage of a study to evaluate the potential of "marginal" agricultural lands to grow dedicated biomass crops.

Other studies assess the current or potential biomass resource for particular applications. For example, a very recent study[4] looks at the potential for switchgrass production for solid-fuel heating systems. A number of other examples come from the Energy Center of Wisconsin (ECW), which has recently conducted assessments of the availability of biomass for fuel in two electric generating facilities.[5] [6] A June 2006 report by the ECW[7] evaluated potential channels for the development of biobased industries in Wisconsin. While the report did not include a full assessment of the biomass resources on which the study was based, it did provide qualitative discussion of the resources.

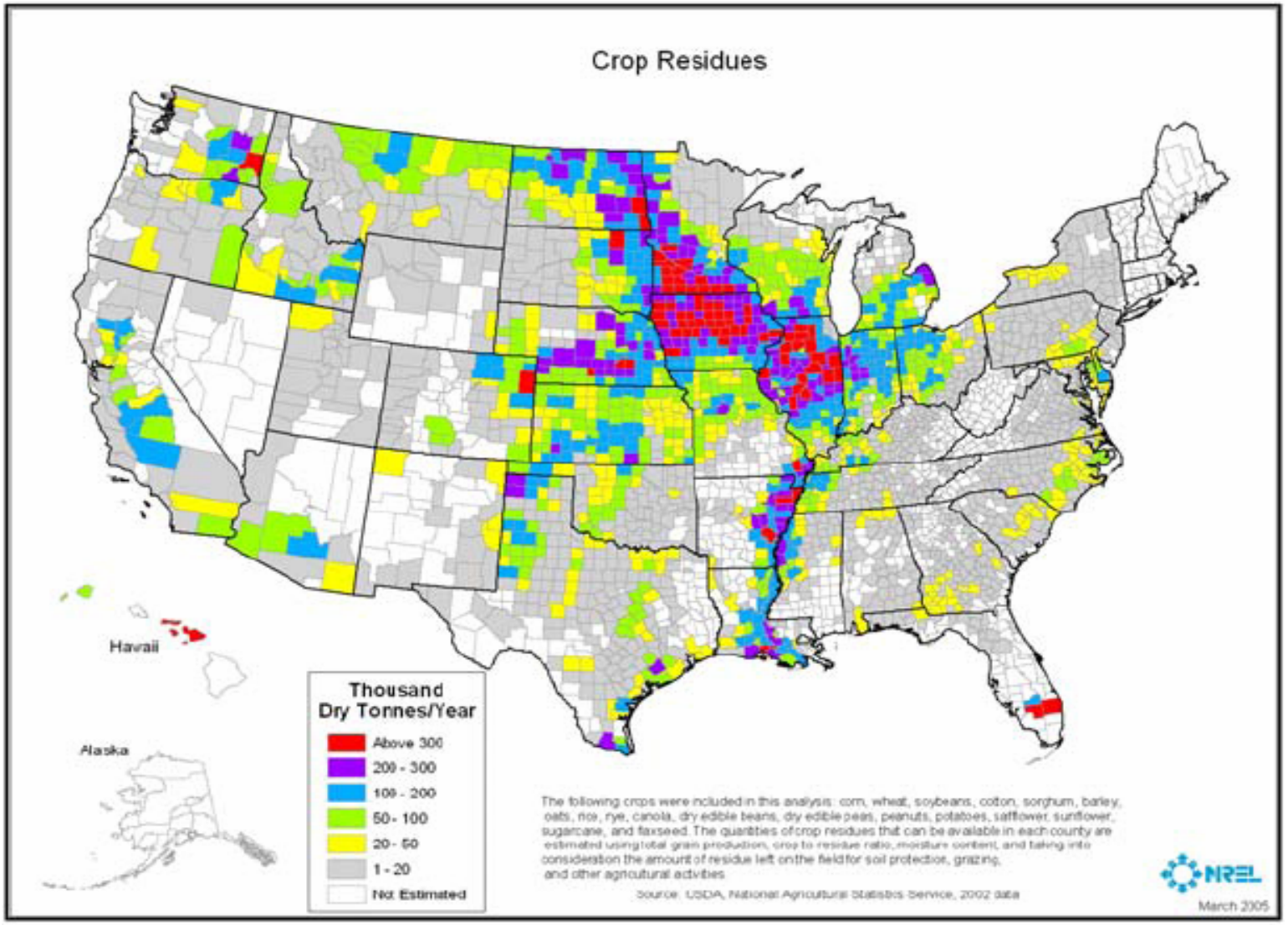
[4] P.A. Porter, et al., *Growing Wisconsin Energy : A Native Grass Pellet Bio-Heat Roadmap for Wisconsin*, Agricultural Ecological Solutions, June 2008.

