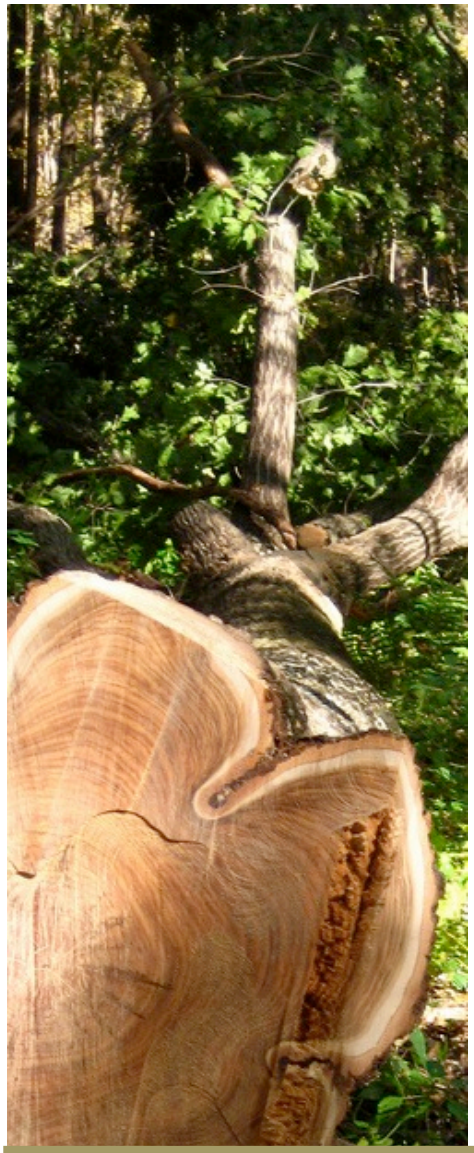

The Current State of Wood Reuse and Recycling in North America and Recommendations for Improvements

Dovetail Partners
May 2013



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Authors: Jeff Howe, Steve Bratkovich, Jim Bowyer, Matt Frank, Kathryn Fernholz
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Dovetail Partners, 528 Hennepin Ave, Suite 703, Minneapolis, MN 55403
Tel: 612-333-0430 Fax: 612-333-0432 Email: info@dovetailinc.org
www.dovetailinc.org

EXECUTIVE SUMMARY

According to Neal deGrasse Tyson, we are "the stuff of stars". Specifically, "the atoms of our bodies are traceable to the stars that manufactured them…we are biologically connected to every living thing in the world."[1] Therefore, we are also the stuff of trees, and they of us. This connection both simplifies the truth and complicates the story of wood reuse and recycling. The truth is that *all wood is 100 percent recycled material*. That is the nature of renewable materials. It's in the definition. If you put trees in a closed environment, over time they will grow, live, die and re-grow again within that closed system; recycling themselves ad infinitum. The presence of other species, especially animals, aids this process. This closed system is called earth.

To a certain extent this simple truth of how "renewable" and "recycled" are linked complicates the green story of wood because the definitions of reuse and, in particular, recycling are generally based on the use of inorganic materials such as steel, plastic and aluminum. So the answers to reuse and recovery questions, as they relate to wood products, are often "it depends," or involve looking at the problem from a completely different perspective. Today's consumers also tend to view recyclable as superior to renewable, when in fact renewable is a subset of recycled; renewable is a natural form of recycling.

Currently, the United States ranks 1st and Canada 3rd in total global wood production. Together these two countries produce about 28 percent of the world's supply of industrial roundwood. The U.S. produces an average of over 143 million (short) tons of wood products annually. Wood product companies in the U.S. and Canada utilize nearly 99 percent of their manufacturing inputs (pre-consumer recycling) at sawmills and at secondary wood processors such as furniture and cabinetmakers. This near-zero wood-waste within the major manufacturing sectors reflects decades of private and public effort to improve manufacturing processes, develop new products, and add value to wood as a versatile raw material.

The challenge for the future expansion of wood recovery is to go beyond pre-consumer recycling and undertake opportunities to increase utilization of wood classified as post-consumer, including waste from Municipal Solid Waste (MSW)[2] and Construction & Demolition (C&D) collection sites. For some wood products, post-consumer recycling is already commonly occurring, and there are opportunities for greater marketplace recognition and replication of best practices. In other situations, there are significant barriers to expanded wood recovery, reuse and recycling. Making progress in these situations is likely to require new and expanded partnerships, industry innovations, and an appetite for addressing the unique characteristics of wood as a renewable, and therefore naturally recyclable, material.

Purpose & Methods

The purpose of this project was to identify practices and trends in wood reuse and recycling in the U.S. and Canada, and to develop recommendations for increasing such activity. The project examined reuse and recycling from the forest through end-of-life situations for the full spectrum of wood products. To achieve this Dovetail Partners completed an extensive literature review, conducted telephone surveys of wood recovery experts, representatives of municipalities, and

[1] http://www.goodreads.com/quotes/484586-the-atoms-of-our-bodies-are-traceable-to-stars-that

[2] Canada categorizes waste as Residential (R) or Industrial, Commercial and Institutional (IC&I) or Construction, Renovation, and Demolition (CR&D). Residential and IC&I roughly equate to MSW in US.

secondary manufacturers, and developed a series of case studies that highlight current wood recovery efforts in North America and Europe. These methods provided insight into the current state and future opportunities for wood reuse and recycling in the U.S. and Canada.

Summary of Key Findings

Pre-consumer

Wood recycling begins in the forest. Trees, by their very nature of living, dying, rotting and/or burning, are constantly being recycled within a forest ecosystem. This process continues even after a tree is harvested. Part of the life cycle of many forest ecosystems includes fire. Wood combustion, regardless of whether it takes place in an uncontrolled wildfire or in a controlled and efficient biomass boiler, is a method for recycling materials—carbon and water—back "from whence they came." In general, controlled combustion results in lower levels of air pollution and other impacts and is therefore far superior to uncontrolled combustion from an environmental perspective.

Today, pre-consumer wood waste in the U.S. and Canada has been virtually eliminated. Harvesting guidelines and best practices avoid waste of wood materials at the time of harvest, and full utilization has been achieved in manufacturing (sawmill and secondary processor). This success story within the industry is largely due to the recycling of wood residues into various products and the combustion of wood residues for on-site energy production. Appendix B includes a full discussion and reporting of current levels of utilization with the industry.

Post-Consumer

By many measures, there is a great opportunity to expand post-consumer wood recycling. There are significant volumes of waste wood being generated, there are models of success in the collection and recycling of specific types of wood products, and there are marketplace drivers, such as green building, to help support innovation. However, there are also significant barriers. First and foremost, the volume of available post-consumer wood waste is difficult to estimate. For example, the U.S. Environmental Protection Agency (EPA) estimates the U.S. Municipal Solid Waste (MSW) stream at 250 million tons while the estimate from *BioCycle*/Columbia University suggests 390 million tons. The U.S. Forest Service (FS) appears to have the best available estimate of woody yard trimmings generated (18.4 million tons as part of the MSW stream) and wood combustion for energy (5.5 million tons also from MSW). However, it is possible the Forest Service underestimates MSW generation across the country since it uses EPA data in its calculations. Similar challenges with data availability and waste estimates also arise when evaluating wood recycling opportunities in Canada.

The best estimate to-date for the U.S. is that about 70 million tons of MSW and Construction and Demolition (C&D) wood debris are generated annually with over 28 million tons available for recovery[3]. The 70 million tons represent about 14% of total MSW (i.e. all materials) plus about 28% of the total C&D waste stream. According to the EPA, most C&D debris in the U.S. comes from non-residential demolition. The EPA estimates that C&D wood waste alone in 2010 was 36.4 million tons and that 17.3 million tons was available for recovery. The reliability of this estimate is supported by updates to the EPA data that are done by the Forest Service using

[3] The difference of approximately 42 million tons is, per Falk and McKeever 2012, either currently recovered, combusted, or not usable.

economic factors such as housing completions, value of nonresidential construction, and population change. Appendix C provides additional details about MSW and C&D waste generation and wood recovery in the U.S., including further discussion of the challenges related to data collection and analysis.

In Canada, estimates indicate much smaller quantities of available post-consumer wood waste in comparison to the U.S. This is due to differences in economic activity as well as unique methods of categorizing and quantifying waste streams. Natural Resources Canada (NRCan) estimates that unrecovered wood debris in MSW (Residential; and Industrial, Commercial & Institutional (IC&I); and Construction, Renovation, & Demolition (CR&D)) in Canada total about 1.75 million metric tons[4] per year. This is approximately 7 percent of the total annually disposed and unrecovered waste stream.

Regardless of the country, research source, or specific estimate, there remains a large volume of "wood waste" available for recovery in MSW and C&D streams. It can be estimated that on an annual basis there is at least 30 million tons of recoverable wood waste in total for the U.S. and Canada. While the volume of wood debris is a large and complex social concern the amount available for recovery provides potential opportunities for segments of the forest industry, including utilization as a low cost raw material.

Post Consumer Best Practices

There are many examples of *best practices* in wood reuse and recycling involving MSW and C&D waste streams throughout the U.S. and Canada. These existing initiatives were explored through interviews and case study development. This information provides insights into best practices and opportunities for growth and replication to support increased wood waste recovery. Identified key best practices include:

- Designing for deconstruction of structures
- Expanding on-site reuse
- Improving deconstruction process management
- Improving job-site processing capacities
    - Providing for source separation at the construction site
    - Unitizing similar materials for easy handling
- Ensuring processes retain/ensure maximum material value

Some of these practices are relatively common today, but there continue to be opportunities for improvement and expansion.

While some practices can be adopted relatively quickly, others may require longer-term commitments and changes. For example, there may be opportunities to improve building design and expand the prefabrication of building components. Such changes can reduce on-site waste generation and avoid the use of certain fasteners and glues that can limit end-of-life wood recovery. Some regions have also pursued regulations and/or ordinances that restrict wood product disposal in landfills or that provide incentives for greater wood recovery during construction or demolition (see case studies in Appendix E). In general, increased wood recovery from MSW and C&D waste streams requires a commitment to improved planning by

[4] Short ton = 2,000 lbs.; metric ton (tonne) = 2,200 lbs.

project developers and collaboration with municipal and community partners and material suppliers. The wood products industry has an important role to play in identifying and promoting best practices in wood recovery, driving innovation in the design and use of wood products in the built environment, and supporting wood waste reduction and diversion efforts.

Green Building and the Relationship to Wood Recycling

Green building is a growing trend in the U.S. and Canada, including diverse voluntary programs as well as the recent development of green building codes. Definitions of recovered material, reuse, recycled, and recycled-content are inconsistent between various green building programs. To understand the relationship between green building and wood recycling, 42 distinct green building programs used in the U.S. and Canada were identified (Appendix D) and reviewed to determine the extent to which recycling and recovery of materials is recognized and rewarded. Forty-one (41) of the programs award reuse and/or reclamation or recovery of materials for reuse. The use of recycled content materials is recognized in 38 programs and third-party certification of recycled content is sometimes required. The review of green building programs also included looking at the current recycled content of today's common wood construction materials. Wood building materials that commonly contain pre-consumer (post-industrial) recycled content in sufficient proportions to qualify for green building programs include insulation board, medium density and high-density fiberboard, and particleboard. Finger-jointed materials are singled-out in a number of green building programs as an awarded or specified practice. Current data indicate that the overall recycled content of U.S. produced wood building products is in the 10-11 percent range. Canadian figures are likely similar.

Trends in Wood Reuse and Recycling by Primary Use and End Product

By some measures, wood has over 10,000 uses. However, there are a few dominant solid wood uses that make up a vast majority of the volume of softwood and hardwood in Canada and the U.S. In the U.S. these uses include new construction (33 percent), residential repair and remodeling (27 percent), packaging and shipping (14 percent), furniture (8 percent) and other wood uses (18 percent). Within these use categories, the major products include lumber, timber, flooring and other construction and remodeling materials; pallets and shipping containers; diverse categories of furniture; and other major wood uses such as railroad ties and fencing.

Successful reuse and/or recycling of wood products often depends on condition and appearance issues. Reused and/or recycled *flooring* is quite popular today, especially when it can be removed without significant damage. *Timbers* are either used "as is" or remanufactured into products like flooring or wall paneling. *Lumber* and other structural materials can be challenging or costly to reuse because of a variety of issues, including grade stamp concerns. Even with the gradual growth in deconstruction practices, the volume of lumber and other construction material entering the waste stream, as discussed previously, presents a significant opportunity and area for development in the industry.

In contrast to lumber and other structural materials, where challenges to post-consumer recovery remain, there are many solid wood products for which recycling and reuse is already common practice. *Pallets* are the largest use of hardwood lumber in the U.S., and by some estimates, the reuse of pallets has reached 75 percent (three out of four pallets are reused at least once) and a significant number of damaged pallets are recycled into the pallet refurbishment process. Several conditions have supported the growth of pallet recycling including new technology,

improved handling systems, greater customer acceptance, and increased disposal costs that served to increase the economics of recovery. *Railroad ties* are another example of extensive wood product recovery with approximately 95 percent being diverted from the waste stream when removed from service on active and inactive tracks (including nearly 40% reuse and approximately 55% recovered for energy production). Finally, wood *furniture* recycling is so common as to be taken for granted, and today it is rare for undamaged furniture to enter the waste stream.

Barriers and Opportunities for Increased Wood Recovery

In many ways, the barriers and opportunities for increased wood recovery are product and use specific. As noted above, there are examples of wood products that are already commonly recovered, and the experiences within these industries can inform the expansion of wood recycling for other products. Also, to the extent that existing recovery, recycling and reuse efforts qualify for marketplace recognition (e.g., green building programs, labeling claims, etc.) these product attributes should be more effectively quantified through research and promoted through marketing.

Interviews with wood reuse and recycling experts were conducted to further identify barriers and opportunities for increased wood recovery. A summary of the results of these interviews are briefly described below and further discussed in Appendix A.

The single greatest *barrier* to increased wood recovery was described as a lack of end markets and/or market development for reused or recycled materials. Clearly, to the extent that a product does not have a clear customer, it is difficult to develop the systems of production and distribution to meet their needs. Other barriers suggested through the interviews included the lack of a cost-effective system for grading salvaged lumber; inconsistent definitions of reuse, recycling, and bio-fuels to support product consistency and marketing efforts; a need for recognition of combustion for energy recovery as a recycling option; adequate procedures for handling of hazardous woody materials (such as materials coated with lead-based paint); lack of recycling centers for wood waste; and clear capacity and direction for how to proceed in the future (e.g., funding for research and development, pilot projects, government support, and private business development)

The interview results also illustrate a wide range of perceived *opportunities* to support increased wood recovery and development of associated benefits. Potential opportunities for supporting increased wood recovery include engaging the existing forest products industry in various forms of product stewardship, promoting deconstruction and better utilization practices for recovered material (e.g., for high-quality old-growth lumber from existing buildings), promoting community benefits of wood recovery, encouraging wood waste diversion ordinances and/or incentives, providing better information and education to project developers and other key stakeholders regarding wood recovery options, promoting carbon benefits of wood recovery, and supporting activities that "level the playing field" between renewable (wood) and non-renewable resources.

Thinking Creatively About the Industry's Role in Wood Waste Minimization

The forest products industry has a long history of innovation directed toward greater utilization of wood raw materials and reduction of waste. This innovation is illustrated by the elimination

of pre-consumer waste within forest products manufacturing. This successful innovation resulted from a focused effort on research, product development and diversification, on-site energy generation, and business-to-business raw material exchange. Given the success of this effort it may make sense to utilize a similar, creative approach to the remaining challenge of increasing post-consumer recycling of woody materials. One way to address wood in the waste stream might be to prevent it from turning into waste in the first place – by keeping as much as possible at manufacturing centers where there are existing capacities to recover and reuse it. A strategy of *wood-waste-minimization* could be accomplished in several different ways and will necessarily vary depending upon the product, use, and customer. Undertaking a wood-waste-minimization strategy could offer diverse benefits to the forest products industry, in addition to reducing the volume of post-consumer wood waste.

One approach to reducing the quantity of wood waste being generated in construction settings could be to increase interaction between product manufacturers, builders, and the architectural design community. Constructive engagement could focus on both how design impacts utilization and on how new product designs might reduce waste during new construction and/or improve recovery potential at end-of-life (e.g. during deconstruction). For example, strategies to increase panelization within the construction industry might be investigated. More broadly, it might be possible to vertically integrate the production of sheathing, underlayment, structural panels, and other panel products into wall-component manufacturing to provide new options for creation of building shells to home-builders that would both reduce builder costs and greatly reduce or eliminate waste at the construction site. Similarly, lumber manufacturers could provide part-labeled, cut-to-length lumber directly to major builders and others, thus keeping wastes at the factory (that is, providing alternatives beyond the standardized dimensional lumber in two-foot increments).

Finally, to the extent that wood recycling is going to meet expectations of recycling initiatives used for other products, including paper, the solid wood industry has a critical role to play in developing and supporting take-back and wood recycling collection initiatives. There are several different approaches that can be used for establishing and expanding these types of programs and a number of efforts in this area are already underway. Similar to paper recycling that largely started with newspaper drives and has gradually expanded to today's innovations around recovery of coated and wax papers, wood recycling likely has the potential to expand from today's pallet, railroad tie, and flooring recycling to incorporate more complex materials and assembled products. Moving along this spectrum will require commitments within the industry and with partners to address the research needs, product innovations, marketing systems, and other barriers and opportunities that may be specific to individual products, uses, and customers.

Recommendations

The following recommendations are offered to support increased wood reuse and recycling throughout the U.S, and Canada. Wood reuse and recycling is not a one-size-fits-all situation so recommendations may be appropriate for some communities/regions/states/provinces and not for others.

Big Picture/Overarching Themes

- *Promote the Uniqueness of Wood* - Work to develop an understanding of the nature of wood as a renewable and naturally recycling material. This is critical to valuing wood as a green material.

- *Celebrate the Success* - Promote the fact that the forest products industry has largely eliminated pre-consumer wood waste and that today there are a number of major wood products produced from pre-consumer waste materials that were historically incinerated (without energy recovery) or landfilled.

- *Work nationwide to address MSW and C&D wood waste* - Recognize that post-consumer wood waste is a significant issue nationally in both the U.S. and Canada and that there may be opportunities to address waste issues at a national scale, including through more extensive funding of research, and development of potential incentives for greater material recovery.

- *Collaborate with MSW and C&D industries and local communities to find waste recovery solutions* - Collection and disposal of MSW & C&D waste and debris typically involves participants that must deal with unique material handing and economic situations at a local level. In this regard, solutions may require new and community-based partnerships and specific strategies that may vary by locality and region.

- *Seek to Replicate Success* - Large-scale reuse and recycling of wood waste from MSW and C&D depends greatly on the type of material involved. For some materials (pallets, railroad ties, furniture) there are well-established and economically self-sustaining recovery methods. For other materials (new construction waste, demolition waste) there are specific challenges that need to be overcome. There are emerging models for addressing these challenges, and potential for further replication of best practices and models of innovation.

- *Gain Recognition for What is Already Working* - To the extent that existing recovery, recycling and reuse efforts qualify for marketplace recognition (e.g., green building programs, labeling claims, etc.) these product attributes should be more effectively quantified and promoted.

- *Recognize that Green Building is An Opportunity Not a Threat* - Green building is driving recovery and reuse of specific high value products (flooring and doors are examples) resulting in standard markets for some products (products made from salvaged barn wood in some markets are worth $10/sq. ft.) and the development of new small wood products businesses (see recommendation below on 'reuse'). Constructive engagement and support for green building can help expand opportunities for wood in the built environment.

- *Bring the Strength of Industry and its Partners* - Massive (industry scale) improvement in reuse and/or recycling of wood requires an ability to produce something out of all kinds of wood waste. To be able to accomplish this scale of wood recycling, significant new initiatives involving the industry and its partners will be needed, including research, product development and diversification, business-to-business collaborations, and

customer consultation. One approach might be to pursue a wood-waste-minimization strategy that builds from past success in eliminating pre-consumer waste during manufacturing.

Research-Related Recommendations

- *Data Collection* – To better quantify wood waste conditions in the U.S., there is a need to merge U.S. EPA and BioCycle/Columbia University methodologies. It is also recommended that U.S. Forest Service urban tree data be used to estimate woody yard trimmings. The same measurement units should be used between studies (short vs. metric tons is one example), and one comprehensive study should be designed to investigate all sources of wood residues. The development of accurate and replicable data collection techniques in both countries would aid the ability to benchmark wood waste conditions and track changes over time.

- *Map Wood Waste Availability* – There is a lack of available and consistent data related to the distribution and location of wood waste across Canada and the U.S. To address these gaps, there is a need for new research to develop wood-oriented landfill data across these two countries (numbers, type, location, life expectancy), to identify market conditions and policies by region or municipality), and develop a wood waste 'resource' map.

- *Life-Cycle Assessment* – Today consumers may view recyclable as superior to renewable. Yet, renewable is more accurately characterized as a subset of recycled, and renewable can be thought of as a natural form of recycling. Research should be done and/or promoted/communicated more effectively to compare the life cycle impacts of recycled materials with those of renewable materials to help to illustrate the benefits of renewability.

Education and Policy Recommendations

- *Promote community benefits of wood recovery* – There are a number of significant potential social, economic and environmental benefits from increasing wood recovery. For many communities, a significant driver of recycling efforts continues to be concern about diminishing landfill capacities and the rising costs of waste disposal. Increased wood waste recovery, reuse, and recycling could provide jobs, better utilization of local resources, reduced environmental impacts, and other diverse benefits.

- *Host and support programs and events:* Expand offerings of the Building Materials Reuse Association (BMRA) curriculum "Introduction to Deconstruction" and collect and disseminate BMRA case studies of successful wood recovery and recycling. Assist in efforts to continue and expand training events like *Decon 13* and the North American Wood Waste Forum.[5]

- *Understand and address the waste hierarchy* – Within recycling discussions there is debate around the terminology as well as around common understanding of the "highest and best use" of recovered materials. There is a general hierarchy that represents a

[5] Additional sources of wood recovery recommendations can be found at the Proceedings of the North American Wood Waste Forum (http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr216.pdf) and at http://www.dontwastewood.com/.

ranking of practices from the most desirable to least desirable: 1) reduce (rethink), 2) reuse, 3) recycle, 4) recover for energy, and 5) landfill/disposal without energy recovery. Where diverse opportunities for reuse, recycling and recovery are available, this type of hierarchy can aid wood recovery efforts in the U.S. and Canada.

- *Understand and address the role of energy recovery in reducing wood waste* – Combustion is a part of forest ecosystems, and recovery for energy production is one of the ways wood waste is diverted from landfills. Similarly, C&D wood waste is also commonly used to produce compost (another example of life imitating nature). Given that there are significant benefits to utilizing wood for energy, it is important to acknowledge and promote these benefits (e.g., displaces fossil fuels, reduces waste costs and landfill burdens, aids in addressing storm damage, improves energy independence and security), and to support the use of wood waste for energy production where it represents the most viable market alternative to landfill disposal.

- *Develop a 'campaign' or strategy to raise wood recycling consciousness of the general public* – Paper is commonly viewed today as a recoverable and recyclable resource. Paper recycling caught the attention of the general public a half-century ago through "newspaper drives" and other individual or community activities. Understanding the development of paper recovery and recycling over time, and applying lessons learned to foster the recovery, reuse and recycling of wood is a strategy worth exploring and acting upon while also promoting success stories within specific wood product categories.

- *Develop and promote a wood recovery day* –A dedicated day (or week or month) for wood recovery would be useful in raising awareness of the importance of recovering wood in all forms, and would also provide a platform for highlighting current successes in wood recovery and recycling. In addition to awareness, a wood recovery day would generate quantities of material that might otherwise be discarded into a landfill.

- *Target women* – A 2001 UK report noted that 80% of buyers of reclaimed material were women.[6] A U.S. publication noted that women handle 75% of family finances and control more than 60% of all wealth in the U.S. [7] Tapping into the female market could result in positive wood recovery outcomes.

- *Develop an income stream to fund market development* – A portion of a landfill tax in the UK is used to fund projects related to waste management, including projects that focus on developing markets for recycled materials. Whether it is a manipulation of tipping fees, landfill tax, or other mechanisms, additional and regular revenue is likely needed to address the important priority of markets (e.g., limited/fragmented markets, products, supply chain issues, consumer awareness).

- *Address Barriers to Wood Recycling Recognition in the Marketplace* – The Federal Trade Commission's Green Guides define the allowed market and label claims for recycling.[8] To the extent that the Green Guides create barriers to expanded use of recycling claims for renewable materials like wood, efforts should be undertaken to influence the updating

[6] http://www.globaltrees.org/downloads/WoodWasteIntro.pdf
[7] Levinson, J. 2007. *Guerrilla Marketing.*
[8] http://www.ftc.gov/opa/reporter/advertising/greenguides.shtml

of the Guides to improve recognition of the differences between recycling renewable and non-renewable materials. At the same time, to the extent that specific wood product categories or regions/markets may qualify to make recycled claims under the Green Guides, these marketing opportunities should be pursued and promoted more effectively.

Conclusion

Wood, by its very nature, is among the most recyclable, and recycled, materials. The fact that wood is a renewable resource sets it apart from, and perhaps above, many other recyclable items.

On average, about 143 million (short) tons, of wood-based products are produced annually in the U.S. In the U.S. and Canada, the harvesting and manufacture of wood products results in pre-consumer wastes and residues, about 99% of which is used for fuel, pulpwood, and feedstocks for products such as fiberboard and particleboard. The future of wood recycling in the U.S. and Canada is to apply the lessons learned from eliminating pre-consumer wood waste in the major forest industry manufacturing processes to the greater challenge of reducing wood waste in post-consumer waste streams, including Municipal Solid Waste (MSW) and Construction and Demolition (C&D) debris.

An estimate for Canada and the U.S. is that over 70 million tons of wood is in the annual MSW and C&D waste streams. This includes about 14% of the MSW, and about 28% of the C&D waste stream. Of this amount, the total estimated to be available for recovery is approximately 30 million tons per year. The further development and promotion of strategies that encourage the diversion of usable wood from the waste stream will help utilize this wood and have a positive effect on the environment as well as public perceptions of the forest products sector.

Being cognizant of best practices, acknowledging barriers, acting on opportunities, and seeking solutions to challenges, are important factors to recognize when embarking on a North American wood recovery campaign.

The Current State of Wood Reuse and Recycling in North America and Recommendations for Improvement

BACKGROUND

According to the Food and Agriculture Organization of the United Nations (FAO; 2010 statistics) the U.S. and Canada are the 1st and 3rd largest producers of industrial roundwood (IRW) in the world, together producing about 28 percent of the world's supply. The two countries also produce about 14 percent of total global roundwood (the lower percentage due to the significant production of fuelwood in other regions of the world). The U.S. is, in addition, the largest producer of wood products in the world, averaging 143.3 million short tons or 130.3 million metric tons over the past 30 years[9]. Nonetheless, the U.S. consumes more wood than it produces. The U.S. consumed 172 million metric tons of wood products in 2005, with about 45 percent in the form of lumber, 38 percent in pulp (excluding hardboard and insulating board), 6 percent in plywood and veneer, 8 percent in other panel products (including hardboard and insulating board) and 3 percent in "other industrial" categories.[10] Canada, on the other hand, is a major net exporter of both roundwood (logs) and of lumber and other products.

What do we mean?

In recycling discussions, several terms are often used that have distinct but frequently inconsistent meanings. For the purposes of this report, various terms are defined as follows:

Recovery - Material that has entered and been removed from the waste stream, including recovery for energy production. The terms reclaim or salvage may also be used.

Reuse – Material collected for use in the same or another product or process, and not substantially modified from its original form (also may be called "repurposed").

Recycling – Material collected for use in another product or process and may be substantially modified. May include post-industrial (i.e., pre-consumer) or post-consumer collection.

FAO data also suggest that the U.S. consumed about 31 cubic feet of wood per person in 2010; while Canada more than quadrupled that with consumption at 144 cubic feet per person. These numbers are a bit misleading, as a large percentage of Canadian wood "consumed" under this accounting is actually exported as products to other countries. As recently as 2005 the U.S. Forest Products Laboratory, using specific product data, estimated that individuals in the United States consumed an average of 65.7 cubic feet of wood per person, per year, excluding fuel wood, a number that had been relatively stable for almost 50 years. However, this number is likely to have decreased significantly, perhaps by 40 percent or more during to the recent "great recession." This latter data is provided to emphasize the impact of recent economic trends on wood consumption, the potential discrepancies in proportions over the past five years, and the overall scale of the issue.

[9] Falk and McKeever. 2012. Generation and Recovery of Solid Wood Waste in the U.S. *BioCycle*, August, pp. 30-31.

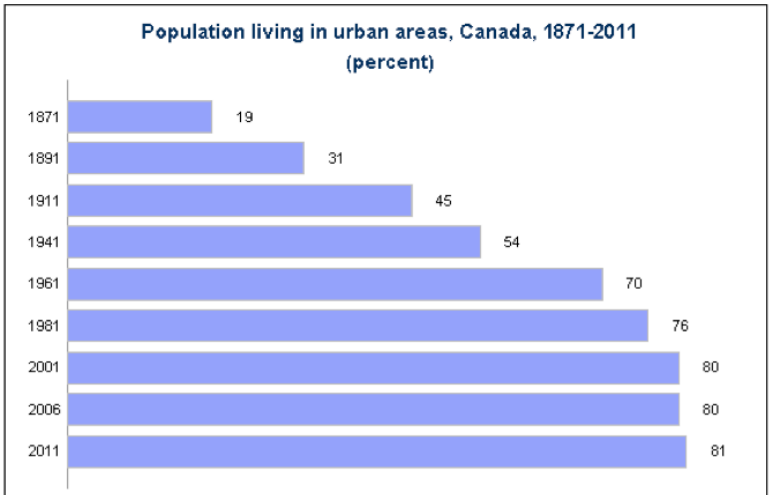
[10] Howard, J. 2007. Timber Production, Trade, Consumption, and Price Statistics 1965 to 2005. USDA-Forest Service, Research Paper FPL-RP-637.

Solid Wood Reuse and Recycling: Geographic Perspective

Geographic issues and cultural behaviors can have a large impact on a country's waste generation and the potential to recover, reuse and recycle materials. The United States currently has a population of about 316 million people and is increasing at a rate of about 2 million people per year.[11] The U.S. covers nearly 2.3 billion acres. About 29 percent of the total land area (excluding fresh water coverage) is considered to be in forest use, 26 percent used as pasture and rangeland, 20 percent as cropland, 13 percent in special use (mostly parks and wildlife areas), about 10 percent in miscellaneous uses, and about 3 percent in urban land.[12] This means, overall, the U.S. has a population density of about one person for every 7.3 acres.

Canada has a population of about 34.5 million people, roughly 11 percent that of the United States, and is increasing at a rate of about 270 thousand people per year.[13] Canada is the third largest geographic country (behind Russia and Antarctica) in the world with a total area just under 2.5 billion acres.[14] Canada has one of the lowest population densities in the world (behind Iceland and Australia), with one person for approximately every 72 acres. Urban areas in Canada make up less than one percent of total land area.

Figure 1. Urban Population in Canada, 1871-2011



Note: For 1981 to 2011, "urban population" refers to persons living within centres with a population of 1,000 or more and within areas with at least 400 persons per square kilometre. Before 1981, "urban population" refers to populations within centres of 1,000 people or more.

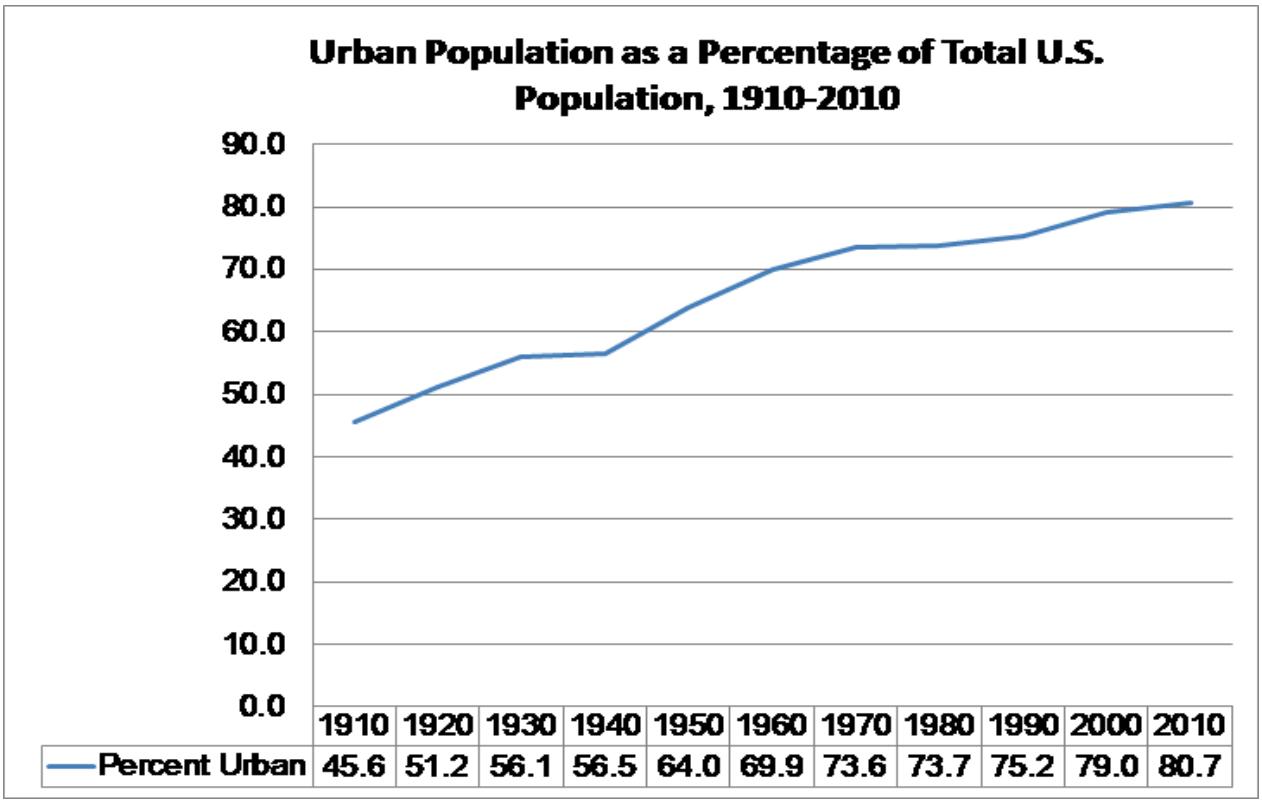
Source: For 1871 to 2001, Statistics Canada. *Population urban and rural, by province and territory (Canada)*. Available from: Summary Tables (accessed October 19, 2006); For 2006 and 2011, *Population and Dwelling Count Highlight Tables, 2011 Census*. Available from: 2011 Census (accessed March 12, 2012).

[Show Data Table]

In spite of the large differences in size and overall population density, evidence suggests that citizens of Canada and the U.S. have similar habits in regard to recycling and disposal of materials. According to United Nations population statistics, approximately 80 percent of the citizens on both sides of the border (81% Canada, 80.7% U.S.) reside in urban[15] areas as compared to a global average of about 58 percent. Both countries have experienced a trend toward increased urbanization for many years. See Canada and U.S. statistics in Figures 1 and 2.

[11] http://www.census.gov/population/www/popclockus.html
[12] http://www.ers.usda.gov/publications/eib-economic-information-bulletin/eib14.aspx#.UUm5n6X3Cu5
[13] http://www.indexmundi.com/canada/population_growth_rate.html
[14] http://www.globalforestwatch.org/english/canada/index.htm
[15] Urban refers to people living in population centers of 1000 people or more and at least 400 persons per square kilometer.

Figure 2. Urban Population in the U.S., 1920-2010



Source: http://blogs.census.gov/2012/04/04/how-do-we-measure-urban-areas/

Overall population density and the proportion of citizens that reside in urban areas can have impacts on an individual's access to reuse and recycling programs. About half of the U.S. population resides in 10 states (CA, TX, NY, FL, IL, PA, OH, MI, GA, and NC), whereas 86 percent of Canada's population resides in four provinces, Quebec, Ontario, Alberta, and British Columbia. It is reasonable to extrapolate from recycling data gathered from some or all of these ten states and four provinces to gain an indication of behavior for a majority of citizens. It is also reasonable to assume that Canadian and U.S. citizens have similar proportional access to reuse and recycling facilities due to their similar urban proportions, in spite of the wide discrepancy in overall population density.

METHODOLOGY

The methodology used in this project included a literature review, surveys of key players in the wood recovery field, and development of case studies.

First, an intensive literature review was conducted for North America. This review investigated sawmill and secondary manufacturing wood utilization practices (including practices as determined through life cycle inventories by CORRIM[16]), and information regarding the presence of wood and wood products in municipal solid waste (MSW) and construction and

[16] CORRIM is the acronym for Consortium for Research on Renewable Industrial Materials.

demolition (C&D) debris; sources include the U.S. EPA, Natural Resources Canada, the U.S. Forest Service, BioCycle magazine, and numerous sources related to the wood pallet industry. Green building programs, and provisions regarding use of recovered and recycled wood, were also a part of the literature review.

In addition to the literature review process, three (3) separate surveys were conducted of key players in the wood recovery field. The first of the surveys was conducted during August and September 2012. Eighteen (18) individuals—representing industry, government, associations and non-profits—were interviewed by telephone using a structured questionnaire. The purpose of the open-ended interviews was two-fold. First, the interviews served as a follow-up to the North American Wood Waste Forum[17] held in February 2012, in Madison, Wisconsin. Second, the intent was to gain greater insight into wood recovery barriers, opportunities, trends and best practices. The results of these interviews are summarized below and further details, including the interview questions, are included in Appendix A.

A second survey was conducted in early-2013. Twelve municipalities throughout the U.S. and Canada were surveyed online and by phone to better understand current wood recycling activities. Also in early-2013, ten secondary manufacturers were surveyed by phone to gather information about current trends in wood disposal or recovery.

The last phase of this project involved development of case studies. Case studies (Appendix E) were developed for specific programs and municipalities in the U.S. and Canada that have implemented unique approaches to wood recovery, including bans on pallet disposal in landfills and diverse incentives for deconstruction and material reuse. Wood recovery in Europe was also investigated with results presented in a case study.

The literature review, surveys, and case studies provided comprehensive insight into the current state—and future opportunities-- for wood reuse and recycling in the U.S. and Canada.

STATUS OF WOOD REUSE & RECYCLING: DISCUSSION

It All Begins in the Forest

Forests are complex natural systems. Both individual trees and total forest ecosystems live and die over time spans that vary from a few years to centuries, and this complexity makes misperception possible and even common. Yet trees are constantly being recycled within a forest ecosystem. They live, they die, they burn, they rot, but in the end they all are reduced to the air, water and soil from which they arose.

Fire and rot play critical roles in the recycling of wood in the forest. To a certain degree rot is simply a biologic, and more patient, means of oxidation of wood than fire. Natural systems apply both approaches to the recycling of wood in the forest, with rot primarily applied at the individual tree scale whereas fire is generally seen at a landscape level.[18] In all cases, these natural systems break down wood primarily into carbon dioxide and water, two of the essential ingredients in wood formation.

[17] Proceedings of the North American Wood Waste Forum can be found at: http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr216.pdf.
[18] Insect infestation could be characterized as a landscape scale application of biological degradation.

