Biomass Availability Analysis – Worcester, Massachusetts

Renewable Biomass from the Forests of Massachusetts



Prepared for the

Massachusetts Division of Energy Resources
&
Massachusetts Department of Conservation and Recreation

Massachusetts Sustainable Forest Bioenergy Initiative
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The analysis contained in this report is based upon our best professional judgement and on sources of information that we believe to be reliable. However, no representation or warrenty is made by Innovative Natural Resource Solutions LLC as to the accuracy or completeness of any information contained herein. Nothing in this report is, or should be relied upon as, a promise or representation as to the future.

This analysis was performed for a hypothetical large biomass plant located somewhere in Worcester, MA, and assumes that other new biomass users do not enter the nearby marketplace. A change in this assumption, or specifics of a project, may change the findings of this report.

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Introduction

This analysis was prepared for the Massachusetts Division of Energy Resources and the Massachusetts Department of Conservation & Recreation with funding provided by the Massachusetts Technology Collaborative – Renewable Energy Trust. This analysis is part of a larger effort to address many facets of biomass energy development in Massachusetts, the *Massachusetts Sustainable Forest Bioenergy Initiative.* More information on this initiative can be found at http://mass.gov/doer/programs/renew/bio-initiative.htm.

This analysis looks at the biomass fuel availability for the area surrounding Worcester, Massachusetts. Similar analyses were also completed for the areas around Pittsfield and Worcester. Additionally, an analysis of biomass availability for the five western counties of Massachusetts (Berkshire, Franklin, Hampshire, Hampden and Worcester) was completed.

Biomass Resources near Worcester

Forest Resources

Using the USDA Forest Service Forest Inventory & Analysis (FIA) system, an analysis of the area surrounding Worcester, MA was conducted[i]. The FIA system permits an understanding of the standing forest inventory, land ownership patterns, timber growth and harvest volumes, and timber mortality volume.

The FIA allows analysis on a radius from a point, in this case Worcester, MA. Analysis was conducted for a 60-mile radius. As shown in Figure 1, a 60-mile radius (red) approximates a 90-minute drive time (blue).

Figure 1. 90 Minute Drive Time and 60 Mile Radius, Worcester, MA

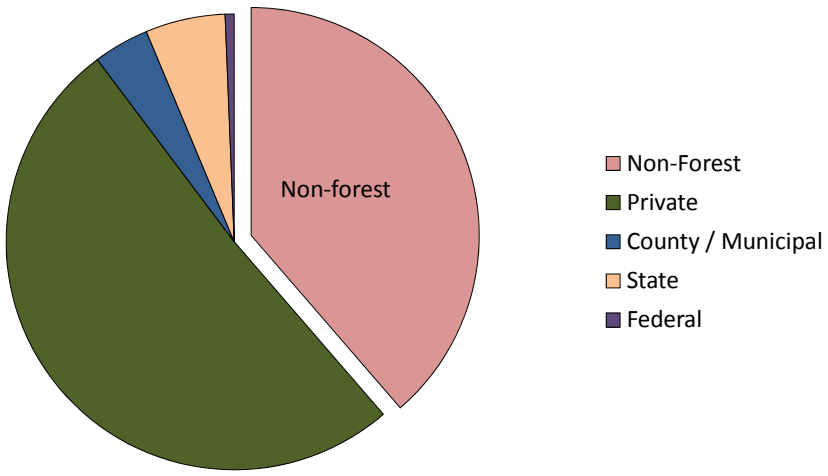
Within a 60-mile radius of Worcester, MA there are 3,933,636 acres of timberland, representing 61% of the land area in the region. Of this timberland, 83% is privately owned, with the remainder under municipal, county, state or federal ownership.

Table 1 and Figure 2 show the distribution of land ownership within the region.

Table 1. Land Classifications within a 60-mile Radius of Worcester, MA

	Acres	% of Timberland	% of All Land
All Land	6,412,938		
Private	3,277,053	83%	51%
Municipal / County	253,748	6%	4%
State	362,736	9%	6%
Federal	40,099	1%	1%
Timberland	3,933,636		61%

Figure 2. Land Classifications within a 60-mile Radius of Worcester, MA



Within a 60-mile radius of Worcester, MA the standing timber inventory is roughly 68% hardwood and 32% softwood. Annual net growth in the region is estimated at over 3.3 million green tons per year[ii], with harvest levels under 1 million green tons annually. Growth above current harvest and mortality levels is roughly 2.4 million green tons annually. Table 2 shows the estimated annual standing volume, growth, and removal for timberland within a 60-mile radius of Worcester, MA.

