APPENDIX P:
COMPETITION FOR BIOMASS RESOURCES

RENEWABLE FUELS ROADMAP AND SUSTAINABLE BIOMASS FEEDSTOCK SUPPLY FOR NEW YORK

Final Report

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1 INTRODUCTION

The breadth of biomass resources clearly has advantages with respect to geographic diversity and opportunity, but there are numerous competing commercial uses, all with their own markets and economic benefits. Familiar uses for biomass resources include paper products and textiles. Even within the relatively narrow category of energy, biomass resources are used as a fuel for electricity production and thermal applications, as well as transportation fuel.

It is beyond the scope of this report to analyze such broad markets in depth or to detail the many underlying economic drivers that will encourage or discourage competition between end-uses for biomass resources. However, this appendix offers a general review of the major markets that are likely to compete for lignocellulosic biomass resources used for ethanol production. Key end-uses among these are bio-powered combined heat and power (CHP), biomass heating, pellet fuels, and pulp. For the most part, these industries are well established, and available industry data are presented to assist the reader in contemplating how biofuel refineries will fare as resource competition becomes more of an issue.

Further, markets for such resources are dynamic. Increases in demand may yield significant increases in supply (Appendix E addresses resource supply). This Appendix focuses on potential demand from other uses for biomass resources that biofuel production facilities will need.

It will also be important to understand what constitutes competition. In the most practical sense, the great diversity among biomass feedstocks and end-uses ensures that not all biomass feedstocks can be used equally well in each application. Chipping high quality hardwoods for boiler fuel, instead of using it for high-end furniture is a poor value proposition. Biofuel refineries will be competing for resources with other industries that use similar types of feedstocks.

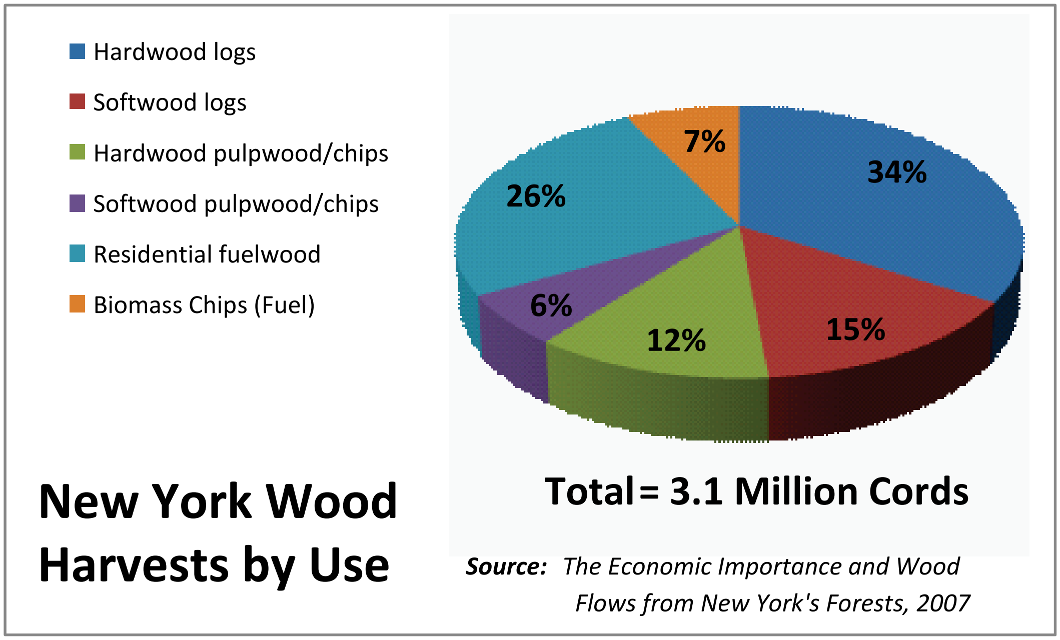
In addition to competition among existing users of feedstocks that a new biofuel industry will face, new sources of competition that have not been considered yet are possible. For example, the large-scale deployment of electric vehicles could introduce the prospect of new sources of feedstock demand in the power industry and new ways that biomass could serve New York's transportation energy needs. Specifically, the increased interest in and purchase of hybrid electric vehicles has enabled electric transportation technologies to advance to the point that many companies are on the verge of introducing next generation plug-in hybrid electric vehicles (PHEV). Rapid growth in PHEV could generate competition faced by biofuels in two ways. PHEV are an alternative to liquid fueled vehicles that biofuels would serve and they are a new electricity load that may increase the demand for biomass feedstocks to fuel electric generation plants. The pace and scale of the growth in the demand for biomass feedstocks from this new transportation technology is difficult to predict but important to note.

