Opportunities for the Woodwaste Resource

By Bob Falk

For most of us, the word recycling conjures up visions of curbside programs focused on collecting glass bottles, aluminum cans, plastic jugs, and old newspapers. Considerable attention has been paid to these "post consumer" waste materials, while until recently, the recycling of solid woodwaste has received relatively little attention. For many decades, waste from the wood industry's sawmills was burned in teepee burners. Today, much of this woodwaste is utilized for new product manufacture (composite products, etc.) But what about other sources of woodwaste in this country? Demolition projects, land clearing, new construction, and other sources generate millions of tons of woodwaste every year. These wastes are typically viewed as a burdensome disposal problem; however, this material has potential to become a usable resource.

The Waste Wood Resource

Our nation is blessed with a vast wood resource. Currently, about one-third of our land mass is forested, approximately 737 million acres (2.98 million km^2). From this land, we yearly harvest about 280 million metric tonnes of wood. **Figure 1** illustrates our dependency on this wood resource. Roughly one-half of all industrial materials used in this country are wood-based, far exceeding the use of all metals, cement, and plastic (on a weight basis).

A portion of these industrial resources ends up being discarded, either through manufacturing waste or product disposal. Because so much of our industrial raw material base is wood fiber, and many of the products produced are short-lived, such as newspapers, paperboard, and packaging, a rather large percentage of our waste stream contains fiber. The majority of the woodwaste generated ends up in three different waste streams: 1) municipal solid waste (MSW); 2) construction and demolition (C&D) debris; and 3) wood and paper residues from primary timber and paper processing.

Municipal Solid Waste

In 1994, about 190 million metric tonnes of MSW were generated in the United States. MSW is defined by the Environmental Protection Agency (EPA) as waste from residential, commercial, institutional, and industrial sources, and includes durable goods, non-durable goods, containers and packaging, food scrap, yard trimmings, and miscellaneous organic waste. MSW does not include: C&D waste, automobile bodies, municipal sludges, corn. bustion ash, and industrial process waste that mayor may not be disposed of in municipal waste landfills or incinerators. By EPA definition, three categories of MSW contain wood fiber: paper and paperboard, yard trimmings, and wood (Fig. 2).

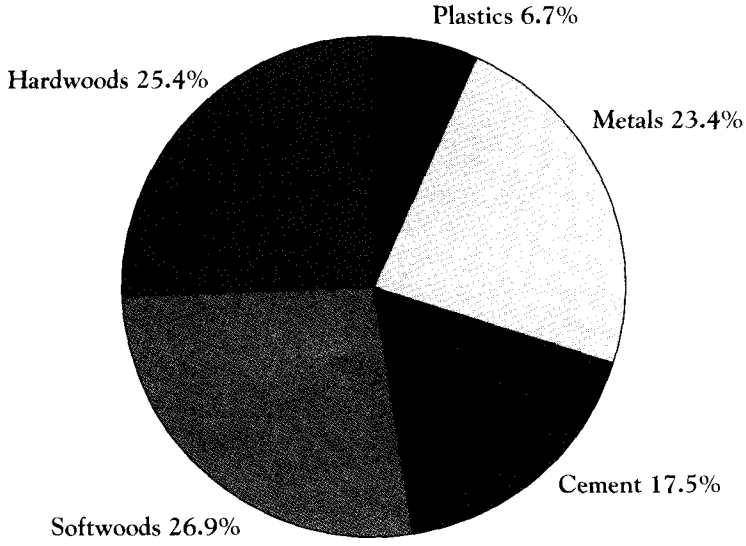

Figure 1. — Consumption of industrial raw materials, U.S. totals, percent by weight, 1995. Fuelwood is included in the total wood usage, Softwoods are assumed to have an average specific gravity of 0.45 and a dry basis moisture content of 15 percent. Hardwoods are assumed to have an average specific gravity of 0.55 and a dry basis moisture content of 10 percent. Source: J. L. Bowyer, University of Minnesota.