Table 2. Annual Growth and Drain, 60-Mile Radius of Worcester, MA[iii]

	Softwood	Hardwood Green Tons[iv]	Total
Standing Volume	77,540,036	161,599,152	239,139,187
Annual Net Growth	1,432,872	2,448,896	3,881,768
Annual Removals	767,661	1,654,757	2,422,418
Net Growth Less Removals	665,211	794,139	1,459,350

The USDA Forest Inventory and Analysis, used to develop the data in Table 2, accounts for only the merchantable stem of the tree – wood that could go to traditional roundwood markets like lumber, veneer, pulp or engineered wood products. While this wood, particularly the lower grades, is available for biomass, the branches and tops of a tree are potentially available as well. In the Northeastern U.S., it is estimated that for every ton of biomass contained in the stem of a tree, another 0.29 tons of biomass are contained in the branches and tops.[v] Table 3 uses the assumption that for every green ton of biomass in the stem, another 0.29 green tons is available in the tops and branches.

Table 3. Annual Growth and Drain (w/ branches), 60-Mile Radius, Worcester, MA

	Softwood	Hardwood Green Tons[vi]	Total
Standing Volume	100,026,646	208,462,905	308,489,552
Annual Net Growth	1,848,405	3,159,076	5,007,481
Annual Removals	990,282	2,134,637	3,124,919
Net Growth Less Removals	858,123	1,024,439	1,882,562

It is important to note that a considerable amount of the nutrients contained in a tree are in the tops (particularly when leaves are on), and removal of high volumes of this material from a logging job can raise concerns about long-term sustainability. For this reason, as well as practical availability, INRS recommends that availability of tops and branches be considered at no more than 50% of reported availability[vii].

This means that nearly 1.7 million green tons of wood could be available before harvest and mortality exceeds growth. This volume of wood, enough to support over 125 megawatts of electric power capacity operationg at industry standard efficiency and capacity factors.

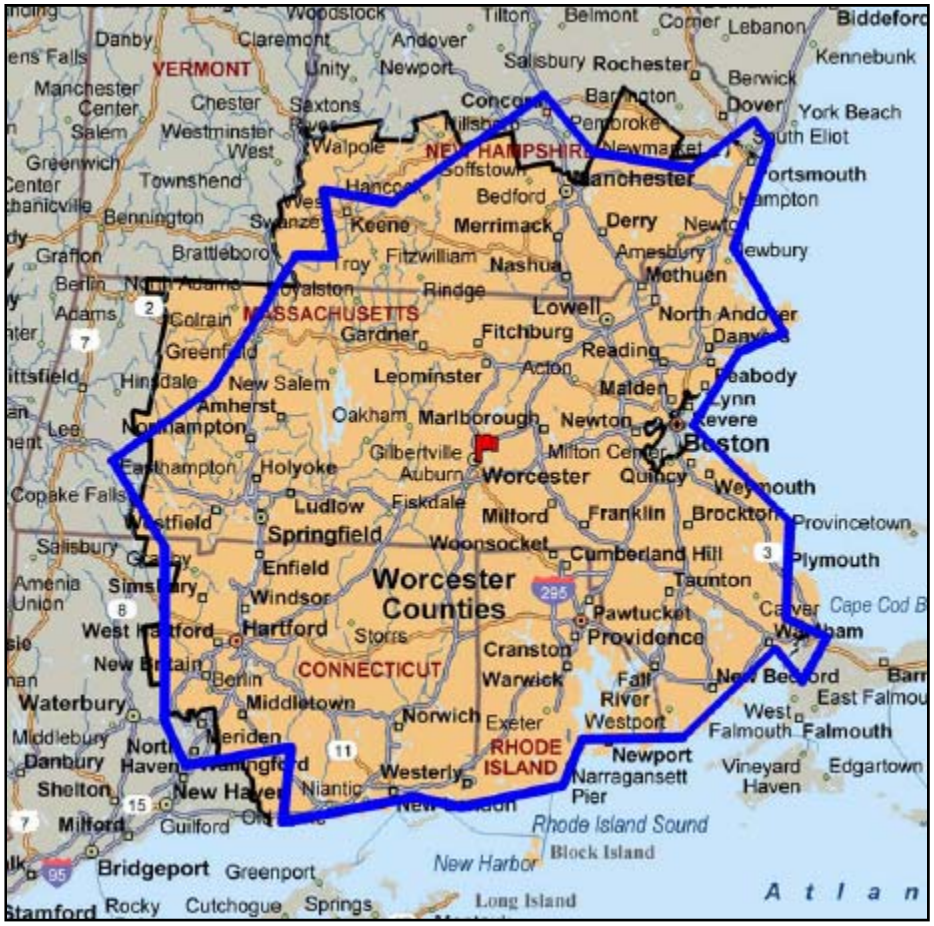
In practical terms, it is highly unlikely that this volume of wood could be harvested in an economic or environemtally responsible manner to supply biomass fuel. Further, some of this wood is sawlogs or other high-value material, and as such would be sent to other markets.

