Resource Potential of Solid Wood Waste in the United States

David B. McKeever

Abstract

Solid wood is usually thought of as a renewable, not a recyclable, resource. However, wood residues from primary timber processing facilities have been made into usable products for decades; wooden pallets are being recycled into new pallets or other wood products at increasing rates. Wood waste from construction and demolition sites is also being recognized as an important commodity. Urban wood waste collection may soon prove to be a valuable resource. An important step in developing wood waste into a viable resource is to quantify the amounts of wood waste available by source and type of material. Three major sources of wood waste exist: municipal solid waste, new construction and demolition waste, and wood residues from primary timber manufacturing facilities. Included in municipal solid waste are pallets and yard waste. Total amounts of wood waste generated, amounts of wood waste generated by type, and amounts of wood waste potentially available for recycling are quantified here for each of these three sources. Estimates are based on published waste generation rates and volumes, measures of economic activity, and trends in wood use in specific markets. Possible uses for each source of wood waste are identified, and recommendations for better utilization of the solid wood waste resource are made.

Introduction

Large amounts of waste are generated in the United States annually. Although much of this material is indeed waste, increasing amounts are now becoming valuable resources. In the past, recycling was limited to a few commodities such as metal, glass, and old newspapers. Today, a much more diverse mixture of waste, including plastic containers and film, used oil and oil filters, fluorescent lighting tubes, and aerosol spray cans, is being recycled.

Solid wood waste is usually not considered to be a recyclable commodity. However, wood residues from primary timber processing facilities have been made into usable products for decades. Nearly all particleboard produced in the United States, for example, is made from primary timber processing facility residues. Wooden pallets and containers are recycled at increasing rates, and solid wood waste from new construction and demolition (C&D) sites is rapidly becoming a valuable commodity. Urban wood waste from the municipal solid waste (MSW) stream is also gaining importance as a wood resource.

A first step in developing solid wood waste into a viable resource is to quantify the amounts of waste available by source and type of material. To do this, published waste characterization reports were reviewed to develop estimates of the types and amounts of solid wood waste generated for each of three major sources of wood waste in the United States: 1) MSW, 2) new C&D waste; and 3) wood residues from primary timber processing. The purpose of this study was to estimate total amounts of waste generated, amounts of wood waste generated, and amounts of wood waste potentially recoverable, by source of material for 1994. Waste estimates were then compared with total industrial roundwood consumption in

The author is Research Forester. USDA Forest Serv., Forest Prod. Lab., Madison, Wis.

1994. This study updates similar estimates made for 1993 (8). Not included in these analyses are wood waste from less important sources, residues left in the woods from logging or cultural operations, and other nonwood agricultural wastes.

Municipal solid waste

Municipal solid waste is waste from residential, commercial, institutional, and industrial sources, and includes waste such as durable and nondurable goods, containers and packaging, food scraps, yard trimmings, and miscellaneous inorganic waste (17). Specific examples of MSW are appliances, automobile tires, newspapers, clothing, boxes, disposable tableware, office and classroom paper, wooden pallets, and cafeteria waste. MSW does not include waste from other sources, such as C&D waste, automobile bodies, municipal sludges, combustion ash, and industrial process wastes that may or may not be disposed in municipal waste landfills or incinerators.

An estimated 189.7 million metric tonnes of MSW were generated in the United States in 1994 (Fig. 1) (17). Except for a slight decline in 1991, MSW generation increased steadily from 79.7 million metric tonnes in 1960. MSW generation is sensitive to overall economic conditions. Periods of economic recession, such as that experienced in 1991, cause deviations of MSW generation from long-term trends. Between 1960 and 1994, MSW generation increased at an average annual rate of 2.58 percent per year. Since 1990, the rate was just 1.49 percent per year, compared with 2.73 percent per year from 1960 through 1990. Overall, MSW is projected to be 198 million metric tonnes by the year 2000. This represents an average annual increase of just 0.7 percent per year from 1993 through 2000. Thus, although total MSW is increasing, it is increasing at a decreasing rate, and is expected to do so into the foreseeable future. Per capita MSW generation averaged 2.00 kg per person per day in 1994, an increase from 1.96 kg in 1990 and 1.21 kg in 1960. Trends in per capita generation closely followed total MSW generation from 1960 through 1990. Source reduction and recycling programs initiated in the late 1980s began to influence waste generation by 1990. Per capita generation began to plateau in the early 1990s; in 2000, it is expected to increase slightly to 2.01 kg per person per day.

