THE WOODY BIOMASS SUPPLY IN MASSACHUSETTS: A LITERATURE-BASED ESTIMATE

MASSACHUSETTS BIOMASS ENERGY WORKING GROUP
SUPPLY SUBCOMMITTEE

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Under Contract to

DIVISION OF ENERGY RESOURCES
and
DEPARTMENT OF ENVIRONMENTAL MANAGEMENT, BUREAU OF FORESTRY

COMMONWEALTH OF MASSACHUSETTS

With Funding from

NORTHEAST REGIONAL BIOMASS PROGRAM, U.S. DEPARTMENT OF ENERGY
USDA FOREST SERVICE, NORTHEASTERN AREA ECONOMIC ACTION PROGRAMS

May 2002

COMMONWEALTH OF MASSACHUSETTS

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1. SUMMARY

The Massachusetts Biomass Energy Working Group (BEWG) is coordinated by the Massachusetts Division of Energy Resources for the purpose of sharing and coordinating the interests and efforts of biomass energy stakeholders in the Commonwealth. The BEWG first met in Boston on June 21, 2001. An early activity was the division of the working group into three subcommittees (Demand Subcommittee, Technology Subcommittee, and Supply Subcommittee) to investigate and report on the state of knowledge of key aspects of the biomass energy market. This report is the result of the Supply Subcommittee.

The purpose of this report is to provide a snapshot, based on a review of relevant literature, of the woody biomass supply in Massachusetts. The intention of this "snapshot" is to build overall confidence in professionals making estimates of the statewide woody biomass supply, for the purpose of evaluating regional biomass energy potential or to serve the needs of early market assessment by project developers.

The Supply Subcommittee estimates the current generation of woody biomass from residues in Massachusetts totals 2,481,308 tons per year. In addition, the forest resource within the Commonwealth is currently growing faster than it is being harvested. The additional wood volume that could be harvested without reducing the current volume of biomass in the forest was estimated to be 1,930,000 tons per year. These estimates are broken down and summarized in Table 1.1, indicating a total woody biomass supply of 4.41 million tons per year. The majority of the biomass residue (61%) is currently being recovered and utilized in a range of applications and markets such as landscaping, pulp and paper, and composites for manufacturing.

TABLE 1.1 SUMMARY OF WOODY BIOMASS SOURCES AND SUPPLY

WOODY BIOMASS SOURCE	AMOUNT (tons/year)
RESIDUE SOURCES	
Municipal Solid Waste	523,500
Construction and Demolition Debris	404,000
Primary Wood Manufacturers - Residues	279,608
Secondary Wood Manufacturers - Residues	225,000
Urban Wood Residues	1,049,200
Subtotal	**2,481,308**
UNUTILIZED ANNUAL NET GROWTH IN MA FORESTS	
Growing-Stock Trees	1,484,000
Branches, Top Wood	446,000
Subtotal	**1,930,000**
TOTAL	**4,411,308**

2. INTRODUCTION

As the Commonwealth of Massachusetts proceeds on its Renewable Energy Initiative and climate change action plan, the opportunities and challenges of biomass energy have become of great importance to policy makers, energy and economic analysts, and industry officials. Offices such as the Division of Energy Resources, the Department of Environmental Management, and the Massachusetts Technology Collaborative play essential roles in the market and policy environment for renewable energy, and energy consultants and the biomass industry provide services and equipment to design and establish energy projects. Both public and private parties are in need of defensible data on biomass supply to aid in the assessment, design, and planning of biomass policies, programs, and projects.

Providing estimates of biomass supply presents several challenges. Particularly difficult is the need to avoid redundancy, or double counting, of supplies that may be accounted for in different biomass categories. Additional challenges include missing data, improper or inconsistent definitions of biomass categories, and incomplete analysis of the total forest resource base in Massachusetts. While this report does provide a review of literature and a well-considered estimate of statewide biomass supply, it recognizes these current limitations of knowledge, as well as ambiguity in the origin of some biomass supplies from within or outside of the Commonwealth.

Biomass is often classified as either "clean" or "dirty", in reference to the contamination of woody material with other wastes or substances. Municipal solid waste (MSW) and construction and demolition (C&D) waste streams regularly include contaminated biomass. Common contaminants are from paints, stains, soils, and chemical spills. While contaminated biomass should not be considered unusable, the market demand and technology (including environmental controls) needed to utilize "dirty" biomass supplies is likely to be different. In some situations, MSW and C&D waste streams can be sorted to remove "clean" biomass from the contaminated supply.

This report adheres to this convention and divides biomass as "clean" or "dirty" depending on its source as indicated in Table 2.1.