The age of a forest has an impact on its recycling processes. Young forests tend to absorb more water from the ground and carbon dioxide from the air than they recycle back to the environment. Very old forests tend to produce more carbon dioxide than they take in. An imbalance of trees of any one age can lead to challenges. For example, in some areas of the western United States today, the volume of relatively young understory can lead to water over-consumption by the forest (and shortages in nearby human populations)[19] serious fire hazard. Well-considered forest management provides for the benefits of clean air and clean water as well as a myriad of other social and environmental benefits while still providing materials for economic use. Forest management practices can also reduce or mitigate random natural events such as forest fire, which in addition to being physically destructive can also release harmful toxins into the atmosphere. By some estimates forest fires may be the largest producer of dioxins in North America.[20]

Sustainable forest harvest methodologies are often designed to mimic natural disturbance, without the random destruction and devastation that natural disturbances cause. When a tree is harvested the proportion of the tree removed from the site varies to some degree by a number of factors, including species. Results of a study that looked at the proportions of various components of trees in the Midwest are included in Table 1.[21] In general, 40-60% percent of the biomass of an individual tree is removed from the harvest site upon harvest (In Table 1 the saw log and upper stem portion account for 54% of volume). The balance is left to degrade through rot and/or fire. In some markets and for some species this proportion may be significantly higher or lower. Many species naturally regenerate from the remaining roots or stump. As woody biomass gains in economic value there may be a trend toward more extensive biomass removal from the site. Development of the wood pellet industry in the southeast U.S. suggests that a higher percentage of biomass will be removed from sites in that region in the future than is currently the trend in other areas. In anticipation of concerns about overharvesting for biomass markets, many regions have implemented or are in

Table 1. Above Ground Forest Biomass Components

Tree Component	Volume		Biomass	
	FT^3	*%*	*Green Tons*	*%*
Bole (gross)				
Saw log portion	9.1	29	0.254	31
Upper Stem	8.0	25	0.225	27
Top & Limbs	7.8	25	*0.218	26
Bark	5.2	17	0.096	12
Stump	1.3	4	0.036	4
Total	31.4	100	0.829	100

*The biomass in bole, tops, and limbs does not include bark

Source: Hahn, Jerold T. (1984)

[19] http://articles.latimes.com/2012/may/08/opinion/la-oe-workman-kill-trees-save-rivers-20120508

[20] U.S. EPA (Environmental Protection Agency). (2006) An inventory of sources and environmental releases of dioxin-like compounds in the United States for the years 1987, 1995, and 2000. National Center for Environmental Assessment, Washington, DC; EPA/600/P-03/002F.

[21] Hahn, Jerold T. Tree Volume and biomass equations for the Lake States. Res. Pap. NC-250. St. Paul, MN; U.S. Dept of Ag, Forest Service, North Central Forest Experiment Station 1984. 10p. http://www.forestry.umn.edu/prod/groups/cfans/@pub/@cfans/@forestry/documents/asset/cfans_asset_185392.pdf

the process of establishing best practices biomass harvesting and required retention of sufficient materials onsite to support biodiversity, soil productivity, water quality and other benefits.

A century ago major wildfires occurred across the U.S. and Canada on harvested land due to the amount of woody biomass that was left on sites. This "slash" was dominantly composed of limbs and treetops, and, upon drying became ready fuel to spur the massive forest fires of the early twentieth century. Current harvesting practices address this issue by mulching or controlled burning of this material, both actions that spur natural recycling (rot & fire) of the materials.

Wood Combustion as Component of Reuse and Recycling

Production of wood products is closely linked with wood combustion, since a major portion of the energy used in manufacturing is wood-derived. Also, wood fuels produced as milling by-products are now supplying energy to a growing clientele. Benefits include industry-wide near energy self-sufficiency, energy security, and fossil fuel displacement as well as a mimicking of natural processes of the environment.

To truly understand the implications of wood combustion, it is important to consider the derivation of wood. Although the basics of photosynthesis are taught in most schools, the implications are rarely obvious and often not applied to the debates of material use, reuse, and recycling. The following is a fundamental balance equation representing how wood is formed.

$$\mathbf{6H_2O + 6CO_2 \Leftrightarrow C_6H_{12}O_6 + 6O_2}$$

Basically water, (**H_2O**), dominantly taken up from the ground through the roots, combines with carbon dioxide (**CO_2**) from surrounding air in the presence of sunlight to form cellulose (**$C_6H_{12}O_6$**) (as well as lignin, hemicellulose and a variety of other complex hydrocarbons[22]), and releases oxygen (**O_2**) to the atmosphere. Wood is made up of about 50±3% Carbon, 6±1% Hydrogen, and 44±3% Oxygen. In most North American species there is also a minute amount (0.2%±) of inorganic minerals.

The complete inorganic oxidation (i.e., combustion) of wood is basically a reversal of the photosynthesis process, resulting in the recycling of CO_2 and H_2O back into the atmosphere. If wood is combusted under controlled conditions, not only are the basic elements of wood recycled, but also the previously harvested solar power is converted to usable energy in the process. The combustion process liberates about 8600 Btu's per dry pound for hardwood and 9000 Btu's per dry pound for softwood, or *essentially the same amount of energy captured from the sun in forming the wood through photosynthesis*.[23]

Wood that has been painted, treated, glued, or in some other way combined with another material may present a challenge to achieving clean combustion. However, *in general, the burning of woody material is simply part of the natural recycling process* of releasing 99.8% of the constituent elements back "from whence they came."

[22] This formula is for illustrative purposes only, there are actually intermediary sugars such as glucose and a variety of other resulting hydrocarbons formed in the process

[23] Rick Curkeet, PE, 2011. Wood Combustion Basics, a presentation at EPA Workshop March 2, 2011.

Developing public recognition that the harvesting of solar energy captured by the photosynthetic process through wood combustion is part of the natural recycling process and is a critical component of the wood-recycling message is crucial. The controlled, efficient combustion of wood is a fundamental way of recycling the material back into its natural elements.

Wood Products Manufacturing and Utilization

The term waste is largely obsolete in the context of today's North American forest products industry. Logs brought to U.S. and Canadian sawmills and other wood products manufacturing centers are converted almost totally into useful products, leaving little to no waste. Figure 3 illustrates the historical trend in wood reuse and recycling within wood products manufacturing over the past 75 years.

Note that the production of primary products increased from 35-39 percent in 1940 to approximately 52 percent in 2005. The use of mill residues in papermaking and the development of products such as particleboard and fiberboard have created a significant demand for what were formerly waste products. In addition, for decades, mills have utilized bark, scraps, and other residuals as sources of energy, providing a high degree of energy independence.

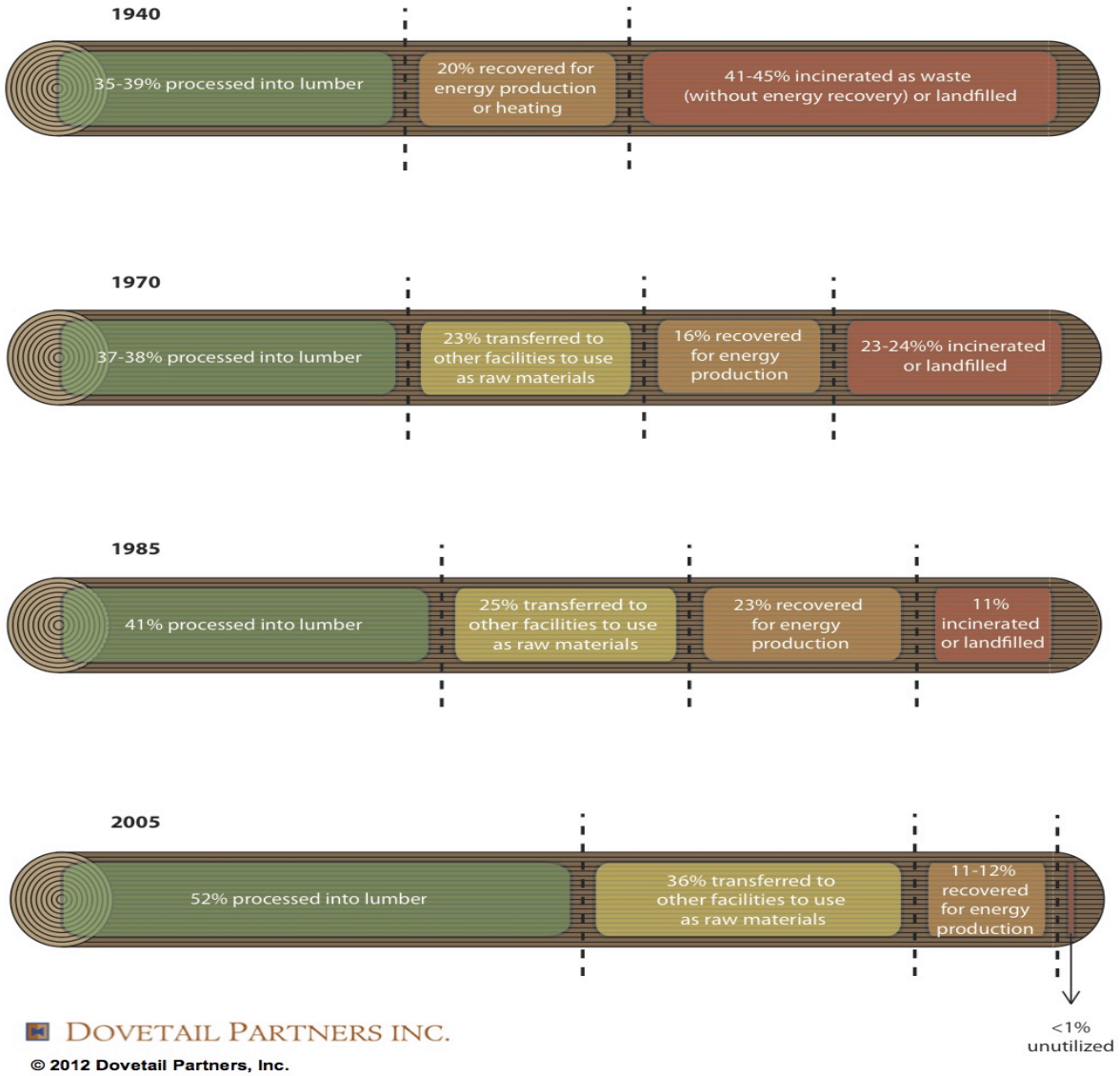
The wood industry is currently the most energy independent of any major economic sector. A detailed analysis of the historical trends of wood waste in forest products manufacturing is included in Appendix B.

To confirm yield and residue estimates in secondary forest products manufacturing, ten secondary manufacturers were contacted. These contacts included cabinet manufacturers, millwork producers and door and window manufacturers. Results indicate that the common practice of selling higher valued "clean" residues (e.g. shavings and sawdust to paper manufacturers and the animal bedding industry) combined with increased use of residues in energy production result in solid waste rates of one percent or less. Although results vary widely by specific product produced, overall, the contacted companies reported:

- Yields of intended products range from 75-95%.
- Residuals have economic value and are unlikely to be landfilled.
- For very low value residuals some residual users will provide the manufacturer with roll-off containers for collecting the material and then remove the collected material for use in their own product or process. These cooperative arrangements increase material reuse and reduce or avoid disposal fees.
- Approximately 50-80% of residuals are recycled into products such as paper, mulch or animal bedding depending on location.
- Approximately 20-50% of residuals are used for heat in the manufacturing process or sold for use in bioenergy production.
- It is rare to find any wood products manufacturer shipping to landfills. In the few cases that this does occur, it is usually for specific items at specific times of the year (e.g. sawdust burned for heat might go to a landfill in summer due to lack of adequate storage). In general less than 1% of wood arriving at wood products manufacturers ends up in landfills (and this confirms results from the literature review as noted in Appendix B).

Based upon this review, it is clear that there is virtually no wood waste generated at primary and secondary forest products manufacturers in Canada and the United States today when combustion for energy recovery is included in the analysis.

Figure 3. Wood Utilization at U.S Sawmills, 1940-2005.



Tracking Post-Consumer Wood Reuse and Recycling

Tracking of specific materials through Canadian and U.S. waste management systems is challenging. A vast majority of the wood products consumed in the U.S. and Canada go into what is generally considered to be long-term use, including many building materials and finished goods. The percentage of wood products *entering* various uses in any given year is fairly well known; however, the volume of wood-based materials being *removed* from long-term use changes annually depending on variables such as age of housing stock, geographic location, and economic climate, in addition to specific uses involved. As a consequence, it is difficult to identify the theoretical maximum proportion of annual volume available for reuse and recycling (e.g., disposal rates). Moreover, the tracking of wood products through their life cycles to disposal is extremely difficult in the aggregate. In addition to the research challenges presented by these conditions, another aspect of this complexity is the fact that increases in total consumption may outweigh specific material recovery improvements. These interactions limit the ability to measure incremental net change in materials entering the waste stream (e.g., gains in recycling rates).

The softwood and hardwood forests of the United States and Canada provide wood products that are used in many applications. This wide array of wood products generates industrial wood by-products during the manufacturing process (pre-consumer) and waste wood when these products are disposed at the end of their useful lives (post-consumer). This waste wood is typically included (by definition) in the categories of Municipal Solid Waste (MSW) and Construction & Demolition (C&D) debris in the U.S., and as Residential, or Industrial, Commercial & Institutional (IC&I), or Construction, Renovation, & Demolition (CR&D) in Canada. Residential and IC&I wastes in Canada roughly conform to the MSW category in the U.S.

In the U.S, current estimates are that 35% (12.1 million tons) of the wood in the MSW stream is recovered for products with an additional 11.1 million tons available for recovery. These recovery rates do not include recovery for use in energy production.[24] For C&D wood in the U.S., 52% (19.1 million tons) is currently recovered, combusted for energy, or not usable, with 48% (17.3 million tons) available for recovery.

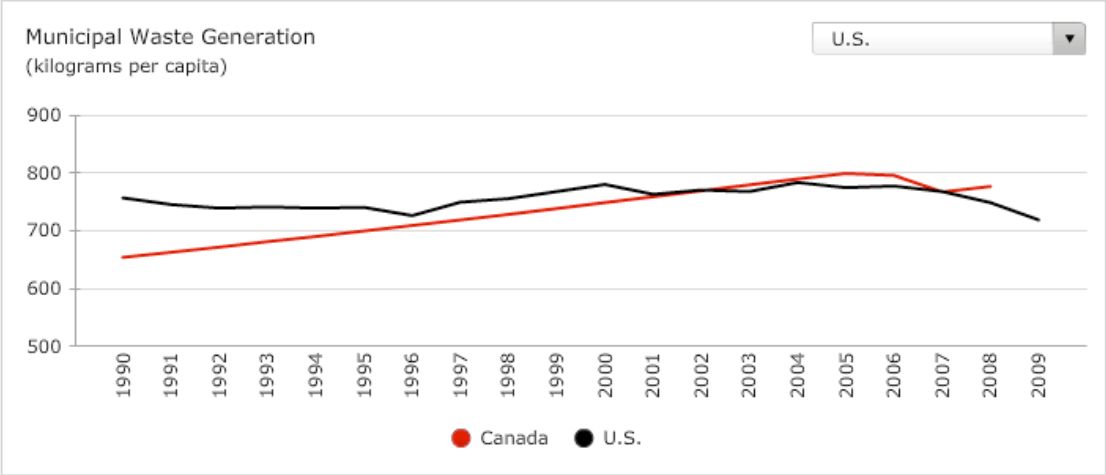
There are a number of methods by which wood waste volumes are estimated, and there is growing interest in a more complete understanding of the amount and types of MSW and C&D wood waste generated in the U.S. and Canada. This information is essential to identifying potential barriers and opportunities related to expanding and improving wood re-use and recycling. Unfortunately, precise, reliable and current data on MSW and C&D wood is not readily available. The data are dispersed among various governmental agencies as well as universities and private companies. Much of the data is not transparent and is difficult to find and interpret. This leads to differences (sometimes quite significant) in volume estimates between studies. Appendix C provides a detailed overview on recent research relating to the wood portion of MSW and C&D waste streams in the U.S. Comparisons are made between different studies and implications arising from differences between these studies are addressed, and a summary of MSW and C&D wood recovery in the U.S. is provided.

[24] Source: U.S. EPA 2011; includes waste from residential, commercial, and institutional sources.

Generation of Waste in Canada and the U.S.

Canada and the United States rank first and second respectively of the 34 countries participating in the Organization for Economic Cooperation and Development (OECD) in terms of Municipal Waste generated per capita. In 2008 Canada generated 777 kilograms (1713 pounds) of waste per person as compared to an OECD average of 578 kilograms (1274 pounds) and a Japanese best of 377 kilograms (831 pounds).[25] For the same year (2008), U.S. per capita waste was about 750 Kilograms (1653 pounds).

Figure 4. Municipal Waste Generation in Canada and the U.S., 1990-2009



Source: http://www.conferenceboard.ca/hcp/details/environment/municipal-waste-generation.aspx

Between 1990 and 2007 per person rates of waste disposal increased for all OECD countries except Japan and Norway (Norway's actually decreased). Figure 4 compares the trend in waste production per person for Canada (red line) versus the United States (black line) for the period of 1990 through 2009.

Status of Wood Recycling in Canada

Approximately 95 percent of Canadian households report access to recycling programs and almost all of these (98%) report that they recycle at least once during the average week. It appears that minimization of the effort required to recycle is critical to recycling rates. Only about one-third (34%) of households without curbside pickup reported they recycled all their waste versus over half (55%) of those with curbside pickup. Luckily, most (84%) Canadians have access to curbside pickup.

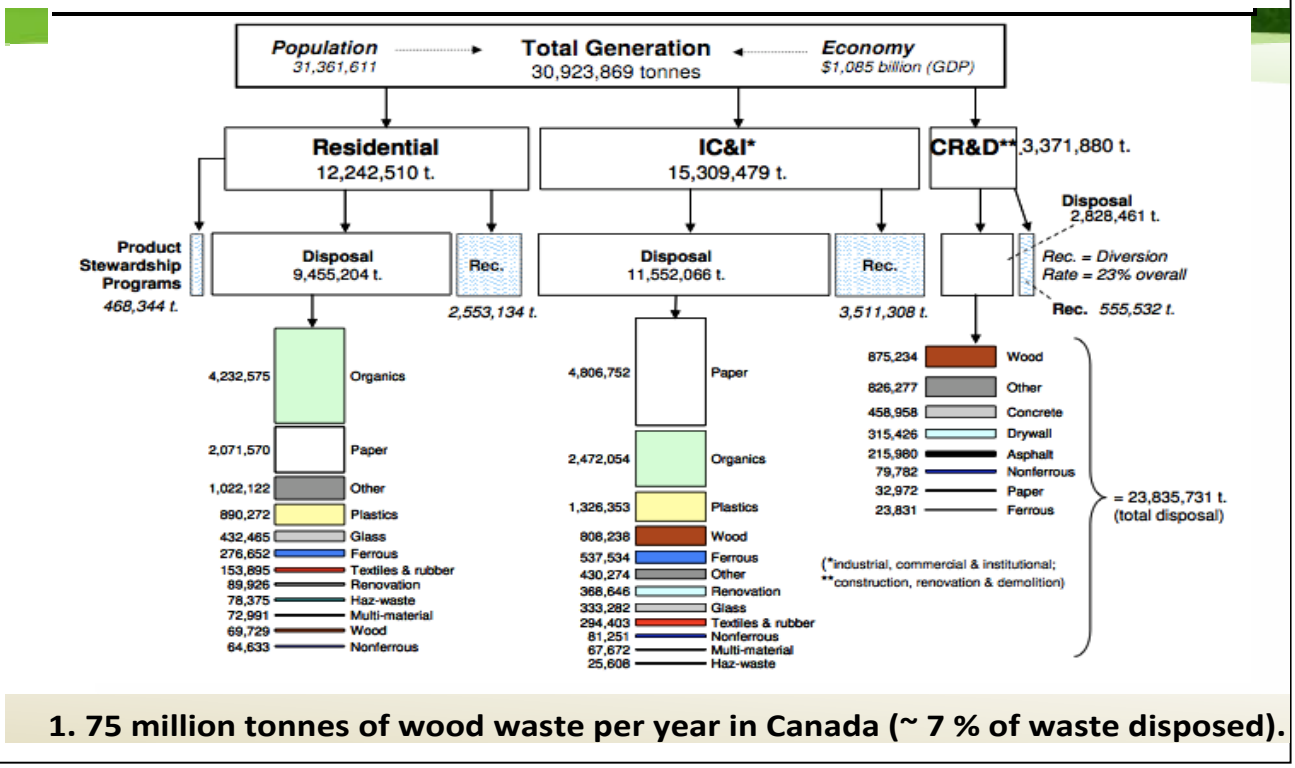
Between 2002 and 2008 recycling in Canada grew from 6.6 million metric tons to almost 8.5 million metric tons.[26] Recycled volumes of wood products and related materials changed as follows (Table 2).

[25] http://www.conferenceboard.ca/hcp/details/environment/municipal-waste-generation.aspx
[26] Canadian data in metric system (e.g. tonnes) except where otherwise noted.

Table 2. Recycling Rates in Canada, 2002 and 2008 (metric tons)

	2002	2008
Newsprint	1,282,955	1,132,398
Cardboard & boxboard	1,122,304	1,400,907
Mixed paper	704,538	931,358
Construction, renovation, and demolition	645,931	720,076

Figure 5. Waste Flows in Canada (NRCan, 2006)



The data above[27] does NOT include materials transported by the generator to secondary processors, such as pulp and paper mills. Also not included are materials processed or managed on-site such as secondary processing or energy generation. These issues are addressed in the text following Figure 3.

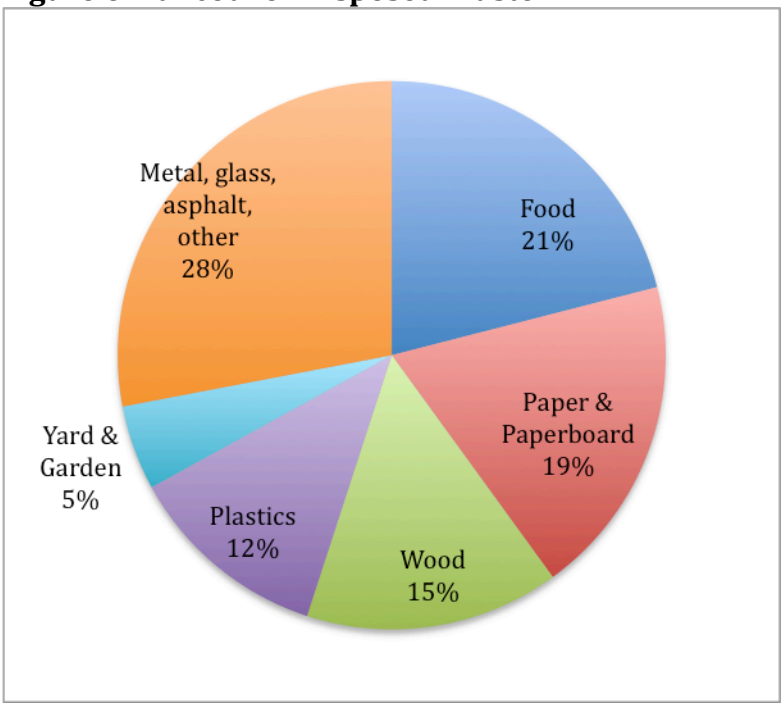
Nationally, about 23% of potential waste in Canada is being diverted from the waste stream through recycling programs.[28] However, about 1.75 million metric tons of solid wood waste (about 7% of total waste) and about 6.88 million metric tons of paper (22%) remain in the current waste stream (Figure 5). For Canadian cities with specific diversion programs (e.g.,

[27] Statistics Canada. Table 153-0043 – Materials diverted, by type, Canada, provinces and territories every 2 years (tons), CANSIM (database).
[28] Mark Hubert presentation of NRCan, 2006 data)

Vancouver) the success rate appears to be much higher, with diversion rates of 30-50 percent and goals of 60-80 percent being common.

The Canadian forest sector in conjunction with waste management organizations has begun a concerted effort to divert wood and forest products from the waste stream in Canada. For example, it is estimated that wood based materials comprise about 30% of waste in waste management facilities in British Columbia as compared to the 23% national average and goals of 60-80%.

Figure 6. Vancouver Disposed Waste



Source: Marr, A. 2009. Carrots & Sticks: "Diverting More Wood from Disposal" presentation at The Sustainable Region Initiative Forum,

Because of Vancouver's high rate of success in recycling, it is currently being tested as a model city for waste reduction. Waste reduction goals of 50-75% are suggested and both barriers to change and reward systems are being evaluated to aid implementation. Major cities such as Vancouver, Calgary, Edmonton, Toronto, and Montreal also appear to be at the forefront of North American trends toward increased reuse and recycling in general, and for solid wood recovery in particular (see Appendix E). However, major waste diversion improvements in cities like Vancouver are so recent that it is indeterminate the degree to which other top 25 (or smaller) cities are adopting these practices. It is also not yet possible to accurately predict national recovery percentages. Clearly Canada is on a trend toward diversion of a majority of recoverable waste from the waste stream and goals of 60-80% diversion rates appear possible for some regions and some materials in a very short period of time. Because very few cities represent such a large portion of the population, this will significantly and positively impact Canada's ability to efficiently improve recovery activities as a nation.

Status of Solid Wood Waste Generation and Recovery in the United States: MSW and C&D

The following discussion summarizes wood waste generation and recovery in the United States within the Municipal Solid Waste (MSW) and Construction and Demolition (C&D) waste streams. Further details are included in Appendix C.

MSW

The EPA MSW total generation values (tons) are well below those of *BioCycle*/Columbia University (the latter numbers are 56% higher than EPA values). Both EPA and

BioCycle/Columbia University do not include woody materials from yard trimmings. Also, neither of these data sources considers combustion for energy production as either recovered or recycled wood.

The Forest Service estimate uses EPA data as the source for their "wood component" category of MSW. The wood component includes items such as wooden furniture and cabinets, pallets and containers, scrap lumber and wooden panels, and wood from manufacturing facilities. The Forest Service adds to this EPA estimate an approximation of woody yard trimmings, and includes an estimate of wood combustion for energy recovery. All three sets of data are summarized in Table 3.

Table 3. Comparison of MSW Estimates for Generation, Combustion, and Recovery from U.S. EPA, BioCycle and U.S. Forest Service (in million tons).

	EPA (2010) (million tons)	BioCycle (2008) (million tons)	Forest Service (2010) (million tons)
MSW Generation: Total for ALL Components	249.9	389.5	249.9 (using EPA data)
Wood Component (Generation)	15.88	Unknown	15.88 (using EPA data)
Woody Yard Trimmings (Generation)	Unknown	Unknown	18.4 (from Appendix C Table 6)
Wood Combustion (for energy)	Unknown	Unknown	5.5 (from App. C Table 6)
Wood Recovered (w/o combustion)	2.3*	Unknown	12.1** (from App. C Table 6)

*Excludes woody yard trimmings.
**Includes woody yard trimmings. Also, the 12.1 million tons is an estimate based on recovery rates referenced in Falk and McKeever 2004.

C&D

As noted earlier, C&D debris (including C&D wood) is excluded from the EPA definition of MSW. *BioCycle* attempts to adopt EPA definitions; therefore, C&D is also excluded from their estimates. Fortunately, the EPA does track C&D debris in a separate effort. The most recent EPA report (2009) is titled "Estimating 2003 Building-Related Construction and Demolition Materials Amounts."

The EPA estimate of C&D waste (2003 data) is based on national statistical data (U.S.) and typical waste generation during building construction, renovation, demolition or maintenance activities. Recovery estimates rely on 2003 data reported by state environmental agencies.

Table 4 reflects materials generated from *building* projects that occur as a result of normal daily life, not *debris* resulting from disasters. However, construction materials resulting from *rebuilding* efforts after a disaster are included in the table below.[29]

[29] In 2008 the EPA published *Planning for National Disaster Debris*, which discussed tools for forecasting disaster debris generation amounts.

The EPA estimates the amount of C&D building-related materials for 2003 at 170 million tons, with 39 percent coming from residential and 61 percent from nonresidential sources.

Table 4. EPA Estimated Amount of Building-Related C&D Materials Generated in the U.S. During 2003*

Source	Residential		Nonresidential		Totals	
	Million Tons	*Percent*	*Million Tons*	*Percent*	*Million Tons*	*Percent*
Construction	10	15%	5	5%	15	9%
Renovation	38	57%	33	32%	71	42%
Demolition	19	28%	65	63%	84	49%
Totals	67	100%	103	100%	170	100%
Percent	39%		61%		100%	

*C&D managed on site should, in theory, be deducted from generation. Quantities managed on-site are unknown.
Note: Data rounded to the appropriate significant digits. Data may not add to totals shown.
(Source: U.S. EPA 2009)

Figure 7 (following page) provides a percentage breakdown of the six building sectors that generate C&D materials. According to the EPA (2009) the largest sector is nonresidential demolition at 39 percent.[30] Residential and nonresidential renovation materials make up 22 percent and 19 percent, respectively, followed by residential demolition at 11 percent. New construction represents 9 percent of total C&D materials (with the new construction divided between residential construction at 6 percent and nonresidential construction at 3 percent).

The U.S. Forest Service (Falk et al. 2012) estimates the generation of construction and demolition waste wood at 6.7 and 29.7 million tons, respectively, for 2010, for a total of *36.4 million tons (*Table 5). This is based on McKeever (2004), and Falk and McKeever (2004) methodology, and applied to 2010 economic drivers such as housing completions, value of nonresidential construction, and population change. An assumption of the Forest Service estimate is that 28% of the C&D waste stream is wood.[31]

Table 5. U.S. Forest Service Estimate of Construction and Demolition Waste Wood Generated, Recovered, Combusted or Not Usable, and Available for Recovery in the U.S., 2010* (million metric tonnes/million short tons)

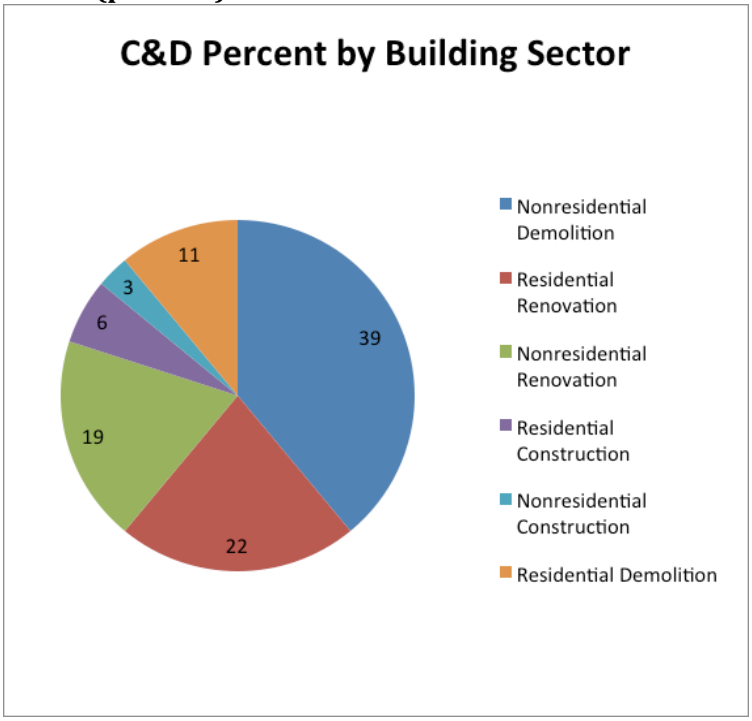
Source	**Generated (tonnes/tons)**	**Recovered, Combusted, Not usable (tonnes/tons)**	**Available for Recovery (tonnes/tons)**
Construction Waste Wood	6.1 / 6.7	1.7 / 1.9	4.4 / 4.9
Demolition Waste Wood	26.9 / 29.7	15.6 / 17.2	11.3 / 12.5
Total, C&D	33.0 / 36.4	17.3 / 19.1	15.7 / 17.3

*Forest Service estimates based on updated demand drivers and estimated recovery rates.
Source: Falk et al. 2012.

[30] The EPA percentages are weight-based; non-residential demolition contains a large quantity of concrete.
[31] Falk and McKeever 2012.

Summary, and Implications of, Municipal Solid Waste and Construction & Demolition Waste Estimates in the U.S.

Figure 7. Contribution to the C&D Materials Stream by Sector (per EPA)



Source: U.S. EPA 2009.

The*BioCycle*/Columbia University estimate of MSW generation in the U.S. is 56 percent greater than the EPA estimate (389.5 million tons vs. 249.6 million tons) (van Haaren et al. 2010). The EPA estimate of wood in the MSW stream is pegged at 15.88 million tons with a recovery of 2.3 million tons (Table 3). The *BioCycle*/Columbia University research makes no attempt to separate wood as an individual category of MSW. Also, the EPA provides no specific data on wood combustion for energy.

The U.S. Forest Service estimate uses the EPA wood component for MSW (15.88 million tons) then adds an estimate of the wood portion of yard trimmings (18.4 million tons) for a "MSW wood" total generation estimate of 34.2 million tons. The Forest Service also estimates that 5.5 million tons of MSW wood is combusted for energy and that an additional 11.1 million tons is available for recovery.

In terms of C&D waste, the EPA reports that in 2003 (most recent data) approximately 170 million tons of material was generated in construction, renovation, and demolition projects; however, wood is not separated from other materials in this estimate. *BioCycle*/Columbia University does not conduct research on C&D materials.

The Forest Service estimates that 36.4 million tons of C&D wood material was generated in 2010 with 19.1 million tons (52%) recovered, combusted, or not usable and 17.3 million tons (48%) available for recovery.

From the MSW and C&D data it can be suggested that a conservative estimate of 10 million tons[32] is combusted for energy recovery in North America but (by current definition) is not tallied as recovered wood.

There is an opportunity (and need) for the U.S. EPA and *BioCycle*/Columbia University to work together on studies of U.S. municipal solid waste management. The EPA has developed strong

[32] This estimate is anchored on the 5.5 million tons of U.S. MSW wood combusted for energy (see Appendix C, Table 6) and the 19.1 tons of U.S. C&D wood that are either combusted, recovered or not usable (see Appendix C, Table 9). Coupled with Canadian wood combusted for energy from MSW and C&D streams (unknown amounts), the estimate of 10 million tons combusted for energy in North America is likely a conservative estimate.

partnerships with industry organizations leading to estimates of materials generated, recycled, or discarded; *BioCycle*/Columbia University has developed good relationships with a robust network of state waste managers who have direct access to MSW generation and disposal data. By working together, the two entities should be able to significantly narrow the huge gap between their independent estimates of MSW generation.

Since the U.S. Forest Service uses the EPA estimate of the "wood component" and adds this value to the wood portion of yard trimmings to calculate a total for MSW "wood", the Forest Service estimate might be low (based on the huge differences in generation rates between the EPA (low rate) and *BioCycle*/Columbia University).

The most current data from the EPA on C&D waste is from 2003, and the wood component from this waste stream is not separated from other materials. The Forest Service estimate on C&D wood (2010 data) is likely the most reliable.

Regardless of the data collection methodology, or the entity conducting the research, it is clear that there is still a large amount of wood available for recovery in the MSW and C&D waste streams.

Wood Recycling Provisions in North American Green Building Programs

Green building is a growing trend in the U.S. and Canada and has the potential to impact material use in the built environment. About 90 green building standards used in various parts of North America (U.S and Canada) were examined to understand how wood recycling is addressed in green building standards. After accounting for those standards or local green building initiatives based wholly on one or more national or regional scope programs, and paring the list to avoid double counting of the base-standards, a total of 42 distinct green building programs were identified as currently being used in the United States and Canada. For each of these programs, provisions related to construction waste reduction, materials re-use, and use of recycled-content materials were summarized by program and by state or province (see tables in Appendix D).

Definitions of the terms *recovered material, reuse, recycled,* and *recycled-content* are inconsistent between various green building programs; some programs differentiate materials using these terms, while others tend to combine recovery, reuse, and recycling under the general terms "recycling," "reclaimed," and "recovered from landfill." However, for those that do make distinctions between these various types of material, definitions provided within the 189.1 Standard of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) come closest to universally describing the differences between these terms:

- *Recovered Material* – Material that would have otherwise been disposed of as waste or used for energy recovery (e.g. incinerated for power generation), but has instead been collected and recovered as a material input, in lieu of new primary material, for a recycling or manufacturing process.
- *Reuse* – includes donation of materials to charitable organizations, salvage of existing materials at new construction, remodeling, and demolition sites, and packaging materials returned to the manufacturer, shipper, or other source that will reuse the packaging in future shipments.

- *Recycled material* – Material that has been reprocessed from recovered (reclaimed) material by means of a manufacturing process and made into a final product or into a component for incorporation into a product.
- *Recycled content* – The proportion, by mass, of recycled material in a product or packaging. Only pre-consumer and post-consumer materials shall be considered as recycled.

The focus of the review was on provisions for reuse and recycling within green building, and it should be noted that those green building programs focused exclusively on energy efficiency were excluded. Had such programs been included, the list would have been much longer, as there are many dozens of green building programs dedicated to energy efficiency alone. There are, in addition, scores more that are wholly based on one or more national or regional-scope green building programs. One recent evaluation (Gruder 2007) identified 148 such programs based on US Green Building Council's Leadership in Energy and Environmental Design (LEED) alone, and another 29 that wholly mirror one or more other green standards. A second recent assessment revealed more than 20 California cities that utilize the Green Points Rated System for residential construction (Office of the Attorney General of California 2012). In this assessment, the LEED and Green Points rated programs are counted only once. LEED Canada, which is different than the form of LEED as promulgated by the U.S. Green Building Council, is counted separately.

Of the 42 distinct green building programs identified, 41 award reuse, and/or reclamation or recovery of materials for reuse. The use of recycled content construction materials is specifically recognized in 38 programs. Two-thirds of these do not differentiate between pre- and post-consumer recycled content, while most of the other programs award twice (2x) the credit for use of post-consumer content than for pre-consumer (post-industrial) content. In many cases, specific products are identified as ones for which recycled content is recognized. Third-party certification of recycled content is sometimes required. Use of finger-jointed materials is singled-out in quite a few programs as an awarded or specified practice.

One initiative identified is not actually a green building program, but instead a comprehensive plan for reducing the quantity of material accepted at landfill sites. The initiative, that of the city of Boston, is included because it is indicative of other such initiatives across North America, and because a primary focus is reduction of wood C&D waste in landfills. A key objective of the Massachusetts initiative is to increase the recycling rate for C&D materials to 50% by 2020. For Boston alone this translates to an objective of reducing C&D disposal by a total of 400,000 tons (of which wood is 31 percent) within a decade. Considering this and other objectives in green building programs of reducing C&D waste, it is likely that interest in recovery/recycling solutions for wood and wood products will increase.

Examples of provisions regarding recycled content in 42 different green building programs:

Provision	Number of Programs That Contain Such a Provision
Reuse/Reclaimed/Recovered	41
Recycled content	37
Recycled content for specific products	
Cabinets/Countertops/Shelving	13
Siding/cladding	11
Decking	8
Interior trim	9
Sheathing	8
Exterior trim	6
Underlayment	6
Flooring	6
Doors	6
Subfloor	1
Use of finger-jointed materials	
Framing, other structural lumber	13
Interior or exterior trim	12

Recycled Content of Wood Building Materials

As mentioned, nearly all (93%) of the identified green building programs award the use of recycled content materials and two-thirds do not differentiate between pre- and post-consumer recycled content. Recycled content provisions in most standards call for 20 to 40% recycled, with several specifying 50% recycled when pre-consumer recycled content is involved. Building materials that commonly contain pre-consumer (post-industrial) recycled content in sufficient proportions to qualify for recycled content provisions of most green building programs include insulation board, medium density and high density fiberboard (MDF and HDF), and particleboard. Recycled content certificates published on-line by Temple-Inland (2012) provide an indication of recycled content for these products. These certificates show at least 75% pre-consumer recycled content in particleboard products; up to 97% pre-consumer recycled content for fiberboard products; and 78% pre-consumer recycled product in medium density fiberboard products. This means that these products would generally qualify for recycled content provisions. This also means, based on 2005 U.S. production statistics (Howard 2009), that the overall recycled content of U.S. produced wood building products was about 10-11%. Canadian figures were likely in the same range.