the wood in the MSW is currently recycled and an additional 54 percent is potentially recoverable. Currently, it is estimated that about 23 percent of the yard trimmings are recovered, and 46 percent are potentially recoverable for reuse. These sources from the MSW account for about 20 million metric tonnes of potentially recoverable solid wood material **(Table 1).**

Paper Waste from the MSW

Although the focus of this paper is solid woodwaste, it is worth noting the progress being made in paper fiber recycling. The recovery and reuse of paper from the MSW is a recycling success story. For many years in the United States, paper and paperboard have been the most heavily recycled component of the MSW, accounting for more than two-thirds of the materials recovered. The availability of paper for recycling is in large measure a result of community-based curbside collection and the U.S. paper industry is approaching an overall 50 percent recovery level. For some grades, such as old newspapers (ONP) and old corrugated containers (OCC), that level has already been exceeded. In 1993, when the recycling rate was about 30 percent, over 38 million metric tonnes of paper and paperboard were recovered for recycling.

Solid Woodwaste from the MSW

Two EPA-defined categories of the MSW contain solid wood: wood and yard trimmings. The wood category contains such items as wood furniture and cabinets, pallets and containers, scrap lumber and panels that are not considered C&D debris, and waste wood from manufacturing facilities. Yard trimmings include leaves and grass clippings, brush, and tree trimmings and removals. Estimates made from regional and national studies suggest that about 10 percent of

C&D Debris

The waste generated from new construction and from building demolition is in a category by itself. Both these activities generate a significant amount of woodwaste, New construction wastes include all forms of wood used in wood frame construction (both residential and commercial), including solid wood, panels, engineered wood products, and packaging.

Nationally, the construction of residential homes alone consumes about 30 million metric tonnes of wood products. As shown in **Table 2,** almost 40 percent of the waste generated on a new home site is woodwaste, about 3,000 pounds (1360 kg). It is estimated that nationally about 6 million metric tonnes of new construction waste is considered feasible for reuse **(Table 1).**

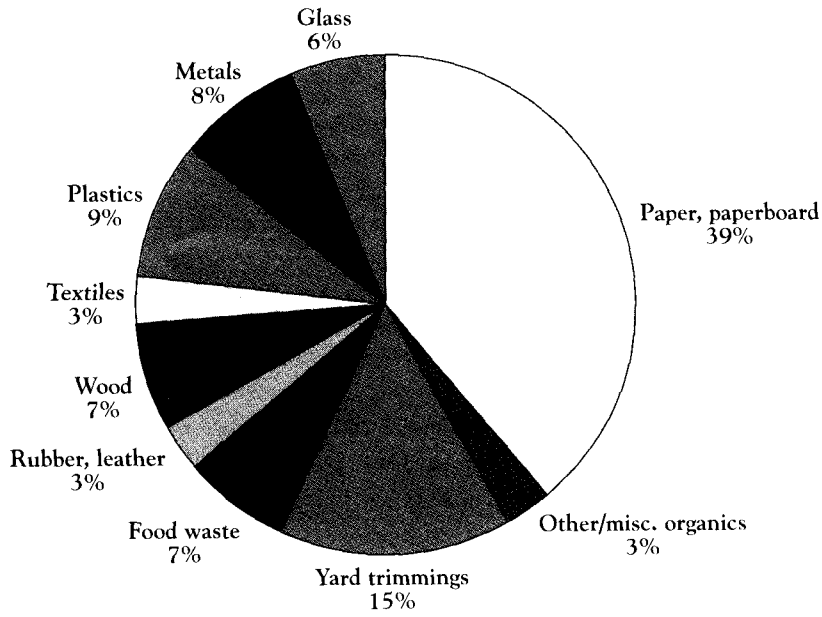

Figure 2—Percentage of municipal solid waste generated in the United States, 1994. Source: U.S. Environmental Protection Agency, Washington, D.C.

Table 1. Waste wood generated and available for recovery.