TABLE 2.1 SOURCES OF CLEAN AND DIRTY BIOMASS SUPPLIES

CLEAN WOODY BIOMASS	DIRTY WOODY BIOMASS
Primary Manufacturers	MSW Stream (not sorted)
Secondary Manufacturers	C&D Waste Stream (not sorted)
Urban Wood Residues	
Net Growth in MA Forests	
MSW Stream (sorted)	
C&D Waste Stream (sorted)	

Recovered biomass is already used in many non-energy and (limited) energy applications with relatively mature markets. Table 2.2 indicates the range of these biomass products and applications. Market applications for biomass energy need to be integrating with (and may impact) these existing market conditions and infrastructure.

TABLE 2.2 PRODUCTS AND APPLICATIONS OF WOODY BIOMASS

PRODUCT	APPLICATION
DIRECT END-USES	
Mulch	Landscaping and Horticulture
Hydromulch	Landscaping and Horticulture
Landfill Cover (Fines and Residuals)	Landfill Cover Layers
Wood Fuel	Wood-Fired Facilities
Bulking Agent	Composting Facilities
Soil Amendment	Landscaping and Horticulture
Animal Bedding	Horse and Livestock Operations
Biofilter Media	Emissions and Odor Control
Refurbished Pallets	Packaging and Shipping Industry
(Re-) Milled Wood Products	Construction and Furniture Trades
MANUFACTURED PRODUCTS	
Wood Composites	Construction and Furniture Trades
Wood-Plastic Composites	Construction and Furniture Trades
Wood-Inorganic Composites	Construction and Furniture Trades
Pulp and Paper	Pulp and Paper Industry
Fuel Pellets	Home and Commerical Heating Industry

Source: Dorn and Associates, 1998 Phase II Report [12, page 44]

This report does not consider existing or potential biomass energy resources from dedicated energy crops, landfill methane, or agricultural or food processing wastes. Importantly, the report does not include information on the costs or market price of biomass supplies. These topics are clearly important for assessing the potential for biomass energy in the Commonwealth but are beyond the scope of this effort.

Based on the expertise of the Supply Committee, data on current biomass supplies were available in a wide range of literature but not conveniently summarized and presented for professional needs. To help organize the review, and structure the summary into useful supply information, the Committee divided the biomass resource stream into six main categories. These six categories are as follows, and results of the review in each category are detailed in Section 3.

Six Categories for Woody Biomass Supply

1. Woody residue from the Municipal Solid Waste (MSW) stream
2. Woody residue from the Construction and Demolition (C&D) waste stream
3. Woody residue from primary wood manufacturers (Primary Manufacturers)
4. Woody residue from secondary wood manufacturers (Secondary Manufacturers)
5. Urban wood residue
6. Unutilized annual net growth in Massachusetts forests.

A glossary of key terms used in this report and generally in the biomass and forestry literature is provided in Appendix A. A list of useful website for biomass energy and forestry, including related Massachusetts information is provided in Appendix B.

Within this report, the use of "tons" refers to short tons, equal to 2000 pounds. When considering the weight (and energy value) of biomass, the moisture content is important. Typically, tons of biomass are qualified as "green" tons or "dry" tons, or the weight with and without the water content, respectively. For the purpose of this report, the Supply Committee has not differentiated biomass supplies by green or dry tons. However, based on the six categories listed above, biomass supplies are generally dry from 4, green from 3, 5, and 6, and mixed from 1 and 2.

3. LITERATURE REVIEWS AND BIOMASS SUPPLY ESTIMATES

3.1 MSW Woody Residue

Dorn and Associates [12] report that MSW woody residue is composed primarily of wooden pallets and shipping containers. They also report that the primary recovery pathways for pallet recycling are through pallet refurbishers and wood residue recycling operations at disposal facilities, and that, nationally, 55% of pallets were recovered in 1995. The USDA Southern Research Station, in conjunction with Virginia Tech University, estimated that over 223.6 million pallets (6.16 million tons) entered landfills (both as MSW and C&D) in 1995 [4]. Dorn and Associates also estimate that 186,300 tons/year of pallets and shipping containers were potentially available for additional recovery, but the key barrier to recovery lie in the recovery process [11, page 42]. Pallets and shipping containers are less likely to be used by wood-fired facilities in New England because of associated contamination [5]. Woody MSW likely contains soil, chemicals, and other contaminants making it less desirable for use in energy production with older wood-fired technology.

Table 3.1 presents the estimates Dorn and Associates gave for generated and recovered woody biomass from MSW in Massachusetts in 1996. Note that only 39% of the 523,500 tons generated were recovered [11]. Dorn and Associates estimated a potential maximum recovery rate of 75%, or 392,600 tons, in that same year [11].

