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Investigation of Private/Public Financial and Organizational Mechanisms to Initiate the Creation of New Markets and Expansion of Existing Markets for Products Made from Wood Residues, By-Products and Wastes

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Because we reached out to the wood products and forestry industry within the broader East Coast region, we would like to thank all of those individuals who are too numerous to mention here for their time and the valued input that they provided.

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INTRODUCTION AND SUMMARY

The purpose of this project was to establish the level of wood wastes and residues available within Maryland as well as nearby regions and to assess the potential to add value to these low-cost feedstock materials. This upgrading of the wood wastes or residues to a higher value product allows the adding of employment into the economy which does not currently exist within the State. Given that waste wood and residues will continue to be a forest products industry by-product and a waste stream from urban and suburban landscape maintenance and management, this resource base is seen as sustainable and secure for the long term.

The first part of the project was to conduct a survey and to estimate the total available resources. The project team looked at the availability of the resource on a cost per ton basis, thus providing a yardstick for comparing productive uses that are feedstock supply cost sensitive. Part I of this report entitled: "An Inventory of Wood Residues, By-Products, and Wastes in Maryland and Delaware" describes this survey, its data sources, and results.

Part II of the report is entitled "Products Made From Wood Residues, By-Products And Wastes" which covers the potential for higher value products that can be made from these materials and discusses aspects of their markets within the State.

Part III addresses the opportunities for the creation of new markets and the expansion of existing markets for the products made from wood residues, by-products and wastes. This section of the report relied upon a specialized survey instrument developed to gather current information regarding the potential wood waste-based products and their market potential/timing. The survey instrument was sent to a group of experts and individuals in the forestry and forest products area from both the State and region. The survey instrument also covered organizational and financial issues related to this industry. This section discusses the survey results.

Part IV of this report is entitled "Possible Public/Private Financial and Organizational Mechanisms for Initiating the Creation of New Markets and the Expansion of Existing Markets". This section discusses existing financial and organizational mechanisms and approaches and also makes recommendations on what could be done in this area.

The reader may draw his or her own conclusions from what is presented in the four sections of this report. However, the researchers have drawn conclusions about what could be done to make better uses of wood wastes and residues within the State and have offered several specific action oriented recommendations. These recommendations and supporting rationale are contained in Part V of the report.

PART I
AN INVENTORY OF WOOD RESIDUES, BY-PRODUCTS, AND WASTES IN MARYLAND AND DELAWARE

Wood residues, by-products, and wastes are ubiquitous across much of Maryland and Delaware. These materials may be found variously in urban, suburban, and rural settings; they can be the product of public activities and private enterprise, the latter including both commercial and industrial entities. Wood residues, by-products, and wastes can be categorized into two broad classes of woody materials. The first, logging, land clearing, power line right-of-way maintenance, and urban and suburban tree trimming operations may generate whole trees, large parts of trees (including tops and stumps), and whole-tree chips. The second broad class of materials is comprised of a variety of commercial and industrial entities, including the forest products industry and others, may generate a variety of coarse and fine woody materials, including sawdust, planer shavings, bark, pole peelings, veneer cores, and the like.

These different materials variously are referred to as residues, by-products, and wastes. Although there is significant ambiguity in the common use of these terms, there are useful distinctions worth noting. Residues may not be concentrated at single points of generation; for example, the tops and branches of trees left spread over relatively wide areas after logging activities are often referred to as logging residues. By-products and wastes are more typically concentrated at single points of generation, such as at sawmills, furniture makers, and pallet remanufacturers. The distinction that commonly separates by-products and wastes in this usage is that producers often sell by-products while they sometime pay for waste disposal.

Across the two-state region, a variety of woody materials qualify as by-products. In western Maryland, for example, dry sawdust is often sold to make charcoal briquettes. In Delaware and on Maryland's Upper and Lower Eastern Shore, in contrast, most fine materials, including sawdust and planer shavings, are sold for use as poultry litter. Where feasible, whole tree chips are sold to paper mills and bark is sold for making mulch. The coarser materials generated at sawmills and other facilities may be processed to be sold as the previously mentioned by-products, burned as hog fuel, left piled on site, or taken to a recycler for disposal.

Past experience has revealed that certain contacts will state that there are no wood wastes generated in either state: others will indicate there are wood wastes available. Recyclers, some land clearing companies, and a few others will typically respond that there are no wood wastes, as there is a market and demand for every bit of wood fiber they produce or handle. According to them, nearly all of this material is recycled and none ends up in a landfill. There is indication, however, that demand might not be as strong for these materials as some might like. One large recycler will send paper-grade wood chips to a distant paper mill, but only when demand for mulch for landscaping is down. The demand for mulch appears to be strong enough at other times so that economic returns justify the recycler's expense of treating ground or crushed pallets and other dry, white wood to make landscape mulch acceptable to buyers.

The smaller tree service companies, on the other hand, typically report that they end up either giving away chipped material for free or they bear the burden of hauling this material to recyclers for disposal. In other words, there is no demand for this material that produces much, if

any, economic return. The representatives of the tree service companies contacted in this study would be pleased to be paid for the materials they generate. The fine distinction here is that the recycler sees these materials as a by-product with a market, while the small tree service company sees them as a waste needing disposal.

The State of Maryland

Estimates of the total amount of wood residues, by-products, and wastes in Maryland (and for each of the categories for the entire state) are shown in the lower-right-hand corner of the Table 1-1. This total is based on an estimate of biomass feedstock availability on a State-by-State basis throughout the United States prepared by a consortium of Oak Ridge National Labs, the University of Tennessee, and Science Applications International Corporation (SAIC).[1] This information was collected, analyzed, and reported in 1999 and updated the following year.

Table 1-1. Wood Residues, By-Products and Wastes in Maryland (green tons ×1,000) (See Appendix C for a list of counties in each region)

Region	Delivered Price ($/ton)			Region	Delivered Price ($/ton)		
	< 30	< 40	< 50		< 30	< 40	< 50
Western Maryland				Upper Eastern Shore			
Forest residues	65	94	121	Forest residues	23	33	42
Mill by-products	0	4	46	Mill by-products	0	2	20
Urban wood wastes	47	47	47	Urban wood wastes	24	24	24
regional subtotal	112	144	214	regional subtotal	46	58	85
Central Maryland				Lower Eastern Shore			
Forest residues	56	81	104	Forest residues	25	36	46
Mill by-products	0	4	49	Mill by-products	0	2	27
Urban wood wastes	173	173	173	Urban wood wastes	15	15	15
regional subtotal	230	258	326	regional subtotal	39	52	87
Southern Maryland				State of Maryland			
Forest residues	21	30	38	Forest residues	189	273	351
Mill by-products	0	2	24	Mill by-products	0	13	166
Urban wood wastes	82	82	82	Urban wood wastes	341	341	341
regional subtotal	103	114	145	State total	530	627	858

Forestry residues are defined in the SAIC study as logging residues; rough, rotten, and salvable dead wood; excess saplings; and small poletimber. Estimates of the recoverable fraction of this material are based on a survey of standing forest volume, haul distances, and equipment

[1] Marie E. Walsh *et al.,* Biomass Feedstock Availability in the United States, http://bioenergy.ornl.gov/resourcedata/index.html

operating constraints. This analysis, however, does not take into account lower-grade standing timber that is of little or no commercial value. According to the 1999 forest survey for Maryland,[2] fifteen percent of the total volume of the lower-grade sawtimber trees in the state is Grade 4 and 5; this proportion rises to 45 percent if Grade 3 is also included. Similarly, in Delaware,[3] twenty percent of the total volume of sawtimber trees in the state is Grade 4 and 5; this proportion rises to 54 percent if Grade 3 is also included.

Sawmill operators typically prefer procuring and sawing the higher quality Grade 1 and 2 logs, but will accept some Grade 3 logs as well, because they find greater efficiency in (and greater economic return from) sawing the higher quality logs. Loggers, in turn, are predisposed to harvest the higher quality logs because sawmills are willing to pay more for quality. Often there is little or no market for the poorer quality logs. Nonetheless, low quality logs are suitable for a wide range of uses, as discussed in Part II of this report. Therefore, the estimates of forest residues in Table 1-1 likely underestimate the magnitude of the supply of this resource.

Mill by-products are defined in the SAIC study as the by-products resulting from the manufacture of pulp and paper, lumber, veneers, and composite wood products. These by-products include bark, coarse materials (pole peelings, ends, and slabs), and fine materials (shavings and sawdust). Given the method used to estimate the availability of mill by-products in relation to delivered price, it is likely that the amounts reported reflect the actual supply.

Urban wood wastes are defined in the SAIC study as produced from a variety of sources, including urban forestry (tree trimming and land clearing), commercial businesses (the secondary forest products industry and others), municipal solid waste, and construction and demolition debris. The separation and retrieval of clean woody materials from both municipal solid waste and construction and demolition debris is not impossible, but neither is it without difficulty. Also, as noted below, the estimates of supply of urban wood wastes reported by SAIC is predicated on the assumption that all or very nearly all of this material is disposed of in landfills and, therefore, not recycled. In Maryland and Delaware, however, most of the clean wood wastes are recycled. Given the likely counting of construction waste and demolition debris, the estimates of urban wood wastes likely overestimate the magnitude of the supply of this resource.

The amounts of materials, both in each category and State totals, are reported according to a delivered cost, reflecting—depending on the category of material—acquisition, collection, handling, and loading at the material's point of origin; transportation; and unloading at its point of destination. Further, the amount of material is shown according to three price scenarios: a delivered and unloaded cost of less than thirty dollars per ton on a dry-weight basis; less than forty dollars per dry-weight ton; and less than fifty dollars per dry-weight ton.[4]

Depending on the delivered cost, the overall supply of forest residues, mill by-products, and urban wood wastes in Maryland ranges from slightly more than 500 thousand tons per year to

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[2] Thomas Frieswyk, *Forest Statistics for Maryland: 1986 and 1999,* Resource Bulletin NE-154, Northeastern Research Station, Forest Service, U. S. Dept. of Agriculture, p. 80

[3] Douglas M. Griffith and Richard H. Widmann, *Forest Statistics for Delaware: 1986 and 1999,* Resource Bulletin NE-151, Northeastern Research Station, Forest Service, U. S. Dept. of Agriculture, p. 50

[4] Costs are reported in 1995 dollars.

almost 900 thousand tons per year. The largest fraction of this material, irrespective of delivered price, is urban wood wastes, at more than 300 thousand tons per year. Only at the highest delivered cost does the supply of mill by-products approximate the supply of urban wood wastes. In addition, the following trends are observable for each class of material:

- The total amount of materials available as forest residues in Maryland increases as delivered costs increase. The SAIC study reports that as price paid for these materials increases—justifying higher collection and transportation costs—a larger fraction of materials will be recovered and supply will increase.
- Similarly, the total amount of materials available as mill by-products increases as delivered costs increase. The SAIC study reports that as the price paid for these materials increases, that higher price will more successfully compete against prices paid for this material by other users and the supply will increase.
- The amount of material available as urban wood wastes remains constant independent of delivered cost. The SAIC study reports that the bulk of this material is not recycled—that is to say, has few or no competing uses. While this assumption may not be unreasonable for a national assessment it is not valid for circumstances found in Maryland and Delaware because the national assessment cannot possibly take into account all local conditions. The estimated amounts of urban wood wastes can therefore only be viewed for planning purposes as an upper limit for what might be available.

What most all of these woody materials have in common is a relatively low bulk density, translating into relatively high costs of transportation, processing, storage, and handling. Therefore, wood residues, by-products, and wastes historically have been mostly a local resource with the various types of industry arising and flourishing where raw materials are concentrated. In fact, Maryland can be subdivided into five regions (see Appendix C), each characterized generally by the type of forest typically found there: Western Maryland, Appalachian hardwoods; Southern Maryland, southern hardwoods; Central Maryland, northern hardwoods; the Lower Eastern Shore, softwoods (loblolly pine); and the Upper Eastern Shore, a mixture of the hardwoods and softwoods that characterize the adjacent regions. While these generalizations are by-and-large accurate representations, local exceptions nonetheless can be found throughout the regions.

Using the rationale expressed in the previous paragraph, the amounts of materials in the three categories—residues, by-products, and wastes—were disaggregated into amounts found in each of Maryland's five forestry regions. Regional amounts were calculated as a proportion of the total in the State based on the number of commercial entities holding state permits appropriate for doing business in each particular category. The number of permit holders was obtained from county-by-county lists provided by the Maryland Department of Natural Resources, one for tree service companies[5] and the other for the forest products industry, including loggers and sawmills.[6] Recyclers were similarly identified by lists provided by mdrecycles.org.[7]

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[5] http://www.dnr.state.md.us/forests/tree_expert_search.asp, Winter 2006

[6] http://www.dnr.state.md.us/forests/fpo_search.asp, Winter 2006

Sixty-four percent of all loggers in Maryland are found in Western and Central Maryland, accounting for the large proportion of logging residues found there. Similarly, fifty-seven percent of all sawmills are found in Central and Western Maryland likewise accounting for the large proportion of mill by-products found there. Seventy-five percent of all tree service companies and recyclers are found in Central and Southern Maryland serving the more densely populated areas around Baltimore and southwards towards Washington, D. C., accounting for the large proportion of urban wood wastes found there.[8]

The State of Delaware

Estimates of the total amount of wood residues, by-products, and wastes in Delaware (and for each of the categories for the entire state) are shown in Table 1-2. As with the previous table, this total is based on an estimate of biomass feedstock availability on a State-by-State basis throughout the United States prepared by a consortium of Oak Ridge National Labs, the University of Tennessee, and SAIC.[9] This information was collected, analyzed, and reported in 1999 and updated the following year.

Table 1-2. Wood Residues, By-Products and Wastes on the Delmarva Peninsula (tons ×1,000)

Region	Delivered Price ($/ton)		
	< 30	< 40	< 50
Delaware			
Forest residues	26	37	48
Mill by-products	0	4	16
Urban wood wastes	65	65	65
Delaware subtotal	91	106	129
Maryland's Eastern Shore			
Forest residues	47	68	88
Mill by-products	0	4	46
Urban wood wastes	38	38	38
Maryland subtotal	86	110	172
Total Regional Supply			
Forest residues	73	105	136
Mill by-products	0	8	62
Urban wood wastes	103	103	103
Regional total	176	216	302

Delaware, however, does not stand alone, but is part of the Delmarva Peninsula. The geography of the peninsula is such that supplies of residues, by-products, and wastes from throughout the peninsula might be considered resources for use in Delaware. As a result, a regional supply of materials has been fashioned, adding the materials in Delaware to those on Maryland's Upper and Lower Eastern Shore. These are shown in Table 1-2.