Source	Currently generated (10^6 metric tonnes)	Potentially available for recovery (10^6 metric tonnes)
Municipal solid waste[a]		
Waste wood	13.2	7.2
Woody yard trimmings	26.4	12.2
C & D debris[a]		
Construction	6.5	5.7
Demolition	22.7	6.8
Primary timber processing[a]		
Bark residues	26.7	1.4
Wood residues	80.1	4.8
Treated woodwaste[b]	4.7	Uncertain

[a] Source: McKeever, D. 1997, Resource Potential of Solid Waste Wood in the United States, The Use of Recycled Wood and Paper in Building Applications, Forest Prod. Soc., Madison, Wis.

[b] Source: Felton, C.C. and R.C. DeGroot. 1996. The recycling potential of preservative-treated wood. Forest Prod. J. 46(7/8):37-46.

Demolition waste is a much more heterogeneous mix of materials and typically contains woodwaste from framing, panels, flooring, etc., as well as aggregate, concrete, paper, metal, insulation, glass, and other building materials. About 44 million metric tonnes of demolition waste was generated in 1994. It is estimated that about 23 million metric tonnes of wood is contained in this mix. Due to the commingled nature of this waste, it is difficult to estimate the potential recovery of wood; however, if a yield of 30 percent is assumed, about 7 million tonnes of demolition wood, waste is available for recovery.[1]

Primary Timber Processing

The reuse of waste wood fiber that is a by-product of primary timber processing operations is not new. By and large, the wood industry has done a commendable job in reusing large amounts of residues (bark, sawmill slabs, sawdust, and peeler log cores) for a variety of applications. Nearly all of these residues are currently used to produce other products, primarily fiber for paper, building panels, landscape mulch, and/or fuel.

Treated Woodwaste

At this time, the recycling potential for treated woodwaste is unknown. A significant volume of treated wood is produced every year and questions regarding its disposal are being raised. Chromated copper arsenate (CCA) is the primary wood preservative used for the treatment of softwood lumber in the United States. Every year, over 8 million metric tonnes of CCA-treated lumber is produced and it is estimated that over 85 million metric tonnes of this product is in service. The feasibility of recycling treated wood is only now being investigated.

There are two major problems associated with recycling treated wood. First, the exposure of workers to preservative chemicals during the recycling process is of concern and must be investigated. Second, products made from recycled treated wood may not have the same resistance to decay and insects as the original treated wood product. This residual durability must be determined so that the recycled product can be used appropriately.

Nearly 5 million metric tonnes of preservative-treated wood is disposed of annually into landfills, If recycling methods can be developed such that health concerns are mitigated, much of this material can potentially be reused.

Waste generated at a building demolition project.

Table 2. Typical construction waste for a 2,000-ft² (189-m²) home.[a]

Waste material	Amount - lb.
Metals	150 (68.2)[b]
Drywall (gypsum)	**2,000 (909.1)**
Solid sawn wood	1,600 (727.3)
Vinyl (PVC)	150 (68.2)
Engineered wood products	1,400 (636.4)
Masonry **(siding material assumes three sides vinyl siding and brick veneer on** home's front facade)	1,000 (454.5)
Old corrugated containers	600 (272.7)
Other	1,050 (477.3)
Containers (paints, caulks, ect.)	
Total	**8,000 (3636.4)**

[a]Source: National Association of Home Builders Research Center

[b]Values in parentheses are kg.

Conventional Uses for Woodwaste

Markets for residues from primary wood processing are well established, The pulp and paper industry is by far the biggest user of this material, at about 30 million metric tonnes per year. The production of particleboard, medium density fiberboard (MDF), hardboard, and insulation board consumes another 10 million metric tonnes. Other uses, such as mulch, animal bedding, and fuel are also common.

Woodwaste generated from the MSW and from C&D debris is also marketed, but material variability and contamination often limit the use of these wastes to lower value commodity products, such as fuel and mulch, **Figure 3** illustrates the materials input/output stream at Recovery 1, a C&D waste processing plant in the state of Washington. At this plant, waste wood is obtained from land clearing/stumpage, pallets, new construction, and demolition. The land clearing/stumpage and pallet portion of this waste stream produces clean pulp chips usable for the pulp and paper industry. The remaining material produces primarily hog fuel. There is also a small percentage of fines, which can be used as a soil amendment. Scrap metal can be recycled, but other residues have no use and must be landfilled.