The Forest and Wood Products Institute (F&WPI) at Mount Wachusett Community College, reports that "the MSW stream is generally too complex to consider separating the wood waste component, and attempts to do so, mechanically or otherwise, would probably not be economically viable [13, page 9]."

TABLE 3.1 BIOMASS IN THE 1996 MASSACHUSETTS MSW STREAM

MSW WOODY RESIDUE	Generated (tons)	Recovered (tons)	Percent Recovered	Discarded (tons)
	523,500	204,165	39%	319,335

Source: Dorn and Associates, 1999 [11, page 39].

3.2 C&D Woody Residue

Several studies have attempted to quantify the woody residue component in the C&D waste stream. Identification and accounting of this woody component of the larger C&D waste stream is fraught with uncertainty. This section provides several methods based on literature information and Subcommittee expertise, and recommends a figure based on this review.

The F&WPI suggested a straightforward way to quantify this woody component of the C&D waste stream. By applying the results of a 1997 Green Seal study [19] of the makeup of C&D waste to the total generated C&D waste data from DEP's Solid Waste Master Plan [10], F&WPI calculates there was 1,152,000 tons of woody residue in the 1997 C&D waste stream. The results of Green Seal's statewide study are shown in Table 3.2, which predicts that approximately 30% of incoming C&D waste is composed of woody residue.

In a different analysis, George Aronson [2] has rearranged the data from DEP's Solid Waste Master Plan (SWMP) to provide a more coherent look at the woody residue contained in the stream, as shown in Table 3.3.

TABLE 3.2 MAJOR COMPONENTS OF INCOMING WASTE AT STATEWIDE C&D PROCESSING FACILITIES

COMPONENT	PERCENT OF TOTAL
Clean Wood	21%
Dirty Wood *	9%
Bulky (fluff)	10%
Dirt	25%
Metal	7%
Aggregate	27%

* The use of Dirty Wood for energy is included in this estimate, but would require different conversion technologies or emission controls.

Source: Green Seal, 1998 Report [19]

TABLE 3.3 RECYCLED AND DISPOSED C&D WASTE IN 1999

C&D MANAGEMENT IN 1999	PERCENT	TOTAL (TONS)
ABC Recycling *	71.7	3,370,000
Metal Recycling	1.1	50,000
Other Recycling	1.1	50,000
Wood Recycling	1.1	50,000
Net Export	5.5	260,000
Total Disposed Material	19.6	920,000
Total Generation	**100.0**	**4,700,000**

* ABC Recycling contains Asphalt pavement, Brick and Concrete rubble.

Source: DEP, Solid Waste Master Plan [10]

From Table 3.3, of the 4.7 million tons of C&D waste generated in 1999, 920,000 tons of material was landfilled. Applying the 30% figure from Green Seal (see above) for the percent of woody component to both disposed (920,000 tons) and exported (260,000 tons) C&D waste, Aronson concludes that 354,000 tons of woody residue is within the non-recycled C&D waste. Of this amount, and based on the percentages in Table 3.2, 247,800 tons would be "clean" and

106,200 tons would be "dirty" woody residue. Adding the reported quantity in Table 3.3 for recycled woody material (50,000 tons) brings the total of potentially available woody biomass to 404,000 tons.

Limitation and assumption behind this analysis are important to discuss. The analysis assumes that 30% of the landfilled debris is woody material, despite the fact that 50,000 tons of wood was already recovered for recycling. A reasonable assumption is that the recycled wood was material recovered with relative ease, and that the remaining woody material may be less than 30% of the remaining debris and less easy to recover. Wiltsee [18], for example, assumes that only 10% of landfilled C&D woody residue is recoverable. Concern might also be raised with regard to the inter-temporal statistical problems of applying 1997 (Green Seal) data to 1999 (SWMP) data. However, Aronson states that Green Seal's data is reliable and considered accurate by industry professionals.

Table 3.4 shows the figures this report has adopted as the most recent and accurate for the woody biomass in the statewide C&D waste stream.