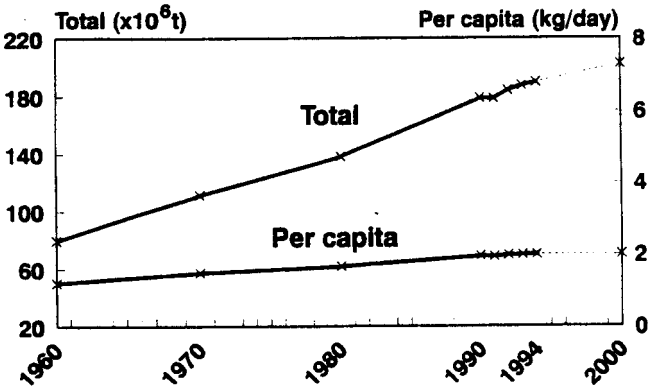

Figure 1.—Total and per capita municipal solid waste generated in the United States, 1994.

A wide variety of products are included in the overall MSW generation figures (Fig. 2). Two categories of MSW—wood and yard trimmings-contain solid wood waste. Wood includes items such as wooden furniture and cabinets, pallets and containers, scrap lumber and panels from other-than-new C&D activities, and wood waste from manufacturing facilities. Wood does not include roundwood or unprocessed wood. Yard trimmings includes leaves and grass clippings, brush, and tree trimmings and removals. The amounts and types generated, currently recovered for recycling, comporting or combustion, and discarded determine the physical supply of solid wood waste that may be available for recovery from the MSW stream.

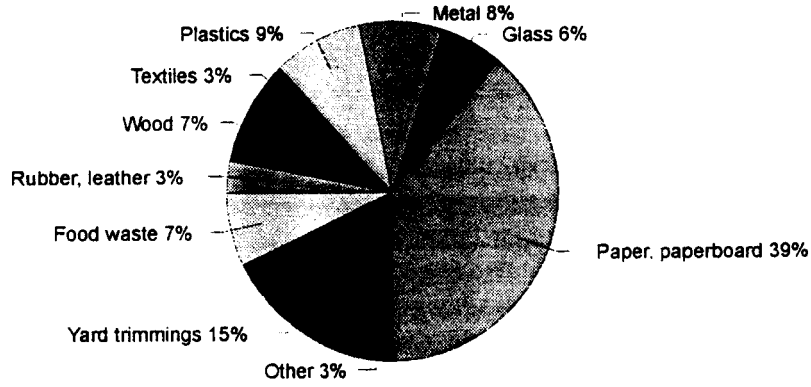

Figure 2.—Percentage of municipal solid waste generated in the United States, by type, 1994. Total weight: 189.7 million metric tonnes.

Wood

In 1994, 13.2 million metic tonnes of soild wood waste were generated in the United States as part of MSW (Table 1)(17). This was nearly 7 percent of all the MSW generated (Fig. 2). Of this, 1.3 million metric tonnes were recovered for recycling or composting; the remainder was discarded. The discarded wood waste was either sent to combustion facilities or landfills. The exact proportion of discards that were combusted is available only for overall MSW, not for specific materials within the waste stream. Approximately 95 percent of all MSW combustion facilities burn either unprocessed mixed waste or processed mixed waste (refuse-derived fuel), both of which contain wood waste. In 1994, 29.5 million metric tonnes of MSW were burned. Wood waste accounted for about 10 percent of all combustible MSW in 1994; therefore, it was estimated that about 10 percent or 3.0 million metric tonnes of wood waste was burned in 1994. Also, some discarded wood waste was too contaminated, commingled with other waste, or otherwise unacceptable for recovery. Overall, an estimated 40 percent or 6.1 million metric tonnes, of all discarded wood waste was either combusted or otherwise unacceptable for recovery, resulting in an estimated 7.2 million metric tonnes of wood waste considered to be recoverable in 1994 (4,5).