The general conclusion to be drawn, from the analysis presented in this Appendix, is that there are significant and real potential sources of competition for the use of the lignocellulosic feedstocks that the biorefineries presented in this Renewable Fuels Roadmap and Sustainable Biomass Feedstock Supply for New York State report (Roadmap) would require. Because it is difficult to assess the extent of competition, the assessment in this Appendix aims to offer some insights into the potential scale and prospects for some of the competing uses for biomass in New York State.

2 BIOMASS VALUE CHAIN – DEFINING THE COMPETITION FOR BIOREFINERY FEEDSTOCKS

The wood products industry is a vibrant and important part of New York's economy. At the highest level, competition for forest-based resources is intense and is dominated by traditional markets. For example, hardwood logs destined for processing into various types of value-added products (e.g., furniture, plywood, lumber, etc.) represent a major share of the forest harvest. Lower-value wood chips (biomass chips) slated for the energy market account for a relatively modest share of harvest activity (Figure P-1).

Figure P-1. New York Wood Harvests by Use



Forest products resources will ultimately find their way into uses that add the most value. Likewise, one may assume the opposite also is true – resources will not be put to long-term use in businesses if they do not provide value or a profitable financial return. Recently, broader debates regarding which biomass end-uses are optimal from a social and environmental perspective have come to the forefront, yet substantial work remains in addressing those issues. From a financial perspective, a few figures provide insight into what end-markets are likely to drive the use and cost of particular resources. Table P-1 illustrates the price of certain commodities relative to each other. Although the data are several years old and market prices fluctuate significantly, the table shows the importance and value of non-energy markets for the forest products industry.

Table P-1. Price Comparison for Wood Products

Size of Tree	7 inches	9 inches	11 inches	18 inches	18 inches
Product	Pulpwood	Boltwood	Small sawtimber	Quality sawtimber	Veneer log
Value	$5/cord	$15/cord	$250/cord	$400/cord	$750/cord

source: The Place You Call Home: A Guide to Caring for Your Land in the Upper Valley, Northern Woodland, 2006, pg. 59

Examining the energy conversion efficiency for different types of uses of bio-feedstocks provides another way of looking at this competition. Table P-2 includes representative efficiency values for converting raw feedstocks to energy products. Although not universally true, efficient use of resources provides some indication of industry profitability, especially when competing for resources.

Similar to other biomass energy projects and pulp markets, biofuel refineries seek out low value biomass, which brings these industries into direct competition for resources. As a result the balance of this discussion will focus on competition among these industries. Currently, energy production provides the driving force for developing energy crops, such as switchgrass or hybrid willow feedstocks. Non-energy use of such crops (e.g., paper pulp production, fodder crops) will not be a factor for a long time.

Table P-2. Industry Processing Efficiency

	Processing Eff. (Out/In)
Thermal Energy	73%
Electricity	24%
Lignocellulosic Ethanol	47%

3 COMPETING MARKETS FOR LOWER VALUE BIOMASS

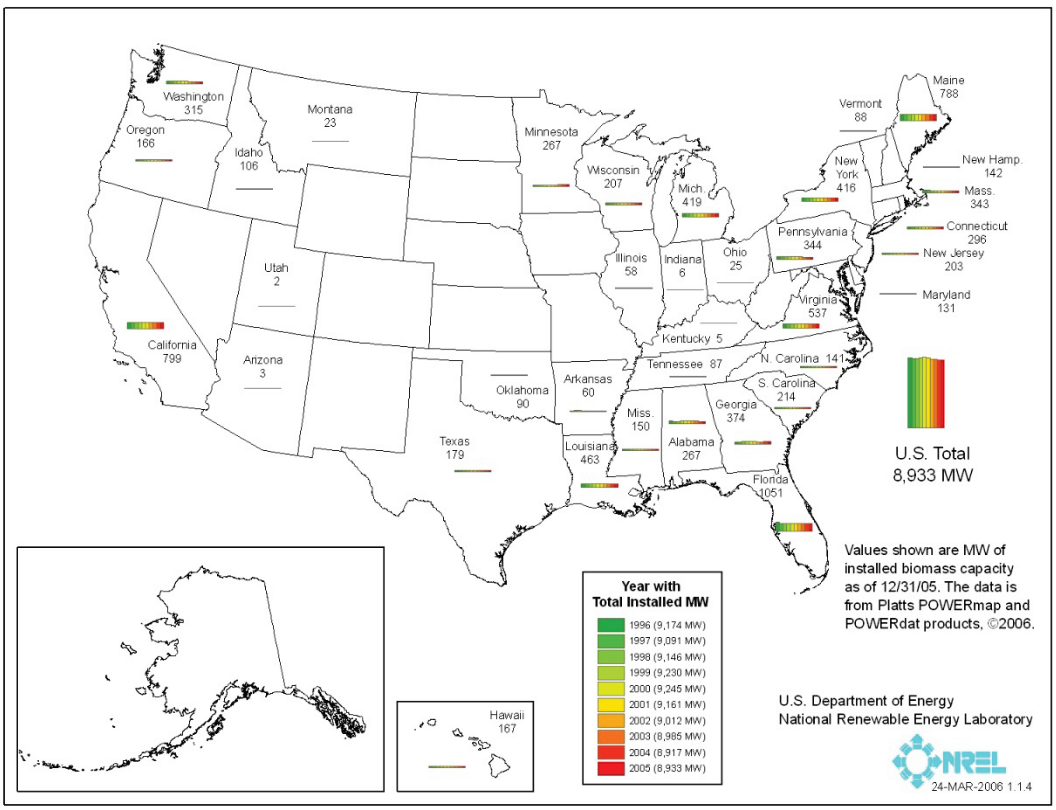
This section addresses the competition for biomass feedstocks offered by biomass electric generation and combined heat and power (CHP), biomass heat (including pellets), and pulp/paper production.