Other Uses for Woodwaste

Recently there has been considerable interest in increasing the use of woodwaste for higher value products. A conference focusing on this topic was held in Madison, Wis., in September of 1996.[2] Several potential material and product types were discussed.

Recycled Lumber and Timber

Millions of board feet of lumber and timber exist in old wood structures slated for disposal (especially industrial and military buildings). The U.S. Army has many wood buildings that were constructed for World War II and are now slated for demolition. It is estimated that these buildings contain over 250 million board feet of lumber and timber that could be reused. More and more, the feasibility of reconstructing buildings rather than demolish, ing them is being explored. Traditional demolition results in a pile of debris that is a mixture of wood, stone, carpeting, metals, and other materials. Reconstruction is the selective dismantling or removal of materials from buildings before, or instead of, demolition. It's been said that demolition is "clearing the table" and reconstruction is "saving the dishes."

In 1993, a study that evaluated the reconstruction of a two-story house in Portland, Oreg., indicated that the manual labor required to dismantle the building for salvage was competitive with the cost of conventional demolition. When the salvage value of materials from the building and the reduced disposal costs were considered, reconstruction cost several thousand dollars less than demolition. Because there are high tipping fees and well-established end-use markets for recyclables in Portland, this may be an optimistic example. It remains to be seen if reconstruction can bean economically attractive strategy nationwide.

Examples of uses of reconstructed wood materials include: 1) large timbers, which are valuable, can be removed from old structures and reused intact as structural members; and 2) wood flooring, siding, doors, and other trim, if not too damaged, can be reused in a new structure. It makes sense to strive for a "highest value use" of recycled materials where possible and reserve solid lumber and timber for uses that maintain their original form. However, the reuse of lumber and timber is hampered by the fact that guidelines on reuse do not exist and that grading rules and engineering design values currently focus on the use of virgin timber. Clarification, and to a certain extent, redevelopment of grading rules and design information specific to old lumber and timber would help its marketability. Only recently has research begun to address these problems. Considering the fact that over 3 trillion board feet of sawn lumber has been produced in this country since 1900 and much of it resides in buildings that will one day be disposed of, these reuse issues are important.