Yard trimmings

Yard trimmings were the second largest single component of MSW in 1994 at 27.8 million metric tonnes, or nearly 16 percent of all MSW (17). Of this, 6.4 million metric tonnes were recovered for recycling or comporting. The remaining 21.4 million metric tonnes were discarded. A recent study by the NEOS Corp. detailed the generation and disposition of all urban tree and landscape residues, not just the proportion in the MSW stream (11). They estimated that in 1993, 95 percent of all urban tree and landscape residues, by volume, were woody residues, and 5 percent were leaf and grass clipping residues. Application of these percentages to 1994 MSW yard trimmings resulted in about 26.4 million metric tonnes of woody yard trimming residues generated, 6.0 million metric tonnes recovered, and 20.4 million metric tonnes discarded. After combustion and allowance for unrecoverable material as a result of contamination, size, commingling with other materials, and cost of collection, about 12.2 million metric tonnes were considered to be available for additional recovery (60% of the total amount discarded) (Table 1) (4,5).

Total solid wood waste

In 1994, nearly half of all solid wood waste in MSW, or about 19.4 million metric tonnes, was considered to be potentially recoverable (Table 1). It should be emphasized that although these amounts were deemed potentially available, many factors affect recoverability and usability, such as the size and condition of the material, extent of commingling with other types of waste, contamination, physical location of the material, and costs associated with acquiring,

Table 1.—Wood waste generated, recovered, combusted, or available for recovery in the United States, by source of material, 1994.

Source	Generated	Recovered, combusted, or unusable	Available for recovery	
			Amount	Percentage of all available
	(million metric tonnes)			(%)
Municipal solid waste				
Wood waste	13.2	6.1	7.2	19
Woody yard trimmings	26.4	14.2	12.2	32
Total	39.6	20.3	19.4	51
Construction and demolition				
New construction	6.5	0.8	5.7	15
Demolition	22.7	15.9	6.8	18
Total	29.2	16.7	12.5	33
Primary timber processing				
Bark residues	26.7	25.3	1.4	4
Wood residues	80.1	75.3	4.8	12
Total	106.8	100.6	6.2	16
Total wood waste	175.6	137.5	38.1	100

transporting, and processing the material into a usable raw material. Overall economic conditions and changing recycling rates will affect future supplies. Estimates of recoverable solid wood waste for 1994 are practical limits to overall supply, given current recovery technology and costs, not exact amounts that were specifically available.

New construction and demolition waste

New C&D waste is commonly considered to be a single form of waste, but it is not. These wastes originate from distinctly different sources, have different characteristics, and differ in ease of separation, recovery, and recyclability. New construction waste, particularly wood waste, originates from the construction, repair, and remodeling of single-and multifamily houses and low-rise new nonresidential buildings. Demolition waste originates at any site where a building or other structure is being demolished. New construction waste tends to be much cleaner than demolition waste and consists of contemporary types of materials. Demolition waste is usually contaminated with foreign materials, such as paints, fasteners, wail covering materials, and insulation. It typically contains a diverse mix of materials. Some materials in demolition waste are no longer being widely used in new construction or are considered to hazardous, making them potentially more difficult to recycle. New construction waste can be readily separated on the job site with little effort by the builder, whereas source separation of waste at the demolition site can be very time consuming and costly Demolition practices would have to be radically altered to achieve adequate job site source separation. For these reasons, C&D wastes were evaluated separately.

Although C&D waste recovery is increasing, little consistent information is available nationally for developing overall estimates of materials generation and recovery. Available data are limited to specific case studies and points in time that mayor may not reflect overall national trends and vary widely. The C&D waste generation rates published in the past 25 years ranged from a low of 0.05 kg/person per day (19.9 kg per year) to 1.60 kg/person per day (582.6 kg per year) (14). Factors that affect C&D generation rates include new construction activity, types of structures being built or demolished, types of materials in these structures, rate of demolition activity, age of structure being demolished, and extent to which materials are removed from structures for reuse or recycling prior to demolition. Because of variability in reported C&D waste generation rates and the many factors that affect them, information from specific case studies that could be linked to national levels of construction activity and population was used to estimate C&D waste generation in 1994. The resulting estimates, although not precise estimates of the size or extent of this waste stream, particularly regionally or locally, provide a good, overall view of the C&D waste resource.