TABLE 3.4 BIOMASS IN THE 1999 MASSACHUSETTS C&D WASTE STREAM

C&D WOODY RESIDUE	Generated (tons)	Recovered (tons)	Percent Recovered	Discarded (tons)
	404,000	50,000	12%	354,000

Source: George Aronson, unpublished data

Of the waste streams analyzed in this report, the C&D waste stream is the most likely to experience significant change in the near future. Regarding C&D waste, the F&WPI states [13, pages 6-7]: "In most New England states, fewer landfills are accepting C&D materials. While the number of C&D facilities has grown in recent years, in many instances what has been perceived as recycling is little more than volume reduction. With the supply of landfill space declining in the state, true recycling activities will outpace volume reduction if an economically viable market exists for the materials. With fewer disposal options, generators of C&D materials will use recycling facilities as a disposal outlet and will inevitably pay a premium tip fee for the convenience." The SWMP reports [10, pages 4-4 to 4-6] that: "DEP recognizes that with the current shortfall in overall disposal capacity in the state, C&D is competing with MSW for landfill space. Landfill operators prefer to take MSW over C&D because MSW is denser and uses less landfill space. Transfer stations are also less willing to handle bulky C&D waste and lack the capacity to do so, as well. A small number of new processors who take mixed C&D have started business in the last few years, but additional processing capacity is needed in Massachusetts to further increase C&D recovery."

Additionally, the Massachusetts Department of Environmental Protection (DEP) believes that banning the disposal of unprocessed C&D in 2003, in combination with other efforts, will

continue to promote C&D source reduction [10]. They believe that such a ban would preserve landfill capacity, provide a more reliable market for processing facilities (which would in turn increase the likelihood of additional processors being proposed and sited), and provide incentives for source reduction and source separation of C&D recyclables. The DEP also recognizes that the availability of sufficient processing capacity and markets for processed materials is necessary before implementing a ban. The DEP states that it will consider including, in proposed regulations to establish the ban, a provision for delaying the ban beyond 2003, if the processing capacity is not in place or other factors indicate a ban would not be feasible or effective by 2003.

3.3 Primary Manufacturers

Primary manufactures in the wood products industry in Massachusetts are comprised of the approximately 80 stationary sawmills. Four literature sources have been used by the Subcommittee for the analysis of woody biomass residues from these primary manufactures. These sources are the F&WPI's report for the Chelsea Center [13], Charlie Thompson's report for the University of Massachusetts Amherst [17], unpublished data on sawmill residues from the F&WPI [14], and the 1997 Directory of Sawmills, Dry Kilns and Lumber Treaters in Massachusetts [8].

In 1999, the F&WPI surveyed the 40 largest fixed sawmills in Massachusetts [13]. Of the 19 sawmills that replied to their survey, the F&WPI found that, for all species, woody residue from sawmilling activities can be broken down into the following three categories – woodchips, sawdust, and bark. These responders account for about 40% of the total statewide production of lumber. The quantity of residue in each category reported from this study is provided in Table 3.5.

TABLE 3.5 BIOMASS RESIDUES (ANNUAL) REPORTED FROM 1999 F&WPI SURVEY OF STATEWIDE SAWMILLS

BARK (tons)	WOODCHIPS (tons)	SAWDUST (tons)	TOTAL (tons)
53,007	137,000	100,761	**290,768**

Source: F&WPI, 2000 Report [13, page 12]

In the 1995 report for the University of Massachusetts Amherst [17], Thompson surveyed all sawmills in the five western counties of Massachusetts. These sawmills account for about 65% of the statewide production of lumber. Data from that survey is reproduced in Table 3.6. Notice that Thompson's data indicates quantities of wood residues similar to those from the F&WPI analysis (Table 3.5), thereby adding confidence to this report's estimate of the residue stream. However, as both these results are based on only a fraction of the Massachusetts sawmills, these figures likely underestimate the total biomass supply from primary manufacturers.

TABLE 3.6 BIOMASS RESIDUES (ANNUAL) REPORTED FROM 1995 SURVEY OF SAWMILLS IN THE FIVE WESTERN COUNTIES

SPECIES	BARK (tons)	WOODCHIPS (tons)	SAWDUST (tons)	TOTAL (tons)
SOFTWOODS	23,375	64,625	49,500	**137,500**
HARDWOODS	22,275	51,975	49,500	**123,750**
TOTAL	**45,650**	**116,600**	**99,000**	**261,250**

Source: Charlie Thompson, 1995 Report for UMass Amherst [17, page 14]

Further substantiation of the previous two data sets can be found in the more recent F&WPI unpublished survey [14]. Data from the survey indicate that 1.21 tons of woodchips are created for every thousand board feet of timber sawn. Using the estimated annual lumber production from sawmills in Massachusetts [8] of 104 million board feet (MBF), this production would be expected to generate 125,840 tons of woodchips. This estimate is consistent with the other estimates of woodchips (not including bark and sawdust) given in Tables 3.5 and 3.6.