As reported by the North American Fiberboard Association (Wagner 2012), the largest input for fiberboard mills is in the form of chips from local sawmills that are classified as post-industrial or pre-consumer waste. Other inputs include recycled cardboard and recycled paper (both office waste and newsprint), and almost anything else that can be re-pulped. Recycled cardboard and paper, when used, qualifies as post-consumer recycled content.

Finger-jointed wood is widely recognized in green building programs today, primarily based on the understanding that this technology allows the use of short wood pieces that would otherwise go to waste or less desirable uses. Finger jointing in framing and other structural lumber, exterior and interior moulding and trim, and several other product categories is commonly awarded or specified, with no caveat in any green standard as to whether materials used in the finger-jointed products are actually recovered scraps. Production of finger-jointed studs and other forms of finger-jointed framing and structural lumber totaled about 700 million board feet in 1998 (Wood Resources International 2008), and about 800-900 million board feet annually in the period 2006-2007 (various sources). As recently reported (Anon. 2012), paint-grade mouldings are the preferred choice of consumers, accounting for more than 80 percent of U.S. moulding consumption. In recent years MDF has increased in popularity over finger-jointed stock, with the trend toward MDF continuing (Baumeister and Beaulieu 2009, Butzelaar, and Taylor 2008). Based on this data it appears finger-jointed materials are increasing their market share in general, and specification by green building programs is only likely to enhance that growth.

Summary of Findings Regarding Green Building Programs

Reuse of building materials is encouraged and/or rewarded in the vast majority of North American green building standards. Similarly, recycled content of materials is a prominent aspect of many such standards, with use of such materials awarded or specified. Wood products that in general currently satisfy recycled content provisions include fiberboard, medium- and high-density fiberboard, and standard particleboard. In addition, finger-jointed wood products receive recognition as green products in a number of standards.

Reduction of wood volume in C&D waste is a clear objective in landfill waste reduction programs such as that of Boston, Massachusetts. C&D waste reduction is also a prominent part of most green building initiatives. The implication is that interest in recovery/recycling solutions for wood and wood products is certain to increase going forward.

Tracking Wood Consumption, Reuse and Recycling by Primary End Product

By some measures wood has over 10,000 uses. However, there are a few dominant solid wood uses that can be identified as making up a vast majority of the volume of softwood and hardwood in Canada and the United States. These include lumber and other building materials, furniture, pallets and other forms of containers and crating, posts and poles, and a wide-range of consumer goods such as flooring. Figure 10 illustrates major uses of wood in the United States in 2009.[33] It is important to recognize that this volume is extremely low from an historical perspective, due to the recent recession. Total consumption averaged 6.815 billion cubic feet for the 10-year period preceding 2009, peaking at 7.735 billion in 2005; almost double that of the current year (2009). This trend likely had a significant impact on the generation of waste in the U.S. Total consumption of solid wood used in construction in the United States decreased by 50 percent, from 2005 to 2009, with consumption in the residential and non-residential construction segments down 62 percent and 55 percent, respectively. In the same time frame, wood consumption in other manufacturing sectors declined 23 percent.[33] Thus, consumption figures for this time period represent fairly low baselines from an historical perspective.

[33] McKeever, D.B. and J.L. Howard. 2010. Solid Wood Timber Products Consumption in Major End Uses in the United States 1950-2009. USDA FPL General Technical Report FPL-GTR-199.

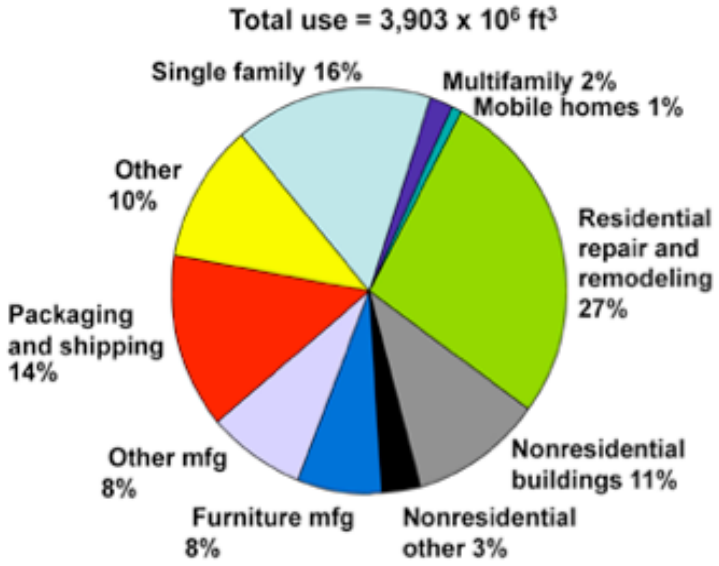
It is important to recognize the impact of a major decline in consumption on reuse/recycling percentage trends when evaluating reuse and recycling proportions. As total consumption volume goes down (and thus the volume entering the waste stream also goes down), if the volume of reused/recycled material remains relatively constant (or even declines by less than the decrease in total volume) then the percentage of reused/recycled material increases. Percentage trends may not be indicative of actual behavior changes under these conditions.

Trends in Market Development For Reused and Recycled Wood

For the purpose of exploring waste trends and new market development it is valuable to focus on the dominant major materials involved. These materials include:

- Construction & Demolition Waste
  - Flooring
  - Timbers
  - Lumber
- Railroad Ties
- Furniture
- Pallets

Figure 8. Total US timber products consumption, by end use, 2009.



Source: McKeever, D.B. and J.L. Howard. 2010. Solid Wood Timber Products Consumption in Major End Uses in the United States 1950-2009. USDA FPL General Technical Report FPL-GTR-199.

Although solid wood is not tracked through the waste stream at this level of product or use detail, it is valuable to look at the major components within those categories. The purpose of this level of tracking would be to identify specific trends and opportunities, since new construction, renovation and remodeling, furniture, and packaging represent about 80 percent of wood consumption annually in the U.S.[34] Each of the above components is explored below, followed by a brief discussion of current trends in solid wood reuse and recycling businesses.

Construction and Demolition (C&D) Waste

C&D waste incorporates a broad category of materials, many of them complex composites. This can make such material difficult to reuse or recycle, other than to burn, and can make combustion controversial.

[34] Canada likely has a similar proportion.

Appearance is a driving factor in wood reuse. Materials with a high appearance value are readily reused, whereas recovery of wood for structural purposes is more challenging. This is certainly in part due to codes limiting the use of non-grade stamped material in structural use. Problems arise because much pre-1950 material was not grade stamped or that the stamps have degraded over time. Another problem can arise when only a portion of a member is removed and that portion is not marked with a grade stamp.. Complex materials such as trusses risk racking damage on removal, degrading their structural integrity. Also, today there is not a clear, consistent, or universally approved and cost-effective protocol for re-grading this material for reuse in structural applications.

There are many small businesses that "deconstruct" buildings and then sell the wood products. Although these "recyclers" are not making a big dent in total volume at this time, there is a real opportunity to increase wood recovery from old buildings. New and improved technologies (e.g., more efficient and expanded use of denailers) and policies that provide greater time for deconstruction activities are helpful in this regard.

Flooring

Hardwood (and, to a lesser extent, softwood or composite) flooring is one of the most visible and popular materials reused today. When it is possible to remove flooring successfully (i.e., without significant damage) from existing buildings, reuse is common. This is driven by the value of the material and the appearance of aged wood or wood from old growth. Although there is little data available that tracks such information, national organizations like the ReUse Center and Lumber Liquidators have created a significant demand for used flooring materials.[35] A review of the Internet shows there are used flooring distributors in virtually every region of Canada and the U.S. Clearly, a large volume of flooring is being diverted.

Timbers

It is rare to see wood timbers in the waste stream these days mainly due to their value as reused materials. Old timbers are especially valuable and can attain prices of 3-4 times that of new material.[36] The most common use appears to be in the form of reuse as timbers or as flooring produced through remanufacturing. Wall paneling is another product commonly made from old timbers. Again, a review of the Internet demonstrates that wood from old timbers (and especially barns) is available from every region of Canada and the U.S.

Lumber

The widespread reuse of recovered framing lumber is hampered by the structural and grade stamp problems discussed previously. In addition, it is time consuming to carefully remove 2x4 or 2x6 material from old buildings without damaging and/or de-nailing the lumber[37]. This material can be recycled (ground) for landscaping and biomass energy use and is increasingly being diverted for this purpose. Also, the volume of this material might represent an opportunity (in specific locations) for recycling into products such as fiberboard.

[35] Other prominent examples include The Woods Company; and Whole Log Lumber.
[36] Source: Don Heise, Architectural Wood Specialties, personal communication.
[37] Joists and rafters from old buildings are also reclaimed by deconstruction firms/individuals.

Railroad ties

The manufacture of railroad ties is a major use of hardwood in the United States and Canada. Railroads also do significant repairs and replacement of wood railroad ties annually. In 2008, 17.1 million wood railroad ties (representing about 63 million cubic feet of wood) were removed from service on active and inactive tracks in the U.S. and Canada. Final disposition of these old ties is as follows:[38]

- 4.7% reused by railroad
- 28.8% reused for landscaping
- 5% reused for other (fence posts, etc.)
- 56.3% recycled into approved/permitted cogeneration and gasification
- 5.1% ended up as waste at approved/permitted landfills

Furniture

Since the late 1990s the volume of wood going into furniture has decreased from an average of more than 10 percent of total consumption to less than 6 percent. This is primarily due to the increased share of furniture consumed in the United States that is produced in other countries. A similar decline in domestic production has occurred in Canada.

There is a comprehensive system of furniture repair and reuse in Canada and the U.S. It is estimated[39] that greater than 95 percent of furniture gets reused in some form or another – and often multiple times. It appears that the higher the economic value of the product, the longer the life span of the product. A family of one of the authors of this report has a chest of drawers with hardware made in Paul Revere's shop that has been passed down through seven generations. Throughout both countries there are thousands of stores that sell used furniture, and yard sales are a common phenomenon through the region. In addition, people commonly place used furniture "for free" in their front yard and it quickly disappears.

Pallets

Although wooden pallets are produced from softwood and hardwood, as well as composite materials, over 80 percent of wood pallets are produced from hardwood lumber. In fact, the production of pallets is the single largest use of hardwood lumber, and especially of the lower grades. Approximately 33 percent of hardwood lumber goes to producing pallets.[40] According to the U.S. Census Bureau there were over 2,948 establishments with almost 60 thousand employees making wood containers and pallets in the U.S. in 2007, producing over $7 billion dollars in annual revenue. In Canada it was reported in late 2011 that there were over 500 establishments employing almost 4 thousand employees with revenues just under $600 million (Canadian $).[41]

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[38] Gauntt, J. 2008. Wood Crossties 2008 Tie Disposal Survey, Railway Tie Association.
[39] DSM Services, Inc, 2007. Massachusetts Construction and Demolition Industry Study, for Massachusetts Department of Environmental Protection.
[40] Hardwood Market Report. 2006: The year at a glance. In: 10th annual statistical analysis of the North American hardwood marketplace, Memphis, TN; 2007. 172pp.
[41] http://www.canadianpallets.com/en/Industry-Statistics_29

The reuse and recycling of pallets is standard practice today although the low unit cost of pallets makes transporting small volumes of them (or the reuse, recycling of odd sizes) difficult. Yet there are individuals and organizations in almost every part of Canada and the U.S. that are creatively approaching this problem. For example, one website lists "35 creative ways to recycle wooden pallets,"[42] and another lists "29 Cool Recycled Pallet Projects: Reuse, Recycle, and Repurpose old Pallets."[43] So pallet reuse has certainly captured the imagination of a wide audience.

At the same time these creative approaches are not generally able to address the volume of pallets that are common to many markets. With U.S. production at about 450 million pallets annually, it is estimated that over three out of four pallets in use today are reused pallets. This still means that 300-500 million pallets are reaching the waste stream annually, comprising 2-3% of MSW nationally.

In Appendix E we include a case study of a North Carolina ban on pallets in municipal landfills. Over a very short period of time, the volume of pallets in NC landfills has declined precipitously. Certainly bans are an effective, if abrupt approach, to addressing this particular component of solid waste. The NC approach pre-considered the potential impact on the pallet industry, and included them in the process up front, which meant they were prepared when the decision was implemented. It was determined that there was significant excess capacity for recycling of pallets in the state (60 million annual capacity versus usage of about 34 million pallets).

An interview with a pallet industry expert suggested that one of the major drivers behind the acceptance of reuse and recycling of pallets is the fact that new technology, better handling systems, greater acceptance of the idea by customers, and the higher cost of disposal, have made used pallets a valuable commodity. The reuse and recycling of pallets can be, and often is, more profitable than the production of pallets from virgin materials.[44]

Increasingly, MSW sites are banning inclusion of pallets in the waste stream and diverting them to recycling facilities where they are funneled to pallet firms or ground for other purposes. The most common result for end-of-life use of waste pallets is to be ground for use in mulch, animal bedding, furnish for secondary manufacture, or as biomass for energy production.

Best Practices for C&D Wood Reuse and Recovery

Given the significance of C&D materials, the following list describes best practices that can be applied to improve wood reuse and recovery from this waste stream. This list was developed from interviews with wood reuse and recycling experts (Appendix A).

Designing for Deconstruction of Structures – Wood recovery is easier when structures are designed to facilitate disassembly at end-of-life (use of different types of glues, fasteners, etc.

[42] www.designrulz.com/…/35-creative-ways-to-recycle-wooden-pallets/
[43] willowhavenoutdoor.com › Featured
[44] Bornstein, B. 2012. Personal communication November, 2012.

can encourage/discourage reuse and recycling of wood). Also, more intelligent design is needed in the prefabrication of wood products (e.g., pre-cut materials before getting to the jobsite).

Expanding Reuse at Construction Site – The onsite reuse of recovered wood into a similar or value-added product is a best practice (e.g. using old framing lumber for jack posts or cripples).

Improving Deconstruction Process Management – Process management means: (1) having a plan to recover materials (building assessment) before the building is removed, (2) receiving bids from deconstruction specialists (in addition to traditional demolition companies), and (3) having removal specifications in place to facilitate reuse of materials. The goal is to efficiently and economically use a mix of hand and mechanical deconstruction practices to retain maximum quantity and quality of the wood.

Improving Job-Site Processing – This practice includes removal of nails, segregation of similar materials, sorting by length, and so on. The best practice is to process the lumber (or other wood materials) at the job-site when physically possible, rather than transporting the materials first and then processing later.

Source Separation at Construction Site to Meet Demand – Separation of materials at the source of the waste was mentioned by many practitioners (see Appendix A) as a best practice that should be implemented for wood as well as other materials. Single-source containers (versus mixed-source) provide an incentive and opportunity for recovering wood for reuse and recycling. LEED and other green building programs have begun to focus more on job-site recovery (source separation) as a key responsibility of contractors/developers. Some regions such as California are already promoting source separation. However, since markets are not readily available for all materials source-separated at construction site, not everyone embraces this as a best practice.

Unitization – Handling wood as a *unit* is a best practice (and already adopted by many in the deconstruction industry). For example, de-nailing and then assembling like material (1 x's, 2 x's,) in clean, packaged bundles.

Retaining/Enhancing Visual & or Structural Values – Salvaging trusses in a manner that they can safely be re-used is one example. Also, disassembling flooring while retaining the tongue and groove integrity, or removing nails from flooring and being careful with the appearance/size of the nail holes, are examples of this best practice (and already adopted by many in the deconstruction industry).

Matching Material Specifications to Available Processing Technology – To a certain degree this is a method of source separation. Matching material specifications to available processing technology involves separating wood for highest and best use. As an example, reusable wood would go to a reuse market, 'clean waste wood' to paper, particleboard, or mulch markets; co-mingled wood to a biomass market; and 'bad (dirty or contaminated) wood' to a landfill.

Best Practices for MSW Wood Reuse and Recovery

The following best practices (see Appendix A) focus on MSW and other types of 'waste wood.'

Bans and Regulations – Where appropriate, policies that ban organics in landfills can drive creativity and lead to new market development. An example is the 2009 legislation in North Carolina to ban landfill disposal of pallets (See Case Study in Appendix E).

Have a Utilization Plan—This best practice pertains to municipal forests (urban forests) where removed trees are more likely to be utilized if a wood recovery (utilization) plan is in place prior to tree removal.

Barriers and Opportunities for Increased Wood Recovery

Barriers to, and opportunities for, greater wood recovery and reuse were determined through interviews with wood reuse and recycling experts (Appendix A). Two or more people mentioned many of the factors listed below. Although not necessarily a consensus opinion, they reflect ideas broader in scope than just a 'laundry list' of comments. These results complement and supplement previous studies done and reflect broad strategic thinking on the issues rather than tactical approaches necessary at the local level.[45]

Barriers – there is a lack of:

- End markets and/or market development (*this was a response from numerous interviewees)*
- Clarity on how salvaged lumber is impacted by grading issues (e.g. grade rule changes over time) and codes/standards in structural applications
- Clear and agreed upon definitions for the terms "reuse and recycling"
- Clarity on bio-fuels definition and standards
- Markets in proximity to biomass – and/or low cost options for trucking biomass *(often the closest market is too distant; this ties into market development as noted above)*
- Agreement on combustion of woody biomass as an acceptable component of reuse/recycling *(this is a major barrier when people view combustion as a 'negative'; alternatively, some people view it as a 'positive')*
- Technology and/or process to deal with wood in combination with other, especially hazardous, substances *(lead-based paint specifically, and other contaminants generally, were often cited by interviewees as a 'policy barrier')*
- Understanding of air emission rules as they apply to woody biomass combustion
- Recycling centers/drop-off points for wood waste
- Agreement between private and public sectors on how best to proceed in the future *(i.e., should we have more or fewer government regulations? how many government demonstration projects are needed versus real-world projects? do government-run businesses compete with, or help, private sector businesses?)*

[45] See "Barriers for DLC Wood Waste" presentation by Corinne Fulton at Metro Vancouver Reduce, Reuse, Recycle forum.

Opportunities[46] *- we could:*

- Improve product stewardship (*manufacturer of product needs to assume more responsibility at product end-of-life)*
- Better utilize high quality old growth lumber that exists in many buildings
- Engage more traditional forest products businesses in becoming involved in wood recovery, once products are at the "end" of their useful life (*old buildings as an example)*
- Promote community benefits of wood recovery (*this includes jobs created, workforce training, use of local resources, climate change, etc.)*
- Encourage wood waste diversion ordinances including manipulation of tipping fees *(the idea is that more wood waste could be recovered by careful crafting of ordinances and changes in tipping fee rates that 'encourage' (mandate) wood recovery)*
- Provide better information and education (I&E) *(this opportunity, including training, was mentioned by many interviewees and includes deconstruction I&E as one example)*
- Support better sorting of materials for reuse *(see Best Practices)*
- Promote 'savings' of money by not landfilling *(demolition companies, tree service firms, and others, should be targeted)*
- Promote carbon benefits of wood reuse and recycling
- Evaluate building design (during all stages) regarding end-of-life use
- Support activities that level the playing field *(this theme was mentioned by numerous interviewees and gets at the issue of making reuse/recycling easy and sensible to everyone; this notion can be addressed by information and education campaigns or through mandates; the bottom line is to encourage good choices and good behavior by publicizing, as an example, the positive aspects of reuse and recycling.*

Thinking Creatively About the Industry's Role in Wood Waste Minimization

Keep Waste at the Manufacturer

Today, the sorting of solid wood product waste at the new construction jobsite in order to facilitate recycling is fairly straightforward. However, it still incurs a cost. Perhaps this is an opportunity, an excuse even, for entrepreneurial commodity producers to rethink the role of OSB and lumber manufacturers in terms of the level of value added they provide to the construction market. With new technology it might be possible to manufacture construction materials "just in time" with significantly higher value, and even eliminate a majority of solid wood waste on the job site and push it back up channel to primary processors who are able to fully utilize the material. Consider five basic possibilities as examples:

Advanced Design

One way to achieve greater design interaction between the product producer and the builder and architectural design communities is to push "advanced design" and prefabrication of wood products (including use/cutting/sizing of wood products). Advanced design should help reduce construction costs and jobsite wood waste through smarter architectural design tools. Fabricated steel products result in little jobsite waste; the goal for wood users should be the same.

[46] Some opportunities can be described as current barriers; it depends on one's perspective.

Rethink OSB manufacture

What if an OSB plant, strategically located near a major market, partnered with a major home-builder(s) to provide building shells more similar to a truss/wall panel plant[47] rather than just OSB? Under those conditions the OSB manufacturer might produce wall-sized panels, machine them for all openings (or even press them with openings planned into the process), buy precut lumber, assemble wall panels, coat external surfaces (wall and roof) with moisture and wind resistant finish, and ship the building package to the jobsite. With the ability to adjust panel size there might even be a re-engineering of wall and floor systems to facilitate on site assembly –in a more "Lego" like process – that would enable single day closing-in of a residence or small building. Perhaps the OSB manufacturer would even provide the installation team. Not only could waste be reduced on the jobsite, it might even be eliminated (or greatly reduced) from the process.

Rethink Lumber Manufacture

Similarly, what if a lumber manufacturer used an optimizing trim saw(s) to provide part-labeled, cut-to-length lumber directly to major builders, panel plants, or to the potential OSB manufacturing firm described in the example above. The net result would likely be that the manufacturer would begin reducing its need to produce lumber in two-foot increments (potentially improving yield), and grading could occur at the final stage for specific use, increasing the flexibility of the plant. Also, once it is known exactly what a piece will be used for, it becomes a part rather than a commodity, resulting in increased ability to provide finger joint and other components as understanding develops. So, in addition to keeping the wastes at the factory, rethinking the process may result in a whole new way of looking at lumber processing and grading. Certainly there would be significant logistical issues, but those are the real value-added activities.

Rethink Manufacturing's Role RE Post-Consumer Wood Waste

A number of organizations have attempted to implement "take-back" programs. This is where the manufacturer, or other member of a channel takes a product back, generally, but not necessarily, as part of a replacement process. As mentioned earlier, pallet companies commonly take back used pallets for refurbishment and resale. In addition a number of replacement window companies now take back old windows and recycle their components. These take back programs are still in their relative infancy, and the window programs today focus on aluminum and vinyl rather than wood, but represent a growing opportunity for industry.

Challenges Facing Wood Recovery Efforts in North America

Wood recovery efforts face a number of challenges in North America. The wide geographical distribution of the industry, diversity of industry 'players', and lack of agreement on the definition of recovery are a puzzle not only to many in the industry but to the general public as well. Even the notion that wood is a renewable resource and its relationship to recycling, as well as the controversial benefits of the combustion of this renewable resource can pose challenges

[47] Simply providing precut products could result in less cutting or waste on the jobsite. This would require more advanced design and a greater level of design interaction between the product producer and the architectural design community.

for the industry. To some degree, wood recovery faces challenges that differ from most other recyclable materials. These challenges are important to recognize before embarking on a North American wood recovery campaign.

Geographical Distribution of Industry

Wood products manufacturers, distributors, wholesalers, retailers, users, discarders, and so on are located from the extreme southeastern U.S. to the far northwest reaches of Canada (and everywhere in-between). However, specific products (e.g. SPF lumber) may be actually used thousands of miles from their source. This distance can create a disconnection between the producer and customers with end-of-life issues, and also create logistical issues for any support programs a producer might wish to engage in. Although a wood recovery campaign would ideally reach across North America, any implementation strategy must be conducted locally.

Diversity of Industry

There exists a long list of 'players' or potential players in wood recovery efforts including sawmills, secondary manufacturers such as flooring or cabinet-makers, pallet manufacturers, construction and demolition industries, wood reclaimers, landscaping (mulch) businesses, wood-to-energy facilities, waste haulers, and the general public. Such a long list creates problems when attempting to describe recovery strategies that could impact the entire industry. For example, an effort in Sarasota, Florida, to prevent historical wooden structures from randomly being destroyed (demolished and then landfilled) likely has no impact on a wood-to-energy recovery boiler at a SPF stud mill in British Columbia. Although both efforts have merit (preserving and/or reclaiming old wooden structures, and burning wood residues for energy), the differences in 'wood recovery' are completely different from one another.

The diversity of the industry also pinpoints another, but similar dilemma. The pallet industry, for example, has been analyzed at length regarding pallet production, repair/reuse, diversion to other products, and discards. Related statistics (by nature of their specificity) are not applicable to other wood-using industries. Consequently, wood recovery campaigns that target all/most wood-using industries will lack the necessary details (statistics) to make significant impacts across the breadth of the wood-using industry. Individual targeted wood recovery 'campaigns' for specific industry sectors are needed.

Issues Related to Long-lived versus Short-lived Products

Many recyclable materials – like paper, aluminum cans and glass bottles – are short-term products (life span of a few years or less), consist of post-consumer materials (many collected curbside), and are typically used as a feedstock for manufacturing a similar product. Wood (especially solid wood products) is different in all respects.

First, wood products are typically long-lived (life expectancy of many years). Second, the majority of wood products (by volume) are currently not collected post-consumer. Third, material that is collected is likely not to be used as a feedstock to make a similar product (think 2x4). By this definition, wood recycling rates are quite low. This is a big disadvantage for wood since it does not fit the traditional definition of recycling. Also, wood recovered for energy production does not meet the traditional recycling definition. However, wood can be reused, leading to a distinct advantage over other materials such as paper, aluminum cans and glass bottles. Reuse is classified higher (better) in the waste hierarchy than either recycling or energy production.

Since most wood products are long-term products (life expectancy of many years), the calculation of recovery percentages poses some challenges. A pine 2x4 stud has a life expectancy greater than one year (this is obvious), and consequently recovery rates need to evaluate current production (for a given year) with recovery (for a given year) of 2x4s (in this example) manufactured long ago. Also, life cycle impacts of recycling a material annually (or less) versus a long-lived product such as wood need to be carefully considered and recognized.

Conflict Between the "Reduce" versus "Use More Wood" Messaging

Many materials collected in curbside recycling programs are manufactured from non-renewable resources as noted above. Wood, fortunately, comes from trees, a renewable resource. This can be a double-edge sword however, in marketing efforts. On one hand, many wood industry advocates argue that North America and the world should use *more* wood, especially as a substitute for non-renewable resources. Conversely, 'more' use of a resource is counter to the 'reduce' mindset that is promoted through the waste hierarchy.[48] The key is likely to use wood more intelligently (less waste, better house designs, etc.).

Recommendations for Wood Reuse and Recycling in Canada and the U.S.

The following recommendations are offered in an attempt to increase wood reuse and recycling throughout North America, particularly in the Municipal Solid Waste (MSW) and Construction & Demolition (C&D) waste streams. Wood reuse and recycling is not a one-size-fits-all situation so recommendations may be appropriate for some communities/regions/states/provinces and not for others. No attempt was made to develop a complete (all-inclusive) list of wood recovery recommendations. Rather, the following list highlights recommendations that 'jumped out' based on results of this project (interviews, literature search, case studies, personal observations, etc.).

Big Picture/Overarching Themes

- *Promote the uniqueness of wood* - Work to develop an understanding of the nature of wood as a renewable and naturally recycling (e.g., biodegradable) material. This is critical to valuing wood as a green material.

- *Celebrate the Success* - Promote the fact that the forest products industry has largely eliminated pre-consumer wood waste and that today there are a number of wood products produced from pre-consumer waste materials that were historically incinerated (without energy recovery) or landfilled.

- *Work nationwide to address MSW and C&D wood waste* - Recognize that post-consumer wood waste is a significant issue nationally in both the U.S. and Canada and that there may be opportunities to address waste issues at a national scale, including through more extensive funding of research, and development of potential incentives for greater material recovery.

[48] The Waste Hierarchy typically begins at the 'top of the pyramid' with Reduce, followed by Reuse and Recycle. After these 3 R's comes Energy Recovery and Landfilling.

- *Collaborate with MSW and C&D industries and local communities to find waste recovery solutions. Collection and disposal of* MSW & C&D waste and debris typically involves participants that must deal with unique material handing situations at a local level. In this regard, solutions may require new and community-based partnerships and specific strategies that may vary by locality and region.

- *Seek to Replicate Success* - Large-scale reuse and recycling of wood waste from MSW and C&D depends greatly on the type of material involved. For some materials (pallets, railroad ties, furniture) there are well-established and economically self-sustaining recovery methods. For other materials (new construction waste, demolition waste) there are specific challenges that need to be overcome. There are emerging models for addressing these challenges, and potential for further replication of best practices and models of innovation.

- *Gain Recognition for What is Already Working.* To the extent that existing recovery, recycling and reuse efforts qualify for marketplace recognition (e.g., green building programs, labeling claims, etc) these product attributes should be more effectively quantified and promoted.

- *Recognize that Green Building is an Opportunity Not a Threat* - Green building is driving recovery and reuse of specific high value products (flooring and doors are examples) resulting in standard markets for some products (salvaged barn wood in some markets is worth $10/sq ft) and the development of new small wood products businesses (see recommendations below on market development). Constructive engagement and support for green building can help expand opportunities for wood in the built environment.

- *Bring the Strength of Industry and its Partners* - Massive (industry scale) improvement in reuse and/or recycling of wood requires an ability to produce something out of all kinds of wood waste. To be able to accomplish this scale of wood recycling, significant new initiatives involving the industry and its partners will be needed, including research, product development and diversification, business-to-business collaborations and customer consultation. One approach might be to pursue a wood-waste-minimization strategy that builds from past success in eliminating pre-consumer waste during manufacturing.

Data Collection—Ongoing Research

- *Merge U.S. EPA and Biocycle/Columbia University methodology* -- The U.S. EPA (Franklin Associates) and *Biocycle*/Columbia University each do separate studies with widely differing results regarding U.S. MSW generation, recovery, energy combustion and landfill discards. These two entities should combine their talents and efforts by merging their MSW research methodologies. In these studies, and in collection of USFS data, the same measurement units should be used, and one comprehensive study should be designed to investigate all sources of wood residues. The development of accurate and replicable data collection techniques is essential to being able to benchmark wood waste conditions and track changes over time.

- *Use U.S. Forest Service urban tree data to estimate woody yard trimmings* – The USFS currently uses a 1993 study conducted by NEOS to estimate MSW woody yard trimmings (the USFS does update the 1993 data based on economic drivers, etc.). USFS research scientists routinely collect data on the U.S. urban tree population. This data could be used to generate estimates of tree removals (woody yard trimmings). These removal estimates could then be verified by using data from select cities regarding annual tree removal rates (1%, 2%, etc.). Such a procedure should produce more reliable (predictable) results on woody yard trimmings than the current method of updating 1993 data.

- *Life-Cycle Assessment* – Today consumers may view recyclable as superior to renewable. Yet, renewable is more accurately characterized as a subset of recycled, and renewable can be thought of as a natural form of recycling. Research should be done and/or promoted/communicated more effectively to compare the life cycle impacts of recycled nonrenewable materials with those of renewable materials to help to illustrate the benefits of renewability.

Data Collection—New Research

- *Investigate landfill data* – There are differences across Canada and the U.S. regarding landfills (e.g., numbers, types (MSW or C&D or both), specific materials received, life expectancy, availability of future space, and tipping fees by state/region/province). A compilation of such information is needed before wide-ranging strategies, policies and regulations (if warranted) can be implemented.

- *Investigate market conditions and policies by region (municipality) of North America* – There is great variance across Canada and U.S. regarding not only markets for recovered wood but also policies or regulations encouraging higher levels of wood recovery. To-date variations in market conditions and policies have not been adequately summarized.

- *Initiate a single study to investigate all sources of wood residues, including MSW, C&D, and yard trimmings (municipal trees).* Today (in the U.S.), different organizations conduct studies on (typically) only one source of wood residue, using differing definitions, assumptions and timeframes, leading to conflicting results and a host of other problems when trying to compile data to provide a national perspective. Ideally, one organization or contractor could conduct such an investigation within a period of 1-2 years.

- *Develop wood waste 'resource' map* – A Canadian and U.S. resource map of potentially recoverable wood (in buildings, houses, bridges, etc.) is needed. This 'map' could be modeled after the U.S. Forest Service's forest resource inventory. Among other benefits, a resource map would identify the location and quantity of high-quality, old-growth lumber that was milled in the past. The compilation of reliable, comprehensive statistics on wood waste, especially with an eye toward historical construction, would be a valuable stimulus to wood recovery.

Education

- *Host and support programs and events:* Expand offerings of the Building Materials Reuse Association (BMRA) curriculum "Introduction to Deconstruction" and collect and disseminate BMRA case studies of successful wood recovery and recycling. Assist in efforts to continue and expand training events like Building Material Reuse Association's (BMRA's) *Decon 13* and the North American Wood Waste Forum.[49]

- *Promote community benefits of wood recovery* – There are a number of significant potential social, economic and environmental benefits from increasing wood recovery. For many communities, a significant driver of recycling efforts continues to be concern about diminishing landfill capacities and the rising costs of waste disposal. Increased wood waste recovery, reuse, and recycling could provide jobs, better utilization of local resources, reduced environmental impacts, and other diverse benefits.

- *Develop a 'campaign' or strategy to raise wood recycling consciousness of the general public* – Paper is viewed today, by nearly everyone, as a recoverable and recyclable resource. Paper recycling caught the attention of the general public a half-century ago through "newspaper drives" and other individual or community activities. Understanding the development of paper recovery and recycling over time, and applying lessons learned to foster the recovery, reuse and recycling of wood is a strategy worth exploring and acting upon while also promoting success stories within specific wood product categories.

- *Develop and promote a wood recovery day* –A dedicated day (or week or month) for wood recovery would be useful in raising awareness of the importance of recovering wood in all forms, and would also provide a platform for highlighting current successes in wood recovery and recycling. In addition to awareness, a wood recovery day would generate quantities of material that might otherwise be discarded into a landfill.

- *Target women* – A recent UK report noted that 80% of buyers of reclaimed material were women.[50] A U.S. publication noted that women handle 75% of family finances and control more than 60% of all wealth in the U.S. [51] Tapping into the female market could result in positive wood recovery outcomes.

Market Development

- *Understand and address the waste hierarchy* – Within recycling discussions there is debate around the terminology as well as around common understanding of the "highest and best use" of recovered materials. There is a general hierarchy that represents a ranking of practices from the most desirable to least desirable: 1) Reduce (rethink), 2) reuse, 3) recycle, 4) recover for energy, and 5) landfill/disposal without energy recovery.

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[49] Additional sources of wood recovery recommendations can be found at the Proceedings of the North American Wood Waste Forum (http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr216.pdf) and at http://www.dontwastewood.com/.

[50] http://www.globaltrees.org/downloads/WoodWasteIntro.pdf

[51] Levinson, J. 2007. *Guerrilla Marketing.*

Where diverse opportunities for reuse, recycling and recovery are available, this type of hierarchy can aid wood recovery efforts in the U.S. and Canada.

- *Understand and address the role of energy recovery in reducing wood waste* – Combustion is a part of forest ecosystems, and recovery for energy production is one of the ways wood waste is diverted from landfills. Similarly, C&D wood waste is also commonly used to produce compost (another example of life imitating nature). However, there is frequently a distinction made in the reporting of wood waste data to identify "recovery for energy" and other forms of landfill diversion that result in "reuse" of the product in a similar form or "recycling" into something that has a new consumer use. Given that there are significant benefits to utilizing wood for energy, it is important to acknowledge and promote these benefits (e.g., displaces fossil fuels, reduces waste costs and landfill burdens, aids in addressing storm damage, improves energy independence and security, etc), and to support the use of wood waste for energy production where it represents the most viable market alternative to landfill disposal.

- *Develop an income stream to fund market development* – A portion of a landfill tax in the UK is used to fund projects related to waste management, including projects that focus on developing markets for recycled materials. Whether it is a manipulation of tipping fees, landfill tax, or other mechanisms, additional and regular revenue is likely needed to address the important priority of markets (e.g., limited/fragmented markets, products, supply chain issues, consumer awareness).

- *Address Barriers to Wood Recycling Recognition in the Marketplace* – The existing Federal Trade Commission's Green Guides define the allowed market and label claims for recycling.[52] To the extent that the Green Guides create barriers to expanded use of recycling claims for renewable materials like wood, efforts should be undertaken to influence the updating of the Guides to improve recognition of the differences between recycling renewable and non-renewable materials. At the same time, to the extent that specific wood product categories or regions/markets may qualify to make recycled claims under the Green Guides, these marketing opportunities should be pursued and promoted more effectively.

- *Develop third-party certification system for reused wood* – The lack of a certification system for reused/recycled wood materials is seen by some as working against wood recovery. Wood reuse is already a 'green' activity but certification could add to its 'greenness' and provide entry into new markets, contacts with new customers, recognition by new peer groups, etc.[53]

- *Develop a larger network of wood drop-boxes/bins* – Recycling of wood waste needs to make sense to everyone, everywhere. Making wood recycling easy can encourage good behavior and good choices. One solution is to have a network of wood collection boxes/bins readily available to the general public. This effort might incorporate the 'boxes' with existing yard waste/ tree trimming recycling sites currently in use. Another

[52] http://www.ftc.gov/opa/reporter/advertising/greenguides.shtml

[53] The Forest Stewardship Council has a standard for sourcing reclaimed materials that offers one example of how recycling verification can be done.

might be to develop a take-back program in which retail/wholesale distributors operate collection sites for clean material.

- *Become more involved as an industry in developing design for deconstruction concepts.* Investigate, for instance, the possibility of screwing rather than nailing sheathing and eliminating the common practice of nailing and gluing decking. Also, help to facilitate research into more cost effective deconstruction techniques.

Conclusion

Wood, by its very nature, is among the most recyclable and recycled materials. The fact that wood is a renewable resource sets it apart from many other recyclable items such as steel, plastic and aluminum.

The U.S. and Canada are the 1st and 3rd largest producers of industrial roundwood in the world, together producing about 28 percent of the world's supply. On average, about 143 million tons, of wood-based products are produced annually in the U.S. For North America, the harvesting and manufacture of these products results in wood residues, about 99% of which are used for fuel, pulpwood, and feedstocks for products such as particleboard. Interestingly, mill use of wood residues for fuel is an important factor in the North American wood products industry being a near zero waste producer (up to 12% of the log volume is used for energy production, resulting in a displacement of fossil fuels). However, another large source of wood (post-consumer) ends up in the solid waste stream.

Estimates for the U.S. place the amount of wood in the MSW and C&D waste streams at over 70 million tons annually, of which 28+ million tons are thought to be recoverable with current technology. This includes about 14% of the MSW, and about 28% of the C&D waste stream. For North America, an estimated 30+ million tons of wood in existing waste streams is available for recovery.

Current data indicate that the overall recycled content of U.S. produced wood building products is in the 10-11 percent range, with Canadian figures likely similar.

In addition, there are discrepancies in the data as to the amount of wood waste in the post-consumer waste streams. One example is the 50+% difference between MSW estimates by the U.S. EPA and *BioCycle*/Columbia University.

For some specific wood products, such as pallets, there are well-established and economically self-sustaining recovery programs. Other products, like furniture, have a comprehensive system of repair and reuse, although much of the activity "flies under the radar screen" of traditional wood recovery programs. Still other products, like railroad ties, have an industry association closely tracking reuse and recycling.

Despite differences in estimates and available data, it is clear that there remains a large volume of wood available for recovery in post-consumer waste streams. The further development and promotion of strategies that encourage the diversion of usable wood from the waste stream, including reuse and recycling, will help in moving toward better utilization of this wood and associated beneficial effects on the environment.

Being cognizant of current reuse and recycling best practices, acknowledging barriers, acting on opportunities, and seeking solutions to challenges, are important factors to recognize when embarking on a North American wood recovery campaign.