[5] *Assessment of Biomass Resources for Energy Generation at Xcel Energy's Bay Front Generating Station in Ashland, Wisconsin,* ECW Report Number 240-1, April 2007.

[6] *Woody Biomass Resource Assessment for Presque Isle Power Plan – Final Report,* ECW Report Number 242-1, August 2008.

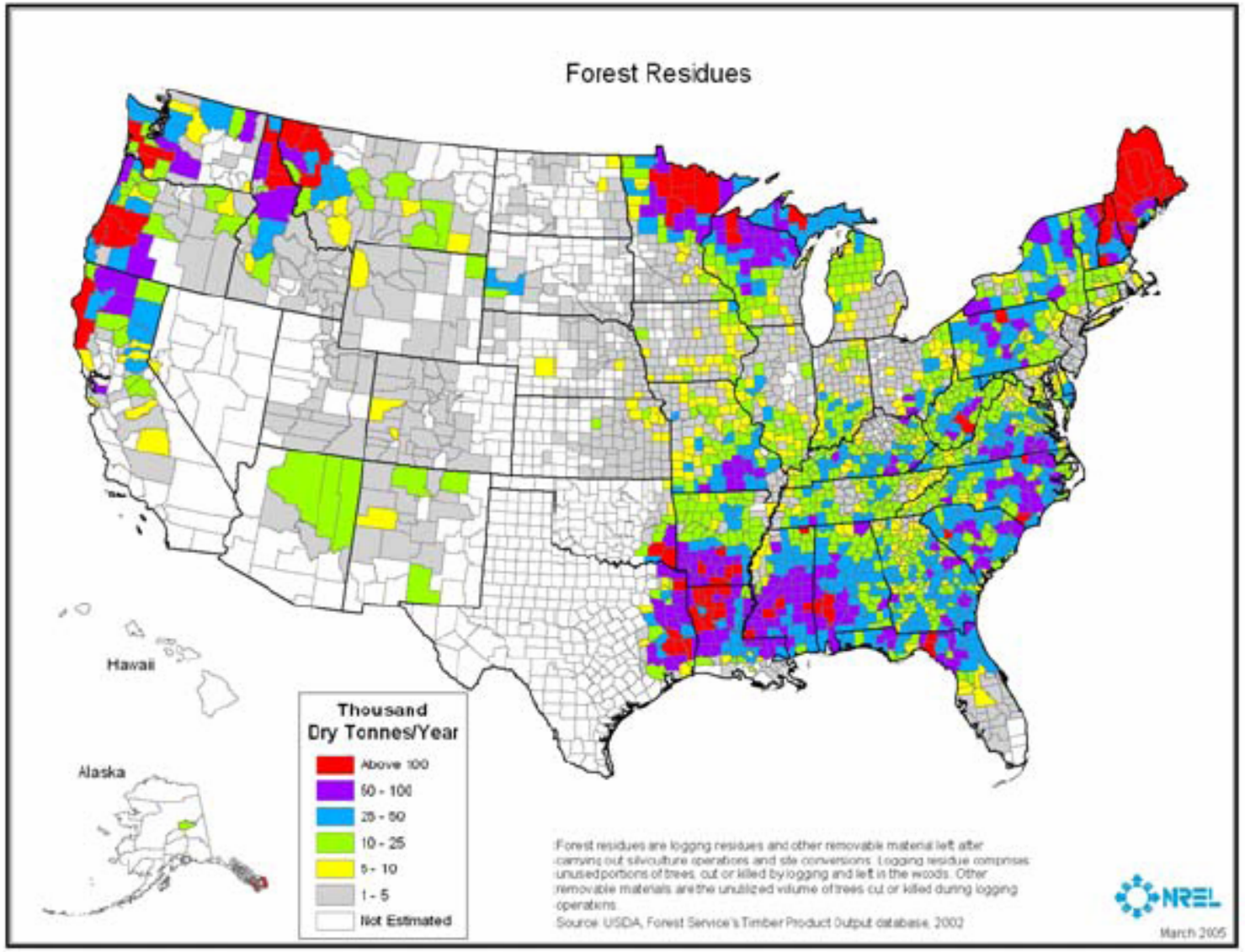
[7] *Wisconsin's Biobased Industry : Opportunities and Advantages Study*, ECW Report Number 237-1, June 2006