The Supply Subcommittee has agreed, for the purposes of this report, that 98% is a conservative and useful estimate of the recovery of biomass residues in stationary sawmills in Massachusetts. Table 3.7 provides the Subcommittee's estimate of available woody biomass from statewide primary manufacturers, based on the above analyses. Currently, this residue typically travels long distances to out-of-state papermills and other markets [16], and the biomass resource affords little benefit to the Commonwealth's economy.

TABLE 3.7 BIOMASS FROM STATEWIDE PRIMARY MANUFACTURER WASTE

PRIMARY MANUFACTURERS	Generated (tons)	Recovered (tons)	Percent Recovered	Discarded (tons)
	279,608	274,016	98%	5,592

3.4 Secondary Manufacturers

For purposes of this report "Secondary Manufacturers" are defined using the Standard Industrial Classification (SIC) codes based on OSHA guidelines (see OSHA's SIC website address in Appendix B). Table 3.8 provides the SIC codes used by the F&WPI to delineate secondary manufacturers operating in Massachusetts [13]. The table also includes the number of firms in each classification, a total of 816 firms across the state.

TABLE 3.8 SECONDARY MANUFACTURERS: SIC CODES AND NUMBER OF MASSACHUSETTS FIRMS

SIC CODE	INDUSTRY DESCRIPTION	NUMBER OF MA FIRMS
2421	Planning Mills	74
2426	Hardwood Flooring	88
2431	Millwork	213
2434	Kitchen Cabinets	167
2439	Misc. Structural Wood	10
2441	Wood Boxes	20
2448	Wood Pallets	37
2449	Misc. Wood Containers	11
2452	Prefabricated Wood Bldgs.	6
2491	Wood Preservers	2
2493	Reconstituted Wood Parts	2
2499	Misc. Wood Products	58
2511	Wood Furniture, non-upholstered	52
2522	Wood Furniture, upholstered	21
2515	Mattresses, box springs	15
2517	Wood Cabinetry	5
2519	Misc. Home Furniture	4
2521	Wood Office Furniture	10
2541	Wood Office Fixtures	49
2542	Wood Partitions	4
2591	Window Fittings	2
2599	Misc. Furniture Fittings	11
3731	Shipbuilding	2
3732	Boat Building & Repair	6
3931	Musical Instruments	3
3944	Games & Toys	4
3949	Sporting Goods	3
3951	Pens	0
3953	Art Materials	1
3991	Brooms & Brushes	4
3993	Signs & Advertising	4
3995	Burial Caskets	2
Total		**816**

Source: F&WPI, 2000 Report [13, Appendix D]

These 816 firms were estimated by the F&WPI [13] to generate approximately 225,000 tons of woody residue in 1999. This residue is composed of sawdust, sander dust, wood chips, shavings, wood flour, rippings, cut-offs, and ends. The Subcommittee also felt that, for the purposes of this report, 98% is an appropriate and conservative estimate of the recovery efficiency for

secondary manufacturers in Massachusetts. This estimate for secondary manufacturers is provided in Table 3.9.

TABLE 3.9 BIOMASS FROM STATEWIDE SECONDARY MANUFACTURER WOODY RESIDUE

SECONDARY MANUFACTURERS	Generated (tons)	Recovered (tons)	Percent Recovered	Discarded (tons)
	225,000	220,500	98%	4,500

Source: F&WPI, 2000 Report [13, page 13]

3.5 Urban Woody Residue

Establishing an estimate of woody biomass production for this category is especially difficult due to the large and diverse group of contributors involved. The following nine groups or types of generators were identified as contributing to biomass production in Massachusetts [15].

1. Commercial Tree Care Firms
2. Municipal/County Park and Recreation Departments
3. Municipal Tree Care Divisions
4. County Tree Care Divisions
5. Electric Utility Power Line Maintenance Firms
6. Nurseries
7. Landscapers and Landscaping Maintenance Firms
8. Excavators and Land Clearing Firms
9. Orchards (Not included in this assessment due to the low survey response and poor data quality.)

For the most part the urban woody residue is "clean" as per the distinction in Table 2.1. Biomass contained in this category includes:

- Wood, including chips, logs, tops and brush, mixed wood (combination of logs, whole tops, and brush), and whole stumps
- Leaves collected during leaf collection *
- Grass clippings *

* Although seasonal leaf collection and grass clippings are included in the First National Inventory [15], these materials are not wood and are of limited value as fuel.

A large percentage of the urban woody residue in the Northeast is from tree trimmings and removal, and is either managed at the point of generation or given away and never enters the solid waste management system. Approximately 56% of tree residues generated are managed on-site. The other 44% are landfilled (17%), sold (12%), sent to recyclers (3%), burned for energy (3%), and open burned, stockpiled, incinerated, or managed in other ways (9%) [13].