Wood Residues

Using data from the USDA Forest Service, the US Environmental Protection Agency, the National Renewable Energy Laboratory / US Deparment of Energy and the U.S. Census Bureau, INRS has developed a national database of biomass residues available by county. For this analysis, counties that are largely within a 90-minute drive time of Worcester include the following, shown in Figure 3:

Massachusetts: Bristol, Plymouth, Norfolk, Middlesex, Worcester, Essex, Franklin, Hampshire, Hampden
Conecticut: Tollend, Windham, New London, Hartford, Middlesex
New Hampshire: Cheshire, Hillsborough, Rockingham
Rhode Island: Providence, Kent, Washington, Bristol, Newport

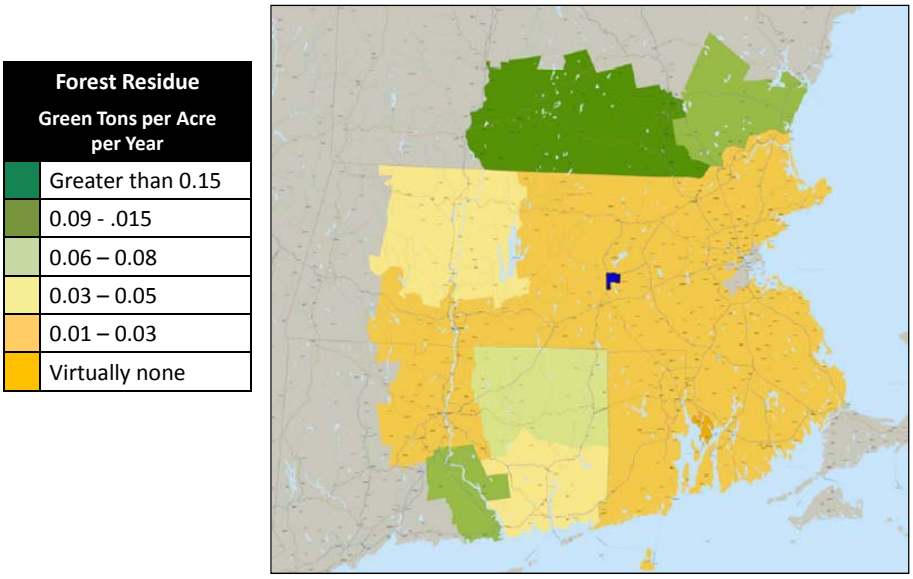
Figure 3. Counties Within a 90 Minute Drive Time of Worcester, MA



Forest Harvest Residues

Forest harvest residue is wood that is left in the forest due to lack of market conditions. In most areas, this is tops, branches and pieces of tree that do not meet local specifications for sawlogs and pulpwood. Forest harvest residue is estimated to be roughly 1 million green tons a year in the counties surrounding Worcester, MA[viii]. This is largely a function of existing harvesting activity – in locations with high volumes of existing logging activity, volumes of forest harvest residue tend to be higher. Figure 4 shows annual harvest residue density by county.

Figure 4. Forest Residues Available by County (estimated)



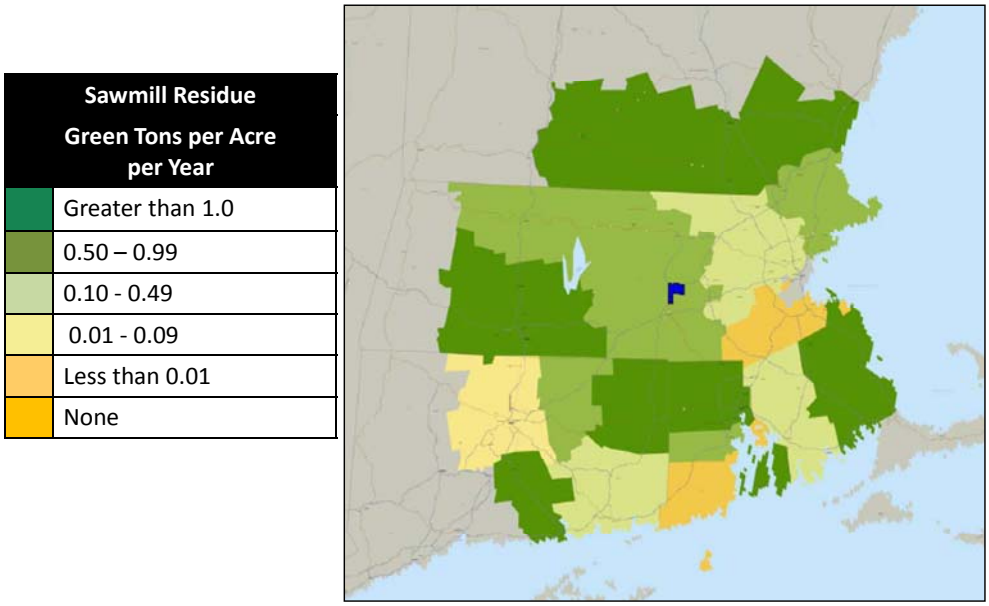
Of note, the region surrounding Worcester, MA has relatively low concentrations of harvest residues. This is largely a reflection of forest harvesting activity in the region, which is active but modest. This region does not currently have the level of forest harvesting seen in neighboring New Hampshire, a state with a relatively large biomass energy industry.