Map 1. Estimated Crop Residues by County



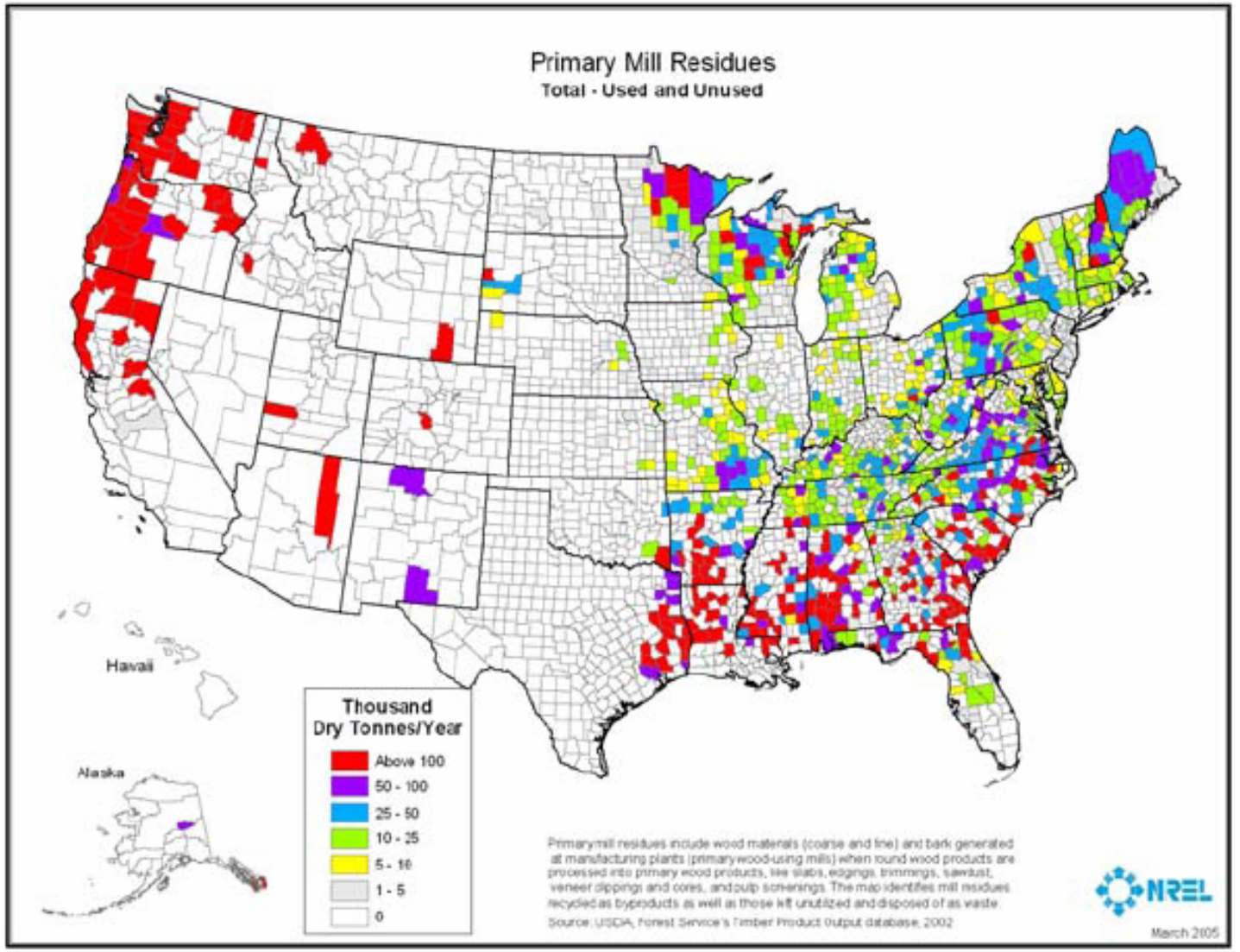
Source: A. Milbrandt, *A Geographic Perspective on the Current Biomass Resource Available in the United States*, NREL TP-560-39181, December 2005.