3.1 BIOMASS ELECTRIC GENERATION AND CHP PLANTS

3.1.1 Industry Review

Spurred by recent policy shifts that encourage the deployment of renewable energy plants, there is increased interest in building new biomass electric generation plants. Biomass power has been an important part of the industrial energy base (usually in the form of CHP) for decades. The following NREL figure (Figure P-2) presents the installed biopower capacity in the United States by state. The installed capacity includes stand-alone generating plants and electric output from CHP plants.

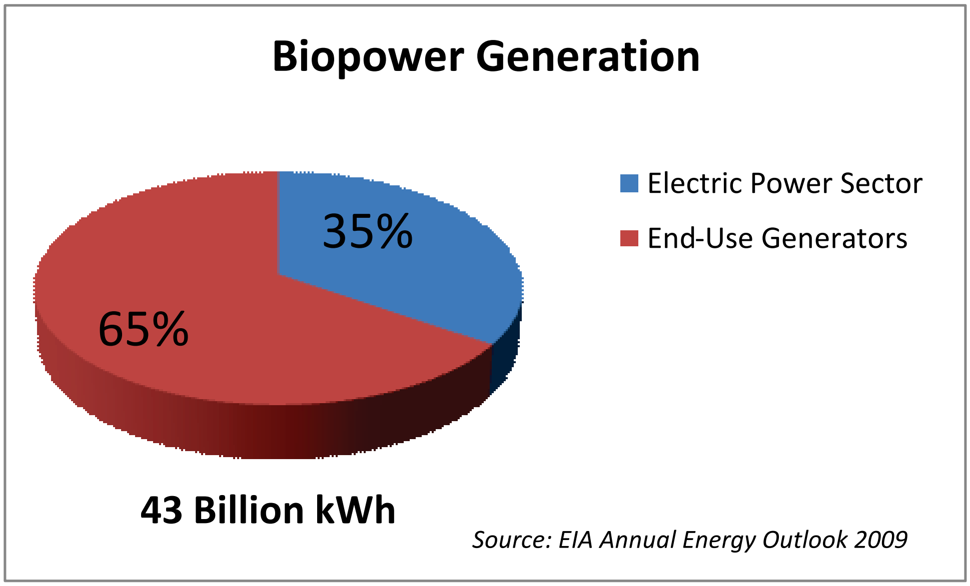
Figure P-2. Installed Biopower Capacity in the U.S.



Most of the existing biomass electric generation capacity was installed by the industrial sector. EIA/DOE data, shown in Figure P-3, indicate that industrial producers, generating on-site power, were responsible for approximately two-thirds of the nation's biopower production.

In New York, the biopower picture is evolving. The state has two dedicated biomass power plants and several coal power plants that are either co-firing or planning to co-fire biomass[1]. Based on information about these plants and the data presented in Figure P-2, New York's biopower base is consistent with the national trend – it is primarily provided through industrial activity.

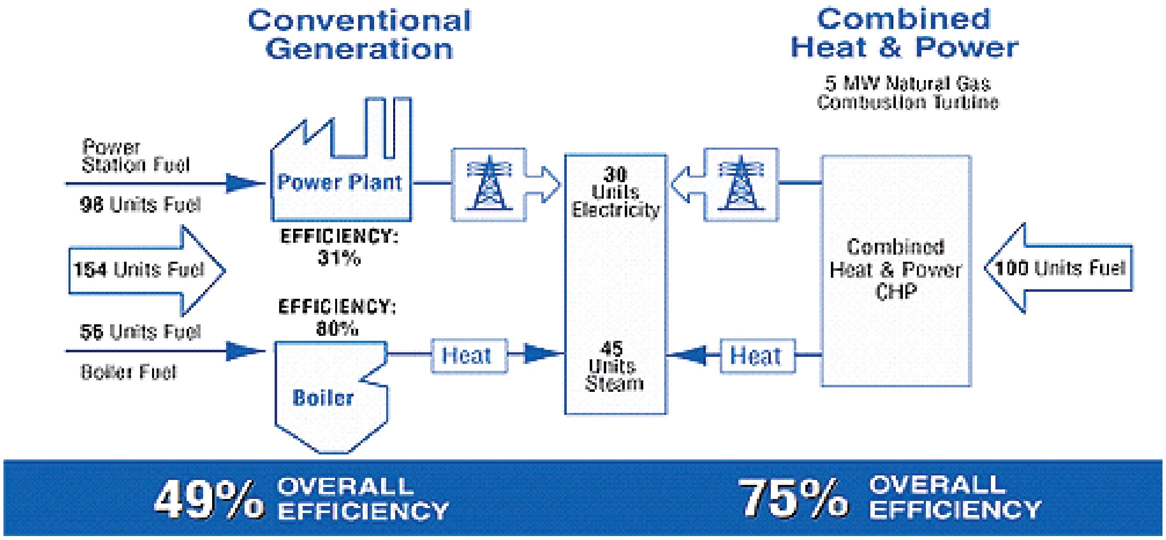
Figure P-3. Biopower Generation by Source