As in the previous analysis, the amounts of materials are reported according to a delivered cost, reflecting—depending on the category of material—acquisition, collection, handling, and loading at the material's point of origin; transportation; and unloading at its point of destination. Further, the amount of material is shown according to three price scenarios: a delivered and un-

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7 http://www.mdrecycles.org/index.asp, Winter 2006

8 http://www.dnr.state.md.us/forests/tree_expert_search.asp, Winter 2006

9 Marie E. Walsh *et al.,* Biomass Feedstock Availability in the United States, http://bioenergy.ornl.gov/resourcedata/index.html

loaded cost of less than thirty dollars per ton on a dry-weight basis; less than forty dollars per dry-weight ton; and less than fifty dollars per dry-weight ton.[10]

Depending on the delivered cost, the overall supply of forest residues, mill by-products, and urban wood wastes in Delaware is around 100 thousand tons per year. Across the Delmarva region, the supply ranges from less than 200 thousand tons per year to 300 thousand tons per year. The largest fraction of this regional supply, irrespective of delivered price, is urban wood wastes, about 100 thousand tons per year. Only at higher delivered prices (greater than $40.00) is the supply of forest residues as large. As before, the following trends are observable for each class of material:

- The total amount of materials available as forest residues in Delaware and the region increases as delivered costs increase. The SAIC study reports that as price paid for these materials increases—justifying higher collection and transportation costs—a larger fraction of materials will be recovered and supply will increase.
- The total amount of materials available as mill by-products increases as delivered costs increase. The SAIC study reports that as the price paid for these materials increases, that higher price will more successfully compete against prices paid for this material by other users and the supply will increase.
- The amount of material available as urban wood wastes remains constant independent of delivered cost. The SAIC study reports that the bulk of this material is not recycled—that is to say, has few or no competing uses. While this assumption may not be unreasonable for a national assessment it is not valid for circumstances found in Delaware and the region, as addressed earlier. The estimated amounts of urban wood wastes thus can only be viewed for planning purposes as an upper limit for what might be available.

[10] costs are reported in 1995 dollars

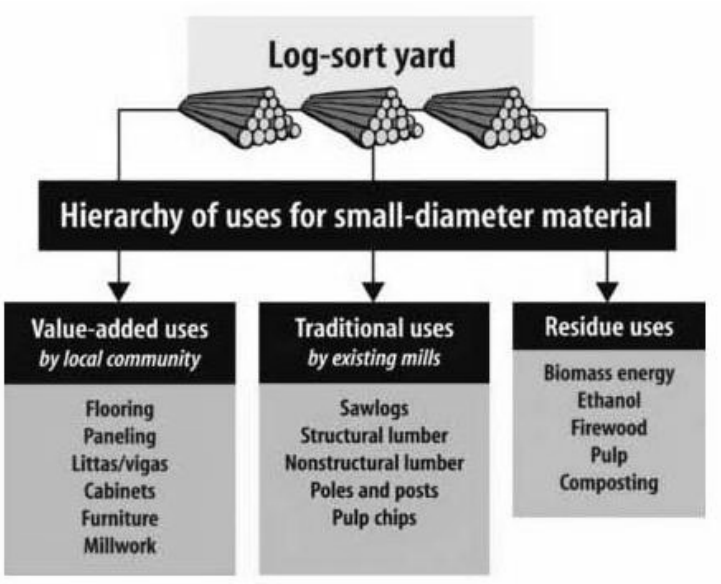
PART II
PRODUCTS MADE FROM WOOD RESIDUES, BY-PRODUCTS AND WASTES

Products from Low-Grade and Small-Diameter Resources

Low-grade trees fall into two classes—trees that are not growing stock (rough or rotten culls and noncommercial species) and trees that are growing stock but not sawtimber (poletimber and saplings and seedlings)—hence the characterization as low-grade and small-diameter.[11] "Small-diameter and underutilized (SDU) material refers to the timber that is left in the forest because it is not economical to remove or local capacity to process it does not exist." [12] In addition, "…low-grade hardwoods are defined as the material remaining in high-graded stands of mixed hardwoods or the hardwood component of pine stands containing very few quality trees and generally unmerchantable due to low value and excess supply." [13]

The hierarchy of uses for small diameter material—value-added uses, traditional uses, and residue uses—are shown in Figure 2-1. Each is discussed in turn.

Figure 2-1. Uses of Small-Diameter Material [14]



Local markets have created the strongest demand for low-grade and small-diameter material. The pallet industry traditionally has been "the largest domestic market for sawn hardwoods and the primary market for low-grade hardwood lumber and cants…." [15] Other local markets for low-grade and small-diameter hardwoods include packaging and dunnage, railroad ties, upholstered furniture frames, flooring, cabinets, furniture, and millwork. Niche markets include pallet parts, bushel crates, fence boards, industrial blocking, grading stakes, farm/shop lumber, coal mine timbers, and construction lumber.[16] What can be innovative is how the output of sawmills is made available to the secondary forest products

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[11] Luppold, William, and Matthew Bumgardner. 2003. *What is low-value and/or low-grade hardwood?* Forest Products Journal. Vol. 53, No. 3. p 55

[12] LeVan-Green, Susan, and Jean Livingston. 2001. *Exploring the Uses for Small-Diameter Trees.* Forest Products Journal. Vol. 51, No. 9. p 11.

[13] Goldstein, Irving S., D. Lester Holley, and Earl L. Deal. 1978. *Economic Aspects of Low-Grade Hardwood Utilization.* Forest Products Journal. Vol. 28, No. 8. p 53.

[14] Courtesy of U.S. Forest Products Laboratory

[15] Cumbo, Dan, Robert Smith, and Philip Araman. 2003. *Low-grade hardwood lumber production, markets, and issues.* Forest Products Journal. Vol. 53, No. 9. p 17

[16] Cumbo, Dan, Robert Smith, and Philip Araman. p 20

industry. To be explored later in this report is the possibility of marketing the lumber produced by small, portable sawmills by way of sellers cooperatives established for that purpose.

All products typically manufactured by sawmills can be from low-grade or small-diameter timber, though not as efficiently or as cheaply as from higher-grade timber. "Some of the [low-grade, small-diameter] material is suitable for high-valued engineered wood products, such as trusses and glue-laminated timber. Other material is suitable for flooring, paneling, and furniture—all high-valued uses." [17] What may be innovative are not the products themselves but how raw materials for these traditional products are recovered and then processed. To be explored in the final section of this report is the possibility of expanding the use of small, portable sawmills, though up until now, "very little of the lumber produced by these mills makes it into commerce as lumber, but they do serve local needs (buildings on farms and local wood workers)." [18]

The typical uses of sawmill residues and other wood wastes and byproducts have been pulp chips, animal bedding, landscaping mulch, firewood, and other fuels. Fuelwood pellets and ethanol and other chemicals are discussed extensively in the following subsections.

Two groups of innovative products from low-grade and small-diameter hardwoods merit mention—glue-laminated beams and woodfiber composites. Cant-sawn lumber[19] from lower-grade, smaller-dimension hardwoods has been extensively evaluated for manufacturing glue-laminated (glulam) beams. Beams made of red maple, yellow poplar, and red oak were shown to meet the bending stress and stiffness design standards for use in building timber bridges.[20] One recent example of innovation in wood composites are 3-D pulp molded products, made like corrugated paper with fibers aligned for strength and with half the weight of particleboard. Another is wood fiber mats used for erosion control and as water filters.

A third group of innovative products that can be made from low-grade and small-diameter hardwoods, composites made of wood fiber with thermoplastic resins, have begun to be used for a number of commercial products and show promise for others. Wood-plastic composites have been used for some time by the automotive industry as a substrate for vinyl, carpeting, weather stripping, and other components. The plastic in the wood-plastic composites used widely for making outdoor decking and railings shields the wood from moisture and insect damage, while the wood protects the plastic from UV damage.[21] Highway markers also are now being made from wood-plastic composites. Additional products are under development, including fenestration applications, moldings, sidings, and trim.[22]

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[17] LeVan-Green, Susan L., and Jean M. Livingston. 2003. *Uses for Small-Diameter an Low-Value Forest Thinnings.* Ecological Restorations. Vol. 21, No. 1. p 35

[18] Personal communication, Richard Widmann, U. S. Forest Service, November 2006.

[19] This referes to the lumber resawn from a cant, a wedge-shaped block of wood, especially one remaining after the better-quality pieces of lumber have been cut off from a piece of timber

[20] Janowiak, John J., Harvey B. Manbeck, Roland Hernandez, and Russell C. Moody. 1997. *Red Maple Lumber Resources for Glue-Laminated Timber Beams.* Forest Products Journal. Vol. 47, No. 4. pp 55-64

[21] http://www.trex.com/products/whatistrex.asp, Winter 2006

[22] Smith, Paul M., and Michael P. Wolcott. 2006. *Opportunities for Wood/Natural Fiber-Plastic Composites in Residential and Industrial Applications.* Forest Products Journal. Vol. 56, No. 3. pp 4-11

Fuelwood Pellets

Wood has been used as a fuel very likely as long as humanity has had access to fire. Wood in a variety of forms and shapes, both as a natural and a manufactured product, is still widely used as fuel. Wood in its natural form is available in fireplace and stove lengths and as chunk-wood, chips, shavings, and sawdust. Manufactured forms of wood fuels include pellets, briquettes, and manufactured fireplace logs.

Wood fuels can be harvested directly from the forest or recovered as a residue from logging, as a by-product from the primary and secondary forest products industry, or as a waste stream from urban areas. Logging residues include the tops and branches of harvested trees and the noncommercial trees not harvested. The by-products of the forest products industry include a variety of coarse materials, such as ends and slabs, and fine materials, such as chips, shavings, and sawdust. Urban wood wastes include tree trimmings, a variety of commercial wastes (used wire spools, pallets, wood crates, etc.), and the woody fractions of construction and demolition debris and municipal solid waste.

Presently, wood fuels are used in a large variety of applications, from homes to utility power boilers. The primary residential use of wood fuels is space heating, though wood fuels can also be used for heating hot water and for cooking. Wood fuels likewise are used in a variety of commercial and institutional facilities, including stores, theaters, schools, community centers, and government buildings. Manufacturing plants, including the forest products industry and others, also use wood fuels as a source of process heat and power. A number of wood-fired power plants operate throughout the country as well.

Wood fuels have several advantages when compared to fossil fuels. If grown and harvested in a sustainable manner, wood fuels can be a renewable resource. What little net carbon dioxide is added to the atmosphere from combusting wood fuels results principally from the use of fossil fuels to transport those wood fuels. In contrast to residual fuel oil and coal, wood contains virtually no heavy metals and only a trace amount of sulfur, both serious environmental pollutants. Combustion of wood fuels generates little ash and that ash is sufficiently benign so that wood ash can be used as an agricultural soil amendment.

One of the chief disadvantages of unrefined wood fuel is its moisture content. When wood is burned, any residual water first evaporates, and this heat of evaporation is heat lost. Thus, the wetter the wood, the lower the net combustion efficiency. Freshly harvested wood, for example, typically has a green-weight moisture content of about 50% and a net combustion efficiency of 67%, while, in comparison, firewood air-dried to a green-weight moisture content of about 20% has a net combustion efficiency of 77%.

The other chief disadvantage of unrefined wood fuel is its density. Crudely compared with coal, for example, green wood chips have about one-third the energy density and about one-third the bulk density—altogether, one-ninth the total Btu's per cubic foot. This disadvantage translates directly into higher transportation, handling, and storage costs. It follows, then, that wood fuel can be refined by reducing its moisture content and increasing its density. "As wood is refined into other forms, its value as a fuel increases. Benefits of refining include ease of handling, transportation, and storage; improved durability; burning with increased efficiency;

lower variability; and higher energy density." [23] Examples of refined wood fuels include manufactured fireplace logs, briquettes, and pellets.[24]

Manufactured fireplace logs typically are intended for use in conventional, open-hearth fireplaces and, as such, their appeal is as much, if not more, for the ambiance as for the heat they provide. Briquettes, because of their uniform shape and size, can be used as stoker fuel in industrial or power boilers, although, in residential applications, briquettes are usually reserved for specialty uses, such as outdoor barbeque grilling. Fuelwood pellets currently are used in residential, commercial, and institutional uses, though mostly for space heating. Of these three manufactured wood fuels, fuelwood pellets likely will find the widest and most beneficial use.

By-products from the forest products industry—in particular, sawdust—and recycled urban wood wastes currently are the usual sources of wood for manufacturing pellets.[25, 26] Whatever the source, the raw material for manufacturing pellets is first ground or pulverized to a uniform size and then dried to a specific moisture content. The pulverized and dried wood is then forced under pressure through a press, compressing the wood into dense pellets. During this process, the pellets are heated causing the lignin naturally occurring in the wood to plasticize. Afterwards, the pellets are cooled and the lignin hardens to bind the pellet together.

The Pellet Fuels Institute maintains the following standards for residential pellet fuel: bulk density, no less than 40 pounds per cubic foot; maximum diameter, from 1/4 to 5/16 of an inch; maximum length ranging from ½ to 1 inch; fines (1/8 inch minus), no more than 0.5% by weight; and sodium content, no greater than 300 parts per million. Standard-grade pellets will contain less than 3% ash and premium-grade pellets, less than 1% ash. Pellets manufactured under these standards for home heating thus will be uniform in size, shape, and density and in moisture and energy content. These pellets, for example, will have nearly twice the energy density and twice the bulk density of green woodchips. Properly designed, operated, and maintained stoves burning these pellets can be expected to achieve a net combustion efficiency of about 83%.[27]

There are important advantages associated with fuelwood pellet transportation, storage, and handling. "Pellets pose none of the explosion risks or environmental pollution from spills as nonrenewable fossil fuels do." [28] Transportation is not volume limited as with green woodchips, meaning a truck can be loaded with fuelwood pellets within highway weight limits with room to spare. Pellets, being densified, require relatively less storage space. Pellets may be stored and conveyed by screw auger without the bridging that occurs with handling green wood chips, and the properly-stored low-moisture pellets won't freeze into solid masses in the winter.

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[23] Bergman, Richard, and John Zerbe. 2004. *Primer on Wood Biomass for Energy.* USDA Forest Service, Forest Products Laboratory. Madison, Wisconsin.