Map 2. Estimated Forest Residues by County



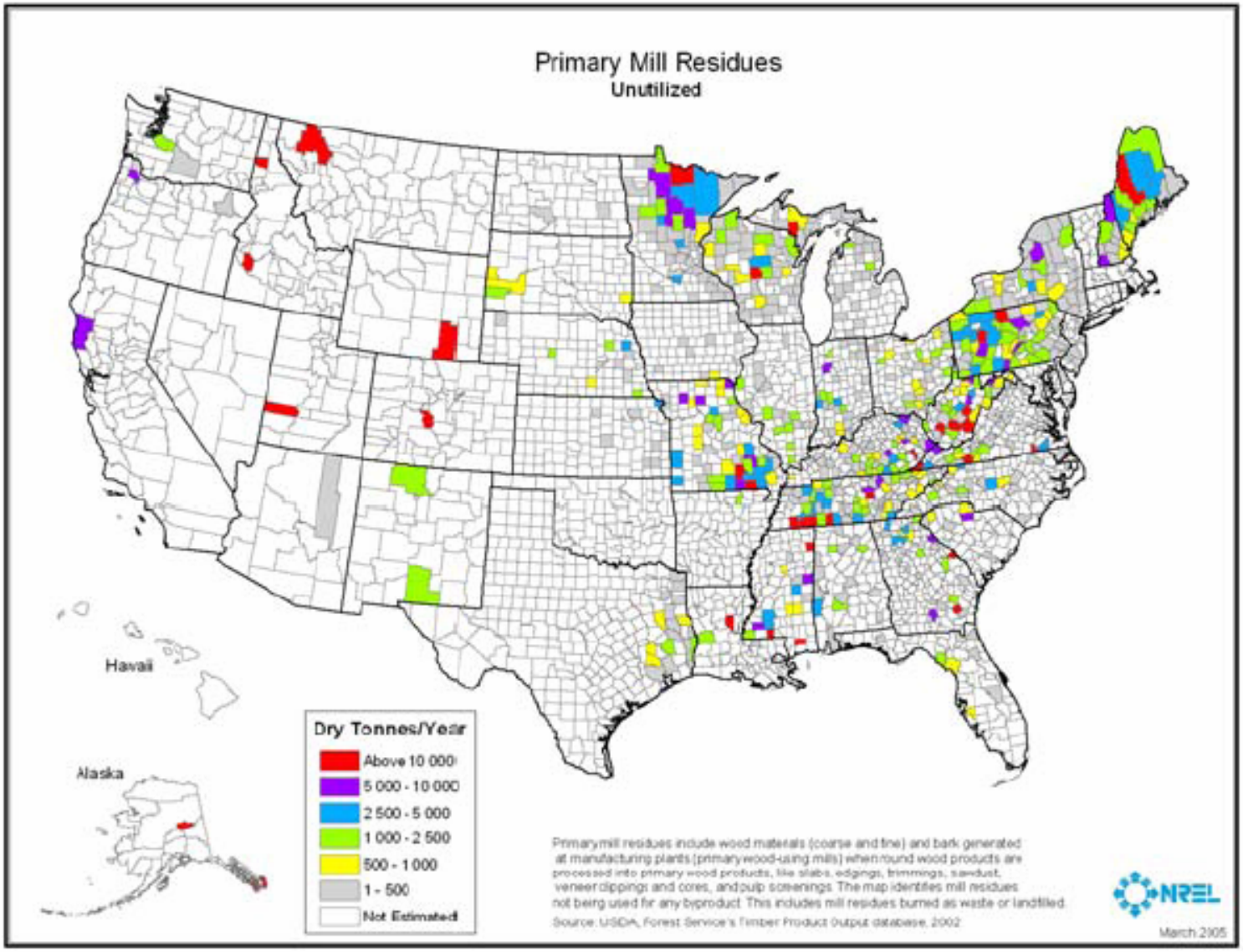
Source: A. Milbrandt, *A Geographic Perspective on the Current Biomass Resource Available in the United States*, NREL TP-560-39181, December 2005.