Given the importance of biomass power for the industrial sector, it is appropriate to take a more detailed look at biomass CHP. CHP plants provide much higher levels of fuel efficiency than electric generation-only biopower plants. This is accomplished by using the heat produced during electricity generation -- heat that is largely wasted in electric-only plants. This concept is shown in the following figure presented in EPA's Catalog of CHP Technologies (Figure P-4).

[1] See Appendix O for additional information on biomass co-firing competition.

Figure P-4. Illustration of CHP Efficiency Benefit



Source: U.S. Environmental Protection Agency. Catalog of CHP Technologies.

Oak Ridge National Laboratory's 2008 report on CHP potential in the United indicated that New York's 5,789 MW of installed CHP capacity in 2006 ranked fourth among states. Biomass has fueled only a small share of this CHP capacity. In NYSERDA's Combined Heat and Power Market Potential for New York State report (Patibandla et al. 2002), biomass-fueled plants accounted for only one percent (56 MW) of the total New York CHP capacity; while natural gas's 4,410 MW accounted for most of the balance.

3.1.2 Resource Competition Potential

While it is difficult to forecast how biomass power and CHP plants will compete with biorefineries for available feedstock resources, it is possible to outline some reasonable boundary conditions using available data. Under current conditions, it is industrial energy production (i.e., bio-thermal and CHP facilities), not utility biopower plants, that pose the strongest competition with new biorefineries for bio-feedstock resources.

With respect to CHP plants, the 2002 NYSERDA CHP study (Patibandla et al. 2002) provides estimates of the remaining technical potential for new CHP in New York State. The technical potential is much larger than the market potential, but this provides a starting point for assessing the potential for additional biomass-fueled CHP.

Because small-scale CHP systems are much less economic than larger ones, we consider only the potential for biomass fueled CHP facilities with capacity greater than 500kWe[2]. Table P-3 provides estimates of biomass CHP technical potential in New York (Patibandla et al. 2002).

Table P-3. Remaining Biomass CHP Technical Potential in New York State

	Sites	MW
Industrial	670	1,277
Commercial	1,866	1,979
Total	***2,536***	***3,256***

The analysis from this Appendix is consistent with the technical potentials presented in the NYSERDA CHP report. Technical potential is significantly greater than what is likely to be developed. A variety of site-specific constraints including the availability of land, zoning, permitting, the cost of alternative energy commodities, and resource availability assure that the technical potential could be difficult to reach. These constraints become particularly challenging for projects in the densely populated areas of New York, so those urban areas are excluded from the technical potential shown in Table P-3. It is reasonable, and consistent with assumptions made by the authors of the NYSERDA CHP report, to conclude that perhaps as much as 10-20% of the technical potential is obtainable over a reasonable period of time and under the right economic conditions. The technical potential is ~ 600MWe[3] of new biomass CHP electric capacity.

A number of assumptions are required to move from technical potential for biomass CHP to an estimate of potential resource competition, e.g., assumptions regarding the power/heat ratio of deployed facilities, operating schedules and the technology deployed. Making some assumptions that reflect current practice for such facilities[4] and using 300-600 MWe as the target output range, one may expect the potential biomass CHP market to demand 3-7 million dry tons of fuel per year. If new CHP facilities were to demand 3-7 million dry tons of biofuel feedstock, this would represent significant competition for resources that the biofuel productions contemplated in the three scenarios of the Roadmap. New biomass-powered CHP facilities could represent considerable competition for the feedstock resources modeled in the Roadmap, which range between 4.2 – 14.6 million dry tons per year.