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The Current State of Wood Reuse and Recycling in North America and Recommendations for Improvements

Dovetail Partners
528 Hennepin Ave, Suite 703
Minneapolis, MN 55403
Tel: 612-333-0430
Fax: 612-333-0432
Email: info@dovetailinc.org

www.dovetailinc.org

Appendix A: Interviews with Industry, Government, Association, and Non-Profit Leaders

Introduction

One method of obtaining information on practices, trends and recommendations for wood reuse and recycling in North America is to talk with key players in the field. During August and September, 2012, 18 individuals—representing industry, government, associations and non-profits—were interviewed by telephone. The purpose of the open-ended interviews was two-fold. First, the interviews served as a follow-up to the North American Wood Waste Forum[54] held in February, 2012, in Madison, Wisconsin. Second, the intent was to gain greater insight into wood recovery barriers, opportunities, trends and best practices.

Individuals (18) participating in the telephone interviews included:[55]

Dave Bennink, Reuse Consultant, Bellingham. Washington
Nathan Benjamin, Planet ReUse, Kansas City, Missouri
Bill Turley, Executive Director, Construction Materials Recycling Association (CMRA)[56]
Nermine Tawfik, Technical Advisor for Metro Vancouver, Burnaby, BC
Gretchen Cheesman, Unsafe Building Hearing Authority, City of Muncie, Indiana
Chuck Goddard, Metro. Area Solid Waste Agency, Dubuque, Iowa
Damian Sawka, The Boxfish Group, Ottawa, Ontario
Steve Changaris, Regional Manager, National Solid Waste Management Association
Jesse White, Sarasota Architectural Salvage, Sarasota, Florida
Matthew McKinney, Waste Management/Recycle America, Portland, Maine
Isabelle Des Chenes, Forest Products Association of Canada, Ottawa, Ontario
Tom Napier, U.S. Army Corps of Engineers, Champaign, Illinois
Vicki Worden, Worden Associates, Camden, Maine
Bryce Jacobson, Metro Solid Waste and Recycling, Portland, Oregon
Jason Haus, Dem-Con Companies, Shakopee, MN
Wes Sullens, STOPWASTE.ORG, Oakland, California
Anne Nicklin, BMRA, Chicago, Illinois
Ted Reif, The ReUse People of America, Oakland, California

[54] Proceedings of the North American Wood Waste Forum can be found at: http://www.fpl.fs.fed.us/documnts/fplgtr/fpl_gtr216.pdf.
[55] See Appendix A for the interview script (questions).
[56] Participated in the interview via Email.

Results

Many of the interview results were mentioned by *two or more people*. Although not necessarily a consensus opinion, they reflect ideas broader in scope than just a 'laundry list' of comments. These broader results have been categorized into barriers, opportunities, trends and best practices.

Barriers

- **End markets (and/or Market Development) need greater attention** (*this was a response from numerous interviewees).*
- **Grading and codes/standards** in structural applications.
- **Confusing definitions of reuse and recycling.**
- **Bio-fuels standards** *(definition of bio-fuels)* **and biomass trucking distances** *(often the closest market is too distant; ties into market development as noted above).*
- **Combustion of woody biomass is controversial** *(this is a major barrier when people view combustion as 'bad'; alternatively, some people view it as a 'positive').*
- **Hazardous substances on/in wood** *(lead-based paint specifically, and other contaminants generally, were often cited by interviewees as a 'policy barrier').*
- **Uncertainty of air emission rules** *(as it relates to woody biomass combustion).*
- **Lack of/limited recycling centers/drop-off points** for wood waste.
- **Potential 'divide' between private and public sectors** on how best to proceed in the future *(i.e., Should we have more or fewer government regulations? How many government demonstration projects are needed versus real-world projects? Do government-run businesses compete with, or help, private sector businesses?).*

Opportunities[57]

- **Product Stewardship** (*manufacturer of product needs to assume more responsibility at product end-of-life).*
- **High quality old growth lumber** in many existing buildings *(the opportunity is that society needs to tap into this resource before it runs out).*
- **Traditional forest products sector has an opportunity to become more involved** in wood recovery once products are at the "end" of their useful life (*old buildings as an example).*
- **Promote community benefits of wood recovery** (*this includes jobs created, workforce training, use of local resources, climate change, and so on).*
- **Wood waste diversion ordinances including manipulation of tipping fees** *(the idea is that more wood waste could be recovered by careful crafting of ordinances and changes in tipping fee rates that 'encourage' (mandate) wood recovery).*
- **Information and education (I&E)** *(this opportunity, including training, was mentioned by many interviewees and includes deconstruction I&E as one example).*
- **Better sorting of materials for reuse** *(see Best Practices).*
- **Promote 'savings' of money by not landfilling** *(demolition companies, tree service firms, and others, should be targeted).*

[57] Some opportunities can be described as current barriers; it depends on one's perspective.

- **Promote carbon benefits.**
- **Evaluate building design (during all stages) regarding end-of-life use.**
- **Level the playing field** *(this theme was mentioned by numerous interviewees and gets at the issue of making reuse/recycling easy, and makes sense, to everyone; this notion can be addressed by information and education campaigns or through mandates; the bottom line is to encourage good choices and good behavior by publicizing, as an example, the positive aspects of reuse and recycling).*

Trends

- **Positive policies (often local)** that stimulate wood recovery *(these include regulations that ban, as an example, the landfilling of pallets; see Best Practices).*
- **Green building.**
- **Deconstruction** *(see Best Practices).*

Best Practices

- **Source separation at construction site** *(source separation at construction sites has been mentioned by 'experts' beyond the interviewee group as a key component of wood recovery initiatives).*
- **Deconstruction of buildings** in an efficient and economical manner including hybrid deconstruction *(with a plan for reuse.)*
- **Building assessment prior to deconstruction** *(includes evaluating 'order' of deconstruction to avoid waste/damage).*
- **Designing for deconstruction** when buildings originally built.
- **Banning of pallet and organics landfilling.**

The following suggestions were mentioned by only one of those interviewed. However, the comments are thought-provoking, and are included here as additional examples of what might be done to encourage more wood recovery throughout North America.

- Wood recovery is not a one-size-fits-all situation; (biomass is appropriate for some communities, as an example, but not for others);
- More public projects are needed to serve as models for the private sector;
- The following reports should be developed: (1) a Publication/document detailing Best Management Practices in wood recovery across North America; (2) a Summary of Market Conditions by region of North America, and (3) a Summary of Policies by region (or municipality).
- A National (North American) Resource Map of all recoverable wood should be developed (on par with the current mapping of U.S. forest resources);
- More *scientists* should be involved in wood recovery (this is especially relevant regarding combustion emissions, climate change, etc.);
- Distinction should be made between short- and long-term wood recovery goals (ex: what can be tackled immediately—low hanging fruit—and what is a multiple year process);
- Distribution network for reuse materials is a barrier;
- Certification (lack thereof) of wood for reuse is a barrier;
- Consider introducing 'energy saved' as part of a LEED point system (from cutting and milling through burning if appropriate);

- Recycled products require more machines than reused products.

Bottom Line

The 18 experts interviewed for the wood recovery project come from various backgrounds, share different experiences, and live and work in various locations throughout North America. However, many of these individuals had similar observations on wood recovery relating to barriers, opportunities, trends and best practices.

In addition to the similarities in opinions expressed by the 18 interviewees, the long (and varying) list of barriers, opportunities, trends, and best practices, shows that a simple fix, or one solution, will likely not adequately address the wood recovery problem in North America. The problem needs to be approached on many fronts. Hopefully, the opinions shared by the 18 'experts' will provide a framework for moving forward in the future.

Telephone Interview Script

Hello, my name is Steve Bratkovich of Dovetail Partners. If you're not familiar with Dovetail, we are a Minneapolis-based non-profit that focuses on environmental issues such as forestry and forest products.

Dovetail is currently involved in a project to investigate wood waste throughout North America. By wood waste, Dovetail is looking into "waste" from sawmill and secondary processors through Municipal Solid Waste (MSW) and Construction and Demolition (C&D) materials.

Can I ask you about your role and/or your organization's role in tackling the issue of "wood waste"?

First, I'd like to make sure I have your name, title, and contact information correct.

Name:_____

Organization: _____

Title/Position: _____

Telephone: (best number to reach you at)_____

Email: _____

Web Link: _____

This interview focuses on wood recovery as it relates to Municipal Solid Waste (MSW) and Construction & Demolition (C&D) materials plus ancillary industries like pallets, poles, outdoor decking, etc.

1 Did you attend the Wood Recovery Forum program at FPL earlier this year? _____

(If yes, Continue to #2) (If no, go to #4)

2 Is there anything regarding wood recovery that the final report missed? (if yes, explain)
3 Is there anything from the Forum that deserves more attention? (if yes, explain)

Go to #12!!

4 Wood recovery barriers include barriers specific to reuse, recycling, biomass (combustion) and mulch and other uses.

4a What barriers come to mind when you think of reuse (by reuse, I mean further or repeated use of the wood product…like using flooring from a deconstructed building as flooring in a new building)?

5 What barriers come to mind when you think of recycling (by recycling, I mean reconstituting the wood product such as grinding a board into feedstock for a panel product like OSB)?

6 Barriers to Biomass (combustion)?

7 Barriers to Mulch and other uses?

Fortunately, there are opportunities for wood recovery in these same 4 categories.

8 What opportunities come to mind when you think of reuse?

9 What opportunities come to mind when you think of recycling?

10 Opportunities for Biomass (combustion)?

11 Opportunities for Mulch and other uses?

12 Now, I'm going to ask you about best practices and trends relating to wood recovery.

12a Can you name a couple "Best Practices" in wood recovery?

13 Are there any "Trends" in wood recovery that deserve mention (especially as a follow-up to this survey)?

The next 2 questions deal with policy – first barriers, and then opportunities.

14 Do you have knowledge of, or recommendations, related to specific policy barriers regarding wood recovery?

15 Can you name any examples of innovative new policy that influences opportunities for wood recovery?

16 What is needed the most across North America to increase the rate of wood recovery?

17 Any ideas that come to mind specifically dealing with how to divert or get more wood out of a deconstruction/demolition situation?

18 Similar ideas on how to get more wood out of the MSW stream?

19 Any thoughts about standardization of data collection across the U.S. and Canada?

20 Finally, can you think of any specific wood recovery sites across North America that might be visited by the Dovetail team to actually see deconstruction/demolition/solid waste management "in action"?? For example, are there people in the field (say) separating wood and drywall, or efficiently removing nails, or retrieving panels, that might be a good site visit for the study team?

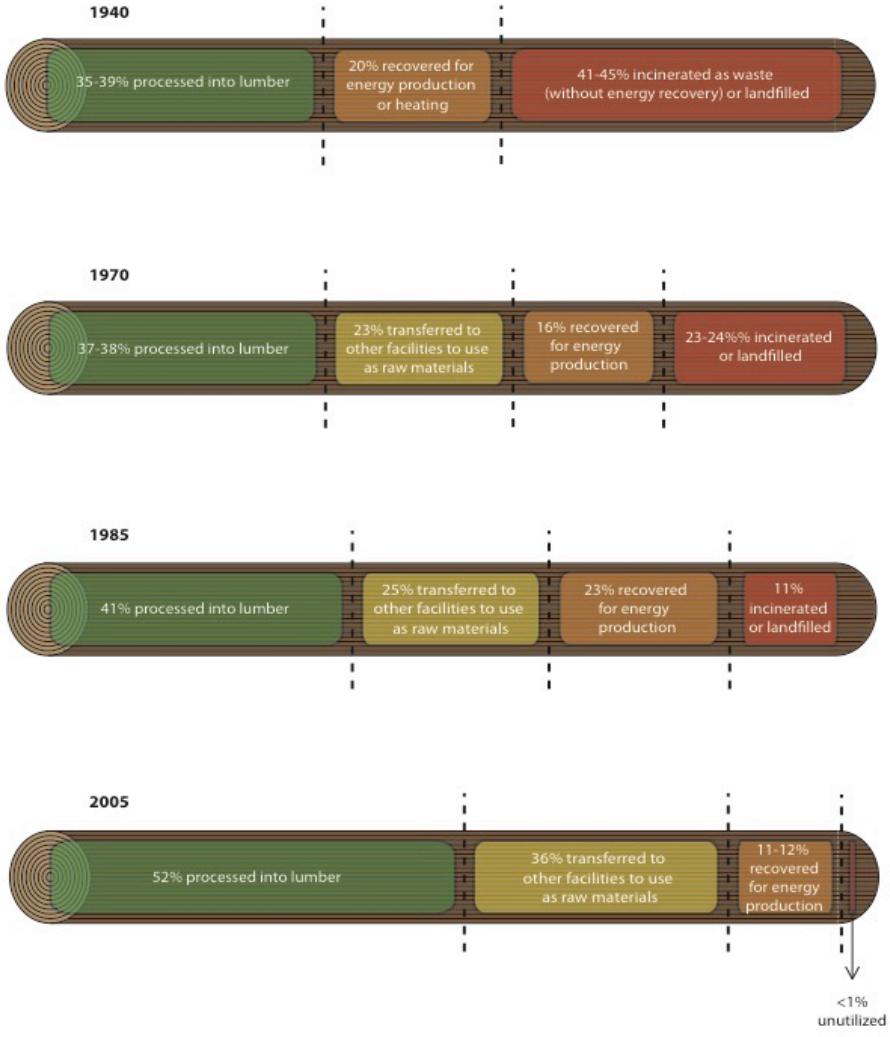
21 Any other thoughts, opinions, insights…relating to wood recovery in North America?

Thank you for your time and input today!

Appendix B: Utilization of Harvested Wood by the North American Forest Products Industry

The term "waste" is largely obsolete in the context of today's North American forest products industry. Logs brought to U.S. and Canadian sawmills and other wood products manufacturing centers are converted almost totally to useful products, leaving little to nothing in the way of wastes (Graphic 1). But it hasn't always been this way. The sector has come a long way since the 1930s, and in-terms of wood use, it has become a zero-waste industry. This is a remarkable achievement and the result of investments in technology, innovations in design, and an increased value on reducing the environmental impacts of manufacturing. The next challenge for the industry will be to turn its attention to possibilities for increasing wood re-use and recovery for recycling at the end of use.

Graphic 1.
Utilization of Harvested Wood by the North American Forest Products Industry, 1940 - 2005



Utilization Standards Pre-1960s

In British Columbia, the yield of rough, green softwood lumber from merchantable timber in 1939 was found to be 55.5% (Jenkins 1939), a figure that translates to about 35-39% after processing to a surfaced, dry condition. At about the same time, a statewide survey of sawmill waste in Oregon (Voorhies 1942) showed similar green lumber yield numbers (51 to 54 percent). The volume of waste in 1939 was, as a result, on the order of 50-60% of the log volume entering sawmills. While Voorhies noted that about 30% of this waste was recovered and used for mill fuel, home heating, or other miscellaneous uses, he reported that virtually all of the remaining volume was incinerated or landfilled. As explained by Voorhies: "Although there is a potential market for many of the known by-products that can be made from sawmill waste, the cost of manufacturing and marketing these products by the usual techniques and methods has generally been more than the selling price." Contributing to the high waste factor was the reality that most of the products that are today commonly made from sawmill residues had not yet been invented; production of particleboard, for instance, did not begin in North America until the early 1950s, and sawmill residues were not used as raw materials in papermaking until the 1960s.

Efficiency in the forest products industry increased substantially following World War II (see sidebar). The growing post-war economy and commercialization of technologies developed during the war years soon led to marked acceleration of the rate of innovation and adoption of new technologies.

The Emergence of Markets for Co-Products

By the late 1960s, there had been little change in lumber yield. Kerbes and McIntosh reported in 1969 that the yield from sawtimber of dry, surfaced western spruce lumber in western Canada was still only about 37%. In that same year, the dry-surfaced lumber yield from southern yellow pine sawlogs was reported as 38% (Williams and Hopkins 1969). What had changed, however, is

Milestones on the Pathway to Zero-Wood-Waste

1930s: Wood waste at 50-60%

1940's – 1950's: Technology improvements associated with innovations following WWII.

1955: First commercially manufactured waferboard.

Mid-1960s: Development of retractable chuck lathe for veneer peeling.

1968: Patent issued for laminated veneer lumber (LVL).

1969: Passage of the National Environmental Policy Act of 1969.

1970: Wood waste at 38%.

1970s: Energy embargo of 1973 and oil supply disruption in 1979.

1971: Best Opening Face Technology introduced.

1971: Patent issued for wood structural I-beams.

1973: Start of USDA Forest Products Lab's Sawmill Improvement Program (SIP).

Mid-1970s: Centerless lathe technology for veneer production introduced.

1981: Wood waste at 17%.

1982: 15% reduction in log requirements (resulting in an additional 640 million bd ft of production without an increase in consumption).

Early-1990s: Parallel Strand Lumber (PSL) developed in Canada.

2000s: Growth in bioenergy technologies and energy efficiencies.

2005: Wood utilization reaches 90%, and productivity has grown 29% since 1965 and 14% since 1985.

2012: Wood waste at 0.14% - 1.5%.

that much of what had formerly been waste, now had value. At this point, sawmills commonly chipped slabs and edgings for use in papermaking and found shavings increasingly in demand as a raw material for particleboard manufacture. Shavings were also used as animal bedding, although often provided free of charge as a means of disposal. New markets were also emerging, with rapid growth of hardboard production and establishment, in 1965, of the medium density fiberboard industry in North America (Ince 2000). Nonetheless, only 25 percent of all wood products mill residuals generated in the U.S. in 1970 were used in the originating plants as fuel, with another 37 percent transferred to other manufacturing facilities for use as raw materials. The remaining 38 percent went unused and either landfilled or burned with no energy recovery (Meil et al. (2007). A very similar situation existed in Canada (Beke et al. 1997).

A Focus on Improving Lumber Yield

In 1973 the U.S. Forest Products Laboratory began a sawmill improvement program (SIP), with a goal of significantly increasing lumber yield. Mills throughout the country were studied to determine yields obtained, and each phase in manufacturing was systematically examined for the purpose of identifying potential for yield improvement. Near-term results were impressive. By 1982 there had been a 15% reduction in log requirements to produce a given amount of lumber (Lundstrum 1982), translating to production of 640 million board feet of additional lumber without any increase in log volume harvested. The SIP program was subsequently replicated in Canada, with similar near-term results.

Technological Development Spurs Productivity Gains, Markets for Residues

Parallel development of technology set the stage for even greater gains in the near future. For example, Best Opening Face technology, which increased lumber yield from logs through computerized evaluation of log positioning prior to sawing, was introduced in 1971. This technology, in conjunction with development of systems for electronic scanning of logs, precise positioning of logs during cutting, optimization of trimming operations, and related technologies would eventually dominate North American production and markedly impact lumber yield. The introduction of log merchandisers, that allowed systematic bucking of long logs and sorting of resulting segments into various use categories for optimum utilization, also contributed to improved utilization. In addition, the concept of composite lumber products was born during this period, with patents issued (in 1968 and 1971, respectively) for wood structural I-beams, and for laminated veneer lumber (LVL). These technologies allowed the production of large-size, high strength “lumber” from small diameter trees of species having relatively low inherent strength.

Technological advancements were not limited to production of lumber. Structural plywood manufacturing was similarly the focus of technological innovation. Development of the retractable chuck lathe made it possible to economically peel small diameter logs to veneer. Introduced in the mid-1960s, this development led to the birth and rapid expansion of the southern pine plywood industry. A decade or so later centerless lathe technology for producing veneer was introduced. This technology allowed the use of logs that previously could not be used in making veneer; this also allowed the peeling of a log down to the center, thus increasing the volume of veneer that could be gleaned from a log.

Driving advancements in structural plywood technology was the emergence of an entirely new family of wood products –structural composite panels. Waferboard, the precurser to oriented strandboard (OSB), was first commercially manufactured in 1955, and accounted for only 0.05 percent of the U.S. structural panel market in 1973. Ongoing development soon led to the emergence of OSB, and rapid displacement of plywood in construction. Again the effect was to allow the economical use of small trees of relatively low inherent strength in production of high-strength products that previously required large diameter logs of high-strength species as raw material.

Cumulatively, these developments led to economic uses for an ever greater portion of each log harvested. Overall, in the 17-year-period between 1965 and 1982 industrial wood output per unit of roundwood input increased by 12 percent (Howard 2007).

Finger-jointing allows the use of end-trimmings or other short sections of wood to produce reconstituted lumber, a relatively high value product; the technique results in bonds that as strong as the wood itself. Similarly, edge-gluing of narrow strips of edge trim from lumber production can be used to create furniture panels or blanks for a wide range of applications. Edge and end trimmings would otherwise be chipped or shredded for use in making paper, fiberboard, particleboard, or bioenergy.

Finger-jointing

Edge gluing

Despite productivity gains and a focus on lumber yield improvement, gains came slowly. Based on SIP program data, Koch (1985) reported the yield of rough green softwood lumber at 53%, and of dry planed softwood lumber at 41% as national averages – a gain of about 14 percent from the late 1930s. The productivity gain is a bit more impressive when viewed in the context of lower average log diameter.

But development and adoption of technology continued to accelerate. By the early 1990s a new type of composite lumber, parallel strand lumber (PSL) had been developed in Canada and was being sold commercially. Oriented strand lumber (OSL), a related product, was also on the commercial market. Moreover, the earlier developed forms of composite lumber – LVL and wood I-beams had by this point achieved wide acceptance in homebuilding applications such as garage door headers and beams, and in commercial/industrial applications as a substitute for steel.

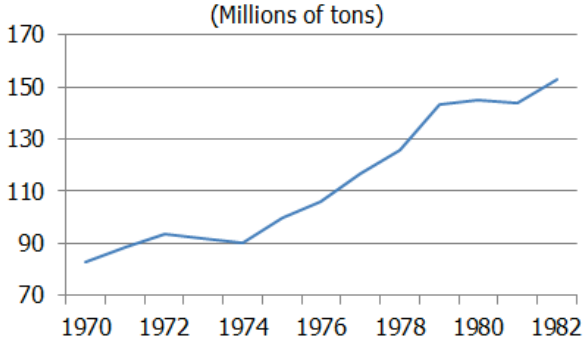
In the solid-sawn lumber arena, the Best Opening Face (BOF) technology, which had been developed in 1971, was by the early 1990s used in conjunction with automated scanners and computer-interfaced production equipment in half of U.S. softwood sawmills, accounting for at least 75 percent of production. Moreover, the use of fingerjointing to produce softwood studs from small pieces of wood that had been previously wasted or burned for power was common practice (see sidebar).

Wood as a Source of Power for the Wood Products Industry

As noted previously, energy was recovered from only a quarter of available wood wastes by generating mills in 1970. At that point, many U.S. sawmills used low-cost fossil fuel rather than wood to meet their energy needs, and most operated teepee-shaped burners in which non-marketable and energy-containing wood residues were incinerated. A number of mills also landfilled unmarketable wastes. This began to change with passage of the National Environmental Policy Act of 1969, which created air quality standards too stringent for continued open-air incineration of waste wood (Zerbe 1988). Environmental legislation also discouraged disposal in landfills, and the combined effect of these legislative initiatives was to increase interest in industrial use of wood wastes and their potential conversion to energy. But it was the energy embargo of 1973, and accompanying supply disruption and oil price increases, that most stimulated a boom in wood energy research and use (Zerbe 1988, Hazel and Bardon 2008). Many sawmills responded by installing heat recovery boilers and cogeneration equipment using what had previously been wastes as fuel. Other segments of the industry made similar moves. Changes were rapid, and dramatic (Figure 1); the use of wood for energy production increased by almost 70 percent in just 8 years (1974 to 1982), with over two-thirds of that increase attributable to the forest products industry. By 1981 the percentage of all sawmill residues landfilled or otherwise disposed of had dropped to 17 percent (from 38 percent in 1970) (Meil et al. 2007), and wood fuel provided about 73 percent of the solid wood industry's energy needs (OTA 1983).

Momentum created by the early '70s oil embargo was reinforced by a second oil supply disruption in 1979. As a result, actions to increase forest industry self-sufficiency continued even as the nation as a whole appeared to become more complacent about energy sources. Zerbe and Skog (2008) reported that all forms of wood residue – sawdust, slabs, edgings, chips, bark, and veneer clippings – were commonly used for energy generation in 2003. This is consistent with the observation of Murray et al. that mills that might have previously sold or given away excess were by 2002 firing all the bark in their boilers; from all sources, The lumber and wood products industry generated around 200 trillion Btu from biomass in 2002 (Murray et al. 2006).

Figure 1
Growth in Wood Use for Energy Consumption in the United States
(Millions of tons)



Source: Zerbe (1988)

In addition to shifting more to wood as a source of energy, the industry also took steps to improve energy efficiency. Energy consumption per unit of output to harvest, transport and manufacture lumber and plywood decreased by 5 and 17%, respectively, between 1970 and 2000 (Meil et al. 2007). The net effect of increased energy generation and energy efficiency was increased energy self-sufficiency on the part of wood products manufacturers. By 2005 the portion of manufacturing process energy derived from residual wood was estimated at 76% for lumber, 90% for plywood and 81% for OSB (Meil et al. 2007).

Industrial Wood Productivity Approaches 100 Percent

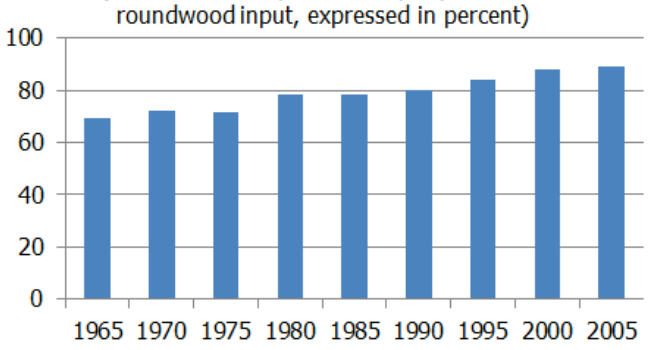
2005

By 2005, the effects of technology development and yield improvement efforts had become more evident. Studies of lumber and total product yield in sawmills of the Pacific Northwest (PNW) and Southeast (SE) regions of the United States found planed dry lumber yields of 55.2 and 48.5% for the PNW and SE, respectively (Johnson et al. 2005). The total marketable product yield in the PNW was 91.1% when expressed as a percentage of debarked log volume, and 83.0% as a percentage of the mass of undebarked logs. Products included pulp chips (26.1% and 28.6% of log mass) and sawdust (6.6 and 7.3%). Another study found a 28% increase in lumber yield in Oregon sawmills in the period 1968-2005 (Gale et al. 2011).

In contrast, the total marketable product yield in the SE region was 95.1% when expressed as a percentage of debarked log volume, and 82.8% as a percentage of the mass of undebarked logs. Products included pulp chips (31.5% and 36.2% of log mass), planer shavings (7.4 and 8.5%) and sawdust (1.7 and 1.9%).

The total utilization percentages determined by Johnson et. al. correspond closely to the U.S. national average industrial wood productivity figure reported by Howard (2007) (Figure 2). This shows that for every 1.0 ton of roundwood input, the output of useful products is 0.892 tons. A nearly identical output number (0.9 tons per 1.0 tons of roundwood input) is reported by the Forest Products Association of Canada. For the U.S. industry as a whole, industrial wood productivity was 29% higher in 2005 than in 1965, and 14% higher than in 1985. Additional data regarding forest products input and outputs by mill category is included at the end of this Appendix.

Figure 2
U.S. Industrial Wood Productivity, 1965 – 2005
(Industrial wood product output per unit of roundwood input, expressed in percent)



Source: Howard, J. 2007. USDA-Forest Service, Research Paper FPL-RP-637, Table 10.

2012

Industrial wood productivity in 2012 is undoubtedly higher than in 2005, if for no other reason than that the utilization of biomass energy has expanded rapidly in North America over the past 5-7 years. An example of this expansion is provided by fuel pellets, produced by an industry that increased its exports of wood pellets by almost 300% in a period of just four years (2008-2011) (Ekstrom 2012).

The current situation is summarized in a recent update to what is commonly known as the "Billion Ton Report" (U.S. Department of Energy 2011). Primary processing mills (sawmills, plywood mills, and paper mills) are reported to have produced about 87 million dry tons of residues in the form of bark, sawmill slabs and edgings, sawdust, and peeler log cores in 2002, with very little of this resource going unused at that point in time. Residue use has only increased since then. The report indicates that only 1.5% of primary mill residue is currently

unused. An extensive study of unused material in Oregon, the nation's largest lumber producing state, suggests that the unused fraction may be even less than that. A 2008 examination of production and disposition of wood residues from Oregon sawmills and plywood/veneer plants (Gale et al.) found that only 0.14% of residues went unutilized, with almost all of that in the form of bark. The tables below provide detailed input and output data for a full range of mill categories and regions of the U.S. A similar study of the residue situation in Canada (Lama 2011) found much the same thing: that generation of wood residues barely meets current regional demand, and that what residues do still remain at mill locations is primarily bark.

Unused residues at secondary manufacturing facilities in the U.S. were reported in the Billion-Ton update as about 6 million dry tons annually; this estimate, however, is based on a 1999 study conducted well before the marked increase in wood energy markets. Current availability of residue from secondary mills is likely similar to that from primary mills – near zero.

The Bottom Line

The portion of harvested wood volume entering primary processing mills in North America that is converted to marketable products, or converted to useful energy, is near 100%. In other words, the wood waste at these mills is near 0%; therefore, in terms of wood use, these are zero-waste facilities. Secondary processing plants are similarly diligent in utilization of raw materials. Mill residues, that for much of the past century represented both an environmental problem and unrealized economic opportunity, are today being fully utilized and provide important benefits.

The industry is now turning its attention to possibilities for re-use and recovery for recycling of a greater portion of wood at the end of use. The paper side of the industry mounted a similar effort in the early 1970s, at a time when recovery of waste paper for recycling stood at 23 percent. By 2011, the percent of paper recovered was 66.8 percent, a near tripling of the proportion of paper recovered in a period of just 40 years. Given the record of success in eliminating wastes in wood products manufacturing processes, tracking progress in the recovery/recycling arena for lumber and other wood products should provide for interesting reading in the decades ahead.

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Forest Products Input/Output Data by Mill Category

Lumber

Softwood Lumber – Pacific Northwest						
In 2000 3.05 m^3 (107.713 ft^3) of logs (PNW) produced:						
Product	kg	% of mass (incl. bark)	% of mass (not incl. bark)	Sold	Used as Fuel	Discarded
Planed dry lumber	774.0	50.3	55.2	774.0		
Rough green lumber	0.0	0	0			
Pulp chips	401.0	26.1	28.6	401.0		
Sawdust (sold)	102.1	6.6	7.3	102.1		
Sawdust (to boiler)	8.2	0.5	0.6		8.2	
Planer shavings	59.2	3.8	4.2	59.2		
Dry sawdust	11.4	0.7	0.8	11.4		
Dry chips	46.5	3.0	3.3	46.5		
Subtotal	1402.4	91.1	100.0	1394.2	8.2	0.0
Bark (sold)	0.0	0				
Bark (to boiler)	116.6	7.6			116.6	
Hog fuel to boiler	19.1	1.2			19.1	
Total	1538.1	100.0		1394.2	143.9	0.0
Summary	Salable products as a % of raw material input (mass basis): 90.6% w bark; 99.4% w/o bark Combusted to generate energy: 9.4% w bark; 0.6% w/o bark Waste incinerated or landfilled: 0					

Source: Milota, M., West, C., and Hartley, I. 2005. Gate-to-Gate Life Cycle Inventory of Softwood Lumber Production. Wood & Fiber Science, 37 (CORRIM Special Edition), pp. 47-57.

Softwood Lumber - Southeast						
In 2000 3.92 m^3 (138.43 ft^3) of logs (SE) produced:						
Product	kg	% of mass (incl. bark)	% of mass (not incl. bark)	Sold	Used as Fuel	Discarded
Planed dry lumber	883.0	42.2	48.5	883.0		
Rough green lumber	1.6	0.1	0.1	1.6		
Pulp chips	659.0	31.5	36.2	659.0		
Sawdust (sold)	34.6	1.7	1.9	34.6		
Sawdust (to boiler)	88.6	4.2	4.9		88.6	
Planer shavings	155.5	7.4	8.5	155.5		
Dry sawdust	0.0	0.0	0.0			
Dry chips	0.0	0.0	0.0			
Subtotal	1822.3	87.0	100.1	1733.7	88.6	
Bark (sold)	82.7	4.0		82.7		
Bark (to boiler)	188.2	9.0			188.2	
Hog fuel to boiler	0.0	0.0				
Total	2093.2	100.0		1816.4	276.8	0.0
Summary	Salable products as a % of raw material input (mass basis): 86.8% w bark; 95.1% w/o bark Combusted to generate energy: 13.2% w bark; 4.9% w/o bark Waste incinerated or landfilled: 0					

Source: Milota, M., West, C., and Hartley, I. 2005. Gate-to-Gate Life Cycle Inventory of Softwood Lumber Production. Wood & Fiber Science, 37 (CORRIM Special Edition), pp. 47-57.

Softwood Lumber – Inland Northwest						
In 2006/2007 836 kg of logs (Inland NW) produced:						
Product	kg	% of mass (incl. bark)	% of mass (not incl. bark)	Sold	Used as Fuel	Discarded
Planed dry lumber	436	52.2	56.0	436		
Pulp chips, green (sold)	216	25.8	27.8	216		
Pulp chips, dry (sold)	4	0.5	0.5	4		
Sawdust, green (sold)	52	6.2	6.7	52		
Planer shavings, dry (sold)	37	4.4	4.8	37		
Wood fiber, green (sold)	3	0.4	0.4	3		
Wood fuel	30	3.6	3.9		30	
Subtotal	778	93.1	100.1	748	30	
Bark (sold)	29	3.5		29		
Bark (to boiler)	29	3.5			29	
Total	836	100.1		777	59	0
Summary	Salable products as a % of raw material input (mass basis): 92.9% w bark; 96.1% w/o bark Combusted to generate energy: 7.1% w bark; 3.9% w/o bark Waste incinerated or landfilled: 0					

Source: Puettmann, M., Wagner, F., and Johnson, L. 2010. Life cycle inventory of softwood lumber from the Inland Northwest U.S. Wood & Fiber Science, 42 (CORRIM Special Edition), pp. 52-66.

Softwood Lumber – Northeast and North Central						
In 2006/2007 931 kg of logs (Inland NW) produced:						
Product	kg	% of mass (incl. bark)	% of mass (not incl. bark)	Sold	Used as Fuel	Discarded
Planed dry lumber	392	37.1	42.1	392		
Pulp chips, green	348	32.9	37.4	348		
Hog fuel, green	3	0.2	0.3		3	
Sawdust, green	84	7.9	9.0	42	42	
Planer shavings, dry	94	8.9	10.1	81	13	
Mixings, dry	10	0.9	1.1		10	
Subtotal	931	87.9	100.0	863	68	
Bark	127	12.0		127		
Total	1058	99.9		990	68	0
Summary	Salable products as a % of raw material input (mass basis): 93.6% w bark; 92.7% w/o bark Combusted to generate energy: 6.4% w bark; 7.3% w/o bark Waste incinerated or landfilled: 0					

Source: Bergmann, R. and Bowe, S. 2010. Environmental Impact of Manufacturing Softwood Lumber in Northeastern and North Central United States. Wood & Fiber Science, 42 (CORRIM Special Edition), pp. 67-78.

Hardwood Lumber – Northeastern U.S.						
In 2005 1170 kg of green logs (1170 is dry weight), and 131kg of bark yielded:						
	kg	% of mass (incl. bark)	% of mass (not incl. bark)	Sold	Used as Fuel	Discarded
Input						
Logs	1,170					
Bark	131					
Total	1,301					
Product						
Green chips	227	17.3	19.4	197.0	30.3	
Green sawdust	189	14.4	16.2	49.0	140.0	
Green bark	139	10.6		138.5	0.5	
Green hog fuel	45	3.4	3.8	26.6	18.4	
Planed dry lumber	535	40.8	45.6	535.0		
Dry shavings	86	6.6	7.4	86.0		
Dry sawdust	46	3.5	3.9	18.6	27.4	
Dry mixings	44	3.4	3.8	44.0		
Total	1,311	100.0	100.1	1,094.7	216.6	0.0
Summary	Salable products as a % of raw material input (mass basis): 84.1% w bark; 81.7% w/o bark Combusted to generate energy: 16.5% w bark; 18.5% w/o bark Waste incinerated or landfilled: 0					

Source: Bergman, R. and Bowe, S. 2008. Environmental Impact of Producing Hardwood Lumber Using Life-Cycle Inventory. Wood & Fiber Science 40(3): 448-458.

Composite Lumber

Laminated Veneer Lumber – Pacific Northwest (2000)						
Inputs	Kg/10^{3}m^3	#/10^3 ft^3				
Dry Veneer	111,000	6,950				
PLV (wood only)	392,000	24,500				
Total	503,000	31,450				
Outputs			%	Sold	Used as Fuel	Discarded
LVL (wood only)	521,000	32,500	95.6	521,000		
Veneer waste	7,540	471	1.4	7,540		
Layup scrap	6,020	376	1.1	6,020		
Tested LVL	1,360	85	0.2	1,360		
Panel trim	673	42	0.1	673		
Sawdust	8,230	514	1.5	8,230		
Total	544,823	33,988	100.0	544,823	0	0
Summary	Salable products as a % of raw material input (mass basis): 100% Combusted to generate energy: 0% onsite, 4.4% offsite Waste incinerated or landfilled: 0					

Source: Wilson, J. and Dancer, E. 2005. Gate-to-Gate Life Science Inventory of Laminated Veneer Lumber Production. Wood & Fiber Science, 37 (CORRIM Special Edition), pp. 114-127.

Laminated Veneer Lumber – Southeast (2000)						
Inputs	Kg/10^{3}m^3	#/10^3 ft^3				
Dry Veneer	614,000	38,400				
PLV (wood only)	0	0				
Total	614,000	38,400				
Outputs			%	Sold	Used as Fuel	Discarded
LVL (wood only)	593,000	37,000	91.3	593,000		
Veneer waste	10,900	683	1.7	10,900		
Layup scrap	22,500	1,401	3.5	22,500		
Tested LVL	1,740	109	0.3	1,740		
Panel trim	16,600	1,040	2.6	16,600		
Sawdust	4,520	282	0.7	4,520		
Total	649,000	40,515	100.0	649,000	0	0
Summary	Salable products as a % of raw material input (mass basis): 100% Combusted to generate energy: 0% onsite, 8.6% offsite Waste incinerated or landfilled: 0					

Source: Wilson, J. and Dancer, E. 2005. Gate-to-Gate Life Science Inventory of Laminated Veneer Lumber Production. Wood & Fiber Science, 37 (CORRIM Special Edition), pp. 114-127.

I-Joists – Pacific Northwest (2000)						
Inputs	$Kg/10^3m^3$	$\#/10^3\ ft^3$				
LVL	1,680	1,130				
OSB	1,640	1,100				
Resins	18	12				
Total	3,338	2,242				
Outputs			%	Sold	Used as Fuel	Discarded
Composite I-Joists	3,010	2,020	89.8	3,010		
Sawdust	342	230	10.2	342		
Total	3,352	2,250	100.0	3,352	0	0
Summary	Salable products as a % of raw material input (mass basis): 100% Combusted to generate energy: 0% Waste incinerated or landfilled: 0					

Source: Wilson, J. and Dancer, E. 2005. Gate-to-Gate Life Science Inventory of I-Joist Production. Wood & Fiber Science, 37 (CORRIM Special Edition), pp. 85-98.

I-Joists – Southeast (2000)						
Inputs	$Kg/10^3m^3$	$\#/10^3\ ft^3$				
LVL	2,400	1,610				
OSB	1,770	1,190				
Resins	12	8				
Total	4,182	2,808				
Outputs			%	Sold	Used as Fuel	Discarded
Composite I-Joists	3,870	2,600	93.0	3,870		
Sawdust	292	196	7.0	292		
Total	4,162	2,796	100.0	4,162	0	0
Summary	Salable products as a % of raw material input (mass basis): 100% Combusted to generate energy: 0% Waste incinerated or landfilled: 0					

Source: Wilson, J. and Dancer, E. 2005. Gate-to-Gate Life Science Inventory of I-Joist Production. Wood & Fiber Science, 37 (CORRIM Special Edition), pp. 85-98.