Sawmill Residue

When sawmills cut cylindrical logs into rectangular boards, residue is produced - including bark, sawdust and mill chips. Actual residue generation varies by species and mill equipment, but a general rule of thumb is that a log in a sawmill produces 60 to 70% of useful timber as boards, 20 to 30% as wood chips, and 10% as sawdust[ix].

Based upon the latest USDA Forest Service Timber Product Output information, sawmill residue (chips, bark and sawdust) in the region is roughly 850,000 green tons in the counties surrounding Worcester, MA.

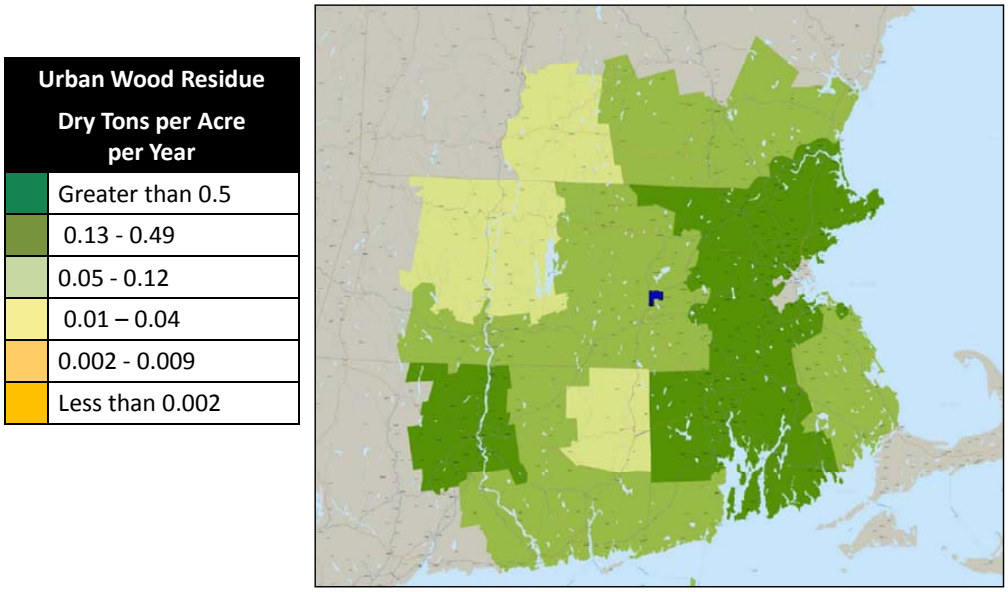
Figure 5. Sawmill Residues Available by County (estimated)



Urban Wood Residues

Urban wood residues include most wood generated as a result of activity in and around urban and suburban areas, and include tree trimmings, utility right-of-way clearing, ground pallets, and the clean woody fraction of construction and demolition debris.

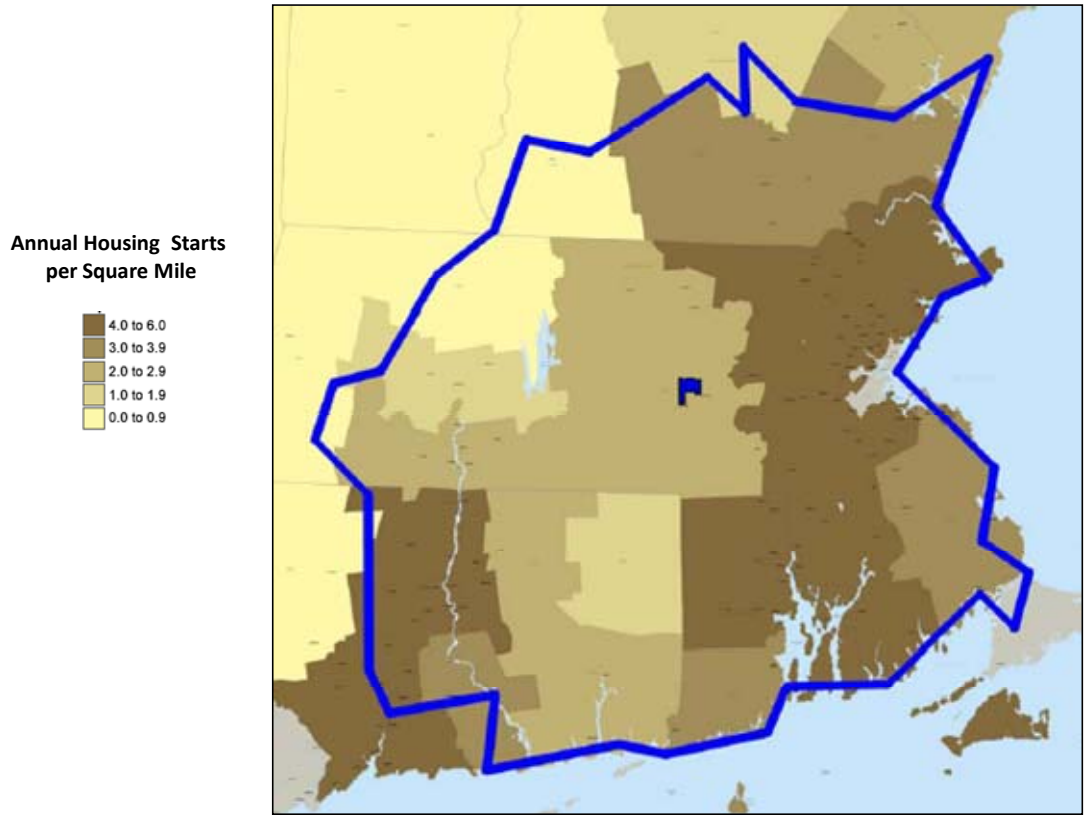
Figure 6. Urban Wood Residues Available by County (estimated)