In other parts of the country, converting existing coal boilers or plants to use biomass is already occurring. In March 2009, Georgia's Public Service Commission approved Georgia Power's request to convert an existing coal-fired plant to burn woody biomass. If built, the plant will become the largest biomass power plant in the United States with an approximate capacity of 96 MWe. At this point, the authors of this report are not aware of any similar plans

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[2] Kilowatt electrical (kWe) is a kilowatt of electrical energy.
[3] Megawatt electrical (MWe) is one megawatt of electrical energy.
[4] This analysis assumes that (1) overall conversion efficiency will be about 60% on higher heating value basis, (2) electricity represents an average of 20% of total energy output of the plant, and (3) that the plant will run year-round with steady thermal and electric loads

in New York. However, a few plants of the same size are possible and could double the resource demand figures noted above for CHP. Additionally, there are numerous political uncertainties that could change the landscape. These include pending carbon legislation and a federal renewable portfolio standard. Either of these could spur electric utilities to further examine their fuel mixes, and result in biomass playing an increased role as a fuel source (See Appendix O).

It may be possible for bio-refineries to address this competition by increasing the value obtained from biofuel feedstocks. One way is to develop CHP facilities at new biofuel refineries that would put biofuel waste streams to use as CHP fuel. This would allow biofuel refineries to provide "over-the-fence" heat and power services to other end-users. This has the potential to meet a portion of the energy demands of competing users. Some biofuel refinery developers are seriously considering such combined facilities where siting is conducive to arrangements of this type.

Currently, wood remains the preferred feedstock for biomass CHP and stand-alone power applications. Switchgrass has the potential to change this situation. For example, in Europe, switchgrass straws are used as a CHP fuel. However, switchgrass contains some chemical compounds (including alkalis) that present technology challenges in some boilers (Cooper, Braster and Woolsey 1998). This will limit the use of switchgrass in boiler applications until boiler technology advances to overcome these challenges. For this reason, biofuel refineries may have less competition for switchgrass resources.

There is potential for future biomass resource competition from increased CHP use, especially if a majority of new CHP applications are fueled by biomass. However, only a very small percentage of CHP units currently use biomass. While it is difficult to predict how many biomass fueled CHP facilities will be deployed, the potential for significant biomass resource demand from CHP applications warrants continued monitoring.

3.2 WOOD CHIPS, INDUSTRIAL RESIDUES AND PELLETS FOR HEAT

3.2.1 <u>Industry Review</u>

Residential heating markets account for about one quarter of New York's wood harvests (see Figure P-1). As indicated in the previous discussion on CHP, wood is an important source of thermal energy in industry as well. Figure P-5, which includes heat and power, shows total biomass energy use by industry sector but does not separate out the way biomass use is involved in energy production. For example, in typical kraft chemical process pulp mills, which account for about 80% of pulp manufacture in the U.S. (Nilsson 1996), thermal energy comprises approximately two-thirds of the total energy requirement (Larson et al. 2006). Mechanical process pulp mills that are intensive users of electricity, may also involve significant steam use for pulp and paper drying (Nilsson 1996). Likewise, lumber kilns have a significant energy demand, and it is not unusual for them to use their own processing residues and imported wood chips to provide this energy. A number of mills in New York operate such facilities.

Figure P-5. 2003 Industrial Biomass Energy Use

Agriculture, Forestry, & Mining
Food & Kindred Industry Products
Lumber
Paper & Allied Products
Chemicals & Allied Products

0.1% 0.6% 2.9% 15.5% 80.8%

Biomass Energy Consumption (TBtus)

Source: US DOE, Biomass Energy Databook - 2003

Source: Adapted from U.S. DOE, Biomass Energy Data Book, 2009

In addition to industrial uses, small boilers are used in many commercial and light industrial facilities to provide space heating, domestic hot water, and process heat, but only a small proportion of small boiler facilities are now fueled with biomass (EEA 2005).