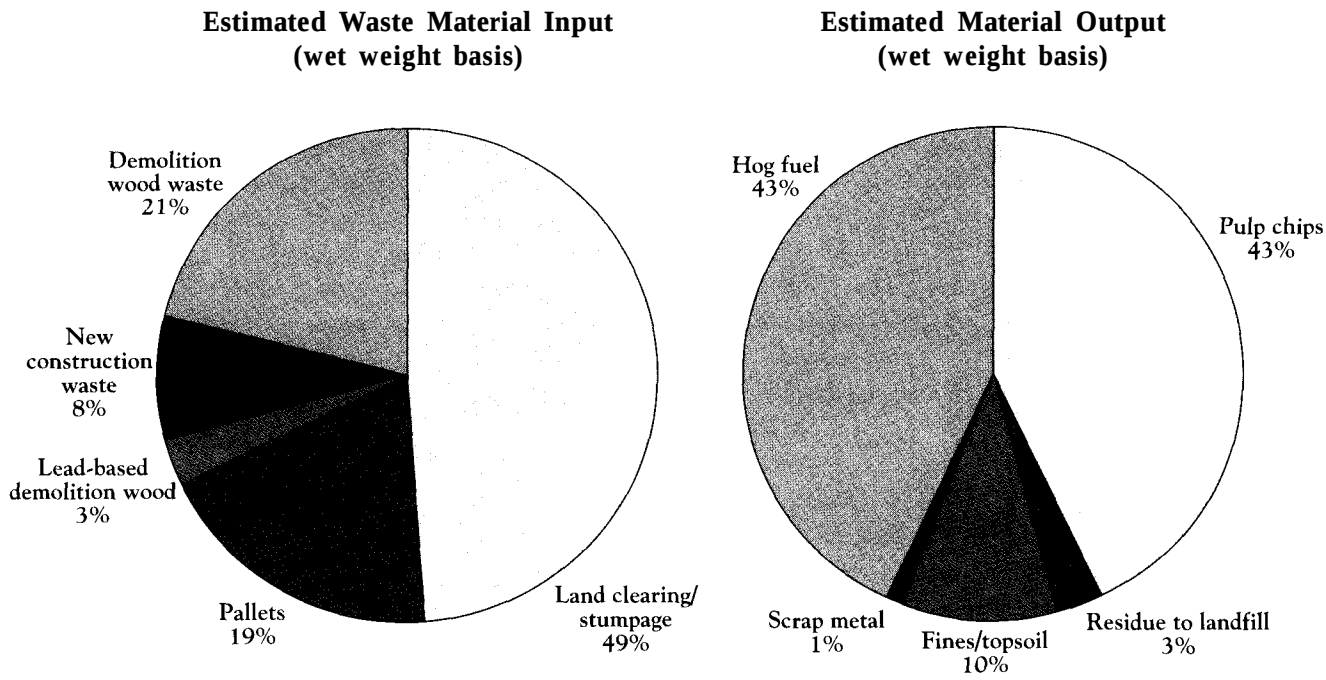

Figure 3.—Estimated material input and output for Recovery 1. Source: *Resource Recycling* magazine, November 1996.

Woodfiber-Plastic Composites

Over the past decade or so, there has been a sharp increase in the use of wood-filled polymeric composites for a variety of applications. The automotive industry manufactures interior parts (e.g., door liners) from these composites and the construction industry uses these materials for exterior applications with members made to standard lumber profiles. Most recently, window and door manufacturers are using these composites as an alternative to clear solid wood in clad components. For more details regarding these products, refer to the feature article by John Youngquist in the October 1995 issue of the *Forest Products Journal.*

Wood/Inorganic-Bonded Products

Recycled particles or fibers of wood held together with an inorganic matrix, such as Portland cement or gypsum, form a composite that can be used in a variety of building applications. These composites offer the potential to be very fire resistant and are highly resistant to attack by decay fungi and insects. These products have been used for decades as construction materials in Europe, Australia, and Japan, but acceptance and growth in the U.S. building products market is only now being realized. Traditionally, virgin fiber was used for these composites, but at least one U.S. manufacturer (Midwest Faswall, Inc., Ottumwa, Iowa) is using a combination of waste wood particles from pallets plus cement to produce a permanent wall form for building construction. James Hardie, Inc., a large Australian manufacturer, is making extensive capital investments in U.S. manufacturing plants in order to produce high density woodfiber/cement panel and roofing products for the U.S. construction market. There is certainly potential for the use of recycled material in these products.

Factors Affecting the Feasibility of Recycling Woodwaste

While it appears that there is a substantial amount of wood available for reuse, as well as a variety of products that might be produced from this wood fiber, several factors affect the feasibility of recycling this material.

Contamination

A major reason that so much of the woodwaste from primary timber processing is utilized (~95%) is that this material is clean and uniform. The primary difficulty in using other forms of wood. waste from MSW and C&D waste streams is that it is often commingled with other materials. Demolition waste is particularly dirty. A demolition waste recycling facility in Massachusetts reports that only about 15 percent of the woodwaste by weight (38% by volume) is usable for their mulch products.

For almost all products produced from woodwaste, cleanliness is an issue. Tolerance of contaminants in high value products, such as MDF and particleboard, is very limited. It's been said that a single Styrofoam coffee cup in a truckload of wood chips destined for an MDF plant is enough to degrade all the boards produced from that truckload. Lower value products, such as boiler fuel, mulch, and animal bedding have tolerance levels for contaminants as well. Most paints (lead!), preservative chemicals, metal, or other foreign materials are not tolerated.

Economics and Market Volatility

How economical it is to recycle woodwaste depends on several factors, including the type of product to be produced from the waste, availability of a nearby resource, and costs of sorting and cleaning. Most importantly, the recycled resource must compete favorably in cost with alternative raw materials.