In the counties surrounding Worcester, MA there is roughly 1 million green tons of urban wood available. This includes an estimated 530,000 green tons of wood from land clearing in the region.

Figure 7 shows the concentration of housing starts in the counties proximate to Worcester, MA. Hosuing starts are a very good indication of the volume of land clearing expected in an area. It is important to note that land clearing activity is heavily tied to new construction activity; when construction activity slows, lower volumes of land clearing wood can be expected.

Figure 7. Land Clearing in the Region Surrounding Worcester, MA with 90 Minute Drive Time



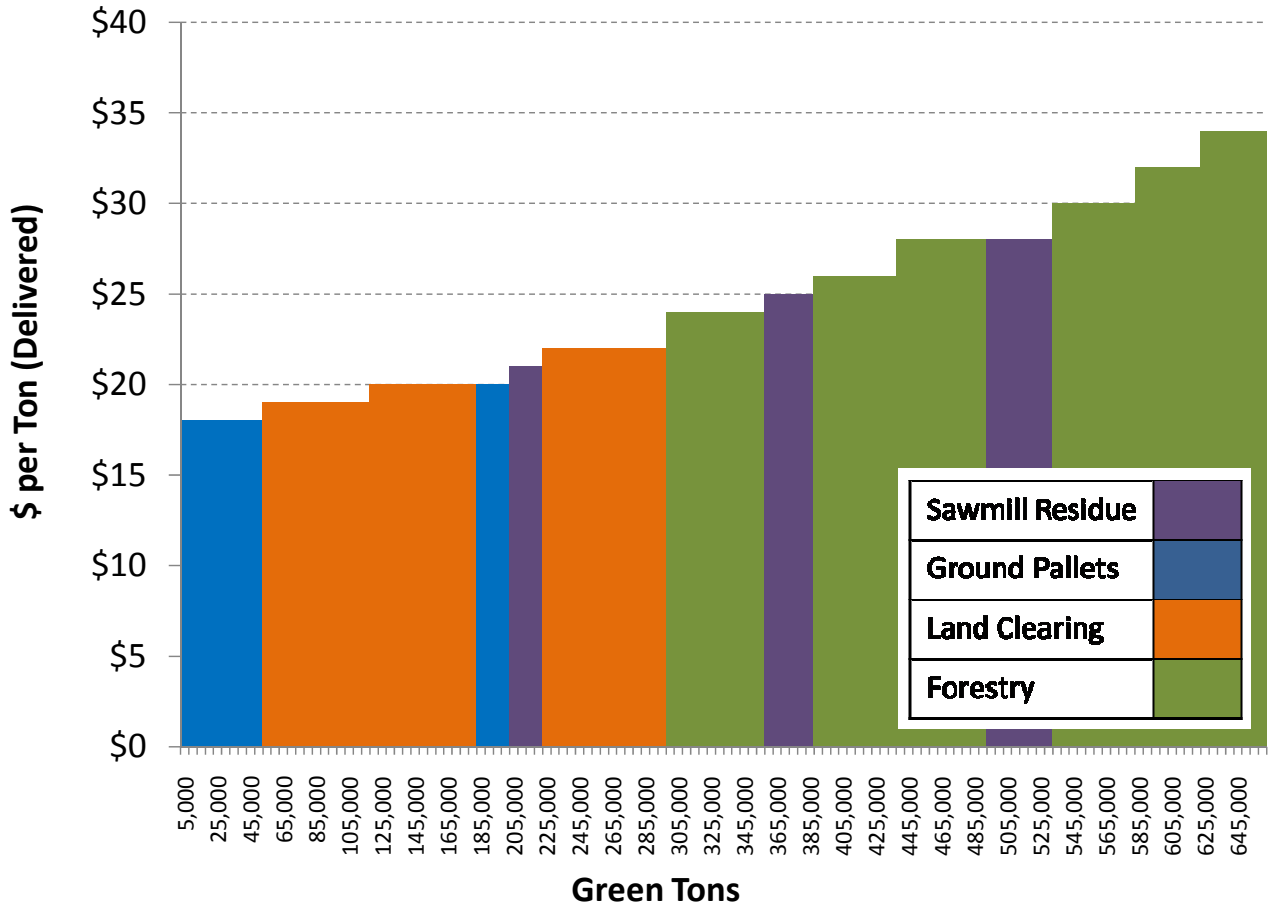
Biomass Supply Pricing

The following table shows *anticipated* biomass supply pricing, by source, for a hypothetical large biomass facility in Worcester, MA. This table shows the incremental volume and delivered pricing[x] by fuel source, the weighted average price, and the total tons.