Map 3. Estimated Total Primary Mill Residues by County



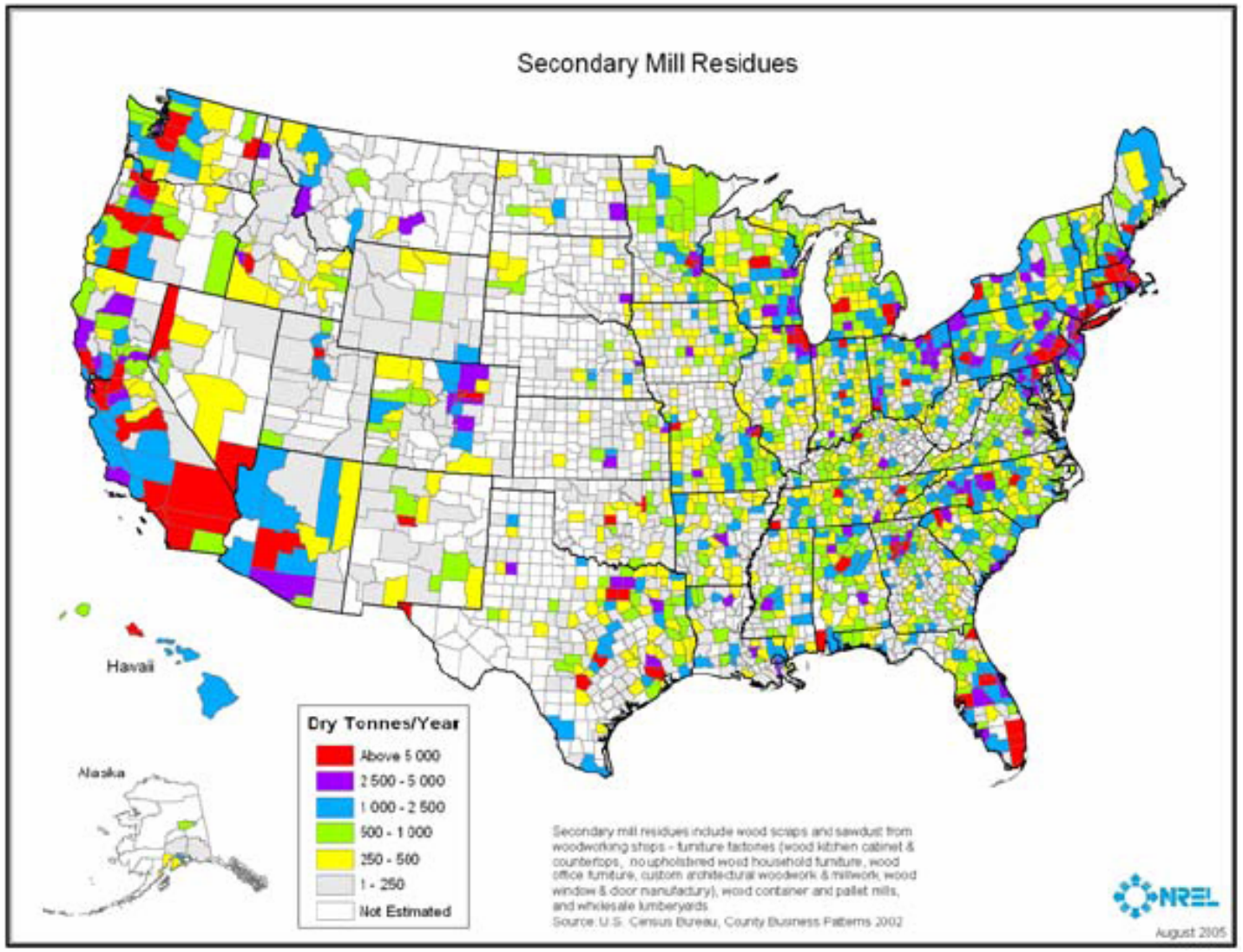
Source: A. Milbrandt, *A Geographic Perspective on the Current Biomass Resource Available in the United States*, NREL TP-560-39181, December 2005.

Map 4. Estimated Unutilitized Primary Mill Residues by County



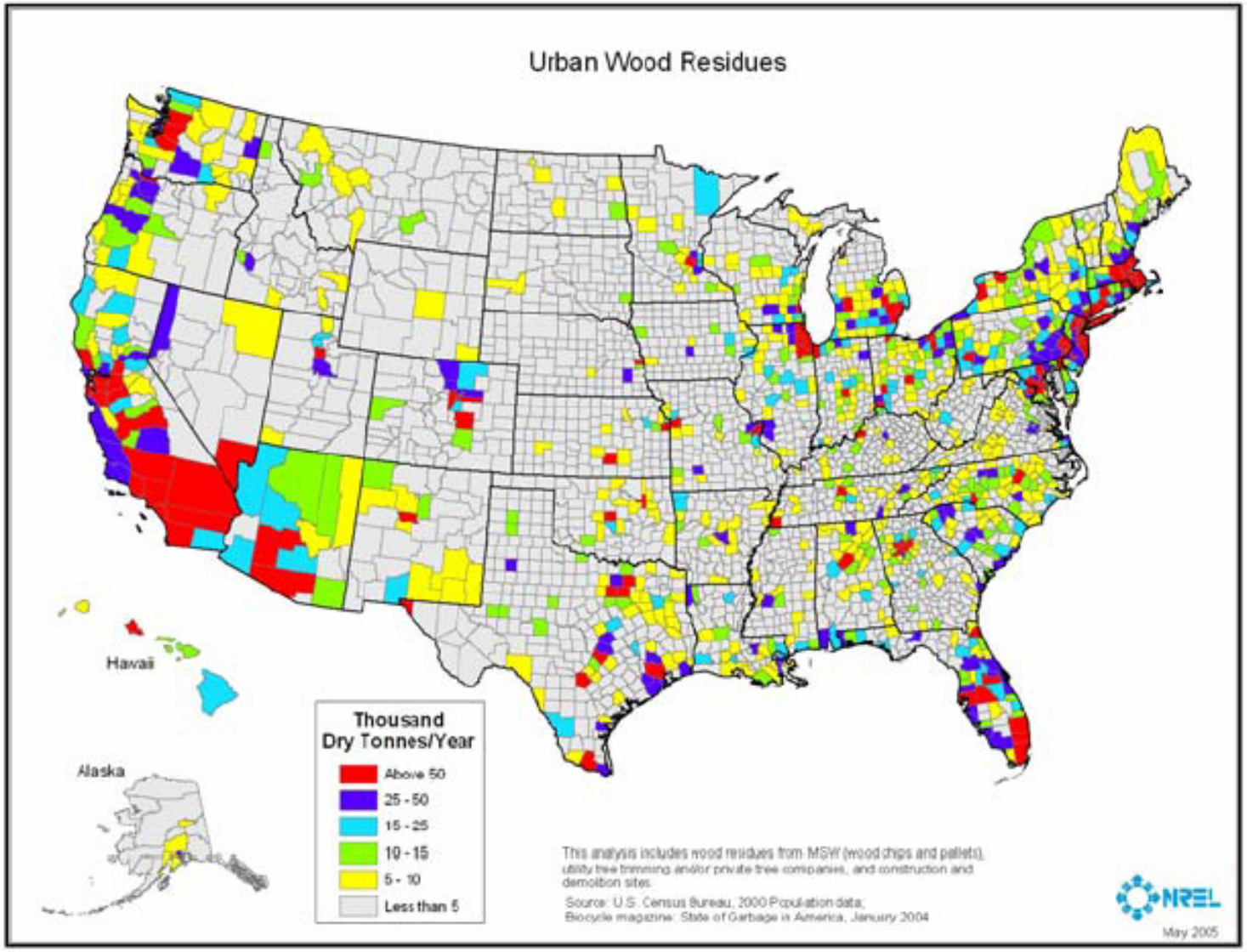
Source: A. Milbrandt, *A Geographic Perspective on the Current Biomass Resource Available in the United States*, NREL TP-560-39181, December 2005.