Figure P-6.6 Commercial Boiler Populations

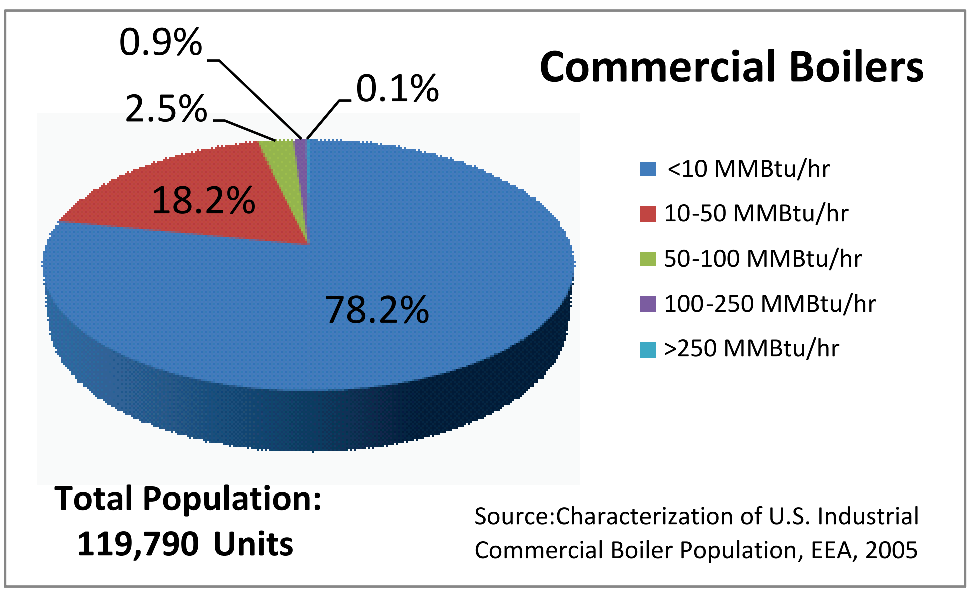
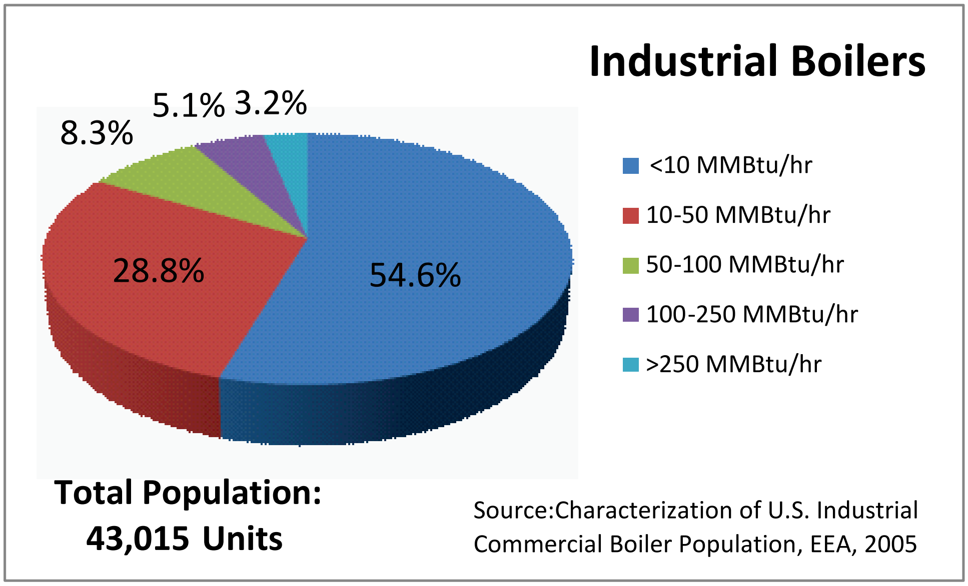


Figure P-7.7 Industrial Boiler Populations



The pellet fuels market is emerging as an important player in the heating and possibly even power markets. A recent study conducted by USDA (Spelter and Toth 2009), collected data on approximately 111 pellet plants operating in the United States and Canada. They found that most of the facilities were relatively small with capacities of less than 80,000 tons per year or less. T he USDA report notes that, "This stems from a business model that has largely been based on the utilization of wastes from sawmills and other wood-processing plants." The report indicates that a number of new mills have been built with the capability and expectation of chipping the full range of wood materials available from forestry operations , thereby making it possible for pellet production to tap a larger share of the wood resource supply. These mills have capacities that are three to four times the size of the mills that were built previously. The report indicates that some of these mills have capacities in the 220-660 thousand tons per year range.

At the end of 2009 New York had seven pellet production plants (See Roadmap Appendix O – Table O-7). The capacities of these plants range from approximately 10,000 to 100,000 tons per year with a total expected capacity of about 330,000 tons per year. New pellet plants are relatively simple manufacturing operations that do not require a large capital investment to establish. The small scale of facilities being built in the region (i.e., 100,000 tons per year or less) do not require a supply of biomass at the levels required by even small biomass electricity plants. Such small scale wood pellet plants are generally relatively easy to supply and finance and so far have not encountered significant community opposition. According to Woodstone USA's Website (www.wspellets.com), a plant that is planned for 2010 will have a capacity of 100,000 tons per year. While it is unclear which wood resource the facility will use, the Website indicates that woodchips will be the feedstock for its pellets.

The USDA report suggests that the capacity of pellet mills in North America was approximately 1.1 million tons in 2003 but had grown to about seven million tons by 2009. Wood pellet production is a fast growing user of wood-fuel resources; while not yet a major consumer of wood fuel in New York, wood pellet production appears to be a growing user of wood resources in New York.