Table 4. Anticipated Biomass Fuel Supply and Pricing

Source	Volume (green tons equivalent)	Price (green tons equivalent)	Extended	Weighted Average Price	Total Tons
pallets	50,000	$ 18.00	$ 900,000	$ 18.00	50,000
land clearing	60,000	$ 19.00	$ 1,140,000	$ 18.55	110,000
land clearing	60,000	$ 20.00	$ 1,200,000	$ 19.06	170,000
pallets	20,000	$ 20.00	$ 400,000	$ 19.16	190,000
sawmill	20,000	$ 21.00	$ 420,000	$ 19.33	210,000
forestry	70,000	$ 22.00	$ 1,540,000	$ 20.00	280,000
forestry	60,000	$ 24.00	$ 1,440,000	$ 20.71	340,000
sawmill	30,000	$ 25.00	$ 750,000	$ 21.05	370,000
forestry	50,000	$ 26.00	$ 1,300,000	$ 21.64	420,000
forestry	50,000	$ 28.00	$ 1,400,000	$ 22.32	470,000
sawmill	40,000	$ 28.00	$ 1,120,000	$ 22.76	510,000
forestry	50,000	$ 30.00	$ 1,500,000	$ 23.41	560,000
forestry	40,000	$ 32.00	$ 1,280,000	$ 23.98	600,000
forestry	40,000	$ 34.00	$ 1,360,000	$ 24.61	640,000

Figure 8. Anticipated Biomass Fuel Supply & Pricing



This pricing assumes a facility with fast unloading capabilities (including truck dumps), the ability to unload and handle a variety of fuels, a screening and processing system for fuel not meeting the facility's specifications, professional management of fuel procurement, and purchase of at least 200,000 green tons annually. Prices during the first year of start-up would be higher than listed above, as regional supply capacity is built.

Each price grouping above includes a number of suppliers, with price reflecting an average price within that grouping. For example, some land clearing chips may be available at less than $19 per green ton, but given the modest level of land clearing in the immediate region, this reflects an average price for the first 60,000 green tons. Price increases within like supplier groupings reflect increased distance to Worcester, need for companies to add processing equipment to existing operations (a significant need in the area around Worcester, MA), and the need to compete directly with other markets as distance increases.

Pricing expectations were established based upon interviews with potential suppliers, INRS knowledge of operating costs of various types of biomass fuel suppliers, knowledge of the existing and potential supply infrastructure, and historic pricing for biomass supply in New England.

Regional Markets for Low-Grade Wood

A number of markets exist or are proposed for low-grade wood, including but not limited to biomass fuel, in the region surrounding Worcester, MA. Figure 8 shows the areas within a 30, 60, 90 and 120 minute drive time of Worcester, MA.

In a 120 mile drive time of Worcester, MA there are ten active, idle or proposed facilities that use biomass, or low-grade wood that comptes with biomass energy production.

- Three operating facilities, with combined annual wood use of up to 840,000 green tons;
- Two idle facilities; and
- Five publicly proposed facilities, in various stages of development;
- Wood use from all of the listed facilities has the potential to reach over 3.1 million green tons.

These figures do not account for the many projects that are in the early stages of development, but have not made public announcements or taken obvious steps to begin development activities. These figures, and accompanying table, show only markets big enough to exert their own market influence. Small facilities, such as seen at schools and hospitals, present excellent opportunities for biomass development , but these small units do not individually influence that overall market for and pricing of biomass fuel.

- Facility name (commonly used name, may not be legal name)
- Location (town, state)
- Status (operating, idle, proposed, etc.)
- Owner (or operator)
- Product (electricity, paper, wood pellets, etc.)
- Size (MW capacity)
- Fuel type(s) used
- Annual wood use (green tons, *estimated*)
- Distance to Worcester, MA (road miles and time)

Figure 9. Four Drive Times Around Worcester, MA (30, 60, 90 and 120 Minutes)