Map 5. Estimated Secondary Mill Residues by County



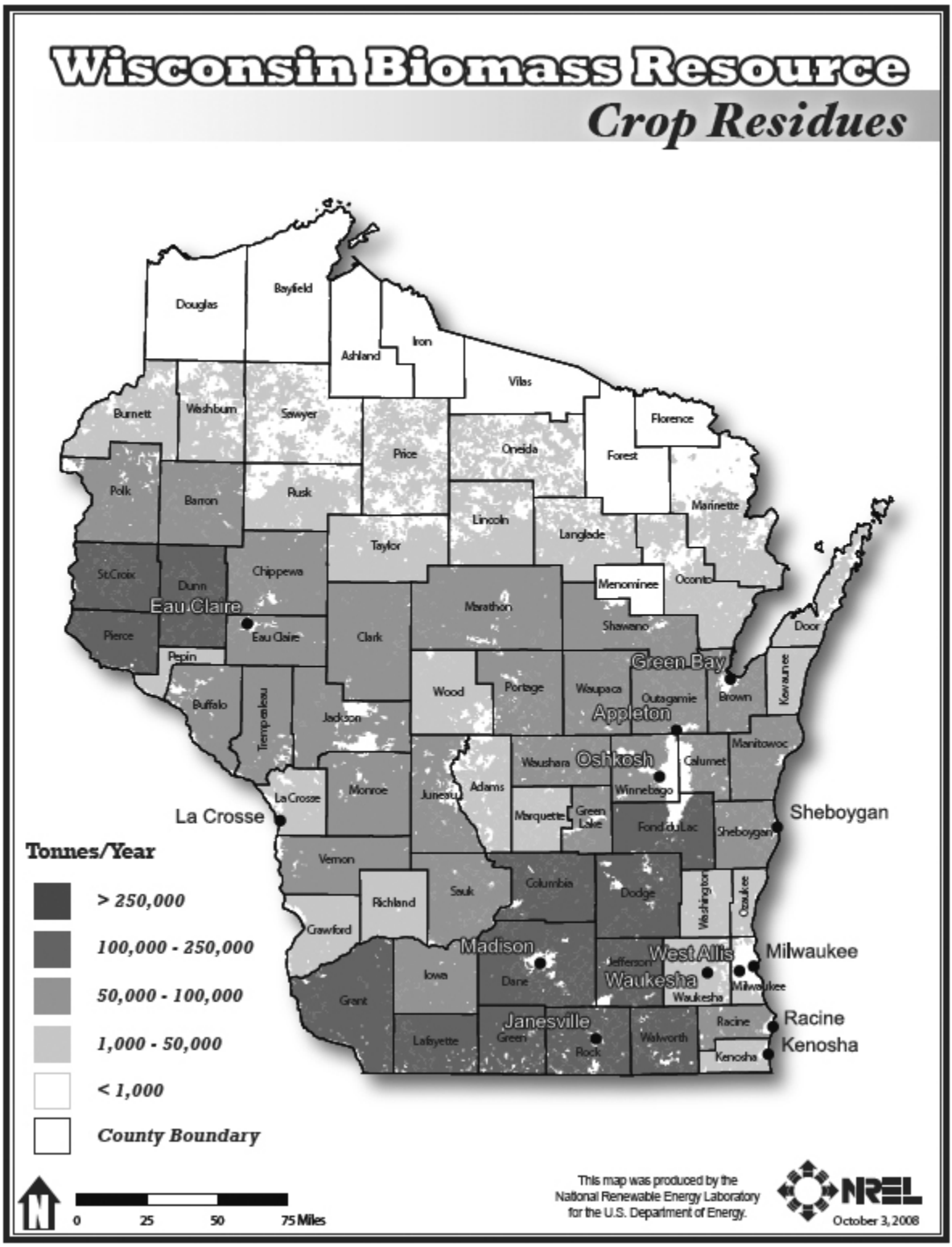
Source: A. Milbrandt, *A Geographic Perspective on the Current Biomass Resource Available in the United States*, NREL TP-560-39181, December 2005.