Table 3.10 reproduces the estimate Dorn and Associates [11] uses for urban woody residue in Massachusetts.

TABLE 3.10 BIOMASS FROM URBAN WOOD RESIDUE

URBAN WOOD RESIDUE	Generated (tons)	Recovered (tons)	Percent Recovered	Discarded (tons)
	1,049,200	755,400	72%	293,800

Source: Dorn and Associates, 1999 Phase III Report [11, page 39]

3.6 Unutilized Annual Net Growth in Massachusetts Forests

An estimate of the potential woody biomass from annual net growth in Massachusetts forests is estimated from the statistics of the Commonwealth's forests reported by Carol Alerich of the U.S. Forest Service [1]. The estimate considers the net growth of growing-stock trees (see glossary, Appendix A) and the net growth of smaller diameter material from branches and top wood. The following considerations are noteworthy regarding the inherent difficulty in providing this estimate.

- Although Alerich predicts there are approximately 1.5 billion live trees one inch or larger in diameter at breast height (DBH) on Massachusetts timberland, it is not clear what the volume of those trees is.

- Alerich states that there are approximately 3.1 million acres of forestland, out of the total 5 million acres that make up the Commonwealth. Of that 3.1 million acres, 84% (2.6 million acres) is considered timberland. However, as timberland in Massachusetts becomes more and more fragmented through urbanization, less and less of it is harvestable. Thus, even though there are 2.6 million acres of timberland in Massachusetts, it is unknown how much of that is available as a biomass resource, and how this resource stock will change in the near or distant future.

- Alerich states that the volume of growing-stock trees, five inches or larger, is 5.7 billion cubic feet. Growing-stock trees make up 91% of live trees at least five inches and larger in DBH.

In Table 39 of [1], Alerich reports that the average annual net growth of growing-stock trees on Massachusetts timberland is 97.451 million cubic feet and that the average annual removal of growing-stock trees is 53.902 million cubic feet. Therefore, Alerich further reports a net growth of 43.549 million cubic feet added to Massachusetts forests annually. The Subcommittee recognizes that the data presented here is taken from surveys conducted in 1985 and 1998, and should not be construed as predicting future forest growth or harvest practices.

Table 3.11 uses these data to calculate that 1,484,000 tons of biomass is represented by the net growth (after removals) of growing-stock trees in Massachusetts.

In addition to the biomass represented by the net growth of growing-stock trees calculated above, additional biomass material exists in the tops of trees above the 4-inch cutoff for the volume included as growing-stock trees. This material is labeled as "branches" by Alerich and is reported in Table 59 of [1] as 18,096,000 dry tons, or 26,239,000 green tons (1.45 green ton per dry ton). This material includes top wood and branches, but does not include foliage, roots/stumps, or cull trees. Applying an annual growth factor of 1.7% consistent with the growth of the growing-stock inventory reported by Alerich, this material represents 446,000 tons per year of additional biomass. Adding this material to the net growth of growing-stock trees, as shown in Table 3.11, provides an estimate of 1.93 million tons of woody biomass from this category.

TABLE 3.11 ESTIMATE OF WOODY BIOMASS FROM UNUTILIZED ANNUAL NET GROWTH IN MASSACHUSETTS FORESTS

	Growing-Stock Trees			
UNUTILIZED ANNUAL NET GROWTH IN MA FORESTS	Net Growth (MCF)	Removals (MCF)	Remaining (MCF)	Remaining (tons)
	97.451	53.902	43.549	1,484,000
	Branches, Top Wood			446,000
			TOTAL	**1,930,000**

MCF = million cubic feet

Remaining (tons) = Remaining (MCF) × 1,000,000 ft^3/MCF × 47 lbs(dry)/ft^3 × 1.45 lbs(green)/lbs(dry) ÷ 2000 lbs/ton

4. CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

The sources reviewed and analyzed in this report by the Supply Subcommittee provide a current estimate of statewide biomass woody residue generation of approximately 2.48 million tons per

year. In addition, the forests of Massachusetts could provide another 1.93 million tons per year of wood biomass, beyond what is being currently harvested, on a sustainable basis. Combined, these sources represent a total statewide woody biomass resource of 4.41 million tons annually.

This estimate provides an upper bound for planners interested in the woody biomass resource. Any project being considered for the state will of course need to develop data on specific sources, residue physical characteristics, transportation, material handling, and raw material pricing as part of any project design or business plan. Furthermore, any substantial biomass energy project will most likely look at the resource availability on a regional basis, not limited to the confines of a particular state.

4.2 Recommendations

The Committee identified the following areas for further study to build upon this supply analysis and further improve the market knowledge of woody biomass in Massachusetts.