New construction waste

New residential and nonresidential building construction and nonbuilding construction generate large amounts of waste amually. Information on the types and amounts of waste generated is sketchy and limited to anecdotes or a few case studies. Nearly all new single-family and low-rise multifamily residential structures are based on traditional wood-time building technology. Therefore, information on this type of construction was used to develop estimates of wood waste generated and recoverable for new construction. Specific waste generation rates were obtained from a case study of the Portland, Oregon, metropolitan area (7). Although specific to the structures examined, the waste generation rates were typical of all new residential construction in 1994, because the individual structures examined had characteristics typical of all new residential construction. This information was used to develop weighted average waste generation rates based on floor area built for new single-family and new multifamily houses. These rates were then applied to total floor area of each type of structure built in the United States in 1994 to develop estimates of total waste generated for residential construction. Estimates were then adjusted to account for new nonresidential construction and residential repair and remodeling. Waste from the production of mobile homes and manufactured housing was not included with new construction because it is a component of MSW.

An estimated 2,237 kg of solid wood waste and 1,215 kg of all other waste (including waste paper) were generated for the average 188.3 m^2 single-family house built in the Portland metropolitan area in 1993 (7). Wood waste was generated at the rate of 11.86 kg/m^2 of finished floor area. Overall, an estimated 88 percent of the wood waste generated was considered to be recoverable. New multifamily construction generated 619 kg of wood waste and 390 kg of other waste per living (apartment) unit. These amounts included not only materials generated per unit, but also prorated amounts generated for common areas such as laundry rooms, lobbies, and recreational areas. Wood waste was generated at the rate of 7.42 kg/m^2 of

finished floor area; 88 percent of this material was also recoverable.

In 1994, 1,198,000 new single-family houses with an average 195 m^2 of floor area and 187,000 multifamily living units with an average 96 m^2 of floor area were built nationally (15). Applying the average wood waste generation and recoverability rates resulted in an estimated 2.8 million metric tonnes of wood waste generated and 2.5 million metric tonnes of wood waste potentially recoverable in 1994 for new single-family construction, and 0.1 million metric tonnes for new multifamily construction generation and recovery (Fig. 3). Based on material use factors (amounts of building materials required per unit of finished floor area) for new residential construction, an estimated 29.0 million metric tonnes of wood products were required in 1994 for all new residential construction (1, 10). Wood waste was about 10 percent of the total amount of wood required to build the structures. Conventional wisdom is that about 5 to 15 percent waste can be expected in new construction. The waste estimates developed here confirm this.

Large amounts of wood products are required for residential repair and remodeling and new nonresidential construction. Therefore, these activities should generate large amounts of wood waste. Reliable information on waste generation rates for these types of construction was not available. However, the types of materials and construction techniques typically used for residential repair and remodeling are the same as those used for new single-family construction. Waste generation for residential repair and remodeling was therefore based on waste generation rates for new single-family construction. Data on wood products use in 1991 for residential repair and remodeling were updated to 1994 using data on total expenditures by type of repair or remodeling activity from the U.S. Department of Commerce (9,16). Total wood products use was estimated to be 25.2 million metric tonnes, with about 2.5 million metric tonnes of wood waste generated and 2.3 million metric tonnes potentially recoverable in 1994 for residential repair and remodeling activities (Fig. 3).

Estimates of amounts of wood products used per constant dollar of expenditure for new nonresidential construction in 1986 were used to estimate total wood products used in 1994 (12). In 1994, an estimated 13.0 million metric tonnes of wood products were used for new nonresidential construction. This is about 45 percent of that used for new residential construction. The wood products and construction techniques typically used to build low-rise, light-frame nonresidential buildings, such as stores and office buildings, are similar to that used for new residential construction. Waste generation is also expected to be similar. Wood is not typically used as the primary construction material for larger nonresidential projects, such as warehouses, high-rise buildings, and highways, and the building techniques are different. Information needed to estimate waste from such building activities was not available. However, wood is not the primary building material for these larger nonresidential projects; therefore, total wood waste generation should not be greatly affected. Using waste generation and recovery rates for new single-family house construction, an estimated 1.0 million metric tonnes of wood waste were generated and 0.9 million metric tonnes potentially recoverable in 1994 (Fig. 3).

Wood waste generation for all new construction (new single- and multifamily residential, residential repair and remodeling, and new nonresidential) was estimated to be 6.5 million metric tonnes in 1994, with 5.7 million metric tonnes available for recovery (Table 1). Only 0.8 million metric tonnes of the generated wood waste was not considered to be recoverable.