Map 6. Estimated Urban Wood Residues by County



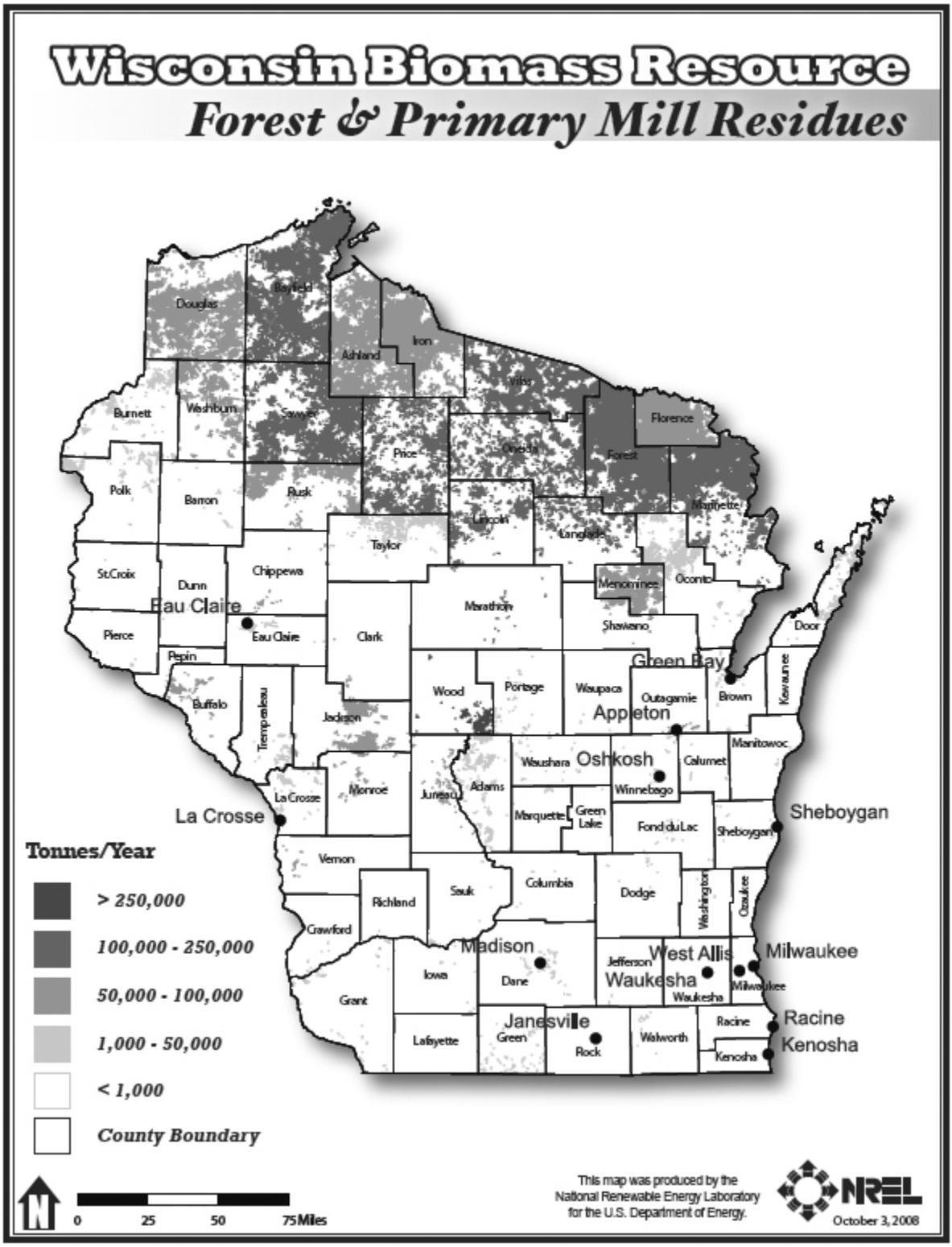
Source: A. Milbrandt, *A Geographic Perspective on the Current Biomass Resource Available in the United States*, NREL TP-560-39181, December 2005.