[24] This discussion ignores torrified wood and charcoal, both of which also are manufactured wood fuels. Torrified or retified wood is the product of partial pyrolysis, which drives off virtually all the moisture and a limited amount of the volatile organic compounds in wood. Charcoal is the product of a more complete pyrolysis, leaving behind mostly fixed carbon. Both torrified wood and charcoal find only very limited use as fuels in this country.

[25] http://www.energex.com/common/wood_energex.php, Winter 2006

[26] http://www.pelletheat.com/pellets/index.php, Winter 2006

[27] http://www.pelletheat.org/2/index/index.html, Winter 2006

[28] http://www.pelletheat.org/3/residential/brochure.pdf, Winter 2006

A large number of companies now manufacture pellet-burning stoves in several sizes and types for a variety of applications. Recently, stoves have been purchased and installed in increasingly large numbers in the northeastern United States, causing a steep rise in the demand for pellets. The Pellet Fuel Institute currently lists sixty manufacturers of fuelwood pellets across the United States, including ten companies in Pennsylvania and one in New Jersey. [29]

Fuels and Chemicals from Woody Biomass

There are three commonly accepted ways, used singly or in combination, to break down wood into its constituent chemicals—using thermal, chemical, and biological processes. Gasification and pyrolysis are examples of thermal processes using heat to break down wood into some combination of gases, liquids, and solids. Acid hydrolysis is an example of a chemical process that converts hemicellulose and cellulose into the five- and six-carbon sugars that are the basic building blocks of these two materials. Enzymatic hydrolysis is an example where biologically-derived enzymes are used to convert hemicellulose and cellulose into sugars.

Gasification and Pyrolysis. Wood distillation, the forerunner of modern pyrolysis technology, is an ancient art and wood was an important feedstock for the manufacture of wood alcohol and other fuels and chemicals through the early 1900's. Due to their relative low cost and high quality, however, natural gas and petroleum soon after became the feedstocks-of-choice for such fuels and chemicals. Only after the oil shocks of the 1970's, when supplies of oil were disrupted and the cost of oil began to substantially increase, was there a surge in technical and commercial development of wood gasification and pyrolysis technologies.

If wood is sufficiently heated in the presence of enough oxygen (the oxygen in air, for example) the wood catches fire and burns, the common process called combustion. If wood is heated in the presence of little or no oxygen (at a minimum, less than required for complete combustion), one of two outcomes will occur. With more heat, the wood will gasify; with less heat, the wood will pyrolyze. The immediate products of gasification and pyrolysis are some combination of gases, liquids, and solids. Slow pyrolysis produces more solids; fast pyrolysis, more liquids; and gasification, more gases.

The principal product of gasification is synthesis gas (syngas).[30] Syngas is composed mostly of hydrogen, carbon monoxide, carbon dioxide and, if the source of the oxygen used in the gasifier is air, also a substantial amount of nitrogen. The hydrogen and carbon monoxide in syngas can be burned as a fuel or, in the presence of certain catalysts, can be converted into other products—gaseous and liquid fuels, such as methane (the principal component of natural gas) or methanol (wood alcohol), or a variety of commodity chemicals and chemical intermediates.

"Low-energy gasifiers are now commercially available, and dozens of small-scale facilities are in operation." [31] Small, modular biomass gasifiers, such as those manufactured by Community Power Corporation, are emerging as a promising technology for generating electric power or for cogenerating heat and power in rural areas, either where power prices are very high

[29] http://www.pelletheat.org/3/residential/fuelAvailability.cfm, Winter 2006
[30] The principal by-products of gasification, depending on the technology used, are varying amounts of ash and char.
[31] http://www1.eere.energy.gov/biomass/large_scale_gasification.html, Winter 2006

and/or where there is no local power supply available. These small, modular gasifiers typically produce enough syngas to generate from five to 50 kilowatts of electric power. Larger systems, generating upwards of five megawatts, are also under commercial development.

The products of pyrolysis are a mixture of gases, liquids, and solids. Heat drives off the volatile hydrocarbons, leaving behind a char. The mixture of longer-chain, volatile hydrocarbons produced by pyrolysis together comprise a tarry liquid, called pyrolysis oil or bio-oil. The mixture of shorter-chain hydrocarbons together comprises a gas. Each of these materials ultimately can be used as a fuel and the liquids and gases also can be used as sources of chemicals.

"Fast pyrolysis has now achieved a commercial success for production of chemicals and is being actively developed for producing liquid fuels." [32] Several large-scale commercial fast-pyrolysis facilities have been built in the United States and Canada by the Ensyn Group of Wilmington, Delaware.[33] A smaller, transportable device is under commercial development by Renewable Oil International in Alabama.[34]

Acid Hydrolysis. Acid hydrolysis is a chemical process for breaking down cellulose and hemicellulose into the sugars that are the basic building blocks of these two materials, cellulose into glucose, a six-carbon sugar, and hemicellulose into glucose and several five-carbon sugars, principally xylose. Two industrial processes, one concentrated acid hydrolysis and the other diluted acid hydrolysis, were developed and have been in use since the late 1800's to convert wood into fermentable sugars.

In the case of concentrated acid hydrolysis, the woody biomass feedstock is first cleaned, dried and reduced in size. The woody biomass may be further treated to loosen cell walls. The pretreated biomass feedstock is then exposed to concentrated acid which decrystallizes the biomass, separating it into its principal constituents—cellulose, hemi-cellulose, and lignin. The cellulose and hemicellulose are then reacted with water (hydrolysis) to break those polymers into sugars that are their basic building blocks. Afterwards, the remaining solids, lignin and residual cellulose, are first separated from the acid-sugar mixture before the sugars in solution are finally separated from acid. The lignin and residual cellulose can be used further as a chemical feedstock or boiler fuel, the acid is recycled back to the process, and the sugars are available for fermentation.

In the case of dilute acid hydrolysis, decrystallization and hydrolysis are accomplished in two separate stages. "The first stage can be operated under milder conditions, which maximize yield from the more readily hydrolyzed hemicellulose. The second stage is optimized for hydrolysis of the more resistant cellulose fraction." [35] Otherwise, the two processes are similar.

Concentrated acid hydrolysis has been used on a large scale at times in the past, particularly in Russia and in Japan during periods of national crisis when ethanol was otherwise unavailable. Only in more recent times have technical advances in the separation of sugars and acid made commercialization of this technology more likely possible. Two companies, Arkenol

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[32] http://www1.eere.energy.gov/biomass/pyrolysis.html, Winter 2006
[33] http://www.ensyn.com, Winter 2006
[34] http://www.renewableoil.com, Winter 2006
[35] http://www1.eere.energy.gov/biomass/dilute_acid.html, Winter 2006

and the Masada Resource Group, currently are working to develop large-scale demonstration facilities. Arkenol is developing a project in California focusing on using agricultural wastes, in particular rice straw, as a feedstock for making ethanol. Masada is developing a project in New York focusing on using the ligno-cellulosic fraction of municipal solid waste as a feedstock.

The past use of dilute acid hydrolysis shares some similarities with that of concentrated acid hydrolysis, with plants operating intermittently during the last fifty years in Germany, Japan, and Russia.[36] Recent technical improvements of reactor designs have made commercialization more likely possible. BC International is currently working to develop a large-scale demonstration project in Louisiana focusing on using sugarcane bagasse as a feedstock.

Enzymatic Hydrolysis. In enzymatic hydrolysis, a mixture of enzymes, generically referred to as cellulases, is used to break down the cellulose and hemi-cellulose found in woody biomass into fermentable sugars. These enzymes are metabolic products naturally occurring in certain species of fungi. Initially, enzymatic hydrolysis was intended to be used in lieu of cellulose hydrolysis in an overall process referred to as separate hydrolysis and fermentation (similar to the process described above for dilute acid hydrolysis).

Research into and development of enzymatic hydrolysis continues with the goal of improving cellulase activity, production efficiency, or some combination of the two. The enzymatic hydrolysis process, indeed, has been improved so that hydrolysis and fermentation can be accomplished together in a single step, referred to as simultaneous saccharification and fermentation, reducing the amount of equipment required and improving the performance of the overall process. More recently, the simultaneous saccharification and fermentation process has been further improved so that multiple sugar substrates can now be fermented together.

The major goal for the program funded by the U. S. Department of Energy has been to reduce the effective costs of using cellulase enzymes, whether by reducing enzyme production costs or by improving enzyme performance. Four years into separate projects, both Genecour International and Novozymes report "over ten-fold decreases to an effective cost of below $0.50 per gallon of ethanol produced. Continuing work is expected to further reduce cellulase costs to about $0.10 per gallon of ethanol [produced]…." [37]

With continuing successes in R&D activities, commercialization of enzymatic hydrolysis technology nears. Iogen Corporation has built a demonstration plant in Canada that now produces ethanol for blending with gasoline. Iogen considers this plant "a final proving stage prior to the rollout of full-scale commercial plants. The company is working with its partners to finalize [commercial] plant locations." [38]

Three Specific Opportunities Appropriate for Maryland and Delaware

Expanding existing businesses or starting new ones presents the classic chicken-and-egg dilemma. If established businesses are to expand or new ones are to start, then there must be a sufficiently large supply of residues, by-products, and wastes suitable to the needs of these

[36] http://www1.eere.energy.gov/biomass/dilute_acid.html, Winter 2006
[37] http://www1.eere.energy.gov/biomass/cellulase_cost.html, Winter 2006
[38] http://www.iogen.ca/news_events/press_releases/2004_04_21.html, Winter 2006

businesses. Likewise, if there is ever to be a dependable, well-developed supply of raw materials, then there must be a sufficiently strong enough demand to attract the producers and handlers of these materials. Supply cannot easily exist in the absence of demand or vice versa.

One solution to short-circuiting this dilemma is to increase demand for the raw materials that can be readily supplied by existing sources to generate the income that will encourage producers and handlers to further divert their supplies of residues, by-products, and wastes from existing markets and dedicate them to the new users. In the short term, products can be made from the raw materials that are readily available and existing business can then be expanded and new businesses created to anticipate the future supply of raw materials.

Near-term Opportunities. The most immediate opportunity for expanding the use of wood residues on the supply side of the supply-demand equation is the formation of a cooperative created specifically to represent smaller tree service companies. The immediate benefit to the tree service company could be shared marketing and other overhead costs, but the primary benefit would be an expanded and stable—hence a more reliable—supply and uniform sales terms and standards for the materials that the timber tree service companies produce.

Raw materials also might be brought to market more cost-effectively through the creation of a limited number of concentration yards strategically located between supply and buyer.[39] The concentration yards would allow the tree service companies temporarily to stockpile different types of materials, allowing fuller loads and more cost-effective transportation, to the benefit of both buyer and seller. With concentration yards, tree service companies could temporarily store and stockpile the occasional saw or veneer log harvested until a large enough load could justify the cost of hauling these higher-valued materials to more-distant markets.

On the demand side of the supply-demand equation, wood-plastic composites perhaps offer the greatest near-term opportunity for creating new businesses. Given the high population density of metropolitan areas and the high cost of municipal waste disposal, a thriving recycling business has arisen which easily could be the supplier of recycled plastics. Again, given the high population density, there is a thriving business in building new homes and maintaining older ones. A number of products made from wood-plastic composites—decking, railings, fenestration applications, moldings, sidings, and trim—could find use in home construction and maintenance. Further, the State might stimulate the creation of this new business by requiring the use of wood-plastic composites in markers and signs along State highways and in parks and other recreational facilities owned and operated by the State.

Fuelwood Pellets. Some of the residues, by-products, and wastes generated in Maryland and Delaware could be used to manufacture fuelwood pellets and the fuelwood pellets used to displace the use of LPG (liquefied petroleum gas) for home heating, especially in homes in rural areas. The benefits of displacing the consumption of LPG with fuelwood pellets to heat homes are reducing domestic consumption of imported fossil fuels, keeping economic benefits in the

[39] A concentration yard similar in some ways to what is suggested here has been operated for several years by Citiwood Works near Trenton, New Jersey.

State, and reducing both carbon dioxide emissions from burning fossil fuels and the contribution of those emissions to global warming.

According to the Energy Information Administration, households in the Northeast census region, which includes Maryland and Delaware, consumed on average 469 gallons of LPG per year per household for space heating in 2001.[40] Assuming

a. that the higher heating value of fuelwood pellets is 8600 Btu's per pound and the green-weight moisture content of the wood is about 45 percent,

b. that there is a rough equivalency in combustion efficiencies for both fuels (near enough about 80 percent for each), and

c. that only about 60 percent of fuel value of forestry residues is recovered and ends up getting made into fuelwood pellets, [41]

then the more than 350,000 tons of forestry residues generated in Maryland per year would have a fuel value equivalent to the LPG used to heat nearly 45,000 homes.

According to information available from the U. S. Bureau of the Census, 61,262 households in Maryland heated their homes with LPG in the year 2000.[42] Therefore, the use of mill by-products to make fuelwood pellets as just shown would produce enough fuel to displace nearly three-fourths of all the LPG consumed for space heating in Maryland homes that year. Using the same assumptions and analysis for Delaware and assuming that the State government would permit wood pellets to be burned as home heating fuel, then the pellets made from the 48,000 tons of forestry residues generated in Delaware per year would displace the consumption of LPG in heating an additional 5,900 homes.

Cellulosic Ethanol. Cellulosic ethanol is undergoing a period of intense interest as production and use of grain-based (primarily corn) ethanol has shown to have some negative consequences. The first of these is that increased demand has driven up the price per bushel of corn to new highs. This has caused price increases in chicken, beef, pork, eggs, and milk products. Nationally, more than 16 million new acres of corn has been planted to meet market demand. In Maryland alone, more than 200,000 new acres of corn has been planted. Moreover, corn loses more nitrogen per acre than most crops and its increased planting by farmers may cause further pollution problems for the Chesapeake Bay. Of course, other steps can be taken to reduce this nitrogen run off issue but increased planting of corn will no doubt exacerbate the Bay's current pollution problem.[43]

One of the ways that both the Federal Government and the private sector are addressing this problem is with ethanol based on cellulosic feedstocks. This has demanded the development of new processes and techniques, and much of this developmental effort is still in process.

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[40] http://www.eia.doe.gov/emeu/recs/byfuels/2001/byfuel_lpg.pdf, Winter 2006

[41] including recovery rate from the forest, use of some of the fuel value for drying green biomass recovered from the woods, and efficiency of pellet manufacture

[42] DP-4. Profile of Selected Housing Characteristics: 2000, Data Set: Census 2000 Summary File 3 (SF 3) - Sample Data, Geographic Area: Maryland.