3.3 RESOURCE COMPETITION POTENTIAL

It is difficult to estimate precisely the potential resource competition that small boilers and the pellet fuel market will pose for biofuel refineries. It is also difficult to separate heat-only applications from the potential competition of CHP facilities. See Appendix E for more information about growth potential for biomass. One may offer some general observations about this competition:

- The installation of new biomass-fired boilers is unlikely to represent a substantial resource threat to biofuel refineries in the near-term. Even over the course of a decade, the cumulative addition of many new small biomass-fueled units is not sufficient to present a serious resource competition concern. Additionally, these units are likely to be dispersed geographically and therefore do not present the large potential resource demand posed by a large centrally located biomass facility.[5]

- Pellet fuel plants targeting higher-grade feedstock than before are increasing their use of biomass resources. Industry trends suggest that larger facilities are emerging with the express intent of using wood chips as feedstock. Additionally, pellet facilities that plan to offer premium grade pellets (low in ash and moisture content) may be competing for the type of feedstock that will be targeted by early biofuel refineries. These materials are generally equivalent in grade to pulp chips and already have multiple end markets For example, Johnson (2009) discusses the recent growth of pellet plants and the expectation that these facilities will continue to increase in the near future. New York's current wood chip demand already includes consumption by pellet mills, and more pellet mills are planned. It is possible that in the future one or two large additional pellet plants may be sited in the State, which could increase resource demand by 0.2 to 1.2 million dry tons per year. Additional information on the wood pellet industry can be found in Appendix O of the Roadmap.

- As competition for biomass resources grows, the biomass supply also is expected to grow. See Appendix E for more information about growth potential for biomass supply.

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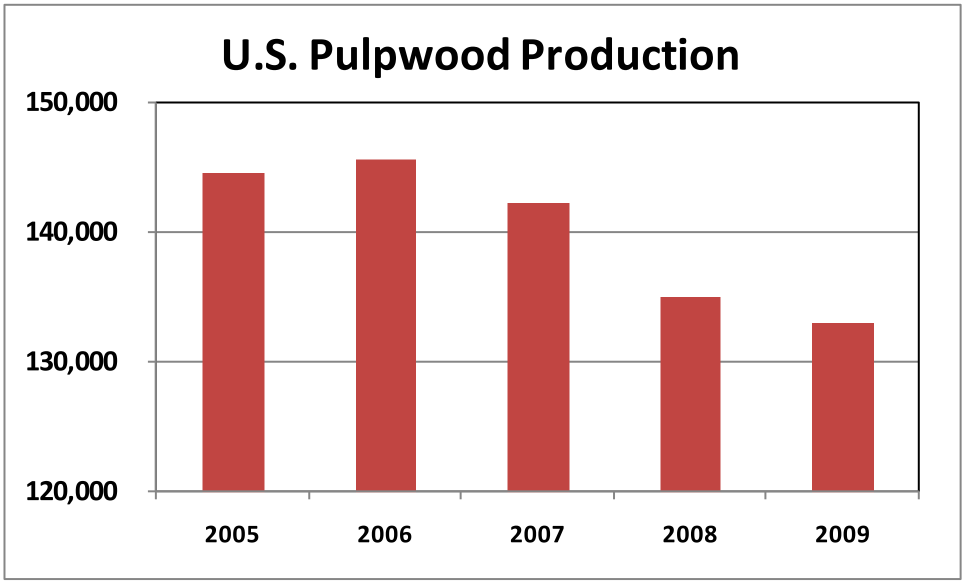
[5] To scale possible impacts, one may consider the results if we assume that new boilers sales in New York may range between 50 and 100 units per year, and that of these 5% might be biomass boilers with an overall heat requirement of approximately 10 MMBtu/hr each. As much as 50 MMBtu/hr of heat will be provided by these units. Using typical figures for biomass boiler efficiencies using wet wood (70% HHV), the total heat input into these new units may be as much as 70 MMBtu/hr. Conservatively assuming that these units will primarily be used for process and space heating (many may be restricted to just space heating) year round, then one might expect that the new applications might require as much as 30,000 dry tons per year of fuel (assuming 8,000 hours of operation and an average higher heating value of 8,500 Btu per dry pound).

4 PULP MILLS

According to a series of reports, pulpwood production in the U.S. has declined over the past five years (Figure P-8). Despite short rebounds in pulp prices from time to time, it does not appear that any major jump in U.S. pulp manufacturing is forecast. In the short-term, there seems to be relatively high excess capacity in the bleached kraft pulping process capacity in the U.S., ranging from 10-14% depending on the type of pulp (CPBIS 2009).

Figure P-8. U.S. Roundwood Pulpwood Production (measured in units of 1,000 cubic meters)



Source: Howard and Westby 2007; Howard and Westby 2009).

Within New York, the pulp mill industry has experienced a significant decline. In the late 1800s the New York pulp industry had no peers in the world. Today, there are only a few remaining pulp mills in the State.

In this respect, pulp mills are more likely to fall victim to competing industries rather than the other way around. Quoting a recent trade analysis publication, “Pulpwood is normally outside the reach of energy buyers, but with demand from traditional end-users falling, prices of pulpwood have dropped to levels barely higher than those of energy wood (Hawkins Wright 2009). It does not appear that demand for biomass for pulping is likely to represent a significant near-term challenge to an emerging biofuel industry in New York.