Glued-Laminated Timbers

Glulam – Pacific Northwest (2000)						
Inputs	Kg/10^3m^3	#/10^3 ft^3				
Lumber	537	33,498				
Unaccounted for wood	55	3,434				
Total	592	36,922				
Outputs			%	Sold	Used as Fuel	Discarded
Glulam beams (wood only)	483	30,162	82	483		
Shavings/trimmings	89	5,535	15	89		
Wood waste	20	1,233	3			20
Total	592	36,929	100	572	0	20
Summary	Salable products as a % of raw material input (mass basis): 96.6% Combusted to generate energy: 0% Waste incinerated or landfilled: 3.2%					

Source: Puettmann, M. and Wilson, J. 2005. Gate-to-Gate Life-Cycle Inventory of Glued-Laminated Timber Production. Wood & Fiber Science 37 (CORRIM Special Issue), pp. 99-113.

Glulam – Southeast (2000)						
Inputs	Kg/10^3m^3	#/10^3 ft^3				
Lumber	670	41,800				
Unaccounted for wood	6	362				
Total	676	42,162				
Outputs			%	Sold	Used as Fuel	Discarded
Glulam beams (wood only)	551	34,400	82	551		
Shavings/trimmings	119	7,140	17	119		
Wood waste	6	381	1			6
Total	676	42,191	100	670	0	6
Summary	Salable products as a % of raw material input (mass basis): 99.1% Combusted to generate energy: 0% Waste incinerated or landfilled: 0.9%					

Source: Puettmann, M. and Wilson, J. 2005. Gate-to-Gate Life-Cycle Inventory of Glued-Laminated Timber Production. Wood & Fiber Science 37 (CORRIM Special Issue), pp. 99-113.

Structural Panels

Softwood Plywood – Pacific Northwest (2000)						
Inputs	$Kg/10^3m^3$	$\#/10^3\ ft^3$				
Logs w/o bark	917.0	1,788				
Purchased dry veneer	3.1	6				
Purchased green veneer	7.2	14				
Total	927.3	1,809				
Outputs			%	Sold	Used as Fuel	Discarded
Plywood (wood only)	470	916	50.7	470		
Wood chips	218	425	23.5	218		
Peeler core	49	95	5.3	49		
Green clippings	16	31	1.7		16	
Veneer downfall	1.7	3.4	0.2		1.7	
Panel trim	55	107	5.9		55	
Sawdust	4.9	9.6	0.5		4.9	
Wood waste to boiler	0.13	0.25	0.0		0.13	
Sold wood waste	11	21	1.1	11		
Sold dry veneer	32	63	3.5			
Unaccounted for wood	70	137	7.6	32	48	22
Total	927	1,809	100.0	780	125.7	22
Summary	Salable products as a % of raw material input (mass basis): 84.1% w/o bark Combusted to generate energy: 13.6% Waste incinerated or landfilled: 2.3%					

Source: Wilson, J. and Sakimoto, E. 2005. Gate-to-Gate Life-Cycle Inventory of Softwood Plywood Production. Wood & Fiber Science 37 (CORRIM Special Issue), pp. 58-73.

Softwood Plywood – Southeast (2000)						
Inputs	$Kg/10^3m^3$	$\#/10^3\ ft^3$				
Logs w/o bark	1,066	2,080				
Purchased dry veneer	4.2	8.1				
Purchased green veneer	5.3	10.4				
Total	1,075	2,098				
Outputs			%	Sold	Used as Fuel	Discarded
Plywood (wood only)	541	1,055	50.3	541		
Wood chips	331	645	30.8	331		
Peeler core	57	112	5.3	57		
Green clippings	89	173	8.3		89	
Veneer downfall	0	0	0		0	
Panel trim	31	61	2.9		31	
Sawdust	2.2	4.2	0.2		2.2	
Wood waste to boiler	16	30	1.5		16	
Sold wood waste	11	21	1.0	11		
Sold dry veneer	0	0	0	0		
Unaccounted for wood	-1.4	-2.6	100.3	-1.4		
Total	1,075	2,098	100.3	940	138.2	0
Summary	Salable products as a % of raw material input (mass basis): 87.4% Combusted to generate energy: 12.6% Waste incinerated or landfilled: 0					

Source: Wilson, J. and Sakimoto, E. 2005. Gate-to-Gate Life-Cycle Inventory of Softwood Plywood Production. Wood & Fiber Science 37 (CORRIM Special Issue), pp. 58-73.

Oriented Strandboard (OSB) (2000)						
Roundwood input per 1,000 ft^3 3/8" basis: 1.4 m^3; 49.5 ft^3						
Inputs	Kg	lb.				
Wood	710.3	1,566				
Bark	61.2	135				
Total	771.6	1,701				
Outputs			%	Sold	Used as Fuel	Discarded
OSB	545.7	1,266	70.7	545.7		
Bark mulch	20.3	44.7	2.6	20.3		
Fines	8.3	18.2	1.1	8.3		
Dust/scrap	4.3	9.53	0.6	4.3		
Wood waste	0.05	0.11	0.0			0.05
Wood ash	1.91	4.22	0.2			1.91
Wood fuel	176.4	389	22.9		176.4	
Unaccounted for wood	14.6	32	1.9			
Total	771.6	1701	100.0	578.6	176.4	1.96
Summary	Salable products as a % of raw material input (mass basis): 75.0% Combusted to generate energy: 22.9% Waste incinerated or landfilled: 2.2%					

Source: Kline, D.E. 2005. Gate-to-Gate Life-Cycle Inventory of Oriented Strandboard Production. Wood & Fiber Science 37 (CORRIM Special Issue), pp. 74-84.

Non-Structural Panels

Particleboard (2004)					
Inputs	Kg				
Green hog chips	60				
Dry hog chips	49				
Green shavings	32				
Dry shavings	405				
Green sawdust	92				
Plywood trim	30				
OSB fines	3.1				
Subtotal	672				
UF Resin	68				
Wax	2.5				
Ammonium sulfate catal.	0.72				
Urea scavenger	2.9				
Total	746				
Outputs		%	Sold	Used as Fuel	Discarded
Particleboard (before sanding)	746				
Particleboard (after sanding)			713		
Wood boiler fuel (sold)	5.2		5.2		
Wood boiler fuel	27.1			27.1	
Wood waste	0.4				0.4
Boiler fly ash	0.1				0.1
Total			718.2	27.1	0.5
Summary	Salable products as a % of raw material input (mass basis): 96.3% Combusted to generate energy: 3.6% Waste incinerated or landfilled: 0.1%				

Source: Wilson, J. 2010. Life-Cycle Inventory of Particleboard in Terms of Resources, Emissions, Energy, and Carbon. Wood & Fiber Science 42 (CORRIM Special Issue), pp. 90-106.

Particleboard recycled content in accordance with provisions of:
LEED – 45%
ANSI/ASHRAE/USGBC/IES 189.1 – 45%
IGCC – 90% (Qualifies as recycled material (≥ 50% recycled content))
CALGREEN – 45%
National Green Building Standard (ICC 700) – 45%

Medium Density Fiberboard (2004)					
Inputs	Kg				
Green chips	427				
Green shavings	62				
Dry shavings	125				
Green sawdust	151				
Plywood trim	28				
Subtotal	793				
Urea formaldehyde resin	83				
Wax	5				
Urea scavenger	1				
Total	882				
Outputs		%	Sold	Used as Fuel	Discarded
MDF	741	84.0	741		
Bark mulch (sold)	12.9	1.5	12.9		
Wood boiler fuel (sold)	0.06	0.0	0.06		
Sander dust (fuel)	70	7.9		70	
Woodwaste (fuel)	54	6.1		54	
Woodwaste to landfill	2.21	0.3			2.21
Boiler fly ash to landfill	1.94	0.2			1.94
Total	882	100.0	754	124	4.15
Summary	Salable products as a % of raw material input (mass basis): 85.5% Combusted to generate energy: 14.0% Waste incinerated or landfilled: 0.5%				

Source: Wilson, J. 2010. Life-Cycle Inventory of Medium Density Fiberboard in Terms of Resources, Emissions, Energy, and Carbon. Wood & Fiber Science 42 (CORRIM Special Issue), pp. 107-124.

MDF recycled content in accordance with provisions of:
LEED – 44.5%
ANSI/ASHRAE/USGBC/IES 189.1 – 44.5%
IGCC – 89.1% (Qualifies as recycled material (≥ 50% recycled content))
CALGREEN – 44.5%
National Green Building Standard (ICC 700) – 44.5%

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Appendix C: Solid Wood Waste Generation and Recovery in the United States – MSW and C&D

Introduction

The softwood and hardwood forests of the United States provide wood products that are used in many applications including lumber and other building materials; furniture; pallets and other forms of containers and crating; posts and poles; and a wide-range of consumer goods. This wide array of wood products generates industrial wood by-products during the manufacturing process and waste wood when these products are disposed at the end of their useful lives. This waste wood is typically included (by definition) in the categories of Municipal Solid Waste (MSW) and Construction & Demolition (C&D) wood.

In the U.S, current estimates are that 35% (12.1 million tons)[58] of the wood in the MSW stream is recovered for products with an additional 11.1 million tons available for recovery. These recovery rates do not include recovery for use in energy production.[59] For C&D wood in the U.S., 52% (19.1 million tons) is currently recovered, combusted for energy, or not usable, with 48% (17.3 million tons) available for recovery.

Despite the numbers cited above, there is growing interest in a more complete understanding of the amount and types of MSW and C&D wood waste generated in North America. This information is essential to identifying the barriers and opportunities related to expanding and improving wood re-use and recycling. Unfortunately, precise, reliable and current data on MSW and C&D wood is not readily available. The data are dispersed among various governmental agencies and universities, as well as private companies. Much of these data are not transparent and are difficult to find and interpret. This leads to differences (sometimes quite significant) in volume estimates between studies.

This appendix provides an overview on recent research relating to the wood portion of MSW and C&D waste streams in North America. Comparisons are made between different studies and implications arising from differences between these studies are addressed. Lastly, a summary of MSW and C&D wood recovery in the U.S. and recommendations for 'moving forward' are provided.

Different Studies/Different Numbers for MSW

Currently, there are two major national studies (periodically updated) of MSW data in the U.S.—the Environmental Protection Agency (EPA) report (developed by Franklin Associates) and the *BioCycle*/Columbia University Earth Engineering Center report. These reports use different methods of estimating MSW and result in different numbers.

[58] This estimate is based on updated recovery rates as published in Falk and McKeever 2004.
[59] Source: U.S. EPA 2011; includes waste from residential, commercial, and institutional sources.

EPA

The EPA uses a *materials flow methodology*, which relies heavily on a mass balance approach.[60] Simply put, this methodology is based on production data (by weight) for the material and products in the waste stream. Using data gathered from industry associations, key businesses, and similar industry sources, and supported by government data from sources such as the Department of Commerce and the U.S. Census Bureau, the EPA estimates tons of materials and products generated, recycled, or discarded.[61] Other sources of data, such as waste characterizations and surveys performed by governments, industry, or the press, supplement these data.

To estimate MSW generation, EPA adjusts production data by imports and exports from the U.S., where necessary. Also, allowances are made for the average life spans of different products. MSW not managed by recycling (including composting) or combustion is assumed to be landfilled.[62]

In 2010, the EPA estimated that Americans generated about 250 million tons of trash.[63] Of this amount, nearly 85 million tons (34%) were recycled and composted, with more than 29 million tons (12%) combusted with energy recovery. Discards to landfills and other disposals totaled nearly 136 million tons (54%). (A breakdown of wood in the EPA estimated MSW waste stream is detailed later in this report.)

Table 1. EPA Estimates of United States MSW Generation, Recycling/Composting, Combustion with Energy Recovery and Discards, 2010.

Year	MSW Generation *(million tons)*	Recycled/ Composted *(million tons)*	Combusted with Energy Recovery *(million tons)*	Landfill (Discards) *(million tons)*
2010	249.9	85.0	29.3	136.0

BioCycle/Columbia University

BioCycle/Columbia University also use a materials flow methodology for estimating MSW in the U.S. but a different strategy or approach than EPA (Kaufman and Themelis 2009). Because most states have regulations requiring landfills and waste-to-energy (WTE) facilities to report tons received, *BioCycle* attempts to obtain disposal reports from the relevant regulatory authorities in each of the 50 states, with quantities expressed in short tons. Although recycling tons are typically not regulated, the same agencies tend to track these figures as well, although these numbers are less reliable than those provided for landfilled and WTE tonnages. Consequently, *BioCycle* surveys (using a detailed questionnaire) representatives of waste management departments of each state.

[60] EPA MSW Characterization Methodology. See http://www.epa.gov/osw/nonhaz/municipal/pubs/06numbers.pdf.
[61] As done in previous EPA studies, combustion with energy recovery (wood and rubber tires are examples) is tallied as a separate category and not considered as reuse or recycling.
[62] MSW, as defined by the EPA, does not include C&D debris, which is handled separately.
[63] Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2010. See http://www.epa.gov/epawaste/nonhaz/municipal/pubs/msw_2010_rev_factsheet.pdf.

In order to allow for an "apples to apples" comparison, *BioCyle*/Columbia University researchers adjust reported state values to align with the EPA definition of MSW. A follow-up is then made with state officials to clarify misunderstandings and fill in missing data where possible. This iterative process attempts to characterize landfilled and WTE tons fairly accurately; however, questions still remain regarding the accuracy of the tonnage of material recycled.

The most recent *BioCycle* survey (calendar year 2008) resulted in an estimate 56 percent greater than the EPA estimate for the same year for total tons of MSW generated (see Table below).

Table 2. Comparison of U.S. EPA and BioCycle/Columbia University MSW Generation and Management Data (calendar year 2008) (from van Haaren et al. 2010).

MSW Data	EPA/Franklin *(million tons)*	*BioCycle*/Columbia Univ. *(million tons)*
Total Generated	249.6	389.5
Total Recovery (recycling, composting, mulch)	82.9	93.8
Combustion with Energy Recovery	31.6	25.9
Discards to Landfills	135.1	269.8

Implications

By nature of their methodology, the U.S. EPA has a good working relationship with industry, and provides a reasonable picture of MSW *composition*. The *BioCycle*/Columbia University research demonstrates good relations with a strong network of state waste managers who have direct access to MSW generation and disposal data (Kaufman and Themelis, undated). The *BioCycle* group also notes that they have been able to collect data directly from Material Recovery Facilities (MRFs) and compost facilities that are sometimes unwilling to share with government agencies due to privacy and competition concerns.

Other writers (Humes 2012), and the EPA itself, acknowledge that the EPA underestimates the total amount of trash – MSW – that is generated annually. One implication is that EPA numbers make it difficult to use the agency's tonnage estimates to plan for actual MSW management in practice. A second implication is that a combined effort (building on the strengths of each party) between EPA and *BioCycle* would go a long way to reliably measuring MSW, and ultimately improving waste management practices in the U.S.

A third implication, and one that gets to the heart of this report and efforts to improve material recovery, is that underestimation of MSW, or uncertainty in the data, likely underestimates the amount of wood, or other specific materials, in the MSW stream.

Wood in the MSW Stream

The following table (Table 3) highlights the EPA estimate of MSW in 2010. The estimated amount of "wood" in the MSW stream is 15.88 million tons with a total of 2.3 million tons recovered, for a recovery percent of 14.5. Yard trimmings, which include an unknown amount of green (wet) wood, are included in the table in a separate category. Also, the recovery amount does not include combustion for energy, as noted above.

Table 3. EPA Estimates of U.S. Generation and Recovery of Materials in MSW, 2010 (in millions of tons and percent of generation of each material).*

Material	Weight Generated *(million tons)*	Weight Recovered *(million tons)*	Recovery as Percent of Generation *(%)*
Paper and paperboard	71.31	44.57	62.5%
Glass	11.53	3.13	27.1%
Plastics	31.04	2.36	7.6%
Rubber and leather	7.78	1.17	15.0%
Textiles	13.12	1.97	15.0%
Wood	15.88	2.30	14.5%
Other materials	4.79	1.41	29.4%
Metals			
Steel	16.90	5.71	33.8%
Aluminum	3.41	0.68	19.9%
Other nonferrous metals**	2.10	1.48	70.5%
Total metals	**22.41**	**7.87**	**35.1%**
Total materials in products	**177.86**	**64.78**	**36.4%**
Other wastes			
Food, other***	34.76	0.97	2.8%
Yard trimmings	33.40	19.20	57.5%
Miscellaneous inorganic wastes	3.84	Negligible	Negligible
Total other wastes	**72.00**	**20.17**	**28.0%**
Total municipal solid waste	**249.86**	**84.95**	**34.0%**

*Source: U.S. EPA 2011; includes waste from residential, commercial, and institutional sources.
** Includes lead from lead-acid batteries.
***Includes recovery of other MSW organics for composting.

A closer look at the "wood" component of the EPA estimate (15.88 million tons) is illustrated in Table 4 below.

Table 4. EPA Estimate of Generation and Recovery of Wood in U.S. MSW, 2010 (in millions of tons and percent of generation of each product).

Product	Weight Generated *(million tons)*	Weight Recovered *(million tons)*	Recovery as Percent of Generation *(%)*
Wood (Durable Goods, ex. furniture)	5.89	Negligible	Negligible
Wood (Containers and Packaging, ex. pallets)	9.94	2.30	23.1%
Wood – Total*	15.88	2.30	14.5%

*Total for wood does NOT include combustion.
Table 4 adapted from U.S. EPA 2011, p. 7.
Negligible = less than 5,000 tons or 0.05 percent.

Based on Table 4, wood-based durable goods (like furniture) entering the MSW stream have a near zero (negligible) recovery rate. Wood pallets are recovered at a rate of just over 23 percent, excluding combustion for energy.

Unfortunately, EPA data is not collected in a fashion to allow for the break-down of specific product categories relating to combustion with energy recovery. Table 5, however, provides EPA data on *all* combustion with energy recovery (which includes pallets) for the MSW stream over a 50-year period.

Table 5. EPA Estimates of Generation, Materials Recovery, and Combustion to Energy of MSW – 1960 to 2010 (in millions of tons)*

Activity	1960	1970	1980	1990	2000	2010
Generation *(million tons)*	88.1	121.1	151.6	208.3	242.5	249.9
Total Materials Recovery *(million tons)*	5.6	8.0	14.5	33.2	69.5	85.0
*Combustion with Energy Recovery (includes pallets)*** *((million tons)*	*0.0*	*0.4*	*2.7*	*29.7*	*33.7*	*29.3*

*Table 5 adapted from U.S. EPA 2011, p. 8.
**Includes combustion of MSW in mass burn or refuse-derived-fuel form, and combustion with energy recovery of source separated materials in MSW (e.g., wood pallets, tire-derived fuel)

U.S. Forest Service Estimates

The Forest Products Laboratory, a research unit of the U.S. Forest Service, provides estimates of wood waste including both MSW and C&D material. The Forest Service estimates are "anchored" on EPA estimates and a NEOS Corporation report (Whittier et al. 1995) on the woody component of yard trimmings.

Table 6 shows the distribution of 2010 MSW in various categories. The values for MSW recovered, combusted and not usable are derived from Falk and McKeever 2004. Values for MSW generated and available for recovery are from Falk, McKeever, and Sawka 2012.[64]

Table 6. Forest Service Estimate of MSW Wood Generated, Recovered, Combusted, Not Usable, and Available for Recovery in the United States, 2010. (million metric tonnes/million short tons)*

	Generated (tonnes/tons)	Recovered (tonnes/tons)	Combusted (tonnes/tons)	Not Usable (tonnes/tons)	Available for Recovery (tonnes/tons)
Source					
Wood Component	14.4 tonnes / 15.8 tons	1.3 / 1.4	3.2 / 3.5	3.2 / 3.5	6.6 / 7.3
Woody Yard Trimmings**	16.7 / 18.4	9.6 / 10.6	1.7 / 1.9	1.8 / 2.0	3.6 / 4.0
Total MSW Wood	31.1 / 34.2	11.0 / 12.1	5.0 / 5.5	5.0 / 5.5	10.1 / 11.1

* Values may not total correctly due to rounding.

**Woody yard trimmings are about 55% wood and 45% herbaceous material (Falk et al. 2012)

The Forest Service estimate of total MSW wood generated includes *both* the wood component (using EPA data) and an estimate of woody yard trimmings (not included in the EPA estimate). ***Consequently, the Forest Service estimate of 34.2 million tons (31.1 million metric tons) is approximately double the EPA estimate of 15.8 million tons (over 14.4 million metric tonnes) of MSW wood***. Also, based on the values in the above table, 35% (12.1 million tons) of the wood in the MSW stream is recovered and 16% (5.5 million tons) is combusted for energy with an additional 32% (11.1 million tons) available for recovery.

MSW Recap

The EPA MSW total generation values (tons) are well below the *BioCycle*/Columbia University numbers (the *BioCycle* estimates are 56% higher than EPA values). Both EPA and *BioCycle*/Columbia University do not separate the woody component out of their woody yard trimmings category. Also, neither of these data sources includes combustion as either recovered or recycled wood.

The Forest Service estimate uses EPA data as the source for their "wood component" category of MSW. The wood component includes items such as wooden furniture and cabinets, pallets and containers, scrap lumber and wooden panels, and wood from manufacturing facilities. The Forest

[64] Table 6 values for 2010 woody yard trimmings are presented as a 'green' weight and 'anchored' on 1993 data. Other studies, such as Bratkovich et al. 2011 and Nowak and Crane 2001, present urban tree weights and removals (derived) on a dry basis. Also, if annual urban tree removals average 1.5 percent or greater (based on total volume of the urban forest), then Table 6 likely underestimates the volume (generation) of woody yard trimmings.

Service adds to this EPA estimate an approximation of woody yard trimmings for a grand total of 34.2 million tons. Consequently, the Forest Service estimate (derived) of the percentage of wood in the MSW waste stream is nearly 14% ((15.9 + 18.4)/ 249.9 = 13.7%; see Table 7). The Forest Service also includes an estimate of wood combustion for energy recovery.

Table 7. Comparison of MSW Estimates for Generation, Combustion, and Recovery from U.S. EPA, BioCycle and U.S. Forest Service (in million tons).

	EPA (2010) (million tons)	BioCycle (2008) (million tons)	Forest Service (2010) (million tons)
MSW Generation: Total for ALL Components	249.9	389.5	249.9 (using EPA data)
Wood Component (Generation)	15.88	Unknown	15.88 (using EPA data)
Woody Yard Trimmings (Generation)	Unknown	Unknown	18.4 (from Table 6)
Wood Combustion (for energy)	Unknown	Unknown	5.5 (from Table 6)
Wood Recovered (w/o combustion)	2.3*	Unknown	12.1** (from Table 6)

*Excludes woody yard trimmings.
**Includes woody yard trimmings.

C&D

As noted earlier, C&D debris (including C&D wood) is excluded by the EPA in their definition of MSW. The *BioCycle* report attempts to adopt EPA definitions; therefore, C&D is also excluded from their estimates. Fortunately, the EPA does track C&D debris in a separate effort. The most recent EPA report (2009) is titled "Estimating 2003 Building-Related Construction and Demolition Materials Amounts."

EPA

The EPA estimate of C&D (2003 data) is based on national statistical data (U.S.) and typical waste generation during building construction, renovation, demolition or maintenance activities. Recovery estimates rely on 2003 data reported by state environmental agencies.

Table 8 reflects materials generated from *building* projects that occur as a result of normal daily life, not *debris* resulting from disasters. However, construction materials resulting from *rebuilding* efforts after a disaster are included in the table below.[65]

The EPA estimates the amount of C&D building-related materials for 2003 at 170 million tons, with 39 percent coming from residential and 61 percent from nonresidential sources.

[65] In 2008 the EPA published *Planning for National Disaster Debris*, which discussed tools for forecasting disaster debris generation amounts.

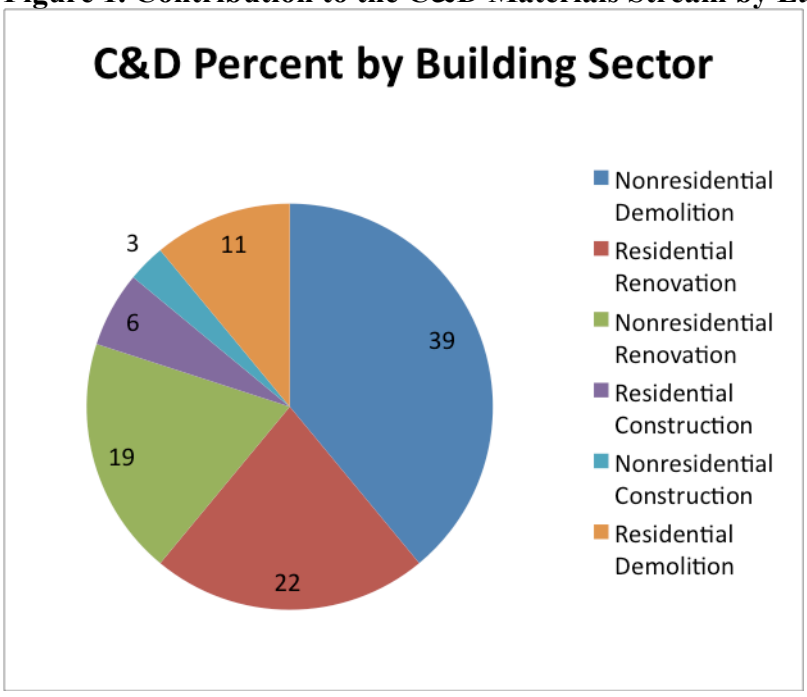
Table 8. EPA Estimated Amount of Building-Related C&D Materials Generated in the U.S. During 2003.*

Source	Residential		Nonresidential		Totals	
	Million Tons	*Percent*	*Million Tons*	*Percent*	*Million Tons*	*Percent*
Construction	10	15%	5	5%	15	9%
Renovation	38	57%	33	32%	71	42%
Demolition	19	28%	65	63%	84	49%
Totals	67	100%	103	100%	170	100%
Percent	39%		61%		100%	

*C&D managed on site should, in theory, be deducted from generation. Quantities managed on-site are unknown.
Note: Data rounded to the appropriate significant digits. Data may not add to totals shown.
(Source: U.S. EPA 2009)

Figure 1 below provides a percentage breakdown of the six building sectors that generate C&D materials. According to the EPA (2009) the largest sector is nonresidential demolition at 39 percent. Residential and nonresidential renovation materials make up 22 percent and 19 percent, respectively, followed by residential demolition at 11 percent. New construction represents 9 percent of total C&D materials (with the new construction divided between residential construction at 6 percent and nonresidential construction at 3 percent).

Figure 1. Contribution to the C&D Materials Stream by Each Building Sector (per EPA)



Source: U.S. EPA 2009.

The EPA (2009) estimates that 48 percent of the 170 million tons of the C&D materials generated in 2003 were recovered, based on state-reported disposal and recovery data. This is a 23 percent increase from the 1996 estimate (although comparisons should be viewed with caution due to different methodologies in 1996 and 2003).

U. S. Forest Service Estimate of Waste Wood in C&D Materials

The U.S. Forest Service (Falk et al. 2012) estimates the generation of construction and demolition waste wood at 6.7 and 29.7 million tons, respectively, for 2010, for a total of 36.4 million tons (33.0 million metric tons) (Table 9). This is based on McKeever (2004), and Falk and McKeever (2004) methodology, and applied to 2010 economic drivers such as housing completions, value of nonresidential construction, and population change. An assumption of the Forest Service estimate is that 28% of the C&D waste stream is wood[66].

Table 9. U.S. Forest Service Estimate of Construction and Demolition Waste Wood Generated, Recovered, Combusted or Not Usable, and Available for Recovery in the U.S., 2010* (million metric tonnes/million short tons)

Source	Generated (tonnes/tons)	Recovered, Combusted, Not usable (tonnes/tons)	Available for Recovery (tonnes/tons)
Construction Waste Wood	6.1 / 6.7	1.7 / 1.9	4.4 / 4.9
Demolition Waste Wood	26.9 / 29.7	15.6 / 17.2	11.3 / 12.5
Total, C&D	33.0 / 36.4	17.3 / 19.1	15.7 / 17.3

*Forest Service estimates based on updated demand drivers and estimated recovery rates.
Source: Falk et al. 2012.

Interestingly (and likely due to the recession), the 2010 construction waste wood estimate (6.1 million metric tons) is down from 2002 (10.5 million metric tons) and the demolition waste wood estimate is up slightly (from 25.2 to 26.9 million metric tons). See Table 10.

Table 10. U.S. Forest Service and EPA Estimates of Construction and Demolition Wood Generated by Various Years and Sources (million metric tonnes/million short tons).

Generation Source	Forest Service, 2002 (tonnes/tons)	Forest Service, 2010 (tonnes/tons)	EPA, 2003 (tonnes/tons)
Construction Waste Wood	10.5 / 11.6	6.1 / 6.7	Unknown
Demolition Waste Wood	25.2 / 27.8	26.9 / 30.0	30.8* / 34.0*
Total, C&D Wood	35.7 / 39.4	33.0 / 36.4	Unknown

*Based on Forest Service assumption from case studies that 40% of demolition materials entering landfills are wood.

Summary of MSW and C&D in the U.S.

MSW

The *BioCycle*/Columbia University estimate of MSW generation in the U.S. was 56 percent greater than the EPA estimate (389.5 million tons vs. 249.6 million tons) (van Haaren et al. 2010). The EPA estimate of wood in the MSW stream is 15.88 million tons with a recovery of 2.3 million tons (Table 4). The *BioCycle*/Columbia University research makes no attempt to separate wood as an individual category of MSW. Also, no specific data on wood combustion for energy is provided by EPA. The U.S. Forest Service estimate uses the EPA wood component for

[66] Falk and McKeever 2012.

MSW (15.88 million tons) plus the wood portion of yard trimmings (18.4 million tons) for a "MSW wood" total generation estimate of 34.2 million tons. The Forest Service also estimates that 5.5 million tons of MSW wood is combusted for energy and an additional 11.1 million tons is available for recovery (Table 6).

C&D

The EPA reports that in 2003 (most recent data) approximately 170 million tons of material was generated in construction, renovation, and demolition projects; however, wood is not separated from other materials in this estimate. *BioCycle*/Columbia University does not conduct research on C&D materials. The Forest Service estimates 36.4 million tons of C&D wood material was generated in 2010 with 19.1 million tons (52%) recovered, combusted, or not usable and 17.3 million tons (48%) available for recovery (Table 9).

Bottom Line

There is an opportunity (and need) for the U.S. EPA and *BioCycle*/Columbia University to work together on studies of U.S. municipal solid waste management. The EPA has developed strong partnerships with industry organizations leading to estimates of materials generated, recycled, or discarded; *BioCycle*/Columbia University has developed good relationships with a robust network of state waste managers who have direct access to MSW generation and disposal data. By working together, the two entities should be able to significantly narrow the huge gap between their independent estimates of MSW generation.

Since the U.S. Forest Service uses the EPA estimate of the "wood component" and adds this value to the wood portion of yard trimmings to calculate a total for MSW "wood", the Forest Service estimate might be low (based on the huge differences in generation rates between the EPA (low rate) and *BioCycle*/Columbia University). The most current data from the EPA on C&D waste is from 2003, and the wood component from this waste stream is not separated from other materials. The Forest Service estimate on C&D wood (2010 data) is likely the most reliable.

Regardless of the data collection methodology, or the entity conducting the research, there is clearly still a large amount of wood generated; 70.6 million short tons is the current best estimate for the MSW and C&D waste streams (34.2 + 36.4 million). The amount available for recovery in these waste streams is also significant at 28.4 million short tons (11.1 + 17.3 million).

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Appendix D: An Examination of Wood Recycling Provisions in North American Green Building Programs

Introduction

Recycled content is a prominent aspect of many North American green building standards, with use of such materials awarded or specified. Construction and demolition (C&D) waste reduction is also a prominent part of most green building initiatives.

This report examines green building programs, model codes, and standards to identify provisions targeting wood re-use and recycling. About 90 green building standards were examined. Current green building programs were determined based on a review of the literature, and on a state-by-state web-based information search. Provisions of each program were reviewed and those related to material recovery, reuse, recycling, and recycled content were identified and are summarized in this report.

Definitions of the terms *recovered material*, *reuse*, *recycled*, and *recycled-content* are inconsistent between various green building programs; some programs differentiate materials using these terms, while others tend to combine recovery, reuse, and recycling under the general terms "recycling," "reclaimed," and "recovered from landfill." However, for those that do make distinctions between these various types of material, definitions provided within the 189.1 Standard of the American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE) come closest to universally describing the differences between these terms:

- *Recovered Material* – Material that would have otherwise been disposed of as waste or used for energy recovery (e.g. incinerated for power generation), but has instead been collected and recovered as a material input, in lieu of new primary material, for a recycling or manufacturing process.
- *Reuse* – includes donation of materials to charitable organizations, salvage of existing materials onsite, and packaging materials returned to the manufacturer, shipper, or other source that will reuse the packaging in future shipments.
- *Recycled material* – Material that has been reprocessed from recovered (reclaimed) material by means of a manufacturing process and made into a final product or into a component for incorporation into a product.
- *Recycled content* – The proportion, by mass, of recycled material in a product or packaging. Only pre-consumer and post-consumer materials shall be considered as recycled.

In addition to reviewing provisions of various green building programs, the extent of wood recycling in North American wood products manufacturing was also reviewed.[67] Recovered wood use in production of standard particleboard, core stock, hardboard, medium-density fiberboard (MDF), high-density fiberboard (HDF), and in finger-jointed wood was specifically considered, as these were judged to be the product categories most likely to incorporate significant quantities of this material.

[67] Information about the use of recovered wood in North American wood products manufacturing was obtained from the Composite Panel Association, the American Fiberboard Association, and the Western Wood Products Association. Published literature was also examined.

Recycling in Green Building Standards

To understand how wood recycling is addressed in green building standards, about 90 green building standards used in various parts of North America (U.S and Canada) were examined. After accounting for those standards or local green building initiatives based wholly on one or more national or regional scope programs, and paring the list to avoid double counting of the base-standards, a total of 42 distinct green building programs were identified as in current use in the United States and Canada.[68] For each of these programs, provisions related to construction waste reduction, materials re-use, and use of recycled content materials were summarized by program and by state or province (see following tables).

The focus of the review was on provisions for recycling and reuse within green building, and it should be noted that those green building programs focused exclusively on energy efficiency were excluded. Had such programs been included, the list would have been much longer, as there are many dozens of green building programs dedicated to energy efficiency alone. There are, in addition, scores more that are wholly based on one or more national or regional-scope green building programs. One recent evaluation (Gruder 2007) identified 148 such programs based on LEED alone, and another 29 that wholly mirror one or more other green standards. A second recent assessment revealed more than 20 California cities that utilize the Green Points Rated System for residential construction (Office of the Attorney General of California 2012). In this assessment, the LEED and Green Points rated programs are counted only once. LEED Canada, which is different than the form of LEED as promulgated by the U.S. Green Building Council, is counted separately.

Recycled Content, Reuse, and Related Provisions of Green Building Programs

Of the 42 distinct green building programs identified, 41 award reuse, and/or reclamation or recovery of materials for reuse. The use of recycled content construction materials is specifically recognized in 38 programs. Two-thirds of these do not differentiate between pre- and post-consumer recycled content, while most of the other programs award twice (2x) the credit for use of post-consumer content than for pre-consumer (post-industrial) content. In many cases, specific products are identified as ones for which recycled content is recognized. Third-party certification of recycled content is sometimes required. Use of finger-jointed materials is singled-out in quite a few programs as an awarded or specified practice.

One initiative identified is not a green building program, but a comprehensive plan for reducing the quantity of material accepted at landfill sites. The initiative, that of the city of Boston, is included because it is indicative of other such initiatives across North America, and because a primary focus is reduction of wood C&D waste in landfills. A key objective of the Massachusetts initiative is to increase the recycling rate for C&D materials to 50% by 2020. For Boston alone this translates to an objective of reducing C&D disposal by a total of 400,000 tons (of which wood is 31 percent) within a decade. Considering this and other objectives in green building

[68] Green building programs focused exclusively on energy efficiency (i.e., no material or content provisions) were not considered further, nor were the various federal, state, regional, and municipal green building initiatives that have adopted by local ordinance or statute one or more green building programs (such as LEED, Green Globes, Built Green, or Green Points Rated). In the latter case, the program is listed only once, in either the national or regional listings.

programs of reducing C&D waste, it is likely that interest in recovery/recycling solutions for wood and wood products will increase.

Examples of provisions regarding recycled content in 42 different green building programs:

Provision	Number of Programs That Contain Such a Provision
Reuse/Reclaimed/Recovered	41
Recycled content	37
Recycled content for specific products	
Cabinets/Countertops/Shelving	13
Siding/cladding	11
Decking	8
Interior trim	9
Sheathing	8
Exterior trim	6
Underlayment	6
Flooring	6
Doors	6
Subfloor	1
Use of finger-jointed materials	
Framing, other structural lumber	13
Interior or exterior trim	12

Recycled Content of Wood Building Materials

As mentioned, nearly all (93%) of the identified green building programs award the use of recycled content materials and two-thirds do not differentiate between pre- and post-consumer recycled content. Recycled content provisions in most standards call for 20 to 40% recycled, with several specifying 50% recycled when pre-consumer recycled content is involved. Building materials that commonly contain pre-consumer (post-industrial) recycled content in sufficient proportions to qualify for recycled content provisions of most green building programs include insulation board, medium density and high density fiberboard (MDF and HDF), and particleboard. Recycled content certification certificates published on-line by Temple-Inland (2012) provide an indication of recycled content for these products. These certificates show at least 75% pre-consumer recycled content in particleboard products; up to 97% pre-consumer recycled content for fiberboard products; and 78% pre-consumer recycled product in medium density fiberboard products. This means that these products would generally qualify for recycled content provisions. This also means, based on 2005 U.S. production statistics (Howard 2009), that the overall recycled content of U.S. produced wood building products was about 10-11%. Canadian figures were likely in the same range.

As reported by the North American Fiberboard Association (Wagner 2012), the largest input for fiberboard mills is in the form of chips from local sawmills that are classified as post-industrial or pre-consumer waste. Other inputs include recycled cardboard and recycled paper (both office waste and newsprint), and almost anything else that can be re-pulped. Recycled cardboard and paper, when used, qualifies as post-consumer recycled content.

Another product that is widely recognized in green building programs is finger-jointed wood, primarily based on recognition that this technology allows the use of short wood pieces that would otherwise go to waste or less desirable uses. Finger jointing in framing and other structural lumber, exterior and interior moulding and trim, and several other product categories is widely awarded or specified, with no caveat in any green standard as to whether materials used in the finger-jointed products are actually recovered scraps. Production of finger-jointed studs and other forms of finger-jointed framing and structural lumber totaled about 700 million board feet in 1998 (Wood Resources International 2008), and about 800-900 million board feet annually in the period 2006-2007 (various sources). As recently reported (Anon. 2012), paint-grade mouldings are the preferred choice of consumers, accounting for more than 80 percent of U.S. moulding consumption. In recent years MDF has increased in popularity over finger-jointed stock, with the trend toward MDF continuing (Baumeister and Beaulieu 2009, Butzelaar, and Taylor 2008).

Summary

Reuse of building materials is encouraged and/or rewarded in the vast majority of North American green building standards. Similarly, recycled content of materials is a prominent aspect of many such standards, with use of such materials awarded or specified. Wood products that in general currently satisfy recycled content provisions include fiberboard, medium and high density fiberboard, and standard particleboard. In addition, finger-jointed wood products receive recognition as green products in a number of standards.