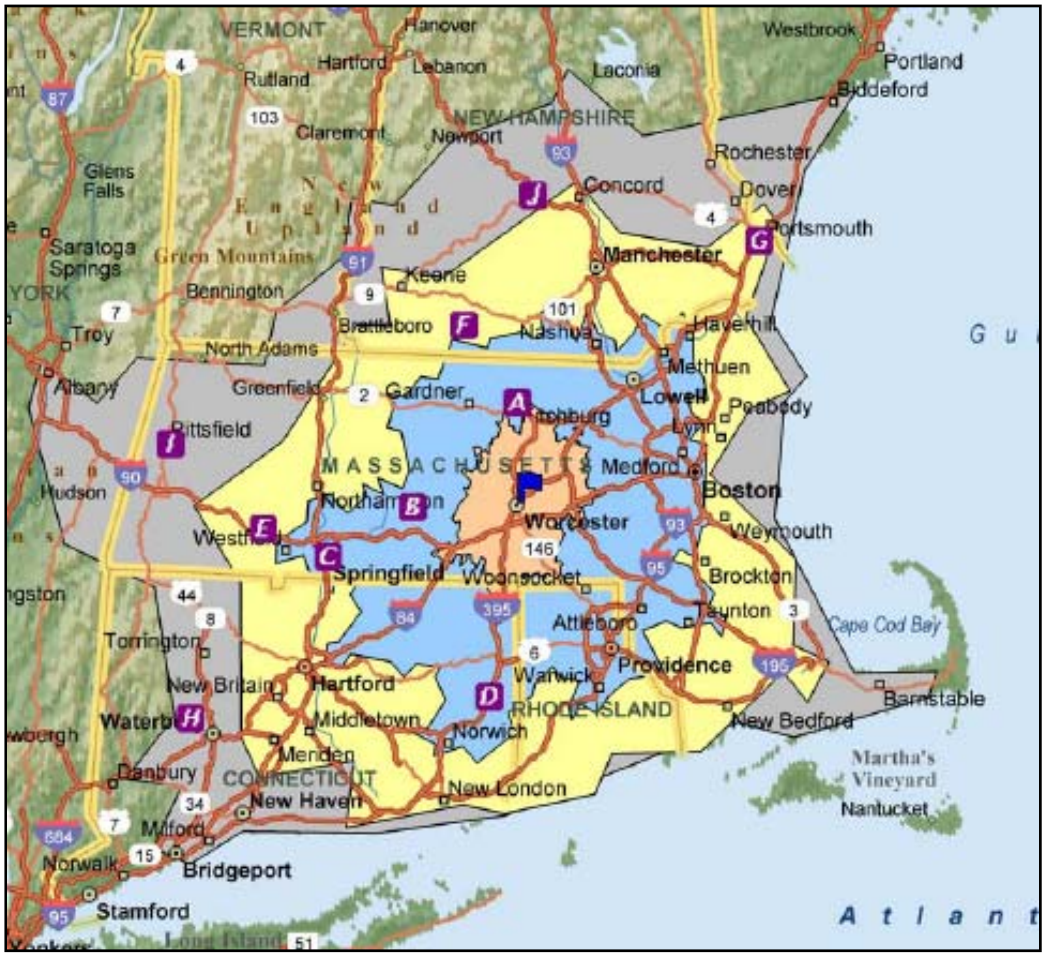


Table 5. Facilities Using Low-Grade Wood near Worcester, MA

Drive Time (Minutes)	Facility	Current	Potential
		Green tons	
60	Pinetree - Fitchburg	180,000	180,000
	Ware Co-Gen	-	50,000
	Palmer Renewable Energy	-	235,000
	Plainfield Renewable Energy	-	400,000
	Subtotal	*180,000*	*865,000*
90	Russell Biomass	-	630,000
	New England Wood Pellet	160,000	160,000
	PSNH Schiller Station	500,000	500,000
	Subtotal	*660,000*	*1,290,000*
	Running Total	*840,000*	*2,155,000*
120	Watertown Renewable Power	-	400,000
	Berkshire Renewable Power	-	600,000
	Bio-Energy	-	140,000
	Subtotal	-	*1,000,000*
	Total	*840,000*	*3,155,000*

Table 6. Facilities within 60 Minute Drive Time of Worcester, MA

Facility A	Pinetree – Fitchburg
Location	Westminster, MA
Status	Operating
Product	Electricity
Owner	Suez Energy North America
Size	17 MW (14 MW wood boiler, 3 MW landfill gas)
Fuel	Whole-tree chips, sawmill residue, ground pallets, paper cubes and landfill gas
Annual Wood Use (est.)	180,000 tons
Worcester – road miles	24 miles
Worcester - minutes	31 minutes

Facility B	Ware Co-Gen
Location	Ware, MA
Status	Idle, approved for MA RECs
Product	Electricity
Owner	Ware Energy Company
Size	8.6 MW (2 units)
Fuel	Construction and demolition
Annual Wood Use (est.)	50,000 tons (estimate)
Worcester – road miles	28 miles
Worcester - minutes	41 minutes

Facility C	Palmer Renewable Energy
Location	Springfield, MA
Status	Proposed
Product	Electricity
Owner	Palmer Renewable Energy
Size	30 MW
Fuel	Wood, derived from a variety of sources
Annual Wood Use (est.)	235,000 tons
Worcester – road miles	52 miles
Worcester - minutes	53 minutes

Facility D	Plainfield Renewable Energy
Location	Plainfield, CT
Status	Proposed, in permitting
Product	Electricity
Owner	Decker Energy International and NuPower
Size	30 MW
Fuel	Whole tree chips, pallets, sawmill residue and the wood fraction of construction & demolition debris
Annual Wood Use (est.)	400,000 tons
Worcester – road miles	44 miles
Worcester - minutes	46 minutes