[43] Washington Post, August, 26, 2007, *"How Corn Ethanol Could Pollute the Bay*",

The goal is to drive the price down to an acceptable level so cellulose ethanol can compete in the fuels marketplace without subsidies.

Battelle Memorial Laboratory published a recent report entitled "Near Term U.S. Biomass Potential" which looked at a national scenario with a target of producing 50 billion gallons of ethanol per year from cellulosic biomass feedstocks. "The primary biomass supply would consist of waste biomass streams plus the production of energy crops." However, the waste biomass was estimated to supply between 40 to 50 percent of the necessary feedstock.[44] The wood wastes within the State and within the region could go a long way toward meeting at least the State's needs with regard to ethanol production.

A recent article indicates that gains are being made in the output of the cellulosic ethanol conversion processes and that production yields actual are already at 70 gallons per ton of feedstock and in one case, the production has been projected up to 114 gallons per ton.[45]

Maryland consumes close to 2.7 billion gallons of gasoline per year.[46] Also, anhydrous, fuel-grade ethanol only has about 66 percent of the energy content of gasoline on a volume basis.[47] As a result, it is not a direct gallon to gallon replacement but has to be looked at on an energy replacement basis. If we only used the lowest priced urban wood wastes in the State and looked at converting it to ethanol, we would have 341,000 tons of feedstock which could be converted at a 70 gallon per ton rate using current technology which would yield 23,870,000 gallons of ethanol. This would replace, on an energy basis, approximately 15,800,000 gallons of gasoline per year. If higher delivery prices are assumed for all the wood residues within the State, the upper limit on cellulosic ethanol replacement of gasoline would be nearly 40 million gallons a year from just wood residue materials. Obviously other feedstock materials like switchgrass could add to the total output of any cellulosic ethanol production facility.

Cellulosic ethanol from wood wastes will not solve all the current energy issues with mobility fuels, as it will take multiple fuels and supply sources to actually solve the mobility fuel problem in the long run. However, each dollar spent on ethanol produced and used in the State is a dollar that stays in the State rather than sent to a foreign-based fuel supplier. When a dollar stays in the State from manufacturing activity, we gain the multiplier effect of the direct, indirect and induced employment. This will help strengthen the State and regional economy not just for one year but for each year into the future.

[44] BioCycle, May 2005, eNews Bulletin
[45] Green Car Congress, 15 July 2006
[46] EIA State Energy Profiles (http://tonto.eia.doe.gov/state/state_energy_profiles.cfm?sid=MD)
[47] DOE Clean Cities, (http://www.eere.energy.gov/afdc/altfuel/fuel_properties.html)

PART III

OPPORTUNITIES FOR THE CREATION OF NEW MARKETS AND THE EXPANSION OF EXISTING MARKETS FOR THE PRODUCTS MADE FROM WOOD RESIDUES, BY-PRODUCTS AND WASTES

Given the specific product opportunities discussed above and the markets that they represent, the project team applied a variation of a modified Delphi process to provide a real world state and regional market outlook. The modified Delphi process was implemented through the use of a structured questionnaire prepared to establish a series of rankings of the potential product markets based on expert input.

The expert input was provided by using a contact listing of individuals in the state and region that already work in the forestry and wood products area. An example of the wood waste questionnaire is contained in the appendix. A complete listing of those receiving the questionnaire is also contained in the appendix.

The questionnaire was sent out by both e-mail and by regular mail. Responses to the questionnaire were handled in a confidential manner after receipt by giving each a serial number: no other identification was attached that would tie a specific response to any given individual responder. This was done to ensure each responder would feel absolutely free to provide their personal opinions and choices on the questionnaire without fear of their specific response being divulged.

Given the topics covered in the questionnaire that relate to products and markets, the report will step through each of the topics and questions asked because they are directly related to any next steps that could be taken by both government and private industry to bring about a higher value use of wood residues, by-products, and wastes.

The first question asked of the expert group was: *"Do you believe that there are sufficient wood waste resources in your state to support the expanded and economically beneficial use of this biomass resource?"* A full 100 percent positive response was obtained. This response supports our original contention that there was ample opportunity to take and upgrade the value of these biomass raw materials that may be landfilled or used as mulch in some cases.

The second question was: *"Do you believe that in order to support an expanded use of wood waste and adequately support a wood waste based state industry a more regional, not state-centric, supply approach is necessary?"* Our response indicated that a full 91 percent indicated yes. Our interpretation is that the State may be a market but it is not a market unto itself for these feedstock materials and the products that can be made from them. A regional perspective could help in ensuring that there is a minimum of overlap in manufactured products and demand is not exceeded locally for any particular feedstock type. This more coordinated approach would allow a more efficient market expansion with reduced risk and at a lower cost.

Question three dealt with expert opinion regarding the potential wood waste-based product value: *"How would you rank order the following product areas for higher value use of wood wastes within your state?* (Please use numbers with one being the highest ranking and moving down in importance with the higher numbers)?" The products ranked included:

a. Wood stove or boiler fuel pellets,

b. Composite decking

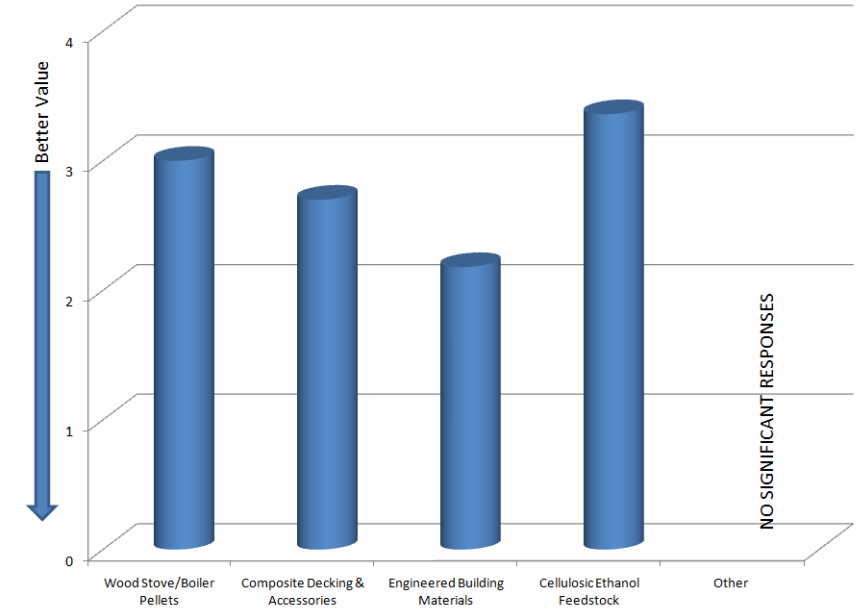
c. Engineered building materials, glulam structural lumber, wood plastic composite structural lumber, wood plastic composite fenestration components, wood plastic composite signage, etc.,

d. Feedstock for cellulosic ethanol production

e. Other end-use, product, or market that you want to suggest and insert in rank order?

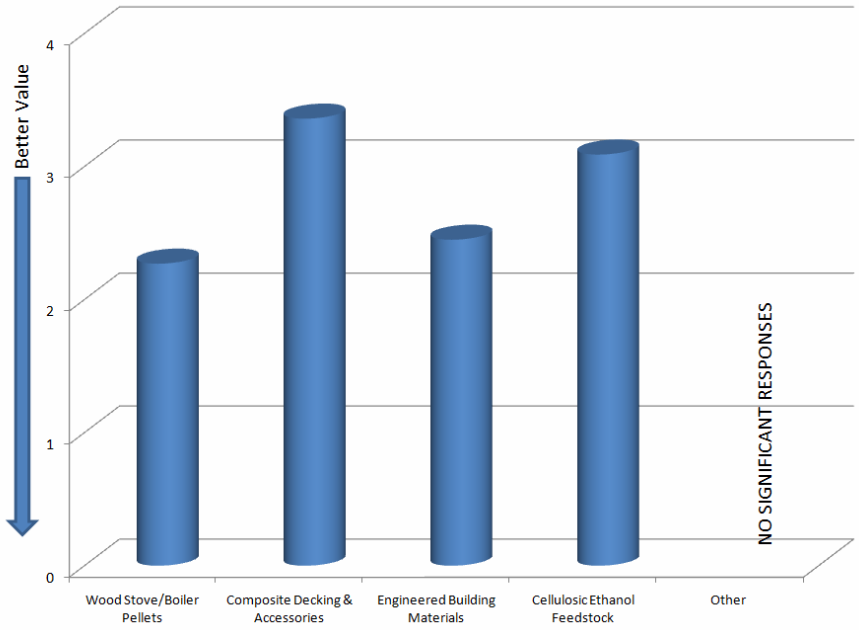
In order to show a relative ranking, responses were averaged in each of the product categories, with one being the highest ranking that could be achieved. Figure 3-1 shows the relative rankings. The engineered building materials ranked the highest based on our survey. The "other" category was not ranked as we received a range of others that went from the highest to the lowest but in almost every case it was only noted by one or two responders. For example, hog wood for industrial boilers and wood chip fuel to fire an ethanol plant, mulch (a currently large but seasonal market), pulp and paper feedstock were among those listed in the other category. These "other" markets are currently mature for the State and were not stressed by more than one or two of the responders.

Figure 3-1. *Question No. 3 Responses on Highest Value Product Uses, Averaged Date, (with lower number representing better value use)*



Question number four took the potential products one step further by asking; *"Using the same four product areas how would you rank order them regarding commercial potential in the near term (next five years) for your state? Commercial potential includes the size of the regional market and a positive impact on state employment."*

Figure 3-2. *Question No. 4*
Responses on Product Commercial Potential within the Next Five Years, Averaged Date (with lower number representing better value use)



Again responses were averaged to determine the responders' collective option on the priority of these product areas. Figure 3-2 depicts these results.

The results do not quite parallel the earlier results from Question Three but they do indicate that the best early markets are represented by technologies which are already in use and require no new development and further commercialization. The fact that cellulosic ethanol is lagging the other products is unsurprising, as the technology is still maturing and holds great potential in the mid to longer term. Pellet fuel makes sense, as the market is increasing based on the competitiveness of this fuel for home heating relative to oil, gas, propane, and electricity. Not surprisingly, some of our research established that neighboring states have pellet fuel production facilities while Maryland has none. In fact, West Virginia already has two pellet fuel production facilities and is currently undertaking a sponsored market study to see if a third plant is warranted. There are currently two pellet plants in Virginia and ten in Pennsylvania.[48] It has been estimated that currently about 800,000 homes within North America are heated by pellet stoves. Given that there are rural areas in Maryland that heavily rely on propane for home heating, continued expansion of pellet fuel opportunities can be expected if fossil heating fuels maintain or stay near their current pricing.

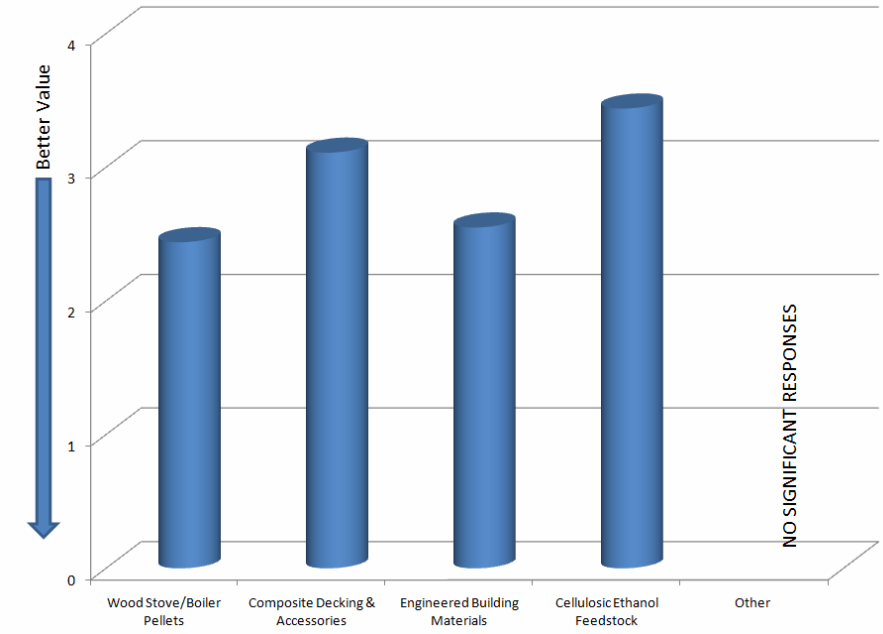
Composite decking is a product area with a significant growth potential given the lower maintenance associated with this building material and the resulting environmental and life cycle cost benefit. The building industry is promoting these composite decking materials as can be

[48] Pellet Fuels Institute

seen from recent building industry publications. [49] Engineered building materials are also a growth area that could be addressed if the state can attract a manufacturing facility that produces these products. The issue of the manufacturing base to take advantage of the wood wastes and produce composite decking or engineered building materials was contained within a written response to Question 4 and is a valid concern.

Question 5 again focused on product areas. In this case, we asked the reviewers to give us their opinions on the relative investment or business risk of these product areas. The question asked: *"Using the same product areas, how would you rank order them regarding investment/business risk. (Please use numbers with one being the lowest risk ranking and moving up in risk with the higher numbers.)".* The responses were again averaged to come up with a relative ranking among the choices. Figure 3-3 depicts these relative results on investment/business risk.

Figure 3-3. *Question No. 5*
Responses on Product Investment/Business Risk (with lower number representing lower risk)



The results from the group of experts was almost as expected based on the research team's own experience and understanding. The only surprise was the risk factor for composite decking being higher than that for engineered building materials. As expected, the cellulosic ethanol risk was at the higher end of the risk scale. Not shown within Figure 3-3 are several other market areas that were supplied by the responders that already exist as proven markets within the state. These included wood chip and hog fuel for larger commercial and industrial boilers and mulch. These "Other" category uses are all low risk and proven markets.

Given that the responders included business and government agency professionals, the research team felt it important to see if the business professionals thought of wood wastes and residues in purely economic and business terms. The following (Question 6.0) was asked to see if that was the case; *"In your opinion do you believe that the goal of any expanded wood waste program should not just be based on pure economic and financial benefits but also include a longer term energy and environmental benefit justification as well?"*

[49] The Best of Fine Homebuilding, Summer 2007, "An Explosion of Decking Choices", page 26

All of the responders answered that the energy and environmental justification is necessary. Written comments included that any specific program or project, however, must be financially self-sustaining in the longer term. This then brings in the question of the public environmental benefits of such a program/project and the possible role of government to assist in developing the markets, technology, etc. to increase the beneficial uses of the wood waste feedstock. This was also addressed in a specific question within the questionnaire that will be discussed later.