Reduction of wood volume in C&D waste is a clear objective in landfill waste reduction programs such as that of Boston, Massachusetts. C&D waste reduction is also a prominent part of most green building initiatives. The implication is that interest in recovery/recycling solutions for wood and wood products is certain to increase going forward.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
United States – National				
ASHRAE 189.1	A minimum of 50% non-hazardous construction and demolition waste shall be diverted from disposal in landfills by recycling and/or reuse. The sum of *post-consumer recycled content* plus one-half of the *pre-consumer recycled content* shall constitute a minimum of 10%, based on cost, of the total materials in the *building project*. The *recycled content* of a material shall be determined by weight. The recycled fraction of the material in an assembly shall then be multiplied by the cost of assembly to determine its contribution to the 10% requirement.	√		
Earth Advantage Home	- Recycle 100% of wood and cardboard construction waste. - Structural lumber and siding – reclaimed/recycled 5-25%/26-50%/51-75%/76-100%. - Recycled content countertops – 25% post-consumer content. - Plastic lumber decking – 50% post-consumer content. - Millwork and interior trim – MDF or finger-jointed.			Post-consumer recycled content awarded only.
EarthCraft	- Divert 75% of wood construction waste from landfill. - Install ≥75% of exterior cladding and trim with ≥25% recycled content material (pre or post-consumer). Recycled content must be certified by Scientific Certification Systems (SCS). - Exterior soffit, fascia, and trim - finger-jointed, MDF, or HDF with no added urea formaldehyde in non-solid sawn wood for ≥75% of mat'l. - Interior trim finger-jointed, MDF, or HDF with no added urea formaldehyde in non- solid sawn wood for ≥80% of trim. - Cabinet faces and countertops - reclaimed wood, MDF with no added urea formaldehyde, or FSC certified. Reused cabinet faces and countertops or the use of material with ≥25% recycled content also qualify for credit. - Outdoor decking and porches - ≥40% recycled content on ≥90% of area. Recycled content must be confirmed by SCS.		√	
Enterprise Green Communities	- Requires that at least 25% of construction waste be diverted from landfill by recycling, salvage, or other waste diversion strategies. - Use recycled content materials. To gain points, recycled materials must constitute at least 90% of the project materials by either weight or volume.	√		Recycled content materials defined as materials with at least 25% post-consumer recycled content, or at least 50% post-industrial recycled content.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
Green Globes	- Points are awarded for demolition and construction waste being diverted from landfill. - Recycled post-industrial (pre-consumer) or post-consumer content materials account for 1-20% or more of building materials, calculated on the basis of either total cost or weight of all building materials. - The same guidelines as above apply independently to furnishings, fitting, and fit-outs.		√	
International Green Construction Code (IgCC)	- Divert at least 50% of construction, deconstruction, or demolition waste from landfill (may be increase to 65 or 75% by local jurisdiction). - As part of requirement that 55% of total materials used in a project (measured by mass, volume, or cost) meet specific guidelines, one option is to use recycled content materials, defined as containing at least 25% combined post-consumer and pre-consumer recovered material AND must be recyclable (meaning that a minimum of 30% of materials are, in fact, routinely recovered and recycled for reuse), OR must contain ≥50% combined post-consumer and pre- consumer recovered material.		√	
LEED	- Recycle or reuse 50% of construction waste (1 pt.) or 75% (2 pts). - Salvaged/reclaimed materials account for ≥5% of the total value of materials (excluding mechanical, electrical, plumbing components) – (1pt); ≥10% (2pts). - The total value of materials used in a project is 10% recycled Content (where recycled content is calculated as post-consumer recycled % + ½ post-industrial recycled %) – (1pt.); 20% (2pts).	√		
Living Building Challenge	- 80% of wood construction waste must be diverted from the landfill by recycling, reuse, salvage, or composting. - The use of salvaged materials is encouraged to acknowledge the considerable value of a material's embodied energy.			No precise definition of recycled or recycled content provided.
National Green Building Std. (ICC 700)	- Points awarded for use of existing or recycled materials as follows. (Points awarded for every 10 percent of total building construction and demolition materials that are reused, deconstructed, and/or salvaged. The percentage is consistently calculated on a weight, volume, or cost basis.)		√	
Sustainable Project Rating Tool (SPiRiT) (US Army)	A project rating tool based on LEED. Provisions related to materials reuse, recycling, and recycled content are the same as in current versions of LEED.	√		

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
United States – State/Regional				
Alabama				
Earth Craft House	See details under United States - National		√	
Alaska				
Arizona				
Arizona Green Builder	- Separate wood product waste on site - Use finger-jointed studs or wood certified under FSC, SFI, CSA or comparable. - Offer reclaimed or renewable wood flooring as an option.			
Phoenix Green Builder	Based on the International Green Construction Code (IGCC) for commercial and the National Green Building Standard for residential construction. Recycled content provisions for materials used in construction are the same as in these programs (see details under United States – National)		√	
Scottsdale Green Building Program	- At least 75% of roof structure is non-solid sawn lumber (metal, engineered lumber, recycled content materials). This item does not include concrete slabs on grade or conventional wood trusses. Additional points for at least 75% of floor structure Additional points for at least 75% of beams, headers and columns Additional points for at least 75% of interior framing - Dwelling uses reconstituted or recycled-content siding (minimum 50% pre-or post-consumer). - Fascia, soffit and trim elements are made of recycled-content materials (including metal) or engineered wood products such as finger jointed trim, fiberboard, laminated strand lumber or OSB. - All interior trim is finger-jointed/engineered wood, domestic hardwood, from an FSC- or SFI- certified sustainable source, is a rapidly renewable material or contains min. 20% recycled content. - No wood base, cove, crown molding, door or window trim is used in the entire home, unless it is recycled or salvaged material.			No precise definition of recycled or recycled content provided.
Arkansas				
California				
Calabasis Green Building Ordinance	Modified LEED – No change to recovery, recycling, recycled content provisions.	√		

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
California				
California Green Building Standards Code	Divert to recycling or salvage for reuse a minimum of 50% of the non-hazardous construction and demolition debris or meet local ordinance, whichever is more stringent (Tier I – 65%; Tier II – 80%). Use ≥10% post-consumer or pre-consumer recycled content materials on the project (percentage based on value). (Tier I – 10%; Tier II – 15%). Use salvaged, refurbished, refinished, or reused materials (≥5% based on total materials cost).		√	
Earth Advantage	See details under United States - National			Post-consumer recycled content awarded only.
Green Point Rated Homes/Green Building Alameda County	- Recycle ≥50% (or ≥65 or ≥80%) of job site construction waste (by weight). - Use recycled content or FSC certified wood decking. - Use engineered or finger-jointed studs for vertical applications. - Use FSC certified wood, rapidly renewable, recycled content, finger-jointed, or local materials for interior finish: 50% minimum for cabinets, interior trim, shelving, doors, and countertops. - Use FSC certified wood, reclaimed or refinished, rapidly renewable, recycled content, or local materials for flooring: minimum 15% of floor area.			No precise definition of recycled or recycled content provided.
Santa Barbara Innovative Building Review Program (Santa Barbara County)	- Recycle and/or salvage for reuse a minimum of 50% (or follow local requirement if more stringent) of the non-hazardous construction and demolition debris, or meet a local construction and demolition waste management ordinance, whichever is more stringent. (Excavated soil and land-clearing debris excluded). - Reuse dimensional lumber (must be re-graded for structural use). - Recycle wood scrap and pallets. - Use re-milled salvaged lumber. - Use finger-jointed framing material (e.g. risers and studs) longitudinal compression loads only. - Use recycled content underlayment for subfloor. - Use recycled-content sheathing. - Use siding with reclaimed or recycled material. - Use finger-jointed trim for cabinetry and wood trim.			No precise definition of recycled or recycled content provided.
West Hollywood Green Building Ordinance	Uses the Green-Points-Rated checklist (see above)			No precise definition of recycled or recycled content provided.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
West Hollywood Green Building Ordinance	Uses the Green-Points-Rated checklist (see above)			No precise definition of recycled or recycled content provided.
Colorado				
Built Green Colorado	- Finger-jointed material used for plate material and studs. - Recycled-content sheathing where shear corners and shear walls are not required (minimum 50% post-consumer content by weight). OSB does NOT qualify for this point. - Non-structural elements of decking materials ≥ 50% or greater recycled content by weight – 3 pts ≥ 80% or greater recycled content by weight – 4 pts Add points for ≥ 25% post-consumer recycled material – 1 pt Add points if product is 100% recyclable (≥ 50% of decking material must be from post-consumer recycled sources to take this point) – 1 pt - Natural cork or 100% recycled or recovered content underlayment. - Doors in home must use non-urea formaldehyde based binders, and constitute one or all of the following: (1 pt per door, max 4 pts) • Recycled content doors (≥ 25% post consumer) • Recovered content doors (e.g. agri-fiber, re-milled wood products) • Reclaimed/reused doors - Recycled and/or recovered-content siding (minimum 40% pre- or post-consumer) on 50% or more of exterior wall area. - Fascia, soffits or trim made of (choose one) Recycled and/or recovered-content materials (minimum 40% pre- or post-consumer) Treated engineered wood from 100% third party certified sustainably harvested sources (note: OSB, natural wood and MDF can take these points). - Cabinet frames, doors and drawer fronts with low-VOC finishes (≤ 250 grams/liter), made from 100% reclaimed or salvaged wood, or 100% agri-fiber composite material (w/ no added urea-formaldehyde resins), or 100% bamboo or other rapidly renewable resource, or third-party certified sustainably harvested sources. - Trim made from SCS Certified composition wood used for trim (i.e. fiber board/MDF) or finger-jointed trim.		√	

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
City of Boulder Green Points Program	- demonstrate that a minimum of 50 percent of construction waste is recycled. Recycling ALL clean wood, cardboard and metal will count for 50% waste diversion. - divert from landfill ≥75% of the waste generated on site. Points will be awarded according to the following: 2 points—Divert 75 percent of construction waste generated on site; 3 points—Divert 85 percent of construction waste generated on site. - For exterior and interior framing use finger-jointed studs (vertical use only for structural components). - For exterior siding use recycled content or FSC certified material. - For decking use FSC certified or recycled-content material. - For countertops use recycled content material. - For cabinets and trim use recovered, recycled content, or FSC-certified material. - For doors use FSC certified or recycled-content material. - For roof, wall, and floor sheathing use FSC certified or recycled-content material.			No precise definition of recycled or recycled content provided.
Eagle County EcoBuild Program	- Use of Colorado beetle kill pine salvaged wood, 3 pts. per material used in over 50%. - Wood, cardboard recycled (2 points per material recycled, must document). - Reclaimed a/o recycled content materials (2 pts per material used in over 50% of building).			No precise definition of recycled or recycled content provided.
Connecticut				
Delaware				
District of Columbia				
Florida				
Earth Craft House	See details under United States – National		√	
Florida Green Building Coalition	- Use recycled content siding or soffit material. - Use finger jointed or laminated products. - 50% of all doors are reused doors or 50% of all windows are reused windows.			No precise definition of recycled or recycled content provided.
Georgia				
Earth Craft House	See details under United States – National		√	

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	100% of post-consumer recycled content + ½ of post-industrial recycled content	
Hawaii				
Hawaii Built Green	- Install recycled content fascia, soffits, or trim. - Use recycled content sheathing. - Use recycled content underlayment. - Window and door frames are wood/composite with recycled content. - Cabinets are made with medium density fiberboard or wheatboard. - Use finger-jointed or engineered wood trim (including MDF). - Use countertops with recycled content. - Recycled content materials used for fences, benches, decking, docks, retaining walls, picnic tables, and landscape borders.			No specific definition provided RE recycled content.
Idaho				
Illinois				
Indiana				
Iowa				
Kansas				
Green Building Program of Kansas City	Based upon the National Green Building Standard for residential structures (See details under United States – National).			No precise definition of recycled content provided.
Kentucky				
Louisiana				
Maine				
Maryland				
IgCC	For details, see United States – National.		√	
Massachusetts				
Solid Waste Master Plan	In 2008, Massachusetts construction and demolition (C&D) materials were recycled at a rate of 66 percent. While this recycling rate is high, the bulk of the recycled tonnage is asphalt, brick, and concrete (ABC), which is routinely recycled (2,330,000 out of 2,520,000 tons). When the ABC tonnage is excluded from the C&D data, the remaining material is only recycled at a rate of 14%. Considering that about 700,000 tons of Massachusetts C&D material is disposed of each year and an additional 400,000 tons is managed as fines and residuals (a relatively low value use), there is considerable room for increased C&D recycling. *(continued on next page)*			Not a green building program, but an example of waste reduction initiatives that are beginning to gain momentum among jurisdictions across the U.S. and Canada.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	100% of post-consumer recycled content + ½ of post-industrial recycled content	
Massachusetts Solid Waste Master Plan *(Continued)*	*(continued from previous page)* A 2007 report conducted for MassDEP estimates that the three largest components of building related C&D material by weight are **wood (31%)**, asphalt roofing materials (11%), and drywall (gypsum wallboard) (10%). (This does not include asphalt paving and concrete, which are already recycled at a high rate from road and bridge construction projects.) **These three materials represent the top targets for increased C&D diversion from disposal.** Increasing C&D recycling will require diverting materials from low value uses such as fines and residuals as well as diverting materials from disposal. **A key objective is to increase the recycling rate for C&D materials excluding ABC to 50% by 2020.** Based on 2007 C&D generation, this would mean reducing C&D disposal and landfill uses such as alternative daily cover and grading shaping materials by a total of 400,000 tons annually by 2020.			Not a green building program, but an example of waste reduction initiatives that are beginning to gain momentum among jurisdictions across the U.S. and Canada.
Michigan				
Green Built Michigan	Based on the National Green Building Standard – for details see United States – National.			No precise definition of recycled or recycled content provided.
Minnesota				
Minnesota Green Star	- Divert ≥70% of wood scrap and broken pallets from landfill. - Decking or patio material is made from recycled content and has low- toxicity **Use of reclaimed (a.k.a. re-used) materials:** - Beams & Headers in walls & floors (50% to 69%, 70-89%, ≥90%) - Floor Joists (50% to 69%, 70-89%, ≥90%) - Subfloor (50% to 69%, 70-89%, ≥90%) - Wall framing (30% to 49%, 50-69%, 70-89%, ≥90%) - Roof beams & headers (50% to 69%, 70-89%, ≥90%) - Rafters or trusses (50% to 69%, 70-89%, ≥90%) - Roof sheathing (50% to 69%, 70-89%, ≥90%) **Use of recycled content materials:** - Decorative coverings for walls and ceiling contain minimum 25% post-consumer recycled content or 40% post-industrial recycled content for 50 or 90% or more of wall/ceiling area. - Flooring contains minimum 25% post-consumer recycled content or 40% post-industrial recycled content for 50 or 90% or more of floor area. - 50% or 90% of millwork, and/or doors, and/or countertops contain ≥25% post-consumer recycled content or 40% post-industrial recycled content. - Cabinetry contains ≥40% post-industrial recycled content.			Both pre-consumer and post-consumer recycled content awarded, but greater credit give to post-consumer recycled.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	100% of post-consumer recycled content + ½ of post-industrial recycled content	
Minnesota Green Communities	- Credit given for materials reuse and use of recycled content materials.			
Minnesota Sustainable Building Guidelines	- Divert at least 75% (by weight) construction, demolition, and land clearing debris from landfill disposal. - Divert an additional 15% (90% total) construction waste. Reuse, recycle and/or salvage an additional 15% (90% total by weight) of construction, demolition, and land clearing waste. - Use salvaged or reused materials for 5% of the total (weight or value) of materials used in the project. - Use materials that contain, in aggregate, a minimum weighted average of 20% post-consumer recycled content , OR, a minimum weighted average 50% post-industrial recycled content.			Recycling is defined as the process of collecting and preparing recyclable materials and reusing them in their original form or in manufacturing processes that do not cause the destruction of recyclable materials in a manner that precludes further use.
Mississippi				
Missouri				
Montana				
Nebraska				
Nevada				
Southern Nevada Green Building Partnership	- Use recycled content materials: oriented strand board (OSB), medium density fiberboard (MDF), etc.			No precise definition of recycled or recycled content provided.
New Hampshire				
New Jersey				
New Mexico				
Santa Fe Residential Green Building Program	- Waste generated during construction is recycled. - A construction waste management plan is developed, posted at the jobsite, and implemented with a goal of recycling or salvaging a minimum of 50 percent (by weight) of construction and land-clearing waste.			No precise definition of recycled or recycled content provided.
New York				
Battery Park City Authority Residential Environmental Guidelines	- Whenever on-site reuse is not possible, recycle cardboard, metals, concrete, brick, asphalt, clean dimensional wood, plastic, glass, gypsum board, carpet, ceiling tile, etc. - Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 12% of the total value of the materials in the project, Excluding mechanical, electrical, and plumbing.	√		Recycled content is determined by dividing the weight of recycled content in an item by the total weight of all material in that item, then multiplying the resulting percentage by the total value of the item. Recycled content materials are defined in accordance with *ISO 14021*.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	100% of post-consumer recycled content + ½ of post-industrial recycled content	
NYC High Performance Building Guidelines	- Prepare a materials resource plan that identifies materials for reuse in the project, for removal, and for recycling. - If an existing building is to be rehabilitated, maintain and reuse 75-100% of the existing building's structural shell. - Based on total materials cost, between 20-50% of the materials (excluding costs for mechanical and electrical systems, plumbing systems, labor, overhead fees etc.) shall contain at least 20% post-consumer recycled content OR a minimum of 40% pre-consumer recycled content.	√		
North Carolina				
Green Built North Carolina	- Outdoor structures, decking, and landscape materials made from recycled materials (min. 40% recycled content). - Recycled and/or recovered-content siding (minimum 50% pre- or post-consumer) on 50% or more of exterior wall area. - Use natural cork / 100% recycled or recovered content underlayment. - Recycled and/or recovered content components (credit available for ALL of the following) >Doors (Min. 50%) >Closet shelving (Min. 90%) >Kitchen casework (Min. 90%) >Flooring (Min. 25 or 75%) Engineered flooring satisfies this requirement.		√	Program was formerly known as NC Healthy Built Homes.
Triangle Region Public Facilities High Performance Building Guidelines	- Recycle/salvage 50% (or 75%) of construction debris. - Specify 25% (or 50%) of materials as 20% post-consumer recycled.			Recycled content based on post-consumer content only.
North Dakota				
Ohio				
Oklahoma				
Oregon				
Earth Advantage	For details see United States – National.			
Pennsylvania				
Rhode Island				
South Carolina				
EarthCraft House	For details see United States – National.			
South Dakota				
Tennessee				
EarthCraft House	For details see United States – National.			

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	100% of post-consumer recycled content + ½ of post-industrial recycled content	
Texas				
Austin Energy Green Building Program	- Minimum 50% by weight of construction waste is recycled/ reused, not landfilled. Documentation required. - Engineered finger-jointed studs used for a minimum of 80% of wall construction. - Use of recycled-content products. - Use of reclaimed/reused materials for doors, hardware, flooring, and trim.			No precise definition of recycled or recycled content provided.
Utah				
Vermont				
Vermont Builds Greener	- Create and implement a plan for construction to provide for the efficient separation of materials which are reusable or recyclable, including separate containers, covered where required, for wood and a number of other materials. - 2 points for each 5% of total value of materials in the building products made with salvaged, recycled or waste-stream content. Examples include re-habilitation of a used house, used doors or cabinets, straw-particle-board, re-sawn salvaged wood, recycled plastic lumber, etc. - Non-wood outdoor decking - minimum 50% (value) recycled content of non-wood decking (1 point per 33% of total decking area). OR 1 pt. if FSC Certified using same percentages. - Install countertops made from recycled materials minimum 75% of countertop area).			
Virginia				
Arlington County Green Home Choice Program	- All kitchen cabinets must be reclaimed or constructed of reclaimed wood; constructed of FSC certified wood; or constructed of biobased materials, such as wheatboard. - Countertop materials with a minimum of 40% recycled content may be used in one or more room applications, with the kitchen counter counting as 2 points and bath vanities counting for one point each up to a total of three points. - All siding is either reclaimed from on-site or elsewhere or has a recycled material content of at least 40%. - Outdoor decking shall have a minimum of 50% recycled material content with one point granted for each feature up to a total of 3 points. - Minimum of 80% of interior and/or exterior wood trim shall be non-solid sawn wood (such as finger-jointed or urea formaldehyde free non-wood materials, such as MDF or HDF. - Minimum of 25% (or 80%) of the total wall framing materials shall be manufactured from non-solid sawn wood, such as laminated or finger-jointed studs. Exterior steel studs are not eligible for this credit unless the entire exterior surface of the studs is covered with a minimum R10 insulated sheathing.			No precise definition of recycled or recycled content provided.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	100% of post-consumer recycled content + ½ of post-industrial recycled content	
Virginia *(Continued)*				
Arlington County Green Home Choice Program *(continued)*	- Send all non-reusable wood from a deconstruction project to a recycling facility. Receipts from the recycling facility must be presented to earn this credit. - The builder shall deliver at least two (or four, or six) of the above waste items (the list includes wood) to a recycling facility and arrange for the recycling of said items. A receipt from the recycling facility is required to earn this credit.			
EarthCraft House	For details see United States – National.			
Washington				
Built Green Washington	- Recycle clean scrap wood and broken pallets by source separation, 85% minimum recycling rate. - Practice waste prevention and recycling and buy recycled Products. - Use finger-jointed studs. - Use recycled-content sub-floor. - Use siding with reclaimed or recycled material on at least 20% of solid wall surface. - Use finger-jointed wood windows. - Use finger-jointed or MDF trim with no added urea formaldehyde, 90% minimum. - Use 100% recycled-content HDPE, salvaged lumber or lumber that is third-party certified sustainably harvested wood that meets the Tier 1 requirements outlined in the Handbook for Decking and Porches.			No precise definition of recycled or recycled content provided.
Earth Advantage	For details see United States – National.			
Sea Green (Seattle)	- Provide a waste plan that diverts 50% (or 75%) of the construction waste from the landfill. - Framing/wall structure: FSC-certified or reclaimed or finger-jointed studs. - Siding recycled content, reclaimed, or FSC-certified. - 50% (or 75% or 100%) of flooring linoleum, cork, bamboo, FSC-certified or reclaimed wood, sealed concrete, recycled-content flooring, or combination. - Decking recycled content, FSC-certified, or reclaimed. - Cabinets, counters, and trim recycled content, FSC-certified, or reclaimed and composite materials must contain no added urea-formaldehyde resins. - Doors(not including garage or insulated doors) recycled Content, FSC-certified or reclaimed. - Window framing recycled content, FSC-certified, or reclaimed. - Sheathing recycled content FSC-certified, or reclaimed.			No precise definition of recycled or recycled content provided.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	100% of post-consumer recycled content + ½ of post-industrial recycled content	
West Virginia				
Wisconsin				
Wisconsin Green Built Home	- Use reused timber or framing lumber (min. 25% lbr. usage). - Use reused hardwood trim, cabinets, and/or doors (min. 25% of stock). - Decks, site furnishings, and other outdoor structures constructed using sustainable, low toxicity materials including reused wood and certified sustainable wood. - Finger-jointed studs, engineered stud material, or plate materials used in constructing the structural frame. - Recycled content sheathing (min. 50% pre- or postconsumer recycled content). - Recycled content siding (min. 50% pre-consumer). - Recycled content siding (min. 50% post-consumer). - Recycled content facia, soffit, or trim (min. 50% pre-consumer – 1pt.) or (min. 50% post-consumer – 2 pts). - Recycled content underlayment (100% of underlayment used). - Flooring made from reclaimed (recycled) wood (min. 50% of wood flooring). - Recycled content doors or MDF. - Finger jointed trim or MDF (min. 75% of trim stock). - Recycled content countertops.			Credit given for both pre- and post-consumer recycled content, but twice the credit given for post-consumer recycled.
Wyoming				

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
Canada – National				
Built Green Canada	- Finger-jointed plate material and/or engineered plate material used for all framing plates. - Finger-jointed studs for 90% of non-structural and/or 90% of structural wall framing. - Recycled content exterior wall sheathing (minimum 50% pre- or post-consumer). - Overhead garage door is made of 75% or greater recycled raw material. - 100% agricultural waste or 100% recycled wood particleboard used for shelving. - Exterior and interior doors with a minimum of 15% recycled and/or recovered content. - Exterior window frames contain a minimum 10% recycled content. - Minimum 25% recycled or reclaimed exterior cladding for 1/3, 2/3, or 90% of exterior. - Recycled and/or recovered content fascia and soffit (minimum 50% pre- or post-consumer). - Exterior trim materials have recycled and/or recovered content (minimum 50% pre- or post-consumer). - MDF and/or finger-jointed casing and baseboard used throughout home, and all jambs. - Domestic wood from reused/ recovered or re-milled sources, 500 ft^2 minimum for Flooring or all cabinets and all millwork. - Verify that a minimum of 25% of the materials collected from the construction site are recycled. - Suppliers and trades recycle their own waste, including leftover material and packaging.		√	
BOMA BEST (Building Environmental Standards)	- Consider among other factors the following criteria in materials selection: • Reused materials. Salvage durable products during demolition. • Recycled content of (new) product. • Ability to recycle product when no longer in use. • Renewable materials. • Life-cycle and maintenance requirements. - Reuse of construction and demolition wastes is encouraged.			No specific definition of recycled materials provided.
BREEAM	- 75% (or 90 or 95%)by weight or 65% (or 80 or 85%) by volume of non-hazardous construction waste diverted from landfill and either: a. Reused on site (in-situ or for new applications) b. Reused on other sites c. Salvaged/reclaimed for reuse d. Returned to the supplier via a 'take-back' scheme e. Recovered from site by an approved waste management contractor and recycled. - BREEAM does not specify recycled/reused content for various materials but instead requires certification of recycled content via an EMS, with verified recycled/ reused content materials counting toward the total percentage of responsible materials used. To achieve points for any given building element, at least 80% of the materials that make-up that element must be responsibly sourced.		√	Recycled materials are defined as materials diverted from pre-consumer and/or post-consumer waste streams that require significant processing before they can be used again.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
Green Globes	- Points are awarded for demolition and construction waste being diverted from landfill. - Recycled post-industrial (pre-consumer) or post-consumer content materials account for 1-20% or more of building materials, calculated on the basis of either total cost or weight of all building materials. - The same guidelines as above apply independently to furnishings, fitting, and fit-outs.		√	
LEED Canada (CAGBC)	- Construction waste management: Of the solid waste (including land-clearing debris) that is generated by construction, renovation, and demolition activities divert more than 50% or 75% from landfill through reuse and recycling. - Materials re-use 5% or 10% of materials used in the project are reused. (1, 2pts.) - Recycled content of construction materials Recycled content of materials used in the project is ≥7.5% or 15% (1, 2 pts.)	√		
LEED - USGBC	See details under U.S. summary. Canadian projects may use the USGBC program where the CAGBC does not have an applicable rating system, such as in the case of LEED for Retail, Healthcare, or Schools. Alternatively, Canadian projects in the areas of retail, healthcare, or schools may be registered under an existing LEED Canada rating system.	√		
Living Building Challenge	- 80% of wood construction waste must be diverted from the landfill by recycling, reuse, salvage, or composting. - The use of salvaged materials is encouraged to acknowledge the considerable value of a material's embodied energy.			No precise definition of recycled or recycled content provided.
R – 2000 (Natural Resources Canada)	Environmental features (the following are included in a short list of features from which at least two must be incorporated into a project): - Cellulose insulation used that meets or exceeds requirements of the EcoLogo Program for recycled raw material. - Sheathing and drywall (product must replace equivalent conventional product throughout the house. - Fibreboard made from recycled newsprint and/or wood fibres. - Siding manufactured from factory and sawmill waste. - Drywall contains recycled gypsum and/or newsprint. - Interior framing and trim (product must replace equivalent conventional product for an entire floor. - Studs and trim are manufactured from sawmill cut-offs and waste and are urea-formaldehyde free.			No specific definition of recycled materials provided.
SB Tool	Use materials with recycled content such that the sum of postconsumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (based on cost or weight) of the total value of the materials in the project; in compliance with the facility Environmental Management System, document purchase of EPA-designated products included in all solicitations relevant to construction, operation, maintenance of or use in the building.	√		

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
Canada –Regional /Provincial				
Alberta				
British Columbia				
Metro Vancouver BuildSmart	Program does not have specific requirements, but instead a guide to best management practices. Included in the listing of best management practices are the following guidelines: - Select materials that have recycled content, and that are recyclable. - Make a distinction between post-industrial and post-consumer recycled content, selecting post-consumer whenever possible. - Consider use of cellulose insulation with 75-95% post-consumer recycled content. - Select interior materials with recycled content. - Use gypsum board with 100% recycled kraft paper for face and back. - Use mineral wood ceiling panels and tiles with 4-21% recycled newsprint as a filler or binder. - Specify MDF with post-consumer recycled content (35%), recycled content (65-100%), or made from wood waste (post-industrial) recycled content.			No explicit definition of recycled content or how it is calculated is provided.
Residential Environmental Assessment Program (REAP) (UBC Campus)	Modeled after LEED, with recycled content, reuse, and material recovery from construction waste provisions the same as in LEED-H.			
UniverCity (Simon Fraser University)	Built in accordance with the Living Building Challenge standard. (See Living Building Challenge, U.S. National)	√		
Vancouver Green Building Strategy	Under the program project developers must submit a completed LEED Canada or Built Green Canada checklist for large projects or a Built Green Canada checklist for single family buildings.			Definitions of recycled content differ depending upon whether the building developer opts for compliance with LEED or Built Green.

Green Building Program	Recycled Requirements	Method of Determining Recycled Content		Remarks
		100% of post-consumer recycled content + ½ of post-industrial recycled content	Post-consumer recycled content + post-industrial recycled content	
Whistler Green	- Submit receipts indicating recycling of construction waste by volume: >50% (1 point); > 65% (2 points); >80% (3 points). - Two materials (each covers a main surface, >10% of floor area, or >3% of material costs excluding plumbing and wiring) are certified for recycled content. An additional credit if four materials meet the same guidelines.			No explicit definition of recycled content or how it is calculated is provided.
Labrador				
Manitoba				
Newfoundland				
New Brunswick				
Northwest Territories				
Nova Scotia				
Nunavut				
Ontario				
Toronto Green Standard for New Low-Rise Non-Residential Development	- Ensure that at least 5% of a project's materials (based on value) comprise salvaged, refurbished or reused materials. - Ensure that at least 15% of a project's construction materials (based on value) comprise recycled content. - Recycle at least 75% of non-hazardous construction and demolition debris. (Recycling is defined as breaking down and reprocessing materials. This is different from reuse, in which whole components are reused. For this target, materials salvaged for reuse can be included).			
Prince Edward Island				
Quebec				
Saskatchewan				
Yukon				

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Appendix E: Case Studies

Wood Recovery in Europe
San Diego County and City C&D Recovery Ordinances
C&D Waste Recycling in the City of Edmonton and Province of Alberta, Canada
Fast-Track Deconstruction Initiatives (Seattle, WA and Vancouver, BC)
North Carolina Wood Pallet Legislation
Reclaimed Barnwood Goes Mainstream

Wood Recovery in Europe

Wood recovery in Europe, and more specifically in European Union (EU) Member States, is both similar to and different from wood recovery in North America. A summary of notable similarities and differences are highlighted below.

Similarities with North America

Tracking, and data collection, for Municipal Solid Waste (MSW) and Construction and Demolition (C&D) waste wood is often lacking in the EU. Studies of MSW categorize wood in the areas of 'wood', 'bulky waste' (including furniture), and likely 'garden waste.' This makes it difficult to get a good sense of quantities and qualities when the material is 'placed' in different MSW categories. C&D wood is typically categorized with glass, metals, plastics, and other materials, leading to a difficulty in determining the amount of wood that is generated and, ultimately, recovered. *(The U.S. and Canada have similar tracking and data collection issues).*

The various countries of the EU use different methodologies in arriving at recycling rates for MSW (Fischer and Werge 2009). These methodologies include a *calculated* rate which is the difference between a generated amount minus landfilled and incinerated amounts, and a *reported* amount of recycled MSW. The differences between these methodologies can be quite large for different EU countries. *(The U.S. EPA and Biocycle/Columbia University use different methodologies for MSW surveys with vastly different results).*

Burning to recover energy, often termed biomass combustion (incineration) is not tallied as recycling in the EU although the activity off-sets fossil fuel emissions. Also, when wood is included in *waste incineration* it has public relations problems; Helsinki is one example. *(This is an issue in North America as well).*

Using wood as an energy source is viewed by many as carbon-neutral *only* when the wood is truly a *waste* material. Others argue that even waste wood combusted for energy could be counter-productive on a large-scale by working against reduction, reuse and recycling initiatives. Wood pellets (as an example), derived directly from forest land, are seen by some activists as bad because (in their opinion) it takes individual trees a long time to re-grow. *(Carbon-neutrality is a contentious issue with some groups in North America).*

Many EU Member States (or locales within Member States) still find landfilling the cheapest and easiest way to dispose of waste. *(A similar situation exists in many locations throughout North America).*

Differences with North America

There is little doubt about the EU's achievements on climate change. EU Member States have ambitious targets to globally cut carbon, broad mandates to shift to renewable energy, and are leading UN climate negotiations, which may have collapsed without the EU's willingness to adopt reduction targets.[69] Consequently, there are differences between wood recovery in the EU

[69] http://www.smh.com.au/environment/climate-change/eu-leadership-on-climate-change-masks-imports-role-20121026-288yz.html#ixzz2AQSoY24d

and in the U.S., some subtle and some large. The following are some of the driving forces for wood reuse and recycling in Europe.

An EU Sustainable Development Initiative was adopted more than a decade ago (Council of the European Union 2006). In addition to targeting renewable energy (see below), the focus is on energy consumption, emissions reduction, sustainable transport, sustainable consumption and production, conservation and management of natural resources and other program areas. *(States, provinces, regions, and municipalities in the U.S. and Canada have individual programs in many or all of these areas but a comprehensive initiative across North America is lacking).*

EU Member States are obliged to source 20% of their energy from renewables by 2020. Bioenergy, sourced from organic matter (including wood), accounts for the biggest slice of renewable energy. EU primary energy production from wood and wood waste grew by 38% between 2003 and 2010. This growth parallels in some degree the 2005 Biomass Action Plan[70] which is part of the EU energy policy (with the stated goal of doubling biomass energy output from 2005 to 2010).

An EC Landfill Directive was initiated in the late 1990s (Magin 2001). The directive is to reduce municipal biodegradable waste to 35% of 1995 levels by 2016. *(Neither the U.S. nor Canada have a nation-wide directive or comparable program in place at this time).*

The European Packaging and Packaging Waste Directive (started in Germany in the early 1990s and passed into law by the EU in 1994) requires manufacturers to recover their own packaging; however, most companies find this impractical, and instead, opt to participate in the voluntary Green Dot program. The basic idea of the Green Dot[71] is that consumers who see the logo know that the manufacturer of the product contributes to the cost of recovery and recycling. The system is financed by the Green Dot license fee paid by the producers of the products. Fees vary by country and are based on the material used in packaging (e.g., paper, plastic, metal, wood, and cardboard,). Fees take into account the cost of collection, sorting, and recycling methods. Today, Green Dot has more than 130,000 participating companies and 460 million packages have been labeled with the Green Dot logo; approximately 14.7 million tons of used packaging waste has been recovered and recycled. *(Neither the U.S. nor Canada have a packaging recovery program).*

An EU Waste Framework Directive was adopted recently to provide a framework for moving toward a European recycling society with a high level of resource efficiency[72]. The goal is to achieve by 2020 a minimum of 70% reuse, recycling or other material recovery by weight of non-hazardous C&D waste. *(Neither the U.S. nor Canada have such an ambitious goal).*

[70] http://europa.eu/legislation_summaries/energy/renewable_energy/l27014_en.htm
[71] http://www.greendotcompliance.eu/en/common-questions.php and http://en.wikipedia.org/wiki/Green_Dot_%28symbol%29
[72] http://ec.europa.eu/environment/waste/construction_demolition.htm

A Sample of Actions/Accomplishments from EU Countries

Numerous EU countries have provided leadership for many of the goals and initiatives noted above. The following is a sampling of actions and/or accomplishments from select EU countries.

Germany – Landfilling of wood has not been permitted since 2003; MSW (all categories) is recycled/composted at 64% and another 35% is incinerated[73]; wood waste recycling rates have jumped from virtually zero in 1995 to over 20 kilograms per capita in 2005; Germany also has various ordinances in place on issues such as incineration plants, generation of electricity from biomass and renewable energy; Germany has achieved a recycling rate of up to 90% in the construction materials sector (Fischer and Werge 2009).[74]

The Netherlands – Disposal of combustible waste in landfills is prohibited by law; 60% of MSW (all categories) is recycled/ composted and another 38% is incinerated; wood waste recycling rates have gone from 2.4 kilograms per capita in 1995 to 19.5 in 2005.

United Kingdom – According to the Wood Recyclers Association[75], the recycling of post-consumer waste wood has jumped from less than 4% in 1996 to about 60% in 2011[76]. A landfill tax was implemented in 1996 with biodegradable waste charged a higher tax; part of the revenue generated from this tax is used for funding waste-related environmental projects including market development for recycled materials. Landfill rates are rising in the UK, likely leading to increased recycling efforts.[77]

UK as an Example

The UK has many firms specializing in reusing (reclaiming) lumber from houses, warehouses, and barns. Products include flooring, furniture, and cabinets. Much of this wood is not included in national reuse or recycling statistics. Also, UK pallets are reused/ repaired to the tune of 20 million/yr.

Panel board mills (plywood, OSB, particleboard) are the UK's oldest and biggest customers of the use of recycled wood. Formerly, board mills made up 95% of the market; today, about 50% as other alternatives for recycled wood (chips) have been developed (including biomass, animal bedding, and land applications such as landscaping).

Biomass is a growing use of recycled wood in the UK and Europe. Major UK biomass power stations are set to come on-line plus small-scale biomass boilers for schools, hospitals, libraries, etc. One driver is the Biomass Action Plan (part of the EU energy policy). Also, waste-to-energy plants are another driver and are more common in Europe (431 in 2005) than the U.S. (89 in 2004).

The UK has a network of community-based wood collection and recycling centers. One effort, the Community Wood Recycling Network, has 23 separate 'social enterprises' (non-profits) scattered across the UK with the sole purpose of keeping wood out of the landfill. This fee-based network focuses on 'wood only' and primarily works with the construction industry—either picking up wood on-site or accepting wood at the recycling center. Members of this 'network' often sell wood at their own retail location to DIY/building enterprises, remanufacture the wood into value-added products, market the wood for firewood, or sell lower-grade material to larger processors who chip the wood and then re-sell it as feedstock for panel-boards, biomass, animal bedding or landscaping.

(Note: The UK is slightly smaller (in land area) than the State of Michigan; or roughly ¼ the size of British Columbia).

[73] All MSW recycling and incineration rates in this document can be found at: http://www.letsrecycle.com/news/latest-news/councils/uk-achieves-ninth-best-recycling-rate-in-europe
[74] Wood waste recycling rates in this document can be found at Fischer and Werge 2009.
[75] http://woodrecyclers.org/
[76] Example of a community-based wood recycling effort: http://www.communitywoodrecycling.org.uk/
[77] Magin 2001.

Finland – High fines discourage people from illegal dumping of waste; local regulations have proven to be efficient in a country with differing population densities (BIPRO 2008).

Norway – MSW wood recycling rates have increased (kilograms per capita) from 2.1 in 1995 to 31.4 in 2006.

Belgium – The country only landfills 4% of its MSW (2007); wood waste recycling rates increased between 1999 and 2005 from 1.9 to 12.0 kilograms per capita.

Sweden – The MSW landfill rate for Sweden is only 4% (2007) while the recycling and incinerating rate is 49% and 47%, respectively (Sweden, along with other Scandinavian countries, has been increasing its use of biomass in energy plants of different sizes and sophistication[78]); Sweden's goal is to use renewable energy and end oil dependency by 2020.[79]

EU (25 countries plus Norway) – Wood waste (as part of MSW stream) recycling rates have jumped from 0.9 to 6.0 kilograms per capita between 1999 and 2005; also, Germany, Denmark, Ireland, Estonia and the Netherlands recycle over 80% of their C&D waste (all categories).