Demolition waste

Demolition waste is the heterogeneous mixture of building materials generated when a building or other structure is demolished. It typically contains aggregate, concrete, wood, paper, metal, insulation, glass, and other contemporary building materials. Depending on the age and type of structure, it may also

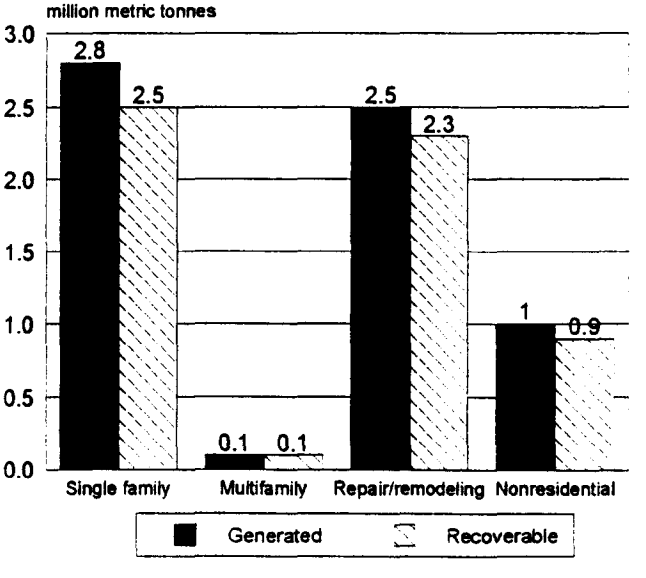

Figure 3.—New construction wood waste generated in the United States, by construction type, 1994.

contain asbestos, lead-based finishes, mercury, polychlorinated biphenyl compounds (PCBs), and other contaminates or hazardous materials. Estimates on the amounts of demolition waste generated have been made over the years. These estimates are usually for specific localities, typically include new construction waste, and are based on the size of the resident population. (Urban areas tend to generate more C&D waste per capita than suburban or rural areas.) The Solid Waste Association of North America reported C&D waste generation rates made by the California Waste Management Board and the New York Solid Waste Management Board for 1968 and 1991, respectively (Fig. 4) (14). Because of the consistency between the New York and California rates, and the relationship of waste generation to population, the New York C&D generation rates were used to estimate demolition waste generated in the United States in 1994.

To estimate demolition waste, total C&D waste was first estimated by annualizing the generation rates from the 1991 New York study and multiplying these rates by the size of the population living in metropolitan and nonmetropolitan statistical areas in 1994. The estimated amount of new construction waste (wood and nonwood wastes) was then subtracted, resulting in an estimated 43.8 million metric tonnes of demolition waste generated in 1994. Information from a 1991 Metropolitan Toronto Waste Composition study indicated that 52 percent of the demolition waste being

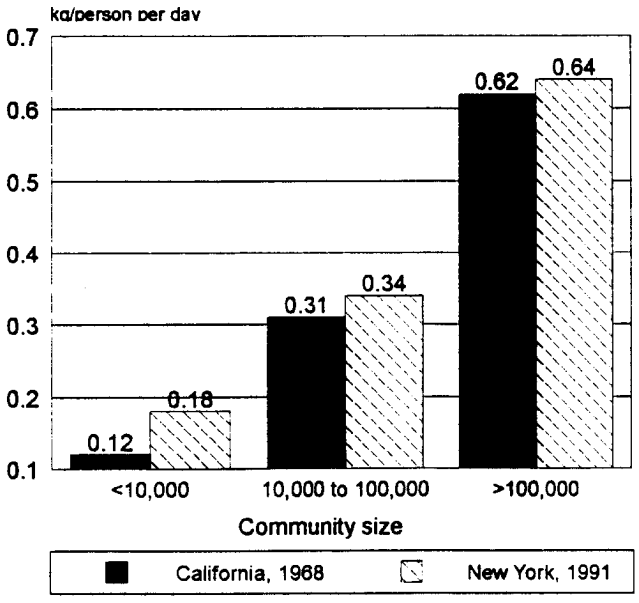

Figure 4.—Construction and demolition waste generation rates for California and New York.

disposed in metropolitan Toronto landfills was wood, and 48 percent was other materials (14). Application of these percentages resulted in an estimated 22.7 million metric tonnes of wood in the demolition waste generated in the United States in 1994 (Table 1).