Table 7. Facilities within 90 Minute Drive Time of Worcester, MA

Facility E	Russell Biomass
Location	Russell, MA
Status	Proposed, in permitting
Product	Electricity
Owner	Russell Biomass LLC
Size	50 MW
Fuel	Whole tree chips, sawmill residue, pallets
Annual Wood Use (est.)	630,000 tons (estimate)
Worcester – road miles	67 miles
Worcester - minutes	1 hour, 10 minutes

Facility F	New England Wood Pellet
Location	Jaffrey, NH
Status	Operating
Product	Wood pellets
Owner	New England Wood Pellet, www.pelletheat.com
Feedstock	Sawmill residue, sawdust, pulp quality chips
Annual Wood Use (est.)	120,000 tons (equivalent of roughly 160,000 green tons)
Worcester – road miles	49 miles
Worcester - minutes	1 hour, 1 minute

Facility G	Northern Wood Power Station (Schiller Station)
Location	Portsmouth, NH
Status	Operating
Product	Electricity
Owner	Public Service of New Hampshire
Size	50 MW
Fuel	Whole-tree chips w/ some sawmill residue and pallets
Annual Wood Use (est.)	500,000 tons per year
Worcester – road miles	88 miles
Worcester - minutes	1 hour, 32 minutes

Table 8. Facilities within 120 Minute Drive Time of Worcester, MA

Facility H	Watertown Renewable Power
Location	Watertown, CT
Status	Proposed, in permitting
Product	Electricity
Owner	Tamarack Energy
Size	30 MW
Fuel	Whole tree chips, pallets, sawmill residue
Annual Wood Use (est.)	400,000 tons
Worcester – road miles	94 miles
Worcester - minutes	1 hour, 42 minutes

Facility I	Berkshire Renewable Power
Location	Pittsfield, MA
Status	Proposed
Product	Electricity
Owner	Tamarack Energy
Size	30 – 50 MW
Fuel	Whole tree chips, sawmill residue, pallets
Annual Wood Use (est.)	Up to 600,000 tons
Worcester – road miles	100 miles
Worcester - minutes	1 hour, 42 minutes

Facility J	BioEnergy
Location	Hopkinton, NH
Status	Idle
Owner	Bio Energy Corporation (privately held)
Product	Electricity and thermal energy
Size	11 MW
Fuel	Traditionally whole-tree chips and pallets
Annual Wood Use (est.)	135,000 – 145,000 tons per year
Worcester – road miles	98 miles
Worcester - minutes	1 hour, 35 minutes

Endnotes

[i] Data developed using latest publicly available complete USDA Forest Service Forest Inventory & Analysis information – Massachusetts 1998, Connecticut 1998, New Hampshire 1997, New York 1993, Rhode Island 1998 and Vermont 1997.
[ii] All USDA Forest Service Forest Inventory & Analysis is presented in cubic feet; converted to green tons assuming 85 cubic feet of solid wood in a cord, a cord of hardwood weighing 2.6 tons, and a cord of softwood weighing 2.3 tons.
[iii] Data developed using latest publicly available complete USDA Forest Service Forest Inventory & Analysis information – Massachusetts 1998, Connecticut 1998, New Hampshire 1997, New York 1993, Rhode Island 1998 and Vermont 1997.
[iv] All USDA Forest Service Forest Inventory & Analysis is presented in cubic feet.; converted to green tons assuming 85 cubic feet of solid wood in a cord, a cord of hardwood weighing 2.6 tons, and a cord of softwood weighing 2.3 tons.
[v] North East State Foresters Association. *Carbon Sequestration and Its Impacts on Forest Management in the Northeast.* December 19, 2002. www.nefainfo.org
[vi] All USDA Forest Service Forest Inventory & Analysis is presented in cubic feet.; converted to green tons assuming 85 cubic feet of solid wood in a cord, a cord of hardwood weighing 2.6 tons, and a cord of softwood weighing 2.3 tons.
[vii] The issue of forest sustainability standards for biomass fuel is beyond the scope of this report, and is a complex and controversial subject matter. However, at least one state, Minnesota, has developed draft biomass harvesting standards. *Draft Biomass Harvesting on Forest Management Sites in Minnesota.* Prepared by the Minnesota Forest Resources Council Biomass Harvesting Guideline Development Committee. May 1, 2007. www.forestrycenter.org
[viii] This figure includes a remarkably high volume of logging residue in Cheshire County, NH. This information could be incorrect or could be the result of unique local conditions. INRS has confirmed the data with the USDA Forest Service and the US Department of Energy / National Renewable Laboratory, and both parties indicate that the baseline data as reported is correctly listed.
[ix] Wakefield, Emily. "PyNe Workshop Report." *ThermalNet.* Issue 04. June 2007.
[x] These prices assume 2007 dollars and oil at $75 per barrel.