Question 7.0 was framed to address access to capital related to expanding the waste wood industry within Maryland. The question asked; *"In your opinion do you believe that capital availability is now limiting the commercial expansion of higher value uses of wood wastes within your state?"* The responses to this question were almost evenly split between the "yes" and "no" with approximately 45 percent responding "yes" and 46 percent responding "no". The balance of the responders, 9 percent, said that they were not sure.

Question 8.0 was developed to highlight the issue of concentrating the wood waste resources in a manner that would reduce costs to any end user of this feedstock. The question asked was, *"In your opinion do you believe that a wood waste suppliers/sellers cooperative could provide an organizational element that would allow for the setup and management of wood waste concentration yards? (This type of storage and concentration facility would assist waste wood end users by ensuring a pre-sorted and adequate supply of feed stock as well as minimize the number and length of their supply truck trips.)"*

The responses to this question were positive with 64 percent in favor of this concept. One party responded with a "maybe" and that it depended on the setup of the cooperative.

The next question, Question 9.0 was based on the issue of whether sufficient technology currently exists to really maximize the potential of wood wastes. The question simply asked; "*In your opinion do you believe that there is a technology availability issue in converting wood wastes to higher value uses/products."* Approximately 55 percent of the responders felt that there is a technology availability issue in converting the feedstock to a higher value end product.

The team next asked, in Question 10, which product areas need additional technology development and implementation. This, of course, was only answered by those who thought there was a technology issue. This reduced the sample size down to 55 percent of the respondents. The question was asked in relation to the product areas that were covered in the earlier portion of the questionnaire. The question was; *"If you answered "yes" in Question 9, please indicate where you believe the technology shortfall is with regard to the following product areas by placing a check-mark where you believe the technology requires more development and more maturity".*

The products/markets covered in this question were the same as used in the earlier sections of the questionnaire and included:

a. Wood stove or boiler fuel pellets,

b. Composite decking

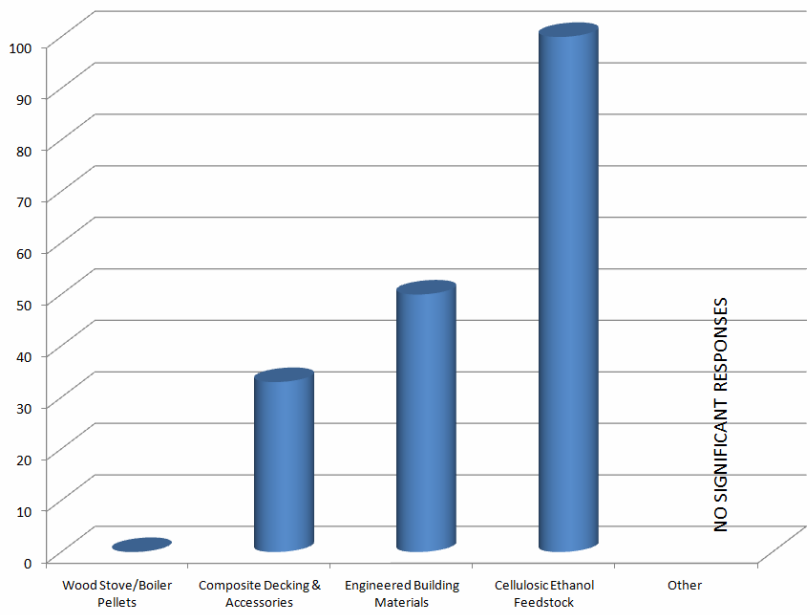
c. Engineered building materials, glulam structural lumber, wood plastic composite structural lumber, wood plastic composite fenestration components, wood plastic composite signage, etc.,

d. Feedstock for cellulosic ethanol production

e. Other end-use, product, or market that the responder felt needed additional technology R&D or availability

Figure 3-4 illustrates the percentage of those that thought additional technology related to the products and markets in question should be made available and/or be proven more mature to enable a growing market.

Figure 3-4. *Question No. 10*
Responses on Product Technology Shortfall, Percentage of Respondents Suggesting More R&D and Technology Maturity is Required



The respondents felt that the wood stove and boiler fuel pellet technology was sufficiently mature that no technology shortfall existed. The remaining product/market areas all were found by the respondents to require a higher level of demonstrated technology or technology maturity. Regardless of the time composite decking and composite building products have been in the market, it appears that knowledgeable individuals still believe that more technical investment and effort is required to move wood wastes into the bigger and higher value markets.

The research team next addressed the area of governmental resources that could be tapped to help move the technology, markets and products forward. The question was phrased so all levels of government would be considered (local/county, state and Federal). Question 11 asked the following; *"Do you think there are untapped organizational resources at the following levels that could assist in bringing about better uses and more economically attractive waste wood uses within your state?"* A simple "yes" or "no" was requested from the respondents.

The categories of government were as follows:

a. County Government

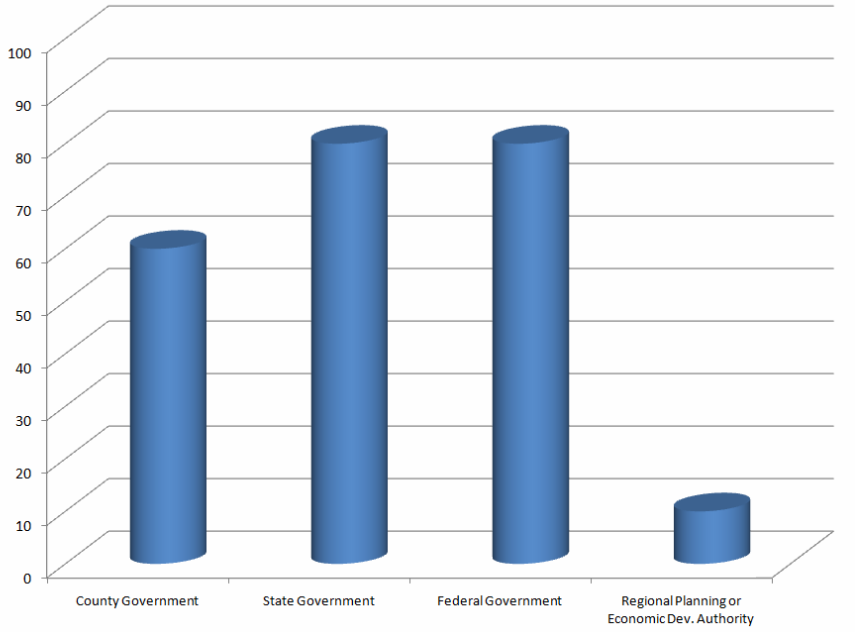
b. State Government

c. Federal Government

d. Regional Planning and Economic Development Organizations

The results shown below in Figure 3-5 were somewhat surprising in that all levels of government got a very positive response on their ability to assist in solving the problem. However, using the term "untapped" also brings into focus that many levels of government are not now engaged or dealing in an organized manner with the wood waste issue.

Figure 3-5. *Question No. 11*
Percentage of Respondents Indicating Availability of Untapped Resources and Assistance from Various Governmental Levels



Question 12.0 was a follow-up to Question 11.0 as it then asked the following: *"Given your response to the above, do you think that a more coordinated approach to the statewide wood waste issue and potential markets is required?"* This, again, was a simple "yes" or "no" question. The response was surprising as 82 percent believed that a more coordinated approach is definitely required. Given that the reference was to "governmental resources" it then begs the question as to coordination between all the responsible levels of government to address this issue.

The next question, Question 13.0, then addressed which types of state-level agencies should be involved. The actual question was asked as follows; *"If you indicated yes, please check which state-level agencies do you think should be involved in a state-level coordinated effort to better use state-based wood wastes?"* The following were the choices that could be checked, and multiple recommendations were accepted.

- Department of Natural Resources
- Department of Agriculture
- Department of the Environment
- Energy Office or Administration
- Department of Business/Economic Development
- State Chartered Technology Development Corporation
- University Research Center or Organization
- All of the above
- Other – added by the respondent, if desired

The results were again interesting as many of the respondents indicated multiple organizations have a role to take or to play in addressing the wood waste utilization as well as its commercial development.

Figure 3-6 depicts a percentage of respondents who selected which types of agencies should be involved and engaged in this issue. What is not shown in this figure is the other recommendation, such as the regional or municipal planning organizations (MPOs, that is municipal public organizations and the agricultural cooperative extension service organizations that exist within most states.) The MPOs do deal with solid waste issues as well as local employment and economic development issues.

Note that in this figure, the State Technology Development Corporation, for example in Maryland it would be the Maryland Technology Development Corporation or TEDCO, did not get any support from the responders.

Figure 3-6. *Question No. 13*
Percentage of Respondents Indicating Agency Type for Involvement in State-Level Coordinated Wood Waste Effort

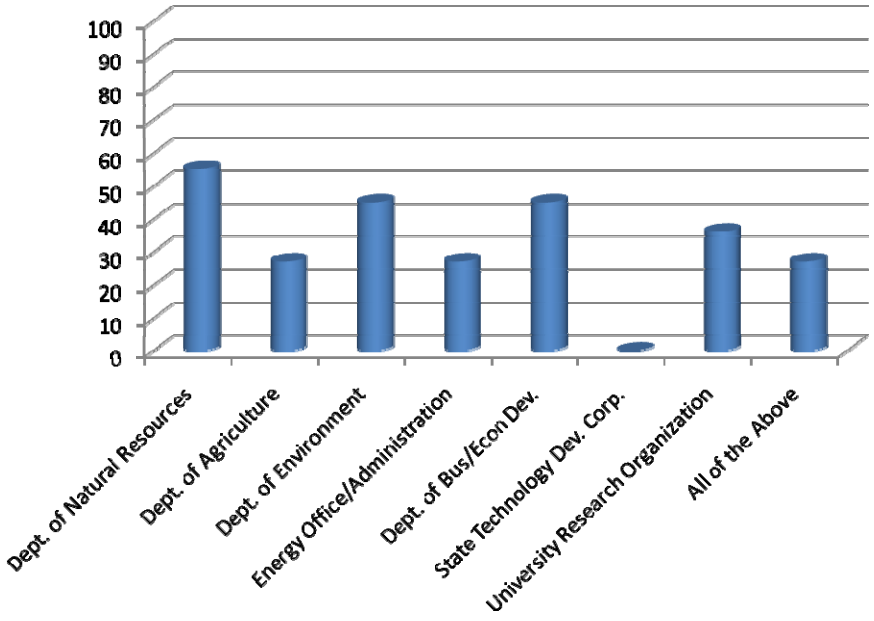
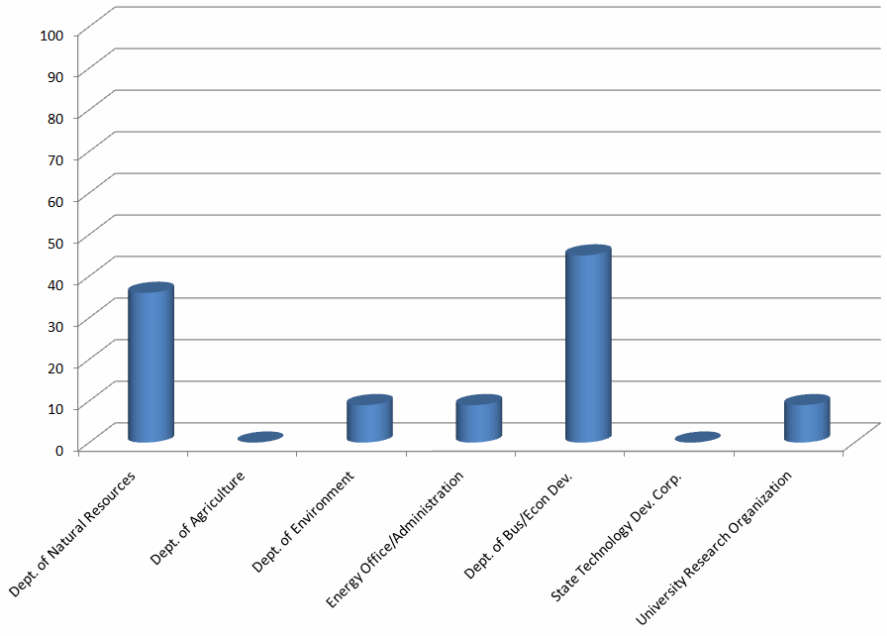


Figure 3-7. *Question No. 14*
Percentage of Respondents Indicating Agency Type for Leadership of State-Level Coordinated Wood Waste Effort



The next question dealt with which governmental organization should take a leadership role in making a coordinated effort actually happen. Question 14.0 was asked as follows: *"If you*

filled in any answers in Question 13.0, please indicate, in your opinion, which state agency "type" might be the correct entity to take the initial lead role in organizing a coordinated approach?" Note that the same agency types were used in this question as in Question 13.0. Figure 3-7 indicates the results for this question.

Note that the Department of Agriculture and the State Technology Development Corporation got no votes for taking a leadership role. The surprising result is that the Department of Business and Economic Development received the highest level of support with the next highest being the Department of Natural Resources. This is somewhat surprising but not unexpected given the business and job issues that this type of agency can address.

Question 15.0 was designed to draw out regional wood waste development and utilization initiatives that the State might be able to draw on for experience or emulate. We did not receive many comments or recommendations in this area. One out-of-state respondents recommended several studies and efforts that were outside of Maryland and out of our region. We fully expected that the States of Pennsylvania, Virginia, and West Virginia would have had a much more aggressive wood waste program beyond their current pellet fuel efforts. However, our survey did not turn up anything directly from our respondents. The question was phrased as follows: *"Within your personal knowledge are you aware of other states (nationally or regionally) which have an exemplary formal program to expand forest products markets which has included upgrading the value of waste wood feedstocks? If so, please provide the aspect of their program that other states could adopt or emulate to provide a similar benefit to your state-based businesses and state citizens. This could be technical assistance, business loans or loan guarantees, assistance with marketing products, etc. Your written response to this question is appreciated."*

In our early research efforts we were somewhat surprised at the fragmentation in the efforts by private sector and governmental organizations when it comes to dealing with wood wastes and viewing these biomass resources as a positive input to higher grade products or renewable energy fuels. The research team's view was that it may be worthwhile to hold some type of formal meeting to bring together all the interested parties and stakeholders. The next question, Question 16, was framed to ask this question of the expert group; *"In your opinion do you think a workshop focused on wood wastes and increasing the economic value from your state's wood waste resources is warranted at this time?"* The response to this question was overwhelmingly positive with 82 percent responding that it would make sense to hold such a meeting, and about 9 percent indicating they were" not sure" and another 9 percent indicating a "no".