A good example of the effect of market forces is illustrated by the experience of Willamette Industries.[3] Willamette has been a pioneer in the use of recycled woodwaste from urban sources. After purchasing a Eugene, Oreg., particleboard plant in 1991, Willamette was faced with a shortage of raw materials. With escalating prices and shrinking supplies of traditional particleboard materials, a new source of raw material was needed if the mill was to be kept operational. Between 1993 and 1995, Willamette used over 100,000 bone dry tons of urban woodwaste in its particleboard plant. Although the market demand for fiber was extremely high in 1995, by 1996 demand had softened, prices for all types of wood fiber dropped dramatically, and there was no longer an economic incentive to use urban woodwaste. In 1996, the price of woodwaste from primary processing (sawdust, planer shavings, etc.) had dropped to as little as 50 percent of the price of the urban woodwaste. As a result, Willamette discontinued business with 10 of its 12 suppliers of urban woodwaste. Although the price paid to the remaining two suppliers for their urban woodwaste is higher than the price of available primary processing woodwaste, Willamette has chosen to maintain purchasing contracts with them.

Variability of the Resource

Because waste wood is generated from a variety of sources, the quality, size, species, dryness, and contamination level can vary tremendously. This variability may necessitate more complex processing systems and can affect final product properties. The amount of sorting that is required is also an economic factor. More sorting means higher costs.

Alternative procedures that might result in the delivery of cleaner woodwaste and the ability to produce higher value products from this recycled material are needed. For example, better segregation of waste at new construction sites, i.e., putting the wood in one container and the packaging materials, etc., in other containers is one way to minimize contamination. To facilitate this procedure, the National Association of Home Builders Research Center has just published a field guide for residential construction waste management.[4] Better separation of MSW and C&D debris would certainly help produce a cleaner waste wood resource.

Dispersion of the Resource

Woodwaste exists almost everywhere. But because transportation costs are high relative to the value of this waste material, it is currently only feasible for woodwaste processing facilities to locate where there is a high volume of waste, i.e., urban areas. Obviously, waste wood processors also prefer locations where high volume users are nearby, such as solid-fuel boiler operations, and where high local landfill tipping fees encourage recycling.

Addressing the Difficulties

There are many technical and economic obstacles to overcome, but the indications are that recycled woodwaste can play an increasing role in the production of a variety of wood-based products. Two difficulties that deserve special attention are: 1) developing an infrastructure that can deliver a clean, consistent waste wood resource; and 2) developing definitions and material standards that will help manufacturers and suppliers more uniformly and consistently trade and use this resource. When progress is made in these areas, the potential of woodwaste to become a viable alternative raw material will be realized

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Accessible information is needed to encourage the use of recycled woodwaste and the following two publications are especially useful.

In cooperation with the USDA Forest Service, the American Forest & Paper Association has developed a directory that lists wood residue receivers nationwide. This document will help those who have recycled woodwaste to find a market for their residue.

The Clean Washington Center, a division of Washington State's Dept. of Community, Trade and Economic Development, has developed a "best practices" manual for woodwaste usage in cooperation with the National Institute of Standards and Technology and the Environmental Protection Agency. This manual contains about 60 best-known uses of wood and concise technical descriptions for the sourcing, handling, and processing of recovered woodwaste, as well as end-use applications, marketing, and safety issues.

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[1] McKeever, D. 1997. Resource Potential of Solid Waste Wood in the United States. In: Proc. The Use of Recycled Wood and Paper in Building Applications. Forest Prod. Soc., Madison, Wis.

[2] The Use of Recycled Wood and Paper in Building Applications. 1997. Proc. 7286. Forest Prod. Soc., Madison, Wis.

[3] Smith, D. 1997. Utilization of Urban Wood in the Manufacture of Particleboard and MDF. In: Proc. The Use of Recycled Wood and Paper in Building Applications. Forest Prod. Soc., Madison, Wis.

[4] Yost, P. and E. Lund. 1997. Residential Construction Waste Management: A Builder's Field Guide. National Association of Home Builders Research Center, Upper Marlboro, Md.