Recoverability of demolition waste is difficult to determine. The charcteristics of demolition waste make it more difficult to recover and recycle than new construction waste. Existing demolition waste recycling operations are very sensitive to contamination. Entire loads of demolition waste are typically rejected if contaminated. Only about 15 percent of the wood, by weight (38% by volume), received at a Massachusetts demolition waste recycling facility is usable (6). These figures are for a specific operation producing a single product and are based on primary crushing of the incoming demolition waste to achieve uniform material size. Differences in treatment technology, products manufactured, and source of demolition waste affect the utilization rate. Based on an assumed overall 30 percent utilization rate, approximately 6.8 million metric tonnes of wood demolition waste were estimated to be recoverable in 1994 (Table 1).

Primary timber processing mill residues

Primary timber processing facilities in the United States generate large amounts of residues in the form of bark, sawmill slabs and edging, sawdust, and peeler log cores. The USDA Forest Service estimated that 26.0 million metric dry tonnes of bark and 74.5 million metric dry tonnes of wood residues were generated at primary timber processing facilities in 1991 (13). Mill residue generation for 1994 was estimated by adjusting the amount of residues generated in 1991 by the change in overall industrial roundwood production between 1991 and 1994. This resulted in an estimated 26.7 million metric tonnes of bark and 80.1 million metric tonnes of wood residues being generated in 1994 (Table 1). Nearly all mill residues are used to produce other products, primarily fiber products, nonstructural panels, and fuel. Just 5 percent of the bark (1.4 million metric tonnes) and 6 percent of the wood residue (4.8 million metric tonnes) were not used in 1994. All this unused residue is considered to be potentially recoverable.

Other sources

There are many other sources of wood waste, including chemically treated wood used for railroad cross ties, switch ties and bridge timbers, telephone and utility poles, and pier and dock timbers, and untreated wood in the form of logging residues left in

the woods, chipped brush and limbs resulting from maintenance of utility right-of-ways, and industrial wood waste outside the MSW stream. This material is either reused, burned, or disposed in hazardous waste landfills; much is being left on site. Chemical treatments and cost of collection makes much of this material difficult to recover. The amounts of wood available from these other sources (with the exception of logging residues) are fairly small compared with that from MSW, C&D waste, and mill residues. For example, in 1993 12.3 million metric tonnes of railroad cross ties were replaced (2). The replacement ties were all treated wood and had an estimated volume of 1.2 million m^3. Bridge and switch tie replacements constituted an additional 0.1 million m^3. The combined volume was equivalent to nearly 0.8 million metric tonnes of ties replaced. If half the volume of wood in the removed ties was sound, then less than 0.5 million metric tonnes of wood would have been recoverable from all railroad tie replacements. This is approximately 10 percent of the recoverable wood residue from primary timber processing mills, the smallest of the three major sources of wood waste. Although wood from other sources may become a valuable resource in the future, they were not included here because of their smaller volumes or obstacles to recovery.

Concluding remarks

An estimated 175.6 million metric tonnes of wood waste were generated in the United States in 1994 from the MSW stream, new C&D waste, and primary timber processing facilities (Table 1). Much of this waste was used to produce new products, for fuel, or was not suitable for other uses as a result of contamination or other physical characteristics. Of the total amount generated, 38.1 million metric tonnes or 22 percent was suitable for additional recovery. In comparison, an estimated 349.6 million metric tonnes of roundwood timber were consumed in the United States in 1994 (3). Recoverable wood waste was therefore about 10 percent of roundwood timber products consumption. More than half the recoverable wood waste was from MSW, about a third from C&D wood waste, and the remainder from primary timber processing mill residues.

Many technical and economic obstacles need to be overcome before much of the recoverable wood waste can be recycled. Nevertheless, this is a valuable resource, and it is playing an ever-increasing role in satisfying the demand for wood-based products. Advances are constantly being made in current utilization and new uses are being found. In the forest products industry, for example, furnish consisting of up to half recycled construction waste, pallets, crating, and other wood waste is being used to produce particleboard at a west coast plant. Also, funding and site planning are underway for a medium density fiberboard plant in Canada that will use urban and industrial wood waste exclusively. This company is planning six additional medium density fiberboard plants for large metropolitan areas in the United States and Canada. The USDA Forest Service Recycling Initiative is aimed at developing uses for wood waste and paper, particularly for building products to be used in residential construction.