The final question asked was about the respondents' potential attendance at such a meeting and was only asked of those that responded in the affirmative to the above question. Question 17 asked, *"If you indicated Yes (in Question 16), would you be willing to be a participant in such a focused Workshop?"* The positive responses to this question were at approximately the 90 percent level. This indicates a high degree of interest and a desire to be involved in any coordinated approach to utilization of waste wood in higher value potential markets.

PART IV
POSSIBLE PUBLIC/PRIVATE FINANCIAL AND ORGANIZATIONAL MECHANISMS FOR INITIATING THE CREATION OF NEW MARKETS AND THE EXPANSION OF EXISTING MARKETS

Public Financial and Organizational Mechanisms

Since the 1980's, state governments have been aware of the potential benefits of using biomass as an energy source. Since biomass is largely considered to be a material derived from vegetable matter, in all of its physical forms it can be captured and harnessed in order to provide a reliable supply of renewable energy. In addition, since biomass is normally associated with either the farming or forestry sectors of the economy, states have begun to recognize the added utility in encouraging the use of biomass, since both the agricultural and forestry sectors of the economy have struggled in comparison with other sectors of the economy.

The interest on the part of states to implement the use of biomass as an energy source has resulted in the establishment of a wide variety of incentive programs, all of which are designed to encourage the greater use of biomass-based materials for the production of energy. Since a comprehensive discussion of every state program is well beyond the scope of this report, the effort at hand will concentrate on the following general areas:

- The first section will provide a discussion of the various types of incentives that have been used by states in order to enhance the use of biomass as a fuel source for producing renewable energy. This section will provide a description of how each type of incentive functions. Since the benefits provided by an incentive are usually related to what it delivers, understanding the incentive types is very important.
- The second section will be more analytical and will explain the various trade-offs between the different incentives. This section will illustrate the differences in incentives both from the standpoint of the provider as well as the recipient. State incentives have trade-offs with respect to what they provide, and there are also administrative differences.
- A third section will provide a brief overview of the types of projects that have been developed as a result of the use of state incentives. This section will conclude with some actual examples of projects that have been developed in various states.

Once we have identified a comprehensive list of potential incentives, we will demonstrate in the final section how these incentives can be integrated into a list of recommended policies designed to enhance the economic value of wood residue within the State of Maryland.

Identification of Incentives

Table 4-1 provides a list of the various types of incentives that have been created by states in order to enhance the development of bio-energy. Tax strategies were deliberately placed at the bottom of the list since greater discussion is needed due to their greater complexity.

Table 4-1. Program Incentives	
Grants	Rebates
Voluntary Programs	Mandates
Loans	Tax Strategies

Grants. The most widely used form of incentive is the state grant. A grant is simply a direct payment to a recipient. The recipient promises to provide some amount of consideration to the state by developing a project requested by the state. While grants provide funding which does not require repayment, they are usually competitive. Competition is created through an RFP [Request for Proposal], which is a public process designed to identify the best possible projects at the lowest possible price. In addition, part of the competition is likely to involve the amount of match funding provided by the recipient. Grant funding normally needs to be approved either through the appropriations process, or through some other area of higher authority. As a result of these factors, an individual grant requires an extensive amount of administrative time on the part of the state.

Voluntary Programs. Voluntary programs have become a very popular form of incentive since there is no cost requirement to the state. Voluntary programs in the bio-power area are most closely linked to the creation of "green-power" programs. In a voluntary program a participant agrees to pay a higher price for the provision of a specific good provided that it is supplied in a previously agreed-upon manner. Individuals who purchase green energy are guaranteed their electric power will be produced only from renewable fuel sources. Instead of a cash payment, therefore, voluntary programs provide a type of "feel good" payment which is more intangible and more difficult measure. Voluntary programs are becoming more popular, however, since there is no expense to the state.

Loans. Loans are a transfer of money to a recipient in exchange for implementing a project requested by the state. Unlike grants, loan funding needs to be returned to the provider. Because money needs to be returned, state governments normally attempt to make this avenue of approach attractive in other ways. Loan incentives have interest rates that are well below the standard market rate. In addition, loan recipients may not necessarily be required to provide as much match funding compared to other incentive systems. The use of loan money in a project is often more restricted and in many cases is limited to the purchase of equipment. States normally employ a strategy of establishing a single loan program through a single administrative request. As a result, while there is still a requirement for budget authorization, this task is limited to a single request. Ultimately, the agency ends up with a great deal of administrative discretion in determining project selection.

Rebates. A rebate is a payment made by the state to a recipient who has normally purchased a particular product. Rebates are contractually associated with a particular item for which the states views as providing some type of public good. In order for the recipient to receive a rebate, the recipient must demonstrate to the state that the agreed upon purchase was actually accomplished. One problem with a rebate system is that the state must establish some type of mechanism for returning the rebate. As a result a rebate system is sometimes less efficient than other incentive types that could be used in the same situation.

Mandates. Mandates are requirements imposed by the state that force others to pay for the incentives. While a mandate creates an incentive it also can create a cost to the provider. As a result, mandates are almost always a product of the political system. When states require the purchase of some type of item or the implementation of some program, the action is non-voluntary. State net-metering programs are an excellent example of mandated programs. In a net-metering program, if an individual agrees to generate electricity from biomass, the individual

is permitted to offset the cost of the electricity purchased from the local utility on a one-to-one basis with the electricity generated from biomass. In this case the incentive is created by the requirement that the utility buy back power at a cost higher than it would normally pay. Because mandates are political in nature, their final composition is usually a product of legislative compromise. Utility companies normally oppose net-metering programs because of the additional cost. Consequently, most states that have net-metering laws also cap the net amount of energy which the utilities are required to purchase thus limiting their cost. In addition, the maximum generation size of bio-power projects under net-metering programs also helps limit utility exposure to excessive costs.

Tax Strategies. Tax strategies are the most complicated of all of the incentive programs created by the states. Grants and rebates, for example, are simple direct transfers to a recipient and therefore have the same impact on different recipients. This is not the case for tax strategies. The reason for this is that each specific tax strategy varies not only on the basis of the individual strategy, but also as a function of the type of recipient engaged in the negotiation. Table 4-2 provides a list of strategies that have been employed by states in order to enhance the use of biomass.

Table 4-2. Tax Strategies
Credits
Exemptions
Deductions
Deferments
Reductions

(Credits) Tax credits, along with exemptions, have long been the most favored means among recipients of funding energy projects of all types. Tax credits can be used to off-set current tax obligations on a dollar for dollar basis. When a recipient is able to accomplish this one to one off-set, the good obtained under this situation is essentially free to the recipient. Because of the way that tax credits function they are a direct cost to the state. Under this incentive system, the state assumes the entire cost of providing the incentive.

Credits can not only be used as repayment for the purchase of goods, but also as an incentive to produce goods. When credits are used for payment on the producer side they are normally referred to as “production tax credits.” On the production side the incentive is designed to encourage expanded production. Many ethanol and bio-diesel production facilities were created as a result of this strategy, but in almost all situations of this type the state limits its financial liability by placing a statewide cap on the total number of gallons eligible for the credit.

(Exemptions) Tax exemptions permit a program participant to purchase goods on a tax free basis. A tax exemption normally requires legislative approval, but once initiated, it is a highly efficient way to provide an incentive since no administrative costs are required. Many states established this form of incentive in order to promote the sale of alternative fueled vehicles. Once an exemption as been established, it benefit is nearly invisible to the state government since usually there is no reporting mechanism.

(Deductions) Tax deductions allow a recipient to off-set a percentage of the tax obligation owed for a particular time period. Since both credits and deductions are applied in the purchase process, it is easy to understand why credits are the favored form of incentive. Normally, providing a tax deduction is a less expensive procedure for government than credits or exemptions.

(Deferments) A tax deferment allows a project recipient to defer paying taxes until some time in the future. While the recipient benefits by being able to delay tax payments, the state also benefits in that some tax payments will eventually be made. New business start-ups sometimes elect to take this type of incentive since they may have higher future costs that can be used to off-set their taxes. Deferments are administratively inefficient, however, and for the most part are not a popular mechanism for developing bio-power projects.

(Reductions) A tax reduction is nothing more than a lowering of the standard tax on a given purchase. Tax reductions can be specified to a given set of items, or they can be set for a specific time period. As a result tax reductions are very target specific. Tax reductions, like all other tax strategies, require legislative involvement.

Incentive Trade-Offs

The incentives provided by state governments in order to encourage projects can be grouped in two broad general areas, supply-side and demand-side incentives. The production side usually involves some type of business or commercial unit while on the product (demand) side the incentive is normally established to encourage consumption. Using these two areas as a framework for analysis, the general trade-offs involved in each incentive program are considered.

Table 4-3. Types of Projects That Have Been Funded Through State Biomass Incentive Programs

AF Vehicles	AF Refueling Facilities
AF & Bio-fuels	Biomass Facilities
Biomass	Biogas
Fuel Cells	Micro-Turbines
Landfill Gas	Anaerobic Digesters
MSW	Methanol
Ethanol	Hydrogen
Biodiesel	Bio-power
CHP Systems	Wood Energy & Stoves

Public data available through the U.S. Department of Energy indicate that most of the projects on the above list were developed through commercial businesses. The vast majority of projects were developed in either the agricultural or forestry sector of the economy. The third largest number of projects was in the transportation sector.

Incentives encompass a wide range of economic strategies. Some strategies work best with large established companies while others provide greater benefits to small and medium sized companies. In some cases, incentives are clearly designed to work on the producer side of the equation, while in other situations they are established in order to encourage greater consumption. Regardless of how individual incentives are used, however, states should be careful to establish aggregate systems with incentives that operate on a consistent basis. Since the category “biomass” covers such a wide range of technical possibilities, State incentive programs are crafted by agencies or legislative committees that may not always communicate on a frequent basis. Fortunately, many states have learned from their mistakes, but in other situations more closely coordinated incentive programs need to be developed.

Supply-Side Incentives. Generally, production projects which produce energy from biomass materials are expensive to build. Projects of this type have normally been built through the use of direct grants, production tax credits or low interest loans, or tax credits. While grants provide a direct injection of capital into the project, they are normally one time opportunities. Production tax credits do not normally provide as much up-front cash, but they remain a valuable revenue stream for as long as the project is functioning. Since grants are a greater initial expense to the state, there is usually a substantial match requirement on the part of the recipient. Because of the cost, grants are normally targeted at specific projects while production tax incentives are a more broad based strategy.

Another major difference between grants and a production tax credit is the out-of-pocket expense required. While most grants require a match, this does not absolutely have to be the case. In the case of production tax credits, however, there will always be a necessary out-of-pocket expenditure required at the outset of a project.

Tax credits work on a completely different basis than the production tax credit or the grant. A tax credit is an incentive that offsets a bottom line tax obligation. In order to benefit from a tax credit the production facility must be funded initially by the recipient without up-front government assistance. Tax credits are therefore more valuable to companies with a high tax burden.

Loans are the least expensive way to provide an incentive, but also they are the least favored among producers. One of the primary problems with loans, aside from the fact that producers must refund the money, is that recipients normally need to meet some type of eligibility requirement. New companies with innovative technology may not be able to qualify for loan assistance.

There are also substantial trade-offs on the government side with respect to the administrative cost. Grants not only have a high initial implementation cost, but once the grant is made a substantial amount of time is required for project oversight. Projects that do not receive the necessary amount of supervision stand a higher risk of failure. States that have experienced a decline in the number of personnel available to manage such projects may elect to use other methods. Loans have an even higher administrative expense, but since the recipient is financially bound to the project the government has a degree of control. Many state governments have had problems, however, with loan defaults from small start-up companies.

What is the best way to encourage the development of energy projects that use biomass as a source of fuel? Again, this becomes a function of the trade-offs discussed above. For a single demonstration project a grant together with a negotiated production tax credit might be the best approach. The grant would help to sustain the initial financing of the project and the production tax incentive would provide long term motivation to complete the project. If a state wants to create an incentive for multiple projects, a production tax credit may be the best method. Production tax credits are tied to the amount of product produced and therefore can apply to multiple projects. Tax credits, loans and grants are directed at a specific target organization. They can work well to get a single project off the ground, but are normally used to product multiple projects. Tax credits work better with large established companies that have heavy tax burdens. Loans are also likely to be a better approach when dealing with established organizations Production tax credits, loans and grants are often provided to mid-sized institutions.

Demand Side Incentives. Tax exemptions, reductions, rebates and voluntary programs have all been used in order to promote the sale of bio-based products. Exemptions, reductions and rebates are similar in that they require legislative approval. The most important difference involves rebates. Since a rebate requires the buyer to take an additional step to obtain a refund, there is an additional administrative cost to the state. States may elect to pay this cost, however, instead of employing a simple tax exemption. By requiring a rebate on a product the state obtains a record of the number of items sold. Exemptions are normally invisible in that there are no reporting features. From an administrative standpoint exemptions and reductions are exactly alike.

Voluntary programs differ most from all other incentive programs. The important thing to consider is that normally they are established as a result of a mandate. Because voluntary programs shift program cost to a potentially unwilling participant they have both political consequences and time limits. Voluntary programs usually expire after a defined period of time.

States have generally used a system of tax exemptions or reductions to promote the use of vehicles that use either ethanol or biodiesel fuels. As a result the data on “in state” sales for these vehicles is incomplete and probably inaccurate. From the public perspective, however, exemptions are a more preferred method for receiving a payback. In some areas these incentives have been sufficient enough to produce side benefits. Some states have experienced ethanol and/or bio-diesel vehicle sales sufficient enough to create the additional incentive of producing refueling facilities. These facilities have been developed without government assistance.

Some states have production facilities that produce bio-based products such as engine lubricant, transmission fluid, or insulation. In order to help sustain these new businesses states have permitted bio-based products to be sold at a reduced tax. One of the controversial aspects of this approach is that critics argue that such products receive favorable tax benefits over competing products already in the market place.

One of the earliest and most successful examples of a voluntary program is the municipal waste recycling system. Initially, government paid some of the cost by providing a subsidy for recycling. Eventually, companies bidding on municipal waste contracts were forced to include a recycling plan. Green power programs work in a similar manner except that power purchasers are required to pay a premium for their energy. Voluntary green power programs have also created spillover benefits in that utilities have elected to build bio-powered facilities.

Because most of the incentives listed above reduce tax revenues, they are likely to be less popular with state legislatures. Voluntary programs not only shift the burden of payments away from the government, but also produce other side benefits. In the future, voluntary programs and mandated programs are likely to be an important strategy for promoting incentives in the bio-power and bio-product area.