- Pricing of Woody Biomass Resource (Supply Curve)
  The current report does not consider the cost of recovering the different forms of woody biomass or what the market price of this resource might be. The quantity and sources of biomass recovered for energy will depend on cost of recovery and distribution, in connection with demand and price. It would be helpful to bioenergy planners and market developers to have historical information on wood residue prices across applications, as well as an estimate of a supply curve (quantity supplied versus market price) for woody biomass as an energy resource.

- Economic Feasibility of Resource Recovery Technologies
  Additional study is required to assess the technical options and economic feasibility of:

- recovering wood residue that is not currently being recovered (clean up of construction and demolition waste, for example),
- harvesting additional forest-based wood resources for energy use, and
- converting existing wood residue usage paths to use as an energy source.

- Biomass Source Details and Market Directory
  The current work focused primarily on statewide summary estimates of biomass production. In each of the woody biomass source categories studied, further investigation is necessary to confirm these estimates, and provide a more sound basis for stimulating economic or business development. Furthermore, identifying and listing specific producers and users of wood residue would help identify the market and improve networking and communications critical for its development.

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APPENDIX A

GLOSSARY OF USEFUL TERMS

The definitions used in this report and provided below come from the following references: [1], [7], [9], [10], [13] and [15]. The reference for each definition is given.

Bioenergy	Useful, renewable energy produced from organic matter. The conversion of the complex carbohydrates in organic matter to energy. Organic matter may either be used directly as a fuel or processed into liquids and gases. [7]
Biomass	Organic matter, living or dead. Biomass includes forest and mill residues, agricultural crops and wastes, wood and wood wastes, animal wastes, livestock operation residues, aquatic plants, fast-growing trees and plants, and municipal and industrial waste. [7]
Chips	Woody material cut into short, thin wafers. Chips are used as a raw material for pulping and fiberboard or as biomass fuel. [7]
Composting	A process of accelerated biodegradation and stabilization of organic material under controlled conditions yielding a product, which can safely be used. [9]
Construction and Demolition Debris (C&D)	Waste building materials and rubble resulting from the construction, remodeling, repair or demolition of buildings, pavements, roads and other structures. Construction and demolition debris includes but is not limited to, concrete, bricks, lumber, masonry, road paving materials, rebar and plaster. [9]
Diameter at breast height (DBH)	The diameter of a tree measured 4 feet 6 inches above the ground. [1]

Energy Crops	Crops grown specifically for their fuel value. These include food crops such as corn and sugarcane, and nonfood crops such as poplar trees and switchgrass. Currently, two energy crops are under development: short-rotation woody crops, which are fast-growing hardwood trees harvested in 5 to 8 years, and herbaceous energy crops, such as perennial grasses, which are harvested annually after taking 2 to 3 years to reach full productivity. [7]
Feedstock	Any material which is converted to another form or product. [7]
Forest Land	Land that is at least 10 percent stocked with trees of any size, or that formerly had such tree cover and is not currently developed for a non-forest use. The minimum area for classification of forestland is one acre. The components that make up forest land are timberland and all noncommercial forest land. [1]
Forest Residues	Material not harvested or removed from logging sites in commercial hardwood and softwood stands as well as material resulting from forest management operations such as precommercial thinnings and removal of dead and dying trees. [1]
Generation	Wood waste produced by generators prior to reuse, recycling, disposal, or other management. Generation does not include "internal" reuse or recycling, which is reuse or recycling of wood waste before it leaves the generators facility. [10]
Green ton	The weight in tons of woody biomass from freshly cut or chipped, unseasoned, wood. "Green" refers to the moisture content in a specific product.
Growing-Stock Trees	These are live trees of commercial species classified as sawtimber, poletimber, saplings, or seedlings; i.e., all live trees of commercial species except rough or rotten trees. [1]
Hardwoods	Usually broad-leaved and deciduous trees. [1]
Landfill	A facility or part of a facility established in accordance with a valid site assignment for the disposal of solid waste into or on land. [9]
Long ton	2,240 pounds. Also known as a shipping ton. Commonly used in Great Britain. [7]