Bottom Line

There are 'wood recovery similarities' between the EU and North America. These similarities focus on data collection issues including methodologies that provide varying numbers, definitions of recycling (particularly regarding combustion), and carbon neutrality arguments. Landfill rates also vary widely within both regions of the world.

The major difference between the EU and North America is the former's attention to, and achievement, regarding climate change and accompanying programs including renewable energy and emissions reduction. There are also individual countries in the EU that have enviable track records regarding MSW and C&D wood recovery.

The U.S. and Canada (industry, policy makers, academia, etc.) should examine the 'EU Model' for guidance, and determine what actions (directives, ordinances, regulations, programs, initiatives, etc.) are appropriate, and transferable, to North America.

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[78] http://onlinelibrary.wiley.com/doi/10.1002/xrs.883/abstract
[79] http://environment.about.com/od/renewableenergy/a/oilfreesweden.htm

San Diego - County and City C&D Recovery Ordinances

Introduction

San Diego County and the City of San Diego have both implemented construction and demolition (C&D) recovery ordinances within the past five years (since 2007). These ordinances were put in place in accordance with rules set forth by the California Integrated Waste Management Act (CIWMA) of 1989.[80] The Act stated that each California county and city was to divert 25% of its respective waste stream by 1995 and 50% by 2000.[81] Section 41780 of the Act required cities and counties to manage waste disposal through the implementation of the Source Reduction and Recycling Element (SRRE), which mandated jurisdictions to create waste management plans utilizing specific diversion goals.

Counties and cities throughout California have addressed the CIWMA and SREE through various diversion plans that focus on specific materials such as plastic, cardboard, and glass, and broader waste stream categories such as food waste (through composting programs) and construction and demolition waste (through C&D material recovery programs). While San Diego County and City share the same name, they act as independent jurisdictions and do not follow each other's ordinances. The following examples depict C&D waste management strategies applied countywide and city-specific.

San Diego County

According to the San Diego County Department of Public Works, 20-25% of their total waste stream volume consists of C&D debris, accounting for over 1 million tons annually.[82] In order to divert C&D materials from landfills, the county instituted a Construction and Demolition Materials Diversion Program ordinance (Appendix I) focused on large-scale redevelopment projects. The ordinance went into effect on April 21, 2007 and applies to projects of 40,000 square feet or greater.[83] It requires recovery of 90% of inert materials (defined by the ordinance as asphalt and concrete, brick/masonry/tile, and dirt) and 70% of all other C&D materials (which includes wood cabinets, doors and windows, as well as wooden pallets and unpainted wood) from a given C&D project.[82]

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[80] Full language from both ordinances is included at the end of the case study.

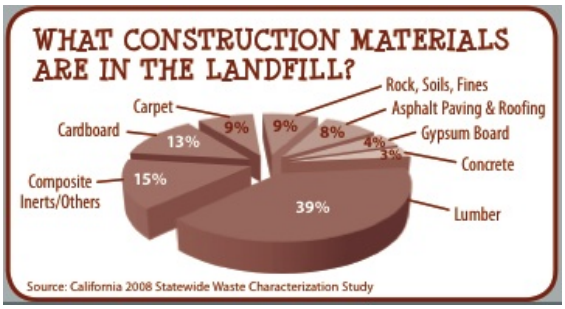
[81] Integrated Waste Management Board. *"Achievement, Progress, and Promise: A Ten-Year Status Report on the California Integrated Waste Management Act."* California Environmental Protection Agency, March 2000. http://www.calrecycle.ca.gov/Publications/Documents/LocalAsst%5C34001017.doc

[82] http://www.sdcounty.ca.gov/dpw/recycling/cdhome.html

[83] When calculating total square footage contractors must include the square footage of each floor of a building as opposed to the building's footprint. Multi-unit residential developments, tract home developments and phased residential and commercial developments must also adhere to the ordinance.

To support C&D ordinance compliance the County created a Construction & Demolition Recycling Guide[84] that lists reasons to recycle, tips for successful C&D waste reduction and recycling, ordinance requirements, tips for recycling additional everyday materials, and a directory of county recycling centers with information pertaining to the types of materials they each accept. The County's C&D ordinance seeks to increase C&D materials recovery from its municipal landfills in order to conserve natural resources, preserve landfill space, and reduce air and water pollution.

Figure 1. 2008 C&D Material Waste Percentages at California Landfills

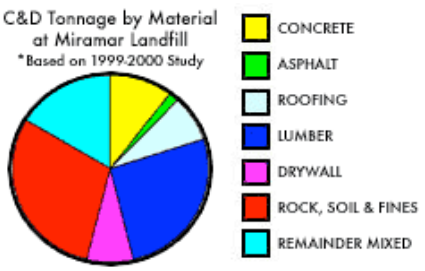


Source: *"Construction & Demolition Recycling Guide."* County of San Diego, Department of Public Works

A 2008 California Statewide Waste Characterization Study reported that wood accounts for the largest percentage (39%) of total landfilled C&D material throughout California. When cardboard (13%) is added, the total wood-based product is greater than 50% of total C&D waste materials (Figure 1).[84]

In order to track C&D materials recovery on a per project basis the ordinance requires building contractors and developers to submit a Construction and Demolition Debris Management Plan. The plan outlines what materials will be generated from the project and how they will be recycled. A fully refundable deposit, or Performance Guarantee, must be submitted prior to the issuance of a building permit. These safeguards help facilitate ordinance compliance. In the first few years of the ordinance, compliance was less than 50%, but it has recently grown to 69%.[85]

Figure 2. Miramar Landfill Waste Materials



Source: http://www.sandiego.gov/environmental-services/recycling/cd/cdbenefits.shtml

The City of San Diego

The City of San Diego also has a C&D ordinance that focuses on materials recovery that requires participation in the Construction and Demolition Debris Diversion Deposit Program (Appendix II) that went into effect on July 1, 2008. It was created to comply with CIWMA and to divert salvageable materials from the city's only municipally operated landfill, Miramar Landfill. This landfill was expected to reach capacity and close between 2011 and 2013 unless action was taken to reduce the volume of materials being brought there. According to the City's Environmental Services Department, which oversees C&D ordinance compliance, an

[84] *"Construction & Demolition Recycling Guide."* County of San Diego, Department of Public Works. http://www.sdcounty.ca.gov/dpw/recycling/Files/Construction_Guide_SJ8_Pgs_1-27.pdf

[85] Personal contact with Stephanie Ewalt, Recycling Specialist II at the Division of Solid Waste Planning and Recycling, County of San Diego Department of Public Works, via phone and email, Feb. 2013.

estimated 35% of total waste disposed of at Miramar Landfill prior to the ordinance was recyclable C&D material, of which a significant portion was wood waste (Figure 2 and Appendix IV).

The City's ordinance requires that any "construction, demolition and remodeling projects requiring building, combination and demolition permits pay a refundable C&D Debris Recycling Deposit and divert at least 50% of their debris."[86] It promotes the use of salvaged C&D materials on-site and recommends that materials not retained on-site should be brought to a Certified Recycling Facility. According to Martha Espinola, Recycling Specialist III at the City of San Diego Environmental Services Department, 89% of total C&D projects for which a deposit refund was requested met the required 50% diversion rate within the first three years of establishment of the ordinance.[87]

According to the ordinance, contractors must:

- Ensure that at least 50% of all project debris is recycled, or reused on/off-site,
- Document and track C&D project materials by completing a Waste Management Form; collecting recycling, reuse and disposal receipts, and documenting materials salvaged through photographs,
- Determine whether C&D materials will be collected together in a mixed C&D load or be source separated, and
- Pass a final city inspection, after which they receive a debris deposit refund. If C&D projects do not meet the 50% recovery rate a pro-rated percentage of the initial deposit is refunded based on project recycling rates achieved.

City of San Diego's Mandatory Recycling Ordinance

In 2007 the city implemented a mandatory homeowner and business recycling ordinance that was phased in through 2010. According to Steven Grealy, the Deputy Director of the city's Waste Reduction and Disposal Division, the mandatory recycling ordinance alone would enable the Miramar Landfill to remain open and operational until 2019. It is expected that together the Construction and Demolition Debris Deposit Ordinance and the mandatory recycling ordinance will allow the landfill to remain operational even longer.

Source: http://www.kpbs.org/news/2010/jan/19/new-recycling-laws-take-effect/

In order to track C&D material diversion rates, the ordinance established guidelines for Certified Recycling Facilities (CRFs). Facilities that have become certified are required to maintain waste diversion data and calculated rates that must be updated every three months. Facilities that have been certified include municipal recycling stations, waste management facilities and waste transfer operations that have passed city inspection and certification. The City's Environmental Services Department oversees diversion rate tracking and has created a Historical Diversion Rates document depicting rates as of the ordinance's implementation (Appendix III). The document shows significant diversion rate growth between the ordinance's effective start in August 2008 through November 2012. As of the end of 2012 all certified operational mixed C&D processing and transfer facilities were diverting at least 70% of C&D materials received. The city tracks mixed C&D facility diversion rates but do not track diversion rates for any one particular category of waste (such as wood).

[86] http://www.sandiego.gov/environmental-services/recycling/cd/index.shtml

[87] Personal contact with Martha Espinola, Recycling Specialist III at the City of San Diego Environmental Services Department, via phone and email, Feb. and March 2013

The City's Environmental Services Department has contracted for waste composition studies of Miramar Landfill to determine material make-up and percentages. The most recent completed analysis was conducted from 1999-2000, before the C&D ordinance was implemented; that analysis found that 34.9% of the total waste stream consisted of C&D materials (Figure 2). Of the total C&D waste materials 9.1% consisted of wood (defined in the study as treated and non-treated lumber).[88] Of all waste materials measured, C&D waste accounted for the greatest volume, followed by paper at 21.2% (Appendix IV). Wood and wood-based products thus made up over one third of the municipal landfills' total composition. An updated waste composition study is currently in the final stages of analysis and should be released in early 2014.[85] The results of this unreleased study should show improved C&D and wood recovery rates in correlation with the Environmental Services Department's Historical Diversion Rates document (Appendix III) and C&D ordinance compliance rates.

The Bottom Line

Waste wood recovery plays a role in the larger goals of both San Diego County and the City of San Diego's C&D recovery ordinances. Both ordinances resulted from a California legislative act requiring broader statewide waste management goals. These ordinances play an important role in aiding the recovery, reuse and recycling rates of wood products and other waste stream materials. To ensure compliance, various tools, including educational materials and monetary incentives, were incorporated into each ordinance's approach. Since C&D waste often contains various wood products, these ordinances serve as examples for other cities, counties and states interested in methods of wood waste recovery.

Important Characteristics of the San Diego County and City's Approach to C&D waste management:

- Statewide regulations on diversion of C&D waste;
- Mandated waste management plans (for jurisdictions);
- Performance guarantee (refundable deposit) prior to issuance of building permit
- City ordinance
- Targets (%) for wood recovery
- Documentation and tracking of C&D project materials
- Tracking of waste diversion data
- Final city inspection

[88] Cascadia Consulting Group, Inc. *"Waste Composition Study 1999-2000: Final Report"* City of San Diego, Environmental Services Department. November 2000.

San Diego County – C&D Materials Diversion Program Ordinance

03/21/07 (4)

ORDINANCE NO. 9840 (NEW SERIES)

AN ORDINANCE ADDING SECTIONS 68.508 THROUGH 68.518 TO THE COUNTY CODE OF REGULATORY ORDINANCES RELATING TO DIVERSION OF CONSTRUCTION AND DEMOLITION MATERIALS FROM LANDFILL DISPOSAL

The Board of Supervisors of the County of San Diego ordains as follows:

Section 1. The Board of Supervisors finds and determines that Public Resources Code sections 41780 et seq., also known as the Integrated Waste Management Act, requires each local jurisdiction in the State to divert at least 50% of solid waste from landfills. Every city and county in California may face fines up to $10,000 a day for not meeting the State law requirement. Reusing and recycling construction and demolition debris is essential to reducing landfill solid waste disposal. Construction and demolition debris waste reduction and recycling programs have been proven to reduce the amount of solid waste deposited in landfills. Except in unusual circumstances it is feasible to divert 70 percent or more of all construction and demolition debris from construction and demolition projects.

Section 2. Title 6, Division 8, of the San Diego County Code of Regulatory Ordinances is amended to add Article II, as follows:

SEC. 68.508. PURPOSE

The purpose of this article is to establish the Construction and Demolition Materials Diversion Program in the unincorporated area of the County. This program is intended to increase diversion of construction and demolition materials from landfills, conserve landfill capacity, extend the useful life of local landfills and avoid potential consequences to the County if it fails to comply with State waste diversion requirements.

SEC. 68.509. DEFINITIONS

For the purposes of this Article, the following definitions shall apply:

(a) "Applicant" means a person who applies to the County of San Diego for a permit for an applicable project.

(b) "Applicable project" means a construction or demolition project subject to a threshold in section 68.510(a).

(c) "Chipping and grinding operation" means an operation or facility that does not produce compost or that mechanically reduces the size of or otherwise engages in the handling of compostable material.

(d) "Construction" means the act of building, making, erecting, remodeling, repairing, renovating, or improving a "structure," as that term is defined in the California Building Code and includes any project for which the County requires a building permit.

(e) "Construction and demolition debris" means nonhazardous waste building material, inert material, soil, packaging, green material and rubble resulting from construction or demolition.

(f) "Conversion rate" means the rate in the standardized Conversion Rate Table approved by the County pursuant to this article for use in estimating the volume or weight of materials identified in a Debris Management Plan (DMP).

(g) "Debris Management Plan (DMP)" means a plan for diverting construction or demolition debris required by this article.

(h) "DMP compliance official" means a person responsible for implementing this article.

(i) "DMP permittee" means a person who is required to divert construction or demolition waste under this article and who has an approved DMP.

(j) "Demolition" means the act of removing, razing or tearing down a structure or any portion of a structure.

(k) "Director" means the director of the County Department of Public Works.

(l) "Divert" means to reuse or recycle construction or demolition debris.

(m) "Diversion requirement" means the requirement in this article to divert a percentage of construction and demolition debris generated by an applicable project.

(n) "Green Material" means any materials related to land development such as yard trimmings, trees, brush and construction and demolition wood waste. Green material does not include food material, bio-solids, mixed solid waste material processes from co-mingled collection, wood containing lead-based paint or wood preservatives, mixed construction or mixed demolition debris.

(o) "Green material processing operations" means a facility or center that processes green material through composting, chipping or grinding operations.

(p) "Inert debris" has the same definition as the term is defined in California Code of

Regulations Title 14, section 17381(k)and means materials such as concrete, soil, asphalt, ceramics and masonry.

(q) "Permitted construction and demolition and inert recycling center" or "CDI center" means a facility or center for which the Local Enforcement Agency has issued an oversight permit to allow the facility or center to receive or process construction, demolition or inert debris.

(r) "Project" means any construction or demolition, which requires a building or demolition permit, or any similar permit.

(s) "Recycling" means the process of collecting, sorting, cleansing, treating and reconstituting materials that would otherwise become solid waste, and returning them to the economic mainstream in the form of raw material for new, reused, or reconstituted products which meet the quality standards necessary to be used in the marketplace.

(t) "Reuse" means further or repeated use of construction and demolition debris.

(u) "Salvage" means the controlled removal of construction and demolition debris from a permitted building or demolition site for the purpose of recycling, reuse, or storage for later recycling or reuse.

SEC. 68.510. THRESHOLD FOR APPLICABLE PROJECTS

(a) An applicable project shall be one in which the total square footage of demolition and/or construction is equal to or greater than 40,000 square feet. In measuring the square footage of a project each floor of a building shall be counted, not just the building's footprint. Projects shall also include paved areas, walkways, driveways, parking areas, decks, patios or any other landscape areas that are demolished, constructed, excavated and/or graded. For the purpose of determining whether a project meets the foregoing thresholds, all phases of a project and all related demolition, construction, excavation or grading occurring on the same or other parcels, as determined by a DMP compliance official, shall be deemed a single project.

(b) All construction and/or demolition projects conducted by the County shall be subject to the thresholds established by this article. The project lead or its contractor shall submit a DMP to the DMP compliance official prior to beginning any activities.

(c) All applicable projects shall comply with this article.

ATTACHMENT C
Section 68.512 incorporating Board Direction from February 28, 2007 (6)

SEC. 68.511 DEBRIS MANAGEMENT PLAN

(a) The County Department of Public Works shall be responsible to implement this article.

(b) An applicant for a project subject to a threshold in section 68.510 shall submit a completed County Debris Management Plan (DMP) with an application for a building permit and/or demolition permit to the Department of Public Works. The DMP shall provide the following information:

(1) The type of project;

(2) The total square footage of the project;

(3) The estimated volume or weight of project construction and demolition debris, by material type that the project will generate;

(4) The maximum volume or weight of construction and demolition debris that can feasibly be diverted via reuse or recycling;

(5) The estimated volume or weight of construction and demolition debris that will be disposed of in a landfill; and

(6) The name and address of any person and/ or recycling facility the applicant proposes to use to collect, process or receive construction and/ demolition debris the project will generate.

(c) The County shall prepare a list of recyclers who accept construction and demolition materials in the unincorporated and incorporated areas of the County. The County shall make the list available to any person upon request.

(d) The County shall prepare conversion rates tables that shall be used by an applicant to calculate the volume and weight of construction and demolition debris.

SEC. 68.512. PERFORMANCE GUARANTEE

(a) The applicant for any applicable project shall submit a performance guarantee to the Department of Public Works as a condition of a building or demolition permit.

(b) A performance guarantee may be in the form of any combination of the following: cash deposit, irrevocable letter of credit, assurance bond, or other recognized form of security the County determines is acceptable.

(c) Cash deposits for a performance guarantee shall be deposited in an interest bearing account and returned with interest, to the Debris Management Plan permittee upon the County's determination of full compliance, or prorated based on the degree of compliance. Any forfeited performance guarantee, including interest on a cash deposit will be used first to recover the County's administrative costs related to processing the DMP. Remaining funds shall be used only for programs to develop or improve the infrastructure for construction and demolition debris.

(d) The amount of a performance guarantee required shall be determined by the following schedule:

Performance Guarantee Values

Building Segment	Guarantee per Sq. Ft.	Maximum Guarantee per Structure
Residential	$0.20	125,000 detached 100,000 attached
Non-residential	$0.20	40,000 commercial 75,000 industrial

SEC. 68.513 DEBRIS MANAGEMENT PLAN

(a) During the first 12 months after the effective date of this article an applicable project shall recycle 90 percent of inert construction and demolition debris and 50 percent of all other construction and demolition debris. After this article has been in effect for 12 months an applicable project shall recycle 90 percent of inert debris and 70 percent or all other construction and demolition debris.

(b) Notwithstanding any other provision of this code, no building permit shall be issued for any applicable project unless a DMP compliance official has approved the Debris Management Plan (DMP). Approval shall not be required, however, when emergency demolition is required to protect public health or safety. A DMP compliance official shall approve a DMP if he determines that all of the following conditions have been met:

(1) The DMP provides all of the information required by section 68.511(b) and

(2) The DMP complies with subsection (a) above.

SEC. 68.514. INFEASIBILITY EXEMPTION

(a) If it is infeasible for an applicant for an applicable project to comply with all of the

requirements of section 68.513(a) the applicant may apply for an exemption. For the purposes of this section "infeasible" means that there is no recycling, salvage, or construction demolition inert processing (CDI) center or onsite reuse options for all or part of the construction or demolition debris a project will generate within a 50 mile radius of the project area, any location from which the applicant regularly operates it's business, or stores its construction or demolition equipment. The applicant shall apply for the exemption on a form provided by the County at that same time as the applicant submits the DMP required by section 68.511(b).

(b) If a DMP compliance official grants the applicant's request for an exemption, the official shall determine what percentage of construction and demolition debris the applicant is required to recycle. In reaching his determination, the official may consult with any State or local official and the applicant. The official shall issue his determination in writing and serve it under section 11.112 of this code.

(c) Within 15 days from the date the official serves the notice, the applicant shall submit a revised DMP or file an appeal under section 68.517.

SEC. 68.515. COMPLIANCE WITH DEBRIS MANAGEMENT PLAN

(a) For each construction or demolition site for which the DMP permit is issued, the DMP permittee shall maintain a daily log for all construction or demolition debris that leaves the site along with the corresponding receipts from any CDI center, recycling center, vendor, green materials operation or disposal or transfer station facility which accepted debris from the DMP permittee. The log and receipts shall contain the weight of the debris the facility accepted and whether the material was disposed in a landfill or recycled. The log shall be made available to any County inspector or DMP compliance official responsible to insure compliance with this article. The permittee's failure to have the log or the information required by this subsection available for inspection constitutes grounds for suspension of the DMP permit.

(b) After construction or demolition begins, a DMP permittee shall submit evidence to the DMP compliance officer demonstrating that the permittee is complying with the approved DMP. At the end of every quarter thereafter until 180 days after the County issues a certificate of occupancy or for a project with multiple phases, the last certificate of occupancy for the project, the DMP permittee shall submit proof of compliance with the DMP. The permittee shall submit quarterly reports according to the following schedule:

Timeframe	Due Date
January to March	April 15
April to June	July 15
July to September	October 15
October to December	January 15

The first report shall be submitted upon first quarterly due date following the project start date. Example: Project starts February 15th, first quarterly report due April 15th.

(c) Proof of compliance required to satisfy the permittee's obligation under subsection (a) above shall be the following:

(1) Receipts from each CDI center, recycling center, vendor, green materials operation and disposal or transfer station facility which accepted construction or demolition debris from the DMP permittee, that contain the weight of the debris the facility accepted and whether the material was disposed in a landfill or recycled.

(2) If a receipt from a recycling center or other facility in paragraph (1) does not contain a statement of the weight of the debris, the DMP permittee shall provide a print out or other verifiable statement of the weight of the debris, produced by a weighing device with a current registration certificate from the County Sealer.

(3) If it is impracticable to weigh the construction or demolition debris the DMP permittee shall measure the debris and submit a statement of the volume along with the calculation of the weight of the debris using the County's conversion rate table as referenced in section 68.511(d)

(4) If the material was reused onsite or collected by a third party for salvage, the DMP permittee shall provide a receipt or other proof of diversion including photos or any additional information relevant to determining compliance with the DMP.

(5) A statement from an authorized representative of the DMP permittee signed under penalty of perjury verifying that the information submitted to the County in compliance with subparagraphs (1)-(4) above is accurate.

(d) If a DMP compliance official determines the DMP permittee has complied with the DMP, the compliance official shall direct that the permittee's performance guarantee be released within 30 days of final DMP submittal. If the compliance officer determines the DMP permittee has not complied with the DMP, the compliance officer shall calculate the percent of the permittee's failure to comply and issue a forfeiture notice to the DMP permittee based upon a sliding scale. The compliance officer shall serve the permittee pursuant to section 11.112 of this code with a statement of compliance or a notice of forfeiture. The permittee shall have 15 days from the date a notice of forfeiture is served to file an appeal of the forfeiture under section 68.517.

SEC 68.516. COUNTY'S RIGHT TO MONITOR, INSPECT AND ENFORCE

(a) As an additional condition of approval of a DMP under section 68.513, the DMP permittee shall consent to allow the County the right to inspect any construction or

demolition site during normal business hours without notice. The DMP permittee shall have the required log available for inspection by the County inspector during normal business hours at each construction or demolition site as required to maintain under section 68.515(a).

(b) If a permittee or any of the permittee's agents or employees refuse to allow a County inspector to inspect the site or the permittee's log the County shall have the right to obtain an inspection warrant under Code of Civil Procedure sections 1822.50 et seq. and suspend the building permit. The County shall also have the right to suspend the permit if the permittee fails to maintain or have available a log required by this article, if the permittee violates any other provision of this article or if the permittee commits any other act which would be grounds for suspension of a building permit or demolition permit.

(c) If the County decides to suspend the permit under this section, the County shall issue a notice of suspension and serve the permittee under section 11.112 of this code. The suspension shall be effective 15 days from the date the County serves the notice of suspension unless the permittee appeals the notice of suspension under section 68.517, which stays the effective date of the suspension until the appeal is decided. If the County determines that any construction or demolition site is unsafe or that the permittee has knowingly failed to comply with section 68.515 the County may suspend the permit immediately and advise the permittee in the notice of suspension that the permit is suspended immediately and state the reasons for the immediate suspension. A notice of immediate suspension is also appealable under section 68.517, but an appeal does not stay the immediate suspension of the permit.

(d) It shall be unlawful for any permittee to continue to operate under a DMP in violation of subsection (c) above. A permittee who violates this section shall be guilty of a misdemeanor for each day the permittee operates in violation of subsection (c) above and upon conviction shall be fined in an amount not to exceed $500 or by imprisonment in the County Jail or both fine and imprisonment.

(e) In addition to prosecuting a permittee who violates subsection (c) above the County may seek injunction relief in any court of competent jurisdiction and civil penalties of up to $1000 a day for each day a permittee violates subsection (c).

(f) It shall also be unlawful for an applicant or a DMP permittee to knowingly provide false information to the County under this article. An applicant or permittee who knowingly provides false information under this article shall be guilty of a misdemeanor and upon conviction shall be fined in an amount not to exceed $500 or by imprisonment in the County Jail or both fine and imprisonment.

SEC. 68.517. APPEALS

The following appeals may be made to the director: (1) a denial of an infeasibility exemption under section 68.514, (2) forfeiture of performance guarantee under section

68.515 or (3) a suspension of the DMP permit under section 68.516. No other appeal shall be allowed under this article. A notice of appeal shall be in writing and filed with or mailed to the director within 15 days from the date the County served any appealable notice. The postmark on any mailed notice of appeal shall be deemed to be the date appellant filed a notice of appeal by mail. The director shall appoint an independent hearing officer to hear the appeal under procedures established by the director. The decision of the hearing officer shall be final.

SEC. 68.518. SEPARABILITY

If any section, subsection, subdivision, paragraph, sentence, clause or phrase of this Article, or any part thereof is for any reason held to be unconstitutional or invalid or ineffective by any court of competent jurisdiction, such decision shall not affect the validity or effectiveness of the remaining portions of this Article or any part thereof. The Board of Supervisors hereby declares that it would have passed each section, subsection, subdivision, paragraph, sentence, clause or phrase of this Article irrespective of the fact that one or more sections, subsections, subdivisions, paragraphs, sentences, clauses or phrases be declared unconstitutional or invalid or effective. To this end the provisions of this Chapter are declared to be severable.

Section 3. This ordinance shall take effect and be in force thirty days after its passage, and before the expiration of fifteen days after its passage, a summary hereof shall be published once with the names of the members of the Board voting for and against it in the San Diego Commerce, a newspaper of general circulation published in the County of San Diego.

APPROVED AS TO FORM AND LEGALITY
COUNTY COUNSEL
BY _____ DEPUTY

Source: http://www.sdcounty.ca.gov/reusable_components/images/dpw/recyclingpdfs/FinalCDord.pdf

City of San Diego – C&D Debris Diversion Deposit Program Ordinance

Article 6: Collection, Transportation and Disposal of Refuse and Solid Waste

Division 6:

Construction and Demolition Debris Diversion Deposit Program

("*Construction and Demolition Debris Diversion Deposit Program" added 10-10-2005 by O–19420 N.S.; effective until a certified recycling facility which accepts mixed construction and demolition debris is operating in the City at a 50% diversion rate.)*

(Amended 12-18-2007 by O-19694 N.S; effective 1-17-2008.)

§66.0601 Findings

The Council of the City of San Diego finds and declares that:

(a) The City operates the Miramar Landfill, which is currently the only municipal landfill in the City. The Miramar Landfill currently is expected to close between 2011 and 2013. Preserving landfill capacity at the Miramar Landfill in order to extend the useful life of the Miramar Landfill for the citizens of the City is a paramount concern.

(b) The City has made and continues to make progress in meeting the waste *diversion* requirements imposed by *AB 939*, but additional efforts, particularly in the *diversion* of *construction and demolition debris,* will assist the City in continuing to meet the goal of *diverting* 50% of its waste from landfill *disposal*.

(c) Studies show that approximately 35% of the waste generated in the City of San Diego delivered for *disposal* is *construction and demolition debris,* which could be *diverted* from landfill *disposal*.

(d) Efforts by the City and the private sector to encourage voluntary *construction and demolition debris diversion* have not been as successful as the City had hoped and additional efforts are necessary to ensure continued compliance with *AB 939* requirements.

(e) *Construction and demolition debris diversion* deposit programs in other jurisdictions in the State, similar to the one implemented by this Division, have proven successful in increasing *diversion* of *construction and demolition debris* and have been favorably received by the California Integrated Waste Management Board.

(Added 10-10-2005 by O–19420 N.S; effective 1-17-2008.)
(Amended 12-18-2007 by O-19694 N.S; effective 1-17-2008.)

§66.0602 Purpose of Construction and Demolition Debris Diversion Deposit Program

The purpose of this Division is to establish the Construction and Demolition Debris Diversion Deposit Program. This program is intended to increase the *diversion* of *construction and demolition debris* from landfill *disposal*, conserve the capacity and extend the useful life of the Miramar Landfill, and avoid the potential financial and other consequences to the City of failing to remain in compliance with *AB 939* requirements.

(Added 10-10-2005 by O–19420 N.S; effective 1-17-2008.)
(Amended 12-18-2007 by O-19694 N.S; effective 1-17-2008.)

§66.0603 Definitions

All defined terms in this Division appear in *italics* and are found in sections 11.0210, 66.0102, and 113.0103 of this Code, except for the terms Building Permit and Demolition/Removal Permit which refer to those terms respectively as used in the Land Development Code and which, consistent with the Land Development Code, are not italicized in this Division. In addition, whenever the following words or phrases are used in this Division, they mean:

AB 939 means the California Integrated Waste Management Act, codified at California Public Resources Code sections 40000 et seq.

Certified recycling facility means a recycling, composting, materials recovery or reuse facility which accepts *construction and demolition debris* and which has been certified by the *Director* pursuant to rules promulgated by the *Director*.

Construction and demolition debris means the waste building materials, packaging, and rubble resulting from construction, remodeling, repair, alteration, and/or demolition operations on pavements, houses, commercial buildings, and other *structures* and may include, but is not limited to, concrete, asphalt, wood, metals, bricks, dirt, rocks, and other inert waste.

Director means the Director of the Environmental Services Department (and its successor) or the designee of the Director of the Environmental Services Department (and its successor).

Disposal means the final deposition of *solid waste* at a permitted landfill.

Diversion or *Divert* means the reduction or elimination of *solid waste* from landfill *disposal*.

Hazardous waste has the same meaning as set forth in section 66.0102 of this Code.

Solid Waste means all putrescible and nonputrescible solid, semisolid, and liquid wastes, including, but not limited to, garbage, trash, refuse, paper, rubbish, ashes, industrial wastes, c*onstruction and demolition debris,* abandoned vehicles and parts thereof, discarded home and industrial appliances, dewatered, treated, or chemically fixed sewage sludge which is not hazardous waste, manure, vegetable or animal solid and semisolid wastes, and other discarded solid and semisolid wastes.
Solid Waste does not include hazardous waste, hazardous substances or medical wastes, as those terms are defined in this Chapter 6 or in State or Federal law.

Waste Management Form Part I means the form prepared by the City Manager on which an *applicant* for a Building Permit or Demolition/Removal Permit shall provide information including, but not limited to, the types and amounts of c*onstruction and demolition debris* the *applicant* anticipates the *development* will generate and the expected c*onstruction and demolition debris diversion* the *applicant* expects to achieve for that *development*.

Waste Management Form Part II means the form prepared by the City Manager on which the *applicant* for a Building Permit or Demolition/Removal Permit shall provide information including, but not limited to, the name and address of the *person* to whom a deposit refund, if any, shall be issued, as well as documentary evidence in a form satisfactory to the *Director* demonstrating the c*onstruction and demolition debris diversion* the *applicant* achieved for the *development*.

(Added 10-10-2005 by O–19420 N.S; effective 1-17-2008.)

Source: http://docs.sandiego.gov/municode/MuniCodeChapter06/Ch06Art06Division06.pdf

City of San Diego – Historical C&D Diversion Rates ('08 -'12)

City of San Diego Environemtnal Services Department

Certified Mixed C&D Processing Facilities
Historical Diversion Rates

Per the Construction and Demolition (C&D) Debris Deposit Ordinance, waste diversion rates for every Certified Mixed C&D Processing Facility are updated every three months. The following table contains the waste diversion rates for the facilities since the effective date of the C&D ordinance. The applicable waste diversion rate(s) for your project is/are determined by the date(s) on each of your receipt(s).

	CERTIFIED MIXED C&D PROCESSING FACILITIES				CERTIFIED MIXED C&D TRANSFER STATIONS				
Effective Date	SANCO Recovery Facility	EDCO CDI Recycling San Marcos	Waste Management Inc.	Otay CDI Processing Facility	EDCO Recovery & Transfer Station	EDCO Station La Mesa	Escondido Resource Recovery	Ramona Transfer Station	Fallbrook Refuse Service
7/1/2008	57%	72%			57%	57%	57%	57%	
9/4/2008	56%	66%			56%	56%	56%	56%	
11/21/2008	66%	64%			66%	66%	66%	66%	66%
2/11/2009	63%	73%			63%	63%	63%	63%	63%
6/19/2009	67%	74%			67%	67%	67%	67%	67%
6/30/2009	67%	74%	50%		67%	67%	67%	67%	67%
8/5/2009	67%	71%	60%		67%	67%	67%	67%	67%
11/6/2009	65%	73%	60%		65%	65%	65%	65%	65%
6/1/2010	62%	68%	60%		62%	62%	62%	62%	62%
8/6/2010	62%	68%	60%	50%	62%	62%	62%	62%	62%
8/16/2010	64%	69%	60%	50%	64%	64%	64%	64%	64%
10/26/2010	64%	69%	60%	56%	64%	64%	64%	64%	64%
11/30/2010	68%	67%	60%	56%	68%	68%	68%	68%	68%
2/15/2011	72%	63%	60%	68%	72%	72%	72%	72%	72%
3/14/2011	72%	63%	66%	68%	72%	72%	72%	72%	72%
5/24/2011	67%	70%	76%	83%	67%	67%	67%	67%	67%
8/24/2011	65%	64%	70%	86%	65%	65%	65%	65%	65%
12/6/2011	64%	70%	70%	84%	64%	64%	64%	64%	64%
1/10/2012	64%	70%	76%	84%	64%	64%	64%	64%	64%
2/22/2012	64%	84%	75%	82%	64%	64%	64%	64%	64%
5/2/2012	73%	66%	75%	85%	73%	73%	73%	73%	73%
6/11/2012	73%	66%	51%	85%	73%	73%	73%	73%	73%
8/14/2012	70%	75%	55%	76%	70%	70%	70%	70%	70%
9/10/2012	70%	75%	Closed	76%	70%	70%	70%	70%	70%
11/14/2012	70%	81%	Closed	80%					

Source: http://www.sandiego.gov/environmental-services/pdf/recycling/cdmixedcertregs.pdf

TABLE 4: OVERALL COMPOSITION OF DISPOSED SAN DIEGO WASTE

Calculated at 90% confidence interval	Percent	+ / -	Tons
PAPER	**21.2%**		**356,578**
Uncoated Corrugated Cardboard	5.1%	0.6%	85,299
Waxed Corrugated Cardboard	0.6%	0.5%	9,680
Paper Bags	0.5%	0.1%	9,063
Newspaper	3.7%	0.3%	61,961
White Ledger Paper	1.2%	0.2%	20,046
Colored Ledger Paper	0.3%	0.2%	4,215
Computer Paper	0.1%	0.0%	1,148
Other Office Paper	0.4%	0.1%	6,540
Magazines and Catalogs	0.9%	0.1%	15,602
Phone Books and Directories	0.3%	0.1%	5,125
Other Miscellaneous Paper	3.3%	0.5%	54,918
Remainder/Composite Paper	4.9%	0.5%	82,981
GLASS	**2.1%**		**34,626**
CRV Clear Bottles	0.5%	0.1%	7,757
Non-CRV Clear Bottles and Containers	0.3%	0.1%	5,869
CRV Brown Bottles	0.2%	0.0%	3,923
Non-CRV Brown Bottles and Containers	0.0%	0.0%	422
CRV Other Colored Bottles	0.3%	0.1%	5,534
Non-CRV & Other Colored Bottles and Containers	0.1%	0.0%	1,449
Flat Glass	0.4%	0.3%	7,361
Remainer/Composite Glass	0.1%	0.0%	2,310
METAL	**5.2%**		**86,682**
Tin/Steel Cans	0.6%	0.1%	9,480
Major Appliances	0.0%	0.0%	727
Other Ferrous Metal	2.6%	0.7%	43,525
CRV Aluminum Cans	0.2%	0.0%	2,558
Non-CRV Aluminum Cans	0.0%	0.0%	257
Other Non-Ferrous Metal	0.3%	0.1%	4,863
Remainder/Composite Metal	1.5%	0.4%	25,272
PLASTIC	**5.9%**		**98,545**
CRV HDPE Containers	0.2%	0.0%	3,914
Non-CRV HDPE Containers	0.1%	0.0%	1,391
CRV PETE Containers	0.1%	0.0%	1,347
Non-CRV PETE Containers	0.3%	0.0%	4,970
Miscellaneous Plastic Containers	0.4%	0.1%	6,383
Film Plastic	2.8%	0.3%	46,649
Durable Plastic Items	0.9%	0.2%	15,357
Remainder/Composite Plastic	1.1%	0.1%	18,533
Sample Count	**1,361**		

	Percent	+ / -	Tons
ORGANIC	**20.3%**		**341,874**
Food	8.3%	0.7%	139,758
Leaves and Grass	4.2%	0.7%	70,193
Prunings and Trimmings	3.0%	0.5%	50,334
Branches and Stumps	0.9%	0.2%	15,661
Agricultural Crop Residues	0.0%	0.0%	0
Manures	0.0%	0.0%	210
Textiles	1.4%	0.2%	22,754
Diapers	1.2%	0.2%	19,740
Remainder/Composite Organic	1.4%	0.2%	23,226
CONSTRUCTION & DEMOLITION	**34.9%**		**586,157**
Concrete	4.1%	0.7%	69,435
Asphalt Paving	0.5%	0.2%	8,496
Asphalt Roofing	2.5%	0.6%	41,197
Non-Treated Lumber	3.8%	0.8%	63,628
Treated Lumber	5.3%	0.6%	89,778
Gypsum Board	2.6%	0.3%	43,333
Rock, Soil and Fines	9.4%	0.8%	157,887
Contaminated soil, street sweepings, drain cleanings	1.1%	0.3%	18,014
Carpet & Carpet Padding	3.0%	0.9%	50,463
Remainder/Composite Construction and Demolition	2.6%	0.4%	43,927
HOUSEHOLD HAZARDOUS	**0.1%**		**2,232**
Paint	0.0%	0.0%	144
Vehicle and Equipment Fluids	0.0%	0.0%	36
Used Oil	0.0%	0.0%	157
Batteries	0.1%	0.0%	1,053
Remainder/Composite Household Hazardous	0.1%	0.0%	841
SPECIAL WASTES	**9.3%**		**155,954**
Ash	0.0%	0.0%	478
Sewage Solids	7.2%	0.0%	120,560
Industrial Sludge	0.2%	0.2%	3,219
Treated Medical Waste	0.1%	0.2%	2,073
Bulky Items	1.3%	0.4%	21,275
Tires	0.1%	0.1%	1,771
Remainder/Composite Special Waste	0.4%	0.1%	6,578
MIXED RESIDUE	**1.0%**		**17,562**
Mixed Residue	1.0%	0.1%	17,562
Total Percent	100.0%		
Total 1999 Tons			**1,680,211**

Source: Cascadia Consulting Group, Inc. *"Waste Composition Study 1999-2000: Final Report"* City of San Diego, Environmental Services Department. November 2000.
http://www.sandiego.gov/environmental services/pdf/geninfo/00wastecompstudy.pdf

C&D Waste Recycling in the City of Edmonton and Province of Alberta, Canada

Introduction

Wood recovery programs operated by private companies, non-profits, and government agencies take many shapes and forms. Price and market incentives can be used to promote the growth of such programs and education plays a key role in program adoption. The following examples depict strategies developed in the province of Alberta, Canada and focus on a municipally operated waste management facility in Edmonton and a provincial construction and demolition (C&D) waste reduction proposal. Both seek to dramatically reduce C&D waste volumes in order to manage landfill capacities and divert used materials that have potential resale value.