Examples of Current Incentive Programs

The final section of this discussion of incentives will provide some examples of programs currently being implemented by states in the Northeast. The information below was provided by Rick Handley of the Northeast Regional Biomass Program. The examples that have been included in this paper were selected because of the way they are integrated into a coordinated

state program. While specific incentive types are normally targeted toward a desired outcome, incentives of different types work best when they add value to other incentive programs. Many years ago insightful state officials learned from the experience of attempting to develop alternative fueled vehicle programs that vehicle sales could only be increased if fueling stations were developed in a concurrent manner. Because of this, the best state programs tend to target a broad variety of basic projects.

New York. In order to establish infrastructure, the state has a $10 million dollar fund available to provide either grants or loans to a fueling station willing to install either a new E85 or biodiesel pump. A station can get $25,000 for a retrofit project. In addition to the up-front cash provision, there is also a tax credit for the installation of clean fuel vehicle refueling property equal to 50 percent of the cost of the property. Even with these lucrative incentives, it would be unlikely that a station owner would invest capital in such a project without the expectation of having sufficient customers. As a result New York also has a number of incentives designed to encourage greater sales of ethanol or biodiesel vehicles. To encourage biofuel use, all biofuels are exempt from state sales tax and excise taxes for motor fuels. There is also a partial sales and use tax exemption for the incremental cost of new alternative fueled vehicles.

New York has also established programs designed to support the production side of the equation. There is a 15 cent per gallon tax credit for the production of bio-fuels. This incentive along with a state mandate on bio-fuel use by state agencies has resulted in the development of several bio-fuel production facilities.

Pennsylvania. The Commonwealth has a comprehensive list of grant programs designed to increase the production and use of bio-fuels. On the production side, there is the Pennsylvania Producer Reimbursement Program. Under this production tax incentive program a bio-fuels producer gets five cents for each gallon of bio-fuel produced in one calendar year by a PA qualified producer. The state has a cap on this funding assistance which cannot exceed 12,500,000 gallons a year per producer. Of a more innovative nature, the state will also provide a percentage of the funding requirement for a bio-fuel project that involves a new application or next phase technology. Two projects, one which uses waste oil and the other which takes advantage of oil from algae, have been funded under this program.

In addition, the state has a variety of programs that target the sale of alternative fueled vehicles. One program provides funding to tax-exempt and non-profit organizations as well as local governments in order to buy down the incremental cost of an alternative fueled vehicle.

Maryland. One example of a “mandated program” is the Maryland net-metering law. This program, which was initially formulated to expand the use of solar energy, now includes biomass. Unlike the programs discussed above which primarily target vehicles, a net-metering law helps to enhance the development of biomass projects designed to produce electricity. Projects involving anaerobic digestion of biomass, landfill gas, or small scale micro-turbines that use biogas are all likely to benefit from having a net-metering law. In a net-metering situation, the subsidy is essentially paid by the local utility through the purchase price of the electricity. Because the cost has been shifted away from the government, net metering laws are an excellent way to encourage the

use of all renewable fuels. States that wish to establish renewable portfolio programs should also develop net-metering programs on a concurrent basis.

The state also passed a renewable fuels act in 2005. The program includes a generous 20 cents per gallon credit when small grain crops are used as a feedstock. There is a 15 million gallon per year total cap for the program which runs from 2008 through 2017.

Maine. Maine has taken a slightly different approach in its attempt to encourage the use of biofuels. Ethanol vehicles, (E85) are taxed at the rate of 0.156 cents per gallon. This represents a tax reduction of 6.4 cents per gallon. At the same time, a five cent per gallon tax credit for biofuels producers has been established. A new energy bill will also cut the excise tax on biodiesel by eight cents per gallon.

Recommended Policy Initiatives for Strategies to Enhance the Value of Wood Residue

In the first section of Part IV we identified a list of various incentive programs which are currently in common use on a broad basis throughout the United States. We also provided an assessment and analysis of how some of these incentives are used in order to provide motivation for the implementation of programs designed to more efficiently use wood residue. This last section will concentrate on the types of policy options that should be used in Maryland and why these procedures are important.

One other critically important note concerning our policy recommendations should be emphasized. *Policy initiatives must be created in a logical framework in an ordered time frame that makes sense from the standpoint of program development.* As an example, it makes no sense to devise a program to encourage factory construction prior to the development of a program to determine the feasibility of factories in the first place. As a consequence, whenever necessary, our policy recommendations will include a discussion of how other policies may first be necessary for implementation.

1. Establish grant programs to encourage feasibility studies.

Our preliminary assessment of the wood industry has identified existing companies that are engaged in business opportunities that could be expanded into Maryland provided the economics are favorable. Because feasibility studies are expensive and because there are no guarantees that results will be favorable, feasibility reports are an expensive risk. By establishing a grant process to help fund feasibility studies, the State will assume a substantial portion of the risk and thus encourage existing companies to consider a move into the Maryland marketplace. As noted above, there are commercial wood chip and pellet companies currently in full operation that have the economic and technical potential to expand into Maryland, but none of these companies will risk moving into a new market without the assurances of a comprehensive market analysis. While it can be argued that loan programs could also be used as a vehicle to accomplish the same end, loans do not protect against economic loss in the event of an unfavorable feasibility assessment. As a result loan programs do not eliminate risk.

Because new business ventures normally result in increased employment opportunities, it would be logical for an organization such as the Maryland Department of Business and Economic Development to provide the leadership in development of this grant initiative. Other or-

ganizations which have an interest in the issue of wood residue include the Maryland Department of Natural Resources and the Maryland Energy Administration. Both of these agencies would be expected to participate in such an initiative. Previously, committees have been established by the governor in order to tackle particularly important problems. We feel this action is critically important and we will expand on it below by including it as one of our recommendations.

2. Provide production tax credits to companies willing to build manufacturing or processing facilities for pellet plants or wood chip processing facilities.

In order to attract businesses willing to invest in the construction of facilities within the State, Maryland needs to provide a system of production tax credits. Since this type of credit is linked to the quantity of overall production, rather than the amount of investment in the facility, credits can be paid over a defined time frame which can span a number of years.

The construction of manufacturing facilities on a local level provides a number of advantages. First, it means that transportation costs for hauling can be reduced. It also means that the products manufactured in those facilities will be closer to newly established local markets. Without providing some type of incentive, prospective businesses will move to other jurisdictions where the economic benefits are more generous.

3. Use a voluntary program approach for operators of coal boilers to co-fire with wood chips.

The State should initiate a voluntary program for coal-fired boiler operators to move to a co-fired approach which would use a 90 percent coal and 10 percent wood mixture. This voluntary system must also be linked to other incentives in order to provide the benefits necessary to obtain full cooperation on the part of participating companies. By making a voluntary system available to qualified boiler operators, the State can create the best possible mechanism for initiating a spirit of cooperation. Using a system of mandates or other regulatory procedures is likely to be met with hostility, and even if successful will result in extensive program delays. In addition, mandates are usually perceived as authoritarian measures and as such normally receive tepid political support. While it is unlikely that there will be an enthusiastic initial response to the program, this may serve to be a benefit. Additional financial assistance will be necessary under this approach and at the beginning of the implementation phase it may be less expensive to the State to have a climate of limited participation.

Another advantage of voluntary programs is that other incentive packages can be integrated into the system. A voluntary approach can be extremely innovative and is limited only by the amount of creative ingenuity on the part of the program administrator. In the present case we recommend that the Department of Natural Resources provide the leadership for this effort. Participants who volunteer to be a part of this process will need to receive additional benefits in the form of either a production tax credit or a tax credit on bottom line earnings. In a voluntary climate, this decision could well be based on negotiations between the company and the State.

One additional item needs to be emphasized with regard to this recommendation. A voluntary program which will eventually result in tasks of a technical nature that require engineering assistance needs to have the assistance of the University of Maryland. The university has tradi-

tionally provided technical assistance to State business, but usually at a cost to the company. The State needs to create a financial program that can be used to reimburse university costs for providing technical assistance to companies engaged in voluntary programs.

4. **Encourage the use of fuels by providing tax credits to individual residents or commercial businesses that switch from non-renewable fuels to renewable bio-fuels such as wood chips or pellets.**

In order to encourage the use of renewable energy and provide competition in the residential and commercial fuel markets, Maryland should create a system of tax credits for those individuals who purchase wood or pellet stoves. Providing tax credits in this manner would increase competition in the market place and help to reduce the price of non-renewable energy. A policy of this type would be particularly effective in both Western Maryland and the Eastern Shore, two areas that traditionally have rather high fuel oil and propane prices. An added advantage of this policy is that these two areas both have a sufficient supply of wood resources to support such an initiative.

5. **Mandate that in each county, some minimum number of new schools should be built with wood chip or pellet systems instead of using non-renewable fuel.**

More than half of the schools in Vermont are heated with wood chips. The chips are supplied by the forest service industry in Vermont so the revenue required to heat the schools stays in State. An interesting aspect of the Vermont program is that many of the schools that currently have wood-fired systems were conversions from some other fuel type. The State made the decision to pay the higher conversion costs in order to eliminate the uncertainty of fuel oil prices. In Maryland, many schools in the Western part of the State are heated with coal while on the Eastern Shore schools normally use fuel oil or propane.

Maryland has a sufficient enough supply of waste wood to alter this situation. By adapting a strategy of installing wood systems in new construction, the State will also avoid paying the higher conversion costs. Implementation of this recommendation should move more rapidly on the Eastern Shore where wood chips are likely to compete easily in the market place with propane or fuel oil.

In Western Maryland, the policy may present some real difficulties. Traditionally, coal has been a difficult product to compete with from the standpoint of price. On the horizon, however, two factors could change this situation. For many years Maryland coal has been primarily been a product for export. With developing countries expanding at an exponential rate, coal is likely to increase in price. This factor could make wood a better candidate to replace coal in new projects. In addition to this, given the changes in the political climate it is not unrealistic to assume that more stringent environmental regulations loom ahead. This could also be a benefit for modern wood chip technology.

6. **Provide incentives to builders who use building materials made from bio-based material generally and wood residue specifically.**

In our view, the most efficient way to accomplish this policy is to provide an incentive by relaxing the zoning requirements on the number of structures permitted in a development.

More severe restrictions mean fewer houses can be built. As the number of houses allowed declines, the builder must either raise the price per house (which makes houses less competitive in the market place), or make less profit. Instead of being held to the allowable limit, however, a builder could be permitted to construct additional houses if all of the houses used bio-based material containing wood residue.

Under such a policy, the builder would promise to install some minimum amount of bio-based building material. Even though the price would be higher than the price of traditional materials, the builder would more than make up the difference by selling the additional houses. Another advantage of this policy is that there is virtually no cost to the State or county government.

7. Provide a tax credit to builders who install pellet stoves or wood chip boilers in new residential or commercial construction.

Pellet stoves and wood chip systems are currently available at most Maryland hardware stores and there is a booming market for these systems in Pennsylvania. We emphasize these points to stress the fact that there is no problem with availability. Most individuals who elect to use wood systems currently use them as auxiliary systems and pay additional cost since they are usually obtained as “add-on” products.

Many more individuals could take advantage of having a wood system as an original equipment item in their home if this policy was adapted. Individuals would be more confident if the systems were builder installed and in most cases the systems would be used as primary heating systems rather that as add on projects.

Because modern wood systems are environmentally efficient, in many cases they actually cost more than regular oil or gas systems. By providing a tax credit, however, builders will be encouraged to pay the additional cost of the wood system in return for the much greater bottom line benefits. It is likely that this proposal could be implemented as a short duration policy. Once fully mature, we feel that favorable reaction to the technology will help to sustain the program via normal market forces. At that point developers will be able to include the additional cost of the wood system into the bottom line price of the house. We see similar consequences for commercial construction under this program.

8. Provide a tax credit on wood system conversion costs that replace heating systems which use non-renewable fuel.

This policy is closely linked to the program cited above, and is designed specifically to “jump start” the use of wood systems in place of traditional heating systems. Since conversion costs tend to be high, providing a tax credit on the entire conversion package could serve as a useful incentive. Most propane customers purchase the product for both heating and “other” uses such as cooking, hot water, and laundry. This level of dependence therefore is likely to be a disincentive for the propane sector since propane is priced on a volume basis. Individuals converting to wood for heat would therefore pay more for propane for laundry and cooking. As a result, this policy is likely to have the greatest impact with respect to fuel oil systems.

9. Work with the National Green Building Council in order to develop policies that result in the use of bio-based wood residue materials in "green" construction.

During the last five years there has been an explosion in the number of green building projects. Proponents of green construction argue that even though the initial cost is actually higher, on a life cycle basis accounting for technological externalities green construction is a benefit. Our policy does not depend on this outcome, but instead on the recognition that much like "green electricity" there is a growing number of environmentally-sensitive individuals who wish to contribute to the cause. We believe that if the State works closely with the Green Building Council, products can be identified that will benefit the bio-based product market involving wood residue.

Once products containing wood residue are included in green projects, the program will work much like a voluntary program. A community of individuals will emerge that will make this approach a success. Should this policy become a reality it appears there would be no cost to the State, however, we recommend that a program of this nature could benefit greatly from the inclusion of university participation. Any time new product development is an issue, university involvement is normally a benefit.

10. Require that outside direction and advertising signs located on state property be made from wood residue products.

Local paper mills and box plants already have the capability to manufacture this type of product, but there is currently no market. A large paper mill, such as the NewPage facility in Luke, is unlikely to pursue such a project as the scale is too small to result in an efficient process. Suppliers do exist, however, but initially it is likely that the State would be forced to purchase product from outside Maryland. As a result initial purchase costs would likely be higher than normal. Once manufacturing companies within the State became aware of this fact, it is likely that in-State competition would emerge. One additional advantage to this approach is that the disposal and recycling cost of old material is likely to be less than for traditional metal signs.

11. Require the use of some amount of cellulosic ethanol in all blends of gasoline.

There are time constraints associated with this policy option. While it was stated earlier that policies should be enacted with respect to some logical time frame, we want to include it in our list of recommendations even though we are perhaps five years away from the development of ethanol from wood.

Currently, there is a concerted effort to build ethanol production facilities in three different States in the Mid-Atlantic region. Much of the feedstock for these efforts is intended to come from corn. Because of policies already enacted in the Midwest, we are now seeing higher corn costs. This increase not only impacts the cost of corn for human consumption, but has created even higher costs for feed corn. As a result, grocery prices for all types of meat have increased.