Literature cited

1. Anderson, R.G. and D.B. McKeever. 1991. Wood used in new residential construction in the United States, 1988. Market Res. Rept. Amer. Plywood Assoc., Tacoma, Wash. 73 pp.
2. Crimmel, C. 1995. Personal communication, March 28. Assoc. of Amer. Railroads, Washington, D.C.
3. Howard, J.L. 1996. U.S. timber production, trade, consumption, and price statistics 1964-94. Preliminary rept. USDA Forest Serv., Forest Prod. Lab., Madison, Wis.
4. Ince, P.J. and D.B. McKeever. 1995. Recovery of paper and wood for recycling: actual and potential. FPL-GTR-88. USDA Forest Serv., Forest Prod. Lab., Madison, Wis. 25 pp.
5. _____ and _____. 1995. Estimates of paper and wood recovery for recycling and potential recovery in the United States. *In:* Proc. Wood Fiber-Plastic Composites Conf. Forest Prod. Soc., Madison, Wis.
6. McElvenny, J. 1995. Personal communication, March 27. Wood Recycling, Inc., Woburn, Mass.
7. McGregor, M., H. Washburn, and D. Palermini. 1993. Characterization of construction site waste. Final rept. presented to METRO, Solid Waste Dept., Portland, Oreg. July 30. 29 pp.
8. McKeever, D.B. 1995. Resource potential of wood-based wastes in the United States. *In:* Proc. 2nd Biomass Conf. of the Americas: Energy, Environment, Agriculture, and Industry. Nat. Renewable Energy Lab., Golden, Colo. pp. 77-87.
9. _____ and R.G. Anderson. 1993. Wood products used for residential repair and remodeling in the United States, 1991. FPL-RB-19. USDA Forest Serv., Forest Prod. Lab., Madison, Wis. 25 pp.
10. _____ and R.B. Phelps. 1994. Wood products used in new single-family house construction: 1950 to 1992. Forest Prod. J. 44:(11/12): 66-74.
11. NEOS Corp. 1995. Final report: Urban tree residues: results of the first national inventory. Prepared for Inter. Soc. of Arboriculture Res. Trust, Allegheny Power Serv. Corp., and Nat. Arborists Foundation. NEOS Corp., Lakewood, Colo. Sept. 1994.
12. Phelps, R.B. and D.B. McKeever. 1990. Recent trends in the consumption of timber products. *In:* An analysis of the timber situation in the United States 1952-2040. R.W. Haynes, coord. RM-199. USDA Forest Serv., Rocky Mountain Forest and Range Expt. Sta., Fort Collins, Colo. pp. 8-42.
13. Powell, D.S., J.L. Faulkner, D.R. Darr, et al. 1993. Forest resources of the United States, 1992. RM-234. USDA Forest

Serv., Rocky Mountain Forest and Range Expt. Sta., Fort Collins, Colo. 132 pp.

14. Solid Waste Association of North America. 1993. Construction waste & demolition debris recycling. A primer. GR-REC 300. Solid Waste Assoc. of North America, Silver Spring, Md.
15. U.S. Department of Commerce, Bureau of the Census. 1995. Characteristics of new housing: 1994. Current Construction Repts. C25/94-A. Washington, D.C. 58 pp.
16. _____. 1995. Expenditures for residential improvements and repair. Current Construction Repts. C50/95-Q2. Washington, D.C. 14 pp.
17. U.S. Environmental Protection Agency. 1996. Characterization of municipal solid waste in the United States: 1995 Update. EPA 530-R-96-001. Prepared by Franklin Associates, Ltd., Prairie Village, Ka. 137 pp.

The Use of Recycled Wood and Paper in Building Applications

These papers were presented during a conference sponsored by the USDA Forest Service and the Forest Products Society, in cooperation with the National Association of Home Builders Research Center, the American Forest & Paper Association, the Center for Resourceful Building Technology, and Environmental Building News.

Madison, Wisconsin, September 1996

Proceedings No. 7286

Forest Products Society
2801 Marshall Court
Madison, WI 53705-2295
(608) 231-1361
(608) 231-2152 fax
http://www.forestprod.org/

Proceedings No. 7286

ISBN 0-935018-88-3

Printed in the United States of America.

9703500