Mill residue	Wood and bark residues produced in processing logs into lumber, plywood, and paper. [7]
Municipal Solid Waste (MSW)	Any residential or commercial solid waste. Refers to wastes such as durable goods, non-durable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic wastes. [10]
Non-Municipal Solid Waste	Non-MSW, as defined by the state of Massachusetts, is all solid waste that is not classified as MSW as well as a variety of other waste-like materials. Included in non-MSW are C&D debris, industrial wastes and sludges, wastewater treatment facility sludges, and street sweepings. They also include certain materials that are, at times, handled using solid waste management practices, such as contaminated media (i.e., dredge and soils). [10]
Primary Manufacturers	For purposes of this report "Primary Manufacturers" is defined as the 81 or so stationary sawmills operating Massachusetts.
Pulp Chips	Timber or residues processed into small pieces of wood of more or less uniform dimensions with minimal amounts of bark. [7]
Recycling	To recover materials or by-products which are reused or used as an ingredient or a feedstock in an industrial or manufacturing process to make a marketable product; or used in a particular function or application as an effective substitute for a commercial product or commodity. [10]
Residue	All solid waste remaining after treatment or processing and includes, without limitation, ash, material which is processed for recycling or composting but is unmarketable or speculatively accumulated due to its inferior quality and other solid waste which is not recovered. Non-recyclable material which is integral to a pre-sorted recyclable product shall not constitute residue for the purpose of calculating residue generation rates. [9]

Secondary Manufacturers	Secondary manufacturers include firms that do not primarily harvest timber or produce lumber. Rather, these firms typically use pre-cut lumber to manufacture products or components. In this report "Secondary Manufacturers" were delineated using the Standard Industrial Classification (SIC) codes based on OSHA guidelines. SIC is an industry classification system that facilitates the collection, tabulation, presentation, and analysis of data relating to establishments and ensures that data about the U.S. economy published by U.S. statistical agencies are uniform and comparable. [13] Note: The North American Industry Classification System (NAICS) has recently replaced the U.S. Standard Industrial Classification (SIC) system.
Short Ton	2,000 pounds. Commonly used in the United States.
Sustainable	An ecosystem condition in which biodiversity, renewability, and resource productivity is maintained over time. [7]
Timberland	Forest land producing or capable of producing crops or industrial wood (more than 20 cubic feet per acre per year) and not withdrawn from timber utilization. [1]
Unutilized Annual Net Growth in Massachusetts Forests	Annual net growth of all trees on timberland in Massachusetts, less the volume of harvested or killed in logging, cultural, or land clearing operations, calculated on an annual basis.
Urban Wood Residue	Green material such as tree limbs, tops, brush, leaves, woodchips, logs, mixed wood, and stumps from urban and landscaping residues. [15]
Waste Streams	Unused solid or liquid by-products of a process. [7]
Wood Waste	Discarded material consisting of trees, stumps and brush, including but not limited to sawdust, chips, shavings and bark. Wood waste does not include new or used lumber or wood from construction and demolition waste and does not include wood pieces or particles containing or likely to contain asbestos, or chemical preservatives such as creosote or pentachlorophenol, or paints, stains or other coatings. [9]

APPENDIX B

USEFUL WEB SITES

NATIONAL SITES

- U.S. Department of Energy: http://www.energy.gov/sources/index.html
- U.S. Forest Service: http://www.fs.fed.us
- Renewable Resource Data Center (RReDC), National Renewable Energy Laboratory, U.S. Department of Energy: http://rredc.nrel.gov
- Pallet Recycling Information, U.S. Forest Service, Southern Research Station, U.S. Department of Agriculture (search on publications): http://www.srs.fs.fed.us
- Standard Industrial Classification (SIC) Code Search, Occupational Safety and Health Administration: http://www.osha.gov/oshstats/sicser.html
- North American Industry Classification System (NAICS), U.S. Census Bureau: http://www.census.gov/epcd/www/naics.html
- ForestWorld: The Sustainable Forest Products Resource: http://www.forestworld.com
- American Bioenergy Association: http://www.biomass.org
- REPP-CREST, Renewable Energy Policy Project and the Center for Renewable Energy and Sustainable Technology: http://www.crest.org/index.html

REGIONAL SITES

- Northeast Regional Biomass Program: http://www.nrbp.org
- CONEG – Coalition of Northeast Governors, (CONEG encourages intergovernmental cooperation in the Northeast on issues relating to the economic, environmental and social well-being of the Northeast states): http://www.coneg.org/default.htm

MASSACHUSETTS SITES

- Massachusetts Division of Energy Resources: http://www.mass.gov/doer
- Massachusetts Executive Office of Environmental Affairs: http://www.mass.gov/envir
- Massachusetts Department of Environmental Management: http://www.mass.gov/dem
- Mt. Wachusett Community College, Forest and Wood Products Institute: http://www.mwcc.mass.edu/HTML/FWP/fwp.html
- Chelsea Center for Recycling and Economic Development, University of Massachusetts: http://www.chelseacenter.org
- Bureau of Waste Prevention Publications, Massachusetts Department of Environmental Protection: http://www.state.ma.us/dep/bwp/dswm/dswmpubs.htm