Map 7. Wisconsin Biomass Resource: Crop Residues



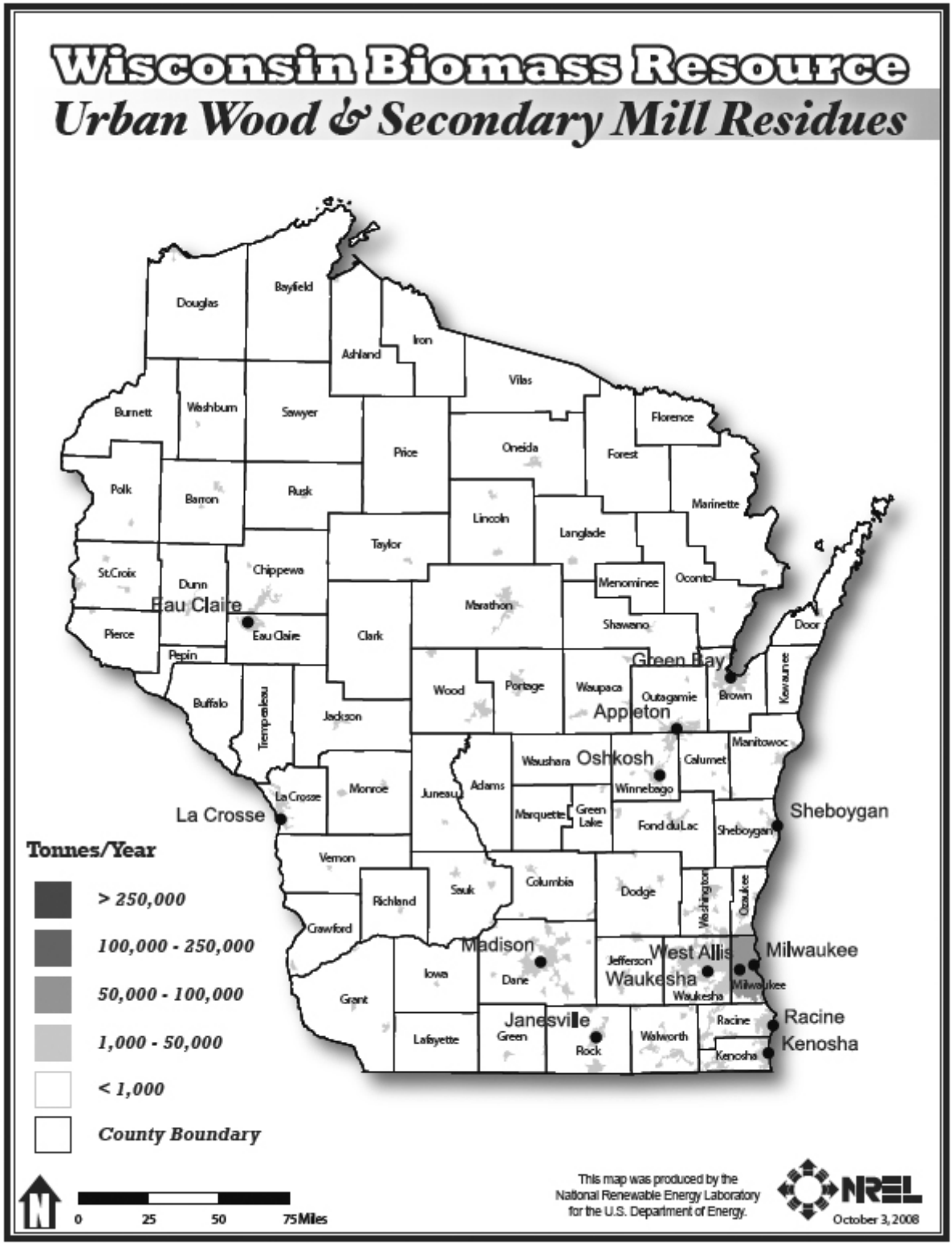
Source: National Renewable Energy Laboratory, October 3, 2008.

Map 8. Wisconsin Biomass Resource: Forest and Primary Mill Residues



Source: National Renewable Energy Laboratory, October 3, 2008.

Map 9. Wisconsin Biomass Resource: Urban Wood and Secondary Mill Residues



Source: National Renewable Energy Laboratory, October 3, 2008.

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