While ethanol from corn is not going to disappear any time soon, the rapid development of cellulosic ethanol will be a considerable benefit to meat and dairy consumers since cellulosic ethanol could displace some corn based product. As soon as it becomes available, Maryland should have a policy in place that can quickly be implemented. Since the technical development

of cellulosic ethanol is an expansive proposition, financing and management of the effort has taken place almost completely at the Federal level.

12. Provide a tax credit to gasoline vendors who use a minimum amount of cellulosic ethanol in their gasoline blends.

This policy recommendation is similar to number 11 above in that it would be premature to legislate such an initiative at present. We have included it, however, because of its critical nature. When cellulosic ethanol actually becomes available, it is likely that it will be more expensive to produce than corn-based ethanol. Unless it supported through some type of subsidy, a local market in cellulosic ethanol will be lost because of market failure. It may also be necessary to provide a tax rebate to consumers at the individual level in order to provide the necessary competition to corn based ethanol.

It is important in the case at hand, as well as in other development projects, that subsidies be applied at critical times. This form of assistance need not be permanent, but must occur in order for various products to become mature in the market place.

PART V
CONCLUSIONS AND RECOMMENDATIONS

The survey of wood waste resources within the State indicates that there is a sufficient amount that can be used as a stable supply of feedstock to upgraded uses over the foreseeable future. The supply increases in total available tons as the price for delivered feedstock material increases. This being said, the real issue is "what is the best path to gain maximum value from these lower grade materials?" "Maximum" value in this case is what products and markets will maximize the employment within the state and provide for a sustainable industry from both a financial and environmental perspective.

The goal of this work was to look at which current and potential uses (products/markets) might make the most sense for the State and try to rank them in a priority order from the standpoint of commercial potential, market timing/acceptable financial risk, and total overall value. The products and markets emerging from our research with high value rankings in order were:

- Wood plastic composites, structural lumber, fenestration components, signage, etc.
- Wood stove or boiler fuel pellets
- Feedstock for cellulosic ethanol production

The explosion in engineered building materials and composite decking is not unexpected given the cost of higher value wood supplies, the better utility of the engineered product from the standpoint of strength, rot resistance, lower maintenance, etc. The problem with these industries is that they can be supplied from the State's wood waste resources but there is little or no manufacturing of these products within the State. It would appear that a more aggressive approach to attracting specialty wood products manufacturers in these two sectors would be in order. Because of the growth in these two product/market areas and high level of residential/commercial construction as well as remodeling that is conducted within the State, we believe and recommend that State economic development executive level staff hold discussions with potential manufacturers who are looking at expanding production. The continued growth of the State's population, coupled with the sustainability or "Green Buildings" movement in the building community, and backed by local and regional state-level efforts, would ensure an expanding market for these types of products.

It should be noted that each market for these products is somewhat unique and each is at its own level of maturity. For example, the wood fuel pellet business uses mature technology but there still is significant business growth in this industry. There are pellet fuel users and potential users in the State, but no pellet fuel manufacturer. This issue is covered in more detail within the body of this report. This lack of local production indicates a market need that could be filled and would provide a State-based product from State-based resources. We recommend conducting a more in-depth study on establishment of a pellet production facility within the State near the higher quality wood waste supply and near the potential end users. The potential end users are in more rural areas and currently heat their homes and businesses with other commercial fuel or energy sources like propane, oil, or electricity that all have recently seen price increases or (in the case of propane or oil) tend to exhibit high price volatility.

Because our economy moves on wheels, the topic of adequate light-duty vehicle fuel supplies at affordable pricing is an issue of great concern over the last several years. Our petroleum supply is not as secure as it should be. Corn-based ethanol is a partial solution to the problem but has economic and environmental impacts that were not fully understood before production expansion was initiated. A longer-term solution attracting considerable government and private interest and investment has been cellulosic ethanol production. Because the feedstocks are not based within the food supply system, the sustainability and cost of this approach may make more sense over the long term. The wood wastes within the State would not supply the total feedstock needs to replace all the motor gasoline that is used within the State but it would help reduce demand for imports, add long term jobs within the State, and have an environmental value. Any landfilled urban wood wastes could be used to supply a portion of the feedstock for a cellulosic ethanol facility that could be located near a petroleum distribution center so that the ethanol could be easily blended with the motor gasoline and distributed. One of the states within the Chesapeake watershed, New York, has just funded several projects aimed toward improving cellulosic ethanol production at lower costs. We recommend that the State agencies with energy and economic development responsibilities monitor this technology and market, and, if appropriate, sponsor research or demonstration of this technology and assist using existing state-level financial support mechanisms to attract a cellulosic ethanol production facility to the State. It makes sense to have production near both the feedstock supply and the product end use location.

Given the supply of wood wastes and residues that come from urban and suburban tree and landscaping services, we would also recommend that the concept of a wood waste supplier/seller cooperative could provide an organizational element that would allow for the setup and management of wood waste concentration yards. We believe that this type of storage and concentration facility would also assist waste wood end users by ensuring a pre-sorted and adequate supply of feed stock and would minimize the number and length of their supply truck trips. The survey results supported this as an enabling effort that would assist in bringing about higher value uses of wood wastes and residues. In order to look at the State's regional needs for such supply infrastructure a specific study and resulting plan is recommended.

One of the more interesting aspects of the survey that was conducted as a part of this project was the discussion of a more coordinated approach to addressing wood wastes and residues within Maryland or any state, as many of the survey respondents were from other states throughout the region. A common thread in many of their responses was a need to better coordinate and focus the efforts of the many state-level organizations that have some responsibility or activity that relates to this resource or the markets it could supply. This need was shown in the survey response charts within the body of the report. We recommend the establishment of an inter-agency committee that could bring the different state-level agencies together on a periodic basis to assist in addressing the higher value uses of wood waste and residues and other forest products issues.

We also asked which type of agency should actually lead and chair such a committee or group and the result was almost a tie between the Departments of Natural Resources and Economic Development. The survey effort also involved private sector organizations and we be-

lieve that the private sector desires better access to the State's economic development resources to expand these markets. As a result, the private sector respondants suggest that the lead for the effort be more focused on the jobs and economic value for adding these new and upgraded wood waste products and markets. We would suggest a co-chair arrangement for such a committee that would allow these two organizations to work closely on other wood products issues as well as the enhanced usage of wood wastes.

Many of the recommendations cited above are related and interdependent. Some policy recommendations are impossible to implement without first having launched a preceding policy which serves as a more appropriate starting point. How policy is made and when it is implemented is of vital importance. Like any other major initiative, it will take a concerted effort to promote the issue of wood residue to a higher level of importance so that it will receive the attention it deserves. The key therefore is that the effort needs to be managed by a collective group over a sustained period of time. The group should have a regular reporting obligation and these reports should be distributed to interested State agencies and various organizations in the private sector for comment.

In government, an issue is *not* considered important until it is visible and important to the public. By organizing a "governors committee" the policy issues are immediately elevated to a higher level of importance. Once an issue is viewed by the governor's office as a priority, the potential for obtaining necessary funding is greatly increased.

Based on the findings and interest garnered in this study, we also recommend that a State agency-sponsored wood waste workshop be held to better bring all the interested parties to the table to discuss the products and markets from wood wastes and residues and develop a comprehensive program to address this resource. The rationale for the regional participation is the overlapping product markets and movement of this resource across state lines. In addition, a more regional approach would allow our State to learn more about what other states have accomplished using this same and currently underutilized resource. The goal of the workshop would be to develop the outline of a comprehensive plan to address the resource and its markets. The waste wood resource and utilization committee discussed in the earlier paragraph could then take over the development of a final plan and plan implementation. The existing wood products and forestry industry within the State needs to be an integral element within this planning process and the resulting plan implementation in order to ensure real success.

APPENDIX A
Questionnaire – Wood Wastes

New West Technologies, LLC of Landover, MD (www.nwttech.com) is conducting a small research study on wood wastes/residues and their beneficial uses. We believe that your input to this research project would be very helpful to the effort and would allow your direct input into helping solve the wood waste issue within your state and regionally**.** All question responses will be kept confidential and will not be associated with any specific responder or organization. As a result, do not sign or print your name or indicate your affiliation on this document.

If you do not have an opinion on a product, specific market, technology, or policy/organizational issue/option a "blank" response is fine. In the following questions we are interested in your opinions and your responses should draw directly on your existing knowledge base and level of understanding regarding wood wastes and their current and potential future uses.

Please send all response back by e-mail or fax. If by e-mail, please send to mpanich@nwttech.com. We have left this document in MS Word so that you can add text responses if you would like. When complete, just save your document by adding the date to the file name and return as an e-mail attachment. If you desire to send by fax, please send to (301) 429-1185. If you should have any difficulties in sending your response by e-mail or fax, please call Ms. Carolyn Gaskin at (301) 429-1180, extension 21. We would appreciate your response as soon as possible, but no later than 8/24/2007.

Start of Questionnaire

1) Do you believe that there are sufficient wood waste resources in your state to support the expanded and economically beneficial use of this biomass resource?

   ___ Yes ___ No

2) Do you believe that in order to support an expanded use of wood waste and adequately support a wood waste based state industry a more regional, not state-centric, supply approach is necessary?

   ___ Yes ___ No

3) How would you rank order the following product areas for higher value use of wood wastes within your state? (Please use numbers with one being the highest ranking and moving down in importance with the higher numbers)

   a. ___ Wood stove or boiler fuel pellets

   b. ___ Composite decking and accessories

   c. ___ Engineered building materials, glulam structural lumber, wood plastic composite structural lumber, wood plastic composite fenestration components, wood plastic composite signage, etc.

   d. ___ Feedstock for cellulosic ethanol production

   e. ___ Other (that you suggest and insert in rank order) _____?

4) Using the same following product areas how would you rank order them regarding commercial potential in the near term (next five years) for your state? Commercial potential includes the size of the regional market and a positive impact on state employment.

   a. ___ Wood stove or boiler fuel pellets

   b. ___ Composite decking

   c. ___ Engineered building materials, glulam structural lumber, wood plastic composite structural lumber, wood plastic composite fenestration components, wood plastic composite signage, etc.

   d. ___ Feedstock for cellulosic ethanol production

   e. ___ Other end-use, product, or market that you want to suggest and insert in rank order?

5) Using the same product areas, how would you rank order them regarding investment/business risk. (Please use numbers with one being the lowest risk ranking and moving up in risk with the higher numbers.)

   a. ___ Wood stove or boiler fuel pellets

   b. ___ Composite decking and accessories

   c. ___ Engineered building materials, glulam structural lumber, wood plastic composite structural lumber, wood plastic composite fenestration components, wood plastic composite signage, etc.

   d. ___ Feedstock for cellulosic ethanol production

   e. ___ Other (that you suggest and insert in rank order) _____?

6) In your opinion do you believe that the goal of any expanded wood waste program should not just be based on pure economic and financial benefits but also include a longer term energy and environmental benefit justification as well?

   ___ Yes ___ No

7) In your opinion do you believe that capital availability is now limiting the commercial expansion of higher value uses of wood wastes within your state?

   ___ Yes ___ No

8) In your opinion do you believe that a wood waste suppliers/sellers cooperative could provide an organizational element that would allow for the setup and management of wood waste concentration yards? (This type of storage and concentration facility would assist waste wood end users by ensuring a pre-sorted and adequate supply of feed stock as well as minimize the number and length of their supply truck trips.)

   ___ Yes ___ No

9) In your opinion do you believe that there is a technology availability issue in converting wood wastes to higher value uses/products.

___ Yes ___ No

10) If you answered yes in Question 9, please indicate where you believe the technology short-fall is with regard to the following product areas by placing a checkmark where you believe the technology requires more development and more maturity.

a. ___ Wood stove or boiler fuel pellets

b. ___ Composite decking

c. ___ Engineered building materials, glulam structural lumber, wood plastic composite structural lumber, wood plastic composite fenestration components, composite wood plastic signage, etc.

d. ___ Feedstock for cellulosic ethanol production

e. ___ Other end-use or market that you may have suggested and inserted in rank order in Question 3?

11) Do you think there are untapped organizational resources at the following levels that could assist in bringing about better uses and more economically attractive waste wood uses within your state?

a) County Government ___ Yes ___ No

b) State Government ___ Yes ___ No

c) Federal Government ___ Yes ___ No

d) Regional Planning and Economic Development Organizations

___ Yes ___ No

12) Given your response to the above, do you think that a more coordinated approach to the statewide wood waste issue and potential markets is required?

_____ Yes _____ No

13) If you indicated yes, please check which state-level agencies do you think should be involved in a state-level coordinated effort to better use state-based wood wastes?

___ Department of Natural Resources

___ Department of Agriculture

___ Department of the Environment

___ Energy Office or Administration

___ Department of Business/Economic Development

___ State Chartered Technology Development Corporation

___ University Research Center or Organization

___ All of the above

___ Other

14) If you filled in any answers in Question13, please indicate, in your opinion, which state agency type might be the correct entity to take the initial lead role in organizing a coordinated approach?

___ Department of Natural Resources

___ Department of Agriculture

___ Department of the Environment

___ Energy Office or Administration

___ Department of Business/Economic Development

___ State Chartered Technology Development Corporation

___ University Research Center or Organization

15) Within your personal knowledge are you aware of other states (nationally or regionally) which have an exemplary formal program to expand forest products markets which has included upgrading the value of waste wood feedstocks? If so, please provide the aspect of their program that other states could adopt or emulate to provide a similar benefit to your state-based businesses and state citizens. This could be technical assistance, business loans or loan guarantees, assistance with marketing products, etc. Your written response to this question is appreciated.

16) In your opinion do you think a workshop focused on wood wastes and increasing the economic value from your state's wood waste resources is warranted at this time?

___ Yes ___ No

17) If you indicated Yes, in Question 16, would you be willing to be a participant in such a focused Workshop?

___ Yes ___ No

End of Questionnaire

APPENDIX B
Questionnaire Contact List

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APPENDIX C: MARYLAND FOREST REGIONS

Western Maryland

- Allegany County
- Garrett County

Central Maryland

- Anne Arundel County
- Baltimore City
- Baltimore County
- Carroll County
- Cecil County
- Frederick County
- Harford County
- Howard County
- Montgomery County
- Prince Georges County
- Washington County

Southern Maryland

- Calvert County
- Charles County
- Saint Mary's County

Upper Eastern Shore

- Caroline County
- Kent County
- Queen Anne's County
- Talbot County

Lower Eastern Shore

- Dorchester County
- Somerset County
- Wicomico County
- Worcester County