5 NEW TRANSPORTATION TECHNOLOGIES COULD PROVIDE NEW PATHWAYS FOR BIOMASS FUEL TRANSPORTATION

The emergence of new electric vehicle technology, especially plug-in hybrid electric vehicles (PHEVs), could substantially alter the extent to which biomass is used to power transportation. This technology introduces the possibility that biomass-fueled electric generation could contribute to providing transportation by displacing liquid fueled vehicles that biofuels aim to serve. Obviously this would complicate the current assessment of competition for biofuel feedstocks that consider the current dominant users of these biomass resources. Here we simply introduce this potentially significant new dynamic by identifying its key elements. It is far too early in PHEV technology development to estimate the shape and scope of the development and even the potential competition between these biomass-powered transportations pathways.

Early in 2004, monthly sales of hybrid electric vehicles were approximately 5,000 units per month. By the middle of 2007 (the peak sales period) sales spiked at approximately 45,000 units per month. This rapid increase in sales and the sheer number of units sold has allowed subsequent generations of vehicles to become more advanced. In the very near-term, several car manufacturers will be offering vehicles that take the next step, i.e., PHEVs.

It is unclear if market adoption will be as rapid for this class of vehicles as it has been for gas-electric hybrids, but the implications eventually may be significant for how biomass resources are used to provide transportation services and thereby reduce imported petroleum products in the transportation sector. There are few options other than biofuels to replace fossil fuels for use in the transportation sector, yet there are other renewable sources of electricity that could displace petroleum in the transportation sector.

The following excerpts from a recent study, "Economic Impact of Electric Vehicle Adoption in the United States" (Sidhu et al. 2008) frames the issue:

> *The widespread adoption of electric vehicles (EVs) in place of internal combustion engine (ICE) vehicles in the United States will have a significant impact on the global economy. . . . Specifically, this change will cause some domestic industries (e.g. gasoline) to shrink, while causing others (e.g. electricity production) to grow. We estimate the petroleum industry will suffer a $174.9 billion decline, while the battery industry will experience $120.3 billion gain at 39% adoption (year 2030). . . . we find EVs to be the more efficient technology, as the total cost of ownership is $7,203 (2008 dollars) less than that of an ICE vehicle[6]. Together with the reduction in imports, consumers will benefit from savings due to the reduced energy and maintenance costs of EVs, which will reach $80 billion (in 2008 dollars) by 2030.*

[6] The study notes indicate that battery costs are paid on a "miles of use" basis as proposed by the electric vehicle services company Better Place http://www.betterplace.com/solution/.

This assessment only introduces this potentially significant issue and focuses on cost of ownership, which is only one component of the overall cost to society.

The link between biomass resource competition and PHEV growth is the use of biomass to generate electricity. Because it is difficult to assess how much of the increase in electricity use associated with new PHEVs would be provided by biomass-fueled electricity generation, it is extremely difficult to estimate the magnitude of the impact on the competing demand for biomass resources. The electric vehicle pathway should be watched for its possible long-term impact on biomass resource demand and its implications for biofuel demand.

6 CONCLUSIONS

Biofuels have the potential to provide new markets for New York's underused forest-based resources and to create markets for some emerging agricultural feedstocks. Biofuels will compete with several industry energy users for these feedstock resources. This increased demand may lead to a larger biomass supply (see Appendix E for more information about biomass supply trends). The development of biomass CHP plants could demand millions of dry tons of biomass resources. Growth of pellet fuel businesses may also compete with new biofuel refineries for New York's forest resource base. Demand for biomass feedstocks by additional biomass-fueled CHP and a growing pellet fuel industry may push up the price for biomass feedstocks used by biofuel refineries. As explained in Appendix O, co-firing biomass in existing coal-fired power plants also may emerge as a significant source of biomass feedstock demand.

In contrast, neither the pulp industry nor institutional/commercial heating (outside of CHP) are likely to pose much competition for the feedstocks the biofuel industry will demand. The nation's pulp industry and especially the industry in New York seem ill-positioned for a major comeback. Therefore, the industry does not appear to present an immediate resource concern. Likewise, anticipated development of institutional/commercial heating systems does not look to be a major competitive force. These facilities tend to have relatively small resource demands.

The forest products and biofuel industries seem to be complementary users of forest resources, allowing the two to coexist sustainably. This is possible because these two industries use different types of forest resources.

The advent of electric vehicle technologies introduces the possibility that biomass could serve both biofuel and biopower vehicle transportation. Biofuels displace liquid fuels that now power most vehicles. Electricity generated with biomass, biopower, may also provide electricity demanded by emerging PHEVs. It is very difficult to assess now how these two biomass-fueled transportation pathways will take shape, but they merit watching. Both pathways require significant investment in technology as well as biomass feedstock development.

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