Edmonton C&D Facility

The City of Edmonton reports having North America's largest collection of modern, sustainable waste processing and research facilities at its Edmonton Waste Management Centre (EWMC). The center contains waste facilities geared toward household recyclables, composting, electronic waste recycling, residential waste, C&D recycling, and landfill gas recovery. Additional facilities under construction as of 2012 include a closed loop paper and glass facility that recycles waste materials into new products, and a waste-to-biofuels facility.

Fairly new to the EWMC is the Construction and Demolition Waste Recycling Facility (CDWRF), which opened in January 2012. The CDWRF serves as a waste management facility for construction and demolition professionals and provides them with competitive dumping fees for recovered C&D wastes (see sidebar). Wood waste is accepted at the facility and can include unpainted, untreated dimensional lumber, plywood and oriented strand board. At least 75% of each individual load dumped at the CDWRF must contain some combination of wood, metal, drywall, asphalt/concrete, asphalt shingles, cardboard or paper.[89]

Edmonton Dumping Fees and CDWRF Operations

Commercially Hauled Waste at Landfills
- Flat rate of $80/ton

Mixed Materials at CDWRF
- Flat rate of $60/ton

Segregated Materials at CDWRF
- Wood (unpainted, untreated): $40/ton
- Drywall (unpainted): $40/ton
- Asphalt Shingles (nails ok): $40/ton
- Concrete (no reinforced steel): No fee
- Metals (ferrous & non-ferrous): No fee
- Brush/Trees (w/minimal soil): No fee

C&D Material Streams Segretated for Recovery at CDWRF:
- Cardboard, asphalt shingles, drywall, metals, untreated wood (e.g., diminsional lumber), treated wood (e.g., OSB, laminate)
- Concrete/asphalt
- Other potentially marketable materials (e.g., carpet underlays)
- Unsorted residuals suitable for Refuse-Derived Fuel

Two options are provided for recycling at the facility – mixed or segregated, to attract a larger array of C&D industry professionals. Disposal fees for segregated materials are at least $20 per ton less than for mixed loads and some segregated materials are accepted at no charge. However, even mixed load disposal fees are still a cheaper alternative for C&D industry professionals than simply dumping material at landfills (see sidebar).[90]

[89] http://www.edmonton.ca/for_residents/garbage_recycling/construction-and-demolition-materials-recycling.aspx
[90] http://www.edmonton.ca/for_residents/garbage_recycling/disposal-rates.aspx

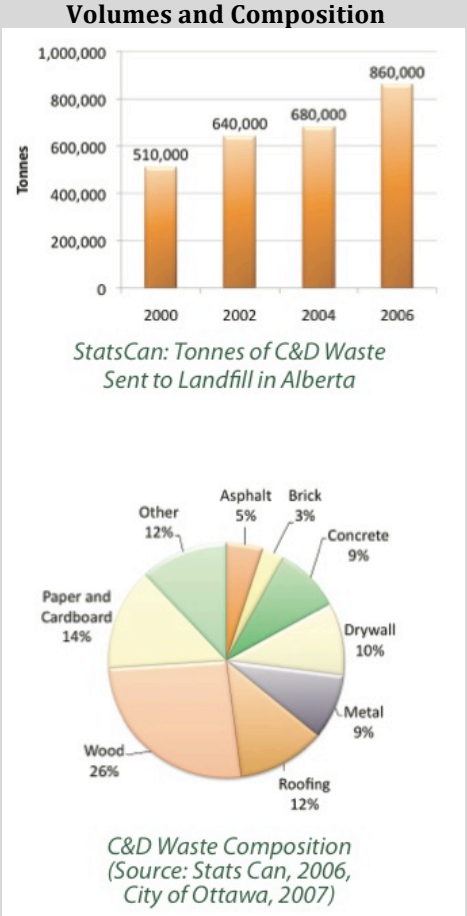
The C&D facility was created at EWMC in order to continue Edmonton's green waste management policies and expand the type and amount of materials received and processed for reuse. By creating the CDWRF, the City has reduced a large category of waste materials typically dumped at landfills while creating a market for the final processed goods. The City encourages the use of the facility by reducing tipping fees to contractors and building developers and by creating the opportunity for them to meet green building program requirements. The newly operational facility can aid building projects seeking to obtain the LEED 50% or 75% waste diversion credits.[91]

The CDWRF has the ability to collect and process nearly 100,000 tons of mixed C&D material annually, of which 70% is expected to be recovered.[91] The facility utilizes mechanical and manual sorting to separate mixed loads of material into re-usable commodities.

The downstream uses of recovered materials include:

- Use of untreated wood (e.g., dimensional lumber, trees and brush) in composting
- Use of drywall as a compost amendment
- Re-cycle of asphalt shingles into asphalt production
- Re-cycle of concrete/asphalt by crushing and use as roadway base
- Recovery of metals for sale to metal recyclers
- Marketing of cardboard and paper for recycling
- Use of other wood materials as feedstock at biofuels facility

Figure 1. Alberta C&D Waste Volumes and Composition



Source: Alberta Environment. *"Construction and Demolition Waste Reduction Program".* http://environment.alberta.ca/documents/Construction-Demolition-program-backgrounder.pdf

The City of Edmonton Waste Management Services expects the new C&D facility to divert at least 50% of the city's C&D materials from its landfills.[92] These efforts in Edmonton, Alberta's capital, and second largest city, complement additional measures undertaken by the Province to reduce total waste volumes.

[91] City of Edmonton, AB. "New Recycling Facility Cuts Construction and Demolition Waste Going to Landfill." March 5, 2012. http://www.edmonton.ca/city_government/news/2012/new-recycling-facility-cuts-construction-waste.aspx

[92] Lee, Melanie. *"Construction and Demolition Waste Sorting Facility."* Waste Management Services, City of Edmonton. Presentation at SWANA Northern Lights Chapter Conference, March 12-14, 2012. www.swananorthernlights.org/brandon2012/proceedings/4b/SWANA%20Presentation_March14.12%20MELANIE%20LEE.pdf

Alberta C&D Waste Reduction

According to estimates by the Alberta Ministry of Environment and Sustainable Resource Development (AMESRD) no more than 10% of total C&D materials produced in the province are currently recycled, even though existing recycling facilities have the capacity to divert more of these materials.[93] Furthermore, they report that 25% of total provincial municipal solid waste sent to landfills in Alberta consists of C&D materials, a volume is continuing to grow (Figure 1). Research also shows that within the C&D waste stream wood and wood products account for 40% of the total composition and are the top two disposed C&D materials (Figure 1).

Additionally, according to a 2006 report by Statistics Canada, Alberta has the highest per capita waste disposal volume in Canada, with an average of more than 1,100 kilograms (roughly 2,425 pounds) of waste generated annually per person.[94] Figure 2 depicts provincial solid waste volumes per capita in 2004 and reinforces the fact that Alberta leads the country. To address these issues, the AMESRD has been working on a provincial C&D waste reduction proposal for over ten years.

Provincial subsidization of disposal infrastructure in Alberta has made waste disposal economical for waste generators and haulers. Additionally, private landfills that manage waste from specific industrial sectors compete with municipal landfills, resulting in low tipping fees. Combined, these two factors have encouraged waste disposal over recovery.[95] This has contributed to the rise of C&D materials sent to landfills.

In 1999, AMERSD decided to focus its attention on C&D materials recovery and landfill diversion and created a C&D Waste Reduction Advisory Committee that was tasked with identifying barriers and opportunities for construction industry waste reduction. The committee worked on raising awareness of C&D materials recovery and encouraging voluntary efforts, yet despite these efforts overall amounts of C&D materials sent to landfills continued to rise.[96] As a result, the committee decided to take more aggressive action.

The committee then commissioned research to identify potential C&D material waste reduction and diversion possibilities. The resulting report was released in April of 2006, and was followed by workshops with building contractors, engineers, architects, municipal government, landfill operators, recyclers and others to discuss report recommendations.[95] Feedback from these workshops then led to the creation of a Memorandum of Understanding and technical advisory group.

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[93] http://www.environment.alberta.ca/02794.html

[94] Cryderman, Kelly. *"Builder Waste Clogs Landfills as Alberta Recycling Initiative Stalls."* Calgary Herald. August 13, 2010. http://www.awrrecycle.com/news.html

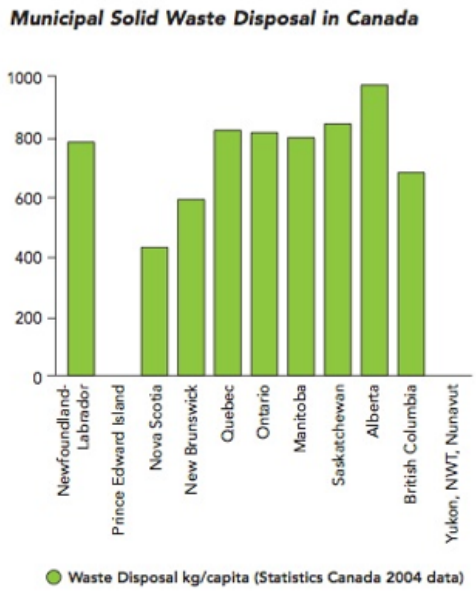
[95] Source: Alberta Environment. *"Too Good to Waste: Making Conservation a Priority."* 2007. http://environment.gov.ab.ca/info/library/7822.pdf

[96] Alberta Environment and Sustainable Resource Development. *"Construction and Demolition Waste Reduction Program."* *http://environment.alberta.ca/documents/Construction-Demolition-program-backgrounder.pdf*

In 2008, a Memorandum of Understanding was signed between AMESRD, the Alberta Construction Association, and the Canadian Home Builders' Association-Alberta Chapter stating that the involved parties agreed to work together toward developing a proposal focused on a regulated C&D waste recovery program. Additional parties including industry representatives, local government officials, environmental and non-government organizations and AMESRD staff members formed a technical advisory group to develop the proposal. The technical advisory group conducted research, developed financial models and held consultations to aid the process. The Memorandum of Understanding is significant because it represents the first time in Canada that voluntary agreements between industry and government have occurred involving C&D waste reduction.[97]

In 2009, the technical advisory group conducted focus groups throughout Alberta with commercial and residential construction industry representatives, C&D recyclers, waste haulers and landfill managers. Feedback received at the meetings was used to further develop and refine the proposal. Despite rising annual C&D waste landfill volumes in Alberta (Figure 1) and the advisory group's C&D proposal efforts, legislation addressing provincial C&D waste reduction has not yet been approved.[98]

Figure 2. 2004 Provincial Municipal Solid Waste Volumes



Source: Alberta Environment. *"Too Good to Waste: Making Conservation a Priority."* 2007. http://environment.gov.ab.ca/info/library/7822.pdf

According to Christina Seidel, Executive Director of the nonprofit Recycling Council of Alberta, the Province is presently very much in a mindset of no new taxes. This is underscored by a pledge on the part of Ed Stelmach, Alberta's last Premier, that there would be no new programs requiring additional taxes or regulatory reform during his term. This stance continues to be held by the current Premier, Alison Redford. As a result, Alberta will most likely not institute a C&D waste reduction program in the near future, even though extensive consultation has occurred between parties representing local government officials, industry, non-profits, environmental organizations and local citizens.[99]

Although Alberta has not been able to pass C&D waste reduction legislation it has developed guidelines and recommended acceptable industry practices for disposal of some C&D waste

[97] Jeffery, Colin. *"Construction and Demolition Waste Recycling: A Literature Review."* Dalhousie University's Office of Sustainability. September 2011. http://www.dal.ca/content/dam/dalhousie/pdf/sustainability/Final%20C&D%20literature%20review.pdf

[98] The report, titled *"Construction, Renovation and Demolition Waste Materials: Opportunities for Waste Reduction and Diversion"* can be found on the AESRD website: http://www.environment.gov.ab.ca/info/library/7703.pdf

[99] Phone conversation with Christina Seidel on 3/12/13

materials. Appendix I provides an example of acceptable industry practices for the management of chemically treated wood waste.

Seidel hopes the work that has already been done to create a framework for potential C&D waste reduction legislation will enable other jurisdictions to create and pass something similar, and states that the Alberta example has dramatically raised the profile of the C&D waste stream. As a result, the city of Calgary has proposed a similar C&D initiative.

The Bottom Line

Wood materials recovery and recycling play a large role at the City of Edmonton's Construction and Demolition Waste Recycling Facility (CDWRF). The recycling facility helps to reduce total municipal waste stream volume, provide the city with green jobs, aid the city's green credentials, and provide contractors and developers with economically beneficial business options and incentives. While the Alberta C&D waste reduction proposal has yet to pass the legislature, despite being backed by vested interests including industry and local government representatives, the province does seek to improve and promote C&D waste recovery at municipal landfills. These examples depict what can be done at various levels (i.e., local, city and provincial/state levels) to improve wood recovery by focusing on a specific waste stream (C&D).

BENEFITS OF EDMONTON C&D FACILITY

- Reduced tipping fees
- Landfill space saved
- Useful life of the landfill is extended
- Makes it easier for developers to acquire LEED diversion credits
- Recovers materials and provides them for reuse
- Reduces the need for virgin material extraction

BARRIERS TO RECOVERING C&D WASTE IN ALBERTA

- Existing subsidized disposal infrastructure
- Existing low waste tipping fees

BARRIERS CONTRIBUTING TO NON-ADOPTION OF PROVINCE-WIDE C&D WASTE REDUCTION PROGRAM:

- Current governments' stance
- Potential increase in regulatory measures

Acceptable Industry Practices, Chemically Treated Wood

Chemically Treated Wood Waste

ACCEPTABLE INDUSTRY PRACTICES

February 2012

Chemically treated wood including telephone/power poles or railway ties are not classified as hazardous waste and can be disposed of in Class I or Class II landfills provided that prior landfill operator permission is obtained.

Chemically treated wood waste is not an inert waste and should never be burned in open fires or disposed of in Class III landfills.

Overview

This document describes Alberta Environment and Sustainable Resource Developments recommended management when dealing with chemically treated wood waste resulting from wood previously treated with creosote, pentachlorophenol (PCP), chromated copper arsenate (CCA), copper naphthenate (CN), ammoniacal copper arsenate (ACA), ammoniacal copper zinc arsenate (ACZA), or other chemical preservatives. The first three are oilborne wood preservatives and the other three are waterborne formulations.

Legal Framework and Waste Classification

The *Alberta User Guide for Waste Managers* states that wood treated with wood preservatives or wood protection products registered under the Canadian *Pest Control Products Act* is not a hazardous waste. Creosote, PCP, CCA, CN, ACA, and ACZA are products registered under this Act. Therefore, chemically treated wood including telephone/power poles or railway ties are not classified as hazardous waste and can be disposed of in Class I or Class II landfills provided that prior landfill operator permission is obtained.

Management of Treated Wood Waste

The potential health and environmental impacts associated with the improper management of chemically treated wood waste demands the adoption of recycling, treatment and disposal practices that include:

- Recycling or additional use under controlled conditions,
- High temperature incineration with stabilization of the resulting ash residue when necessary, or
- Landfill disposal at Class I or II landfills.

Chemically treated wood waste is not an inert waste and should never be burned in open fires or disposed of in Class III landfills.

Additional information on the management practices for treated wood is available from the Canadian Council of Ministers of the Environment's (CCME) publication entitled *Provisional Code of Practice for the Management of Post-Use Treated Wood*. Copies are available by contacting the CCME at 1-800-805-3025 or on-line at www.ccme.ca/publications.

Post-Use of Chemically Treated Wood

Creosote is a complex mixture of about 200 organic chemicals that is used primarily by the industry to preserve wood products such as railway ties and power poles. Under warm weather conditions, creosote tends to create odors and exude from the treated wood. Therefore, the use of creosote-treated wood should never occur indoors and should be avoided in outdoor areas frequented by people, specifically children, or animals.

Concerns raised by the use of PCP treated wood stemmed from the potential for the formation of small amounts of dioxins and dibenzofurans when burned in uncontrolled conditions. The immediate environmental and health impacts of PCP are less evident than those associated with creosote treated wood but are generally more serious. PCP is not very soluble in water and leaches from treated wood at very low rates. Consequently, its reuse, mainly in landscaping, is generally acceptable provided that the exposure to potential receptors is minimized. Additional problems arise with the uncontrolled burning of CCA treated wood because the ash residue contains relatively high levels of copper, chromium, and arsenic.

Summary:

- Post-used treated wood is not a hazardous waste in Alberta;
- Treated wood should be recycled or re-used, disposal is the last option;
- Treated wood waste can be disposed of at Class I or Class II landfills; and
- Burning of chemically treated wood is only acceptable in high temperature incinerators. The resulting ash may require stabilization depending on the wood preservatives.

For more information call the Information Centre
at 780-427-2700 (outside Edmonton dial 310-0000)

Alberta Government

Source: http://environment.gov.ab.ca/info/library/7644.pdf

Fast-Track Deconstruction Initiatives (Seattle, WA and Vancouver, BC)

The cities of Seattle and Vancouver are working to reduce the amount of construction and demolition (C&D) waste that ends up in their respective landfills. Both communities are taking the approach of addressing all forms of C&D waste and opportunities for reuse and recycling. The deconstruction programs are aimed at the construction and building development industries, with some consideration given to homeowners and citizen engagement. Early site access during deconstruction is key since the process is much more time and labor intensive than traditional demolition. As a result, contractors and developers may begin the deconstruction process before receiving their building permit, allowing them the additional time needed to fully maximize the amount of materials recovered.

Seattle, WA

Since the turn of the 21st century the city of Seattle, Washington's local government has pushed for a stronger focus on green building. In 2000 the City's Department of Planning and Development (DPD) created a City Green Building Program as a way to green city-owned buildings. In 2006, to expand Seattle's green building commitment, the program's reach was expanded to include the greening of the city's entire built environment.[100] As a result of this new commitment, the DPD introduced a pilot program in August 2008 called Priority Green. The pilot program was created as a collaborative effort between the DPD's permitting operations and its City Green Building team and seeks to promote and encourage development projects that showcase high-energy performance and sustainable construction practices.[101] Deconstruction practices and the reuse/recycling of materials are integral components of the Priority Green program.

In order to achieve its goals, the pilot program provides various incentives and tools to applicants, including:

- A single DPD contact person for applicants
- Code and process assistance,
- High performance building expectations and goals,
- An integrated permitting process, and
- A list of financial incentives from other city departments.[101]

Components of the Priority Green Program include the following:

- *Priority Green Expedited* – an expedited green building permitting process,
- *Priority Green Facilitated* – an initiative that provides public assistance to innovative green construction projects, and
- *Priority Green Tools* – building code initiatives that provide public technical assistance for green building innovation, zoning changes and deconstruction.[102]

The *Priority Green Tool* that promotes wood recovery, reuse and recycling is the residential deconstruction incentive. This new permitting option provides early site

[100] http://www.seattle.gov/dpd/GreenBuilding/OurProgram/default.asp
[101] http://www.seattle.gov/dpd/news/20090203c.asp
[102] http://www.seattle.gov/dpd/Permits/GreenPermitting/Overview/default.asp

access to building contractors and developers doing residential deconstruction activities as long as building permit applications have been submitted for approval.[103] As a result, contractors and developers may begin the deconstruction process before receiving their building permit, allowing them the additional time needed to fully maximize the amount of materials recovered.

Recovering materials gained during deconstruction reduces the amount of construction waste sent to landfills as compared to the traditional demolition processes. It also reduces demand for virgin material extraction and energy required to process and transport such materials. Thus, the deconstruction process aids applicants, promotes the city's green building and environmental health programs, and educates the public while reducing material waste.

According to the DPD, deconstruction applicants must meet the following requirements:

- One hundred percent of asphalt, brick and concrete will be reused, recycled or beneficially used.
- A minimum of twenty percent of the building materials, by weight, (excluding asphalt, brick and concrete) will be reused.
- A minimum of fifty percent of the building materials, by weight (excluding asphalt, brick and concrete) will be reused, recycled or beneficially used.

In the deconstruction requirements listed above wood is grouped into the larger term "building materials". The city does not include wood in the third requirement because used wood building materials can contain hazardous chemicals and/or paints which make it unusable, or nails and other metals which make it more labor intensive to reuse or recycle. According to the DPD's Director's Rule 4-2009[104], "**beneficial use"** is defined as "the use of solid waste as an ingredient in a manufacturing process, or as an effective substitute for natural or commercial products, in a manner that does not pose a threat to human health or the environment. Avoidance of processing or disposal cost alone does not constitute beneficial use."

In order to track the deconstruction requirements the city requires permit applicants to submit a final Waste Diversion Report upon completion of deconstruction practices verifying actual rates of recovered materials.

Priority Green as a whole is promoted through an interdisciplinary public-private partnership program named the Seattle 2030 District. According to their website, the Seattle 2030 District is a "groundbreaking high-performance building district in Downtown Seattle that aims to dramatically reduce environmental impacts of building construction and operations through education and collaboration across every sector of the built environment."[105] In order to achieve this goal, the project aims to educate and inform property owners, managers, contractors, building developers and tenants of applicable techniques and tools that can be used to reduce a building's environmental impact. Deconstruction plays a large role in reducing built structure environmental

[103] http://www.seattle.gov/dpd/Permits/GreenPermitting/Residential_Deconstruction/default.asp
[104] Details included at the end of the case study.
[105] http://www.2030district.org/seattle/about

impacts at the end of life and beginning of new construction. Priority Green and deconstruction are heavily promoted within the Seattle 2030 District plan as a way to divert C&D materials, reduce landfill volumes, and reduce the need for virgin material extraction.

Vancouver, BC

The City of Vancouver supports wood recovery by offering its citizens an expedited deconstruction program that includes discounted waste tipping fees, which began in 2011.[106] In order to obtain an expedited deconstruction permit contractors must commit to diverting at least 75% of all building materials from any given project, excluding hazardous and banned ones, during the deconstruction process. If 75% of materials cannot be recovered, contractors must apply for a demolition permit instead.

Once obtained, the deconstruction permit also allows a contractor to receive a 50% reduced landfill fee for dumping up to 15 tons of deconstruction materials that cannot be recycled or reused. Additionally, a deconstruction permit allows contractors to start the process earlier than if the demolition route had been chosen. Deconstruction permits are given in advance of building/development permits whereas demolition permits are typically given at the same time.

According to the City of Vancouver, an estimated 22% of waste located at their Lower Mainland landfill currently comes from local construction and demolition waste.[107] To reduce this waste the City promotes and encourages deconstruction using its fast-track deconstruction permitting process and its related monetary incentives. The City also provides deconstruction resources on its website, which includes the following:

- A list of salvage contractors, deconstruction contractors, recycling haulers and depots throughout greater metropolitan Vancouver,
- A demolition, land clearing and construction waste management toolkit,
- A directory of materials banned and prohibited from disposal, and
- A database of local recycling facilities.

In addition to promoting expedited permitting and reduced landfill tipping fees to contractors doing deconstruction, the city promotes another main benefit that deconstruction provides – the ability for contractors to green their businesses. By applying for deconstruction permits instead of demolition permits, contractors can divert waste, earn eligible LEED diversion points for their projects, create green jobs, and aid the city in promoting and achieving its Greenest City 2020 goals.[107]

The Greenest City 2020 Action Plan was devised as a way to propel Vancouver toward becoming the greenest city in the world by the year 2020.[108] In order to achieve this goal the plan focuses on three broad themes – *Zero Waste, Zero Carbon,* and *Healthy Ecosystems*. Within the *Zero Waste* category, Green Demolition Practices were a priority action that aided the city in developing a program encouraging deconstruction. As of

[106] http://vancouver.ca/home-property-development/demolition-deconstruction-permit.aspx
[107] http://vancouver.ca/home-property-development/green-demolition-practices.aspx
[108] http://vancouver.ca/green-vancouver/a-bright-green-future.aspx

October 2012 the Green Demolition Practices priority action had been fully implemented. The *Zero Waste* category also promotes green economy growth and lighter ecological footprints, both of which are aided through deconstruction practices. Similar to Seattle, Vancouver promotes materials reuse and recycling through a stand-alone deconstruction program that is integrated into a larger environmentally focused program with further reaching goals.

Another one of the key actions of the *Zero Waste* category is to reduce, reuse, and recycle more construction, renovation and demolition waste. According to the city, approximately 76% of C&D waste currently generated is recycled or, in the case of wood, used for energy.[109] The city recognizes that there is more that can be done to achieve the *Zero Waste* goal including "reducing barriers to increase the salvage[110] and reuse of building materials in construction projects; pursuing options for waste reduction and recycling options at job sites, including regulation and financial incentives; and establishing more collection locations for clean wood.[111]"

Another resource produced by the city in 2010 geared specifically toward homeowners is a publication titled "Salvage and Reuse: green home renovation, healthy homes for a healthy environment".[112] This publication promotes deconstruction material recovery, reuse and recycling. According to the publication, in 2007 (prior to the fast-track deconstruction permitting process) the C&D industry sent 375,000 tons of waste to landfills in Metro Vancouver, "much of which was wood waste".

The Bottom Line

The cities of Seattle and Vancouver are reducing the amount of C&D waste that ends up in their respective landfills. Both communities are taking the approach of addressing recovery of all forms of C&D waste and opportunities for reuse and recycling.

IMPORTANT STRATEGIES TO SUPPORT FAST TRACK DECONSTRUCTION:

- Early site access
- Deconstruction permit provided before building/development permit
- Material recovery goals
- "Stand alone" deconstruction program

POTENTIAL BENEFITS AND CHALLENGES OF FAST TRACK DECONSTRUCTION:

- Reduced environmental impact
- Creation of green jobs
- Potential to earn LEED diversion points
- Saving landfill space
- Requires additional time, planning ,and potential costs
- Requires coordination between parties

[109] http://vancouver.ca/files/cov/gc2020-goal5.pdf
[110] Salvage here is used in reference to the recovery of C&D materials
[111] Clean wood refers to untreated lumber
[112] http://vancouver.ca/home-property-development/12228.aspx

DPD Director's Rule 4-2009

Applicant: City of Seattle Department of Planning and Development	**Page** 1 of 2	**Supersedes:**
	Publication: 2/9/09	**Effective:** 2/27/09
Subject: Demolition Permit with a Waste Diversion Plan	**Code and Section Reference:** SMC 23.40	
	Type of Rule: Code Interpretation	
	Ordinance Authority: SMC 3.06.040	
Index: Demolition, Building Materials, Deconstruction, Salvage, Waste Diversion	**Approved** **Date** (signature on file) Diane M. Sugimura, Director, DPD	

PURPOSE

Pursuant to Seattle Municipal Code (SMC) 23.40.006 C, DPD may issue a demolition permit for a structure containing a dwelling unit if:

1. A complete building permit application for construction of a new principal structure on the same lot as the structure to be demolished has been submitted to the Director;
2. The demolition permit application and the building permit application are categorically exempt from review under SMC Chapter 25.05 (the City's State Environmental Policy Act provisions);
3. The issuance of some other approval is not required by Title 23 or Title 25 as a condition to issuing the demolition permit; and

Director's Rule 4-2009 – Demolition Permit with a Waste Diversion Plan

4. The Director has approved a waste diversion plan.

Pursuant to SMC 23.40.007, DPD must promulgate rules that define the requirements of an acceptable waste diversion plan. The purpose of this rule is to provide that definition.

DEFINITIONS

"Beneficial use" means the use of solid waste as an ingredient in a manufacturing process, or as an effective substitute for natural or commercial products, in a manner that does not pose a threat to human health or the environment. Avoidance of processing or disposal cost alone does not constitute beneficial use.

"Building materials" means all components of the structure for which the demolition permit is sought, including (but not limited to) such material as concrete, drywall, asphalt, wood, masonry, roofing (including composition roofing), siding, metal, wire, and insulation. "Building materials" also include (but are not limited to) such discrete elements of structures as cabinets, fixtures, flooring, dimensional lumber, doors, siding, and windows.

"Recycling" or "recycle" means transforming or remanufacturing waste materials into usable or marketable materials for use other than incineration (including incineration for energy recovery) or other methods of disposal.

"Reuse" means the recovery of material for repeated use in the same form. "Reuse" includes materials that are reused at the same location as they are generated.

"Structure" means anything constructed or erected on the ground or any improvement built up or composed of parts joined together in some definite manner and affixed to the ground, including fences, walls and signs, but not including poles, flowerbed frames and such minor incidental improvements.

RULE

DPD will approve a waste diversion plan if the applicant executes the plan and submits a form supplied by DPD representing that:

1. A minimum of 20% of the building materials, by weight and excluding asphalt, brick and concrete, will be reused;

2. A minimum of 50% of the building materials, by weight and excluding asphalt, brick and concrete, will be reused, recycled or beneficially used; and

3. 100% of asphalt, brick and concrete will be reused, recycled or beneficially used.

Source: http://www.seattle.gov/dpd/codes/dr/DR2009-4.pdf

North Carolina Wood Pallet Legislation

Introduction

The state of North Carolina has approached wood recovery, reuse and recycling by focusing on a single product that has historically produced large volumes of wood waste – the wood pallet. In the early 2000's the North Carolina state legislature worked with the North Carolina Department of Environment and Natural Resources (NCDENR) to develop legislation that banned certain hazardous and recyclable materials, including wood pallets, from municipal solid waste (MSW) landfills. During the process the NCDENR commissioned a private wood pallet recycling market study to better understand how the materials ban could potentially alter where discarded wood pallets were sent and how they were handled. After the legislation became law, the NCDENR conducted another study to determine how the ban had affected private recyclers' operations and to track the amount of wood pallets diverted.

Legislation

The North Carolina legislature passed the materials ban law in 2005 (Appendix I), and on October 1st, 2009 the ban was fully implemented. A four-year transition period between the creation of the law and when it went into effect was allowed to ensure sufficient time for communities, waste generators and recyclers to institute recycling programs that complied with the new waste bans.[113] After the law passed, the NCDENR Division of Waste Management became the responsible agency for fully implementing and monitoring the policy.

In regard to wood pallets, the law states:
"No person shall knowingly dispose of the following solid wastes in landfills…. Wooden pallets, except that wooden pallets (mixed into construction waste) may be disposed of in a landfill that is permitted to only accept construction and demolition debris."[114]

While the legislation bans wood pallet disposal at MSW landfills, their disposal is still allowed at privately owned and operated construction and demolition (C&D) landfills when generated as C&D waste. Per the legislation, wood pallet disposal from any industry other than the C&D industry is banned at all landfills. However, a county or city may request a waiver for banned materials disposal at MSW landfills, including wood pallets, based on "a showing that prohibiting the disposal of the material would constitute an economic hardship". No waivers have been requested for wood pallet disposal at MSW landfills since the legislation was enacted.[115]

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[113] Yarkosky, Sherry. *"Impacts of Landfill Disposal Ban on Wooden Pallet and Oil Filter Recycling Businesses."* Recycling Works, Volume 17, Number 2. Spring 2011.
[114] http://portal.ncdenr.org/web/wm/sw/landfillbans
[115] Phone conversation with Ellen Lorscheider, Environmental Supervisor for the NCDENR Division of Waste Management, on 2/12/13

Pre-legislation Study

In 2003, prior to the enactment of the disposal ban, a study was commissioned by the NCDENR Division of Pollution Prevention (Appendix II) to assess the existing private wood pallet recycling market, the recycling industry's capacity to handle increased demand should the disposal ban become law, and the recycling industry's position on such a ban. North Carolina State University (NCSU) was chosen to conduct the study and contacted pallet-recycling firms based on mailing lists maintained by the NCDENR Division of Pollution Prevention and NCSU's wood recycling team. A total of 103 pallet-recycling firms were contacted via mail survey and phone, of which 34 responded resulting in an overall response rate of 33%. The results of the study[116] aided the legislature and provided detailed information needed to include wood pallets in the materials disposal ban. A summary of some of the study results addressing existing pallet recycling markets, industry capacity for recycling wood pallets, and industry positions related to the proposed material ban is included below.

Figure 1. Private NC Pallet Recyclers' Processing Method Rates

How received pallets were processed by responding North Carolina pallet recyclers

Processing method	Percent (mean) by company	Percent of total volume
Refurbished (some parts exchanged, pallet not disassembled)	44.8	42.9
Reused (no parts are exchanged, only minor fixes)	20.4	10.9
Recycled (new pallet built from disassembled parts of other pallets)	18.6	29.8
Ground (pallet could not be used due to damage or size)	15.4	16.5
Other	0.9	0.0

Figure 2. Products Made From Private NC Pallet Recyclers' Residuals

Products made from pallet residuals by responding North Carolina pallet recyclers

Product	Percent (mean) by company	Percent of total volume
Boiler fuel	42.6	22.0
Mulch	29.6	48.2
Animal litter	0.1	0.6
Other	27.7	29.3

Figure 1 and 2 Source: Buehlmann, Urs; Bumgardner, Matthew; Fluharty, Tom. "Ban on landfilling of wooden pallets in North Carolina: an assessment of recycling and industry capacity." *Journal of Cleaner Production* 17 (2009): 271-275.

Existing Markets

- In order to address the existing pallet recycling market, the study calculated operator averages as a percent of total respondent answers. According to the study, on average 20% of a single recycling operators' wood pallets were reused, 45% were refurbished, 19% were recycled into other pallets, and 15% were ground (Figures 1). The study also addressed the existing wood pallet residuals market and found that over 70% of residual materials were either used as boiler fuel or mulch (Figure 2).

[116] Buehlmann, Urs; Bumgardner, Matthew; Fluharty, Tom. "Ban on landfilling of wooden pallets in North Carolina: an assessment of recycling and industry capacity." *Journal of Cleaner Production* 17 (2009): 271-275. http://naldc.nal.usda.gov/catalog/22763

Industry's Capacity

- Based on its 34 responses, the study estimated that in 2003 North Carolina had a total wood pallet recycling capacity of close to 60 million units per year. However, only 34 million units were actually recycled that year, indicating that sufficient capacity was available to support increased recycling.

Industry's Position

- A majority of recycling industry respondents thought that a wood pallet ban at landfills was a good idea (56%), while 18% thought it was a bad idea, and 18% were indifferent. These responses suggested there was industry support for the ban and a general agreement that "landfilling of pallets was an inefficient use of resources".

Figure 3. Total Private Sector Wood Pallet Recovery Volumes (Pre and Post Ban)

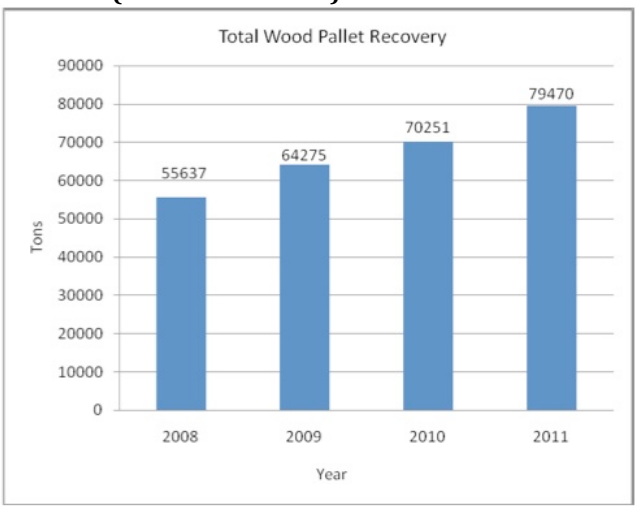


Figure 4. Effects of the NC Wood Pallet Disposal Ban on Private Sector Recyclers

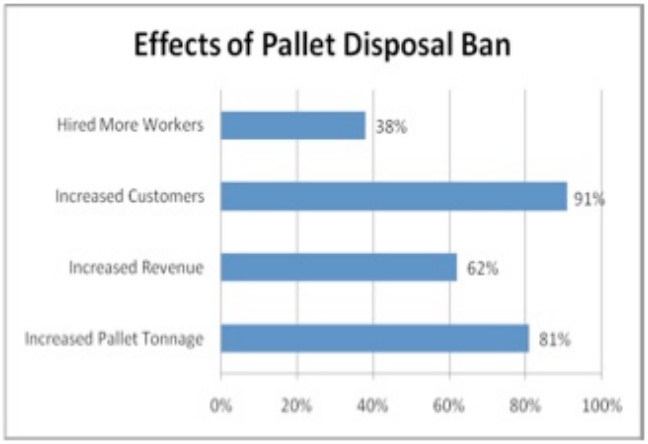


Figure 3 and 4 Source: Yarkosky, Sherry. *"Impacts of Landfill Disposal Ban on Wooden Pallet and Oil Filter Recycling Businesses."* Recycling Works, Volume 17, Number 2. Spring 2011.

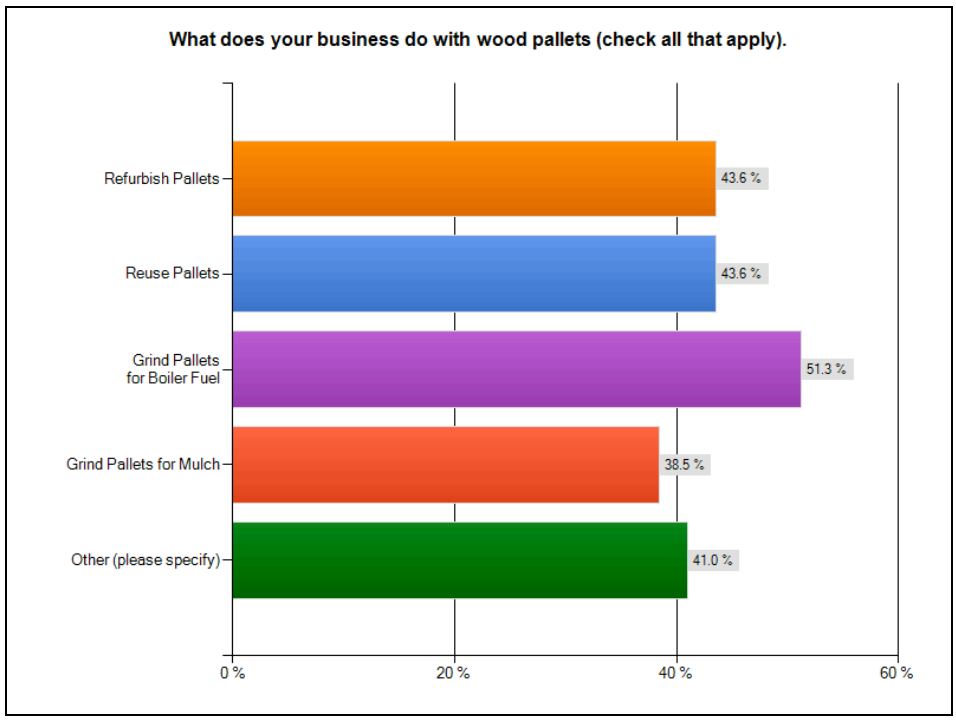
Post-legislation Findings

The materials ban took full effect in 2009, and in the spring of 2011 the NCDENR Division of Environmental Assistance and Outreach conducted a study of private sector pallet recyclers to determine how the disposal ban affected their businesses (Appendix III). A survey was sent to a total of 88 wood pallet recyclers. NCDENR staff also contacted businesses by phone and fax. A total of 48% of contacted pallet recyclers responded.

According to the findings, total wood pallet recovery rates by private recycling businesses increased in 2009 and 2010 by 16 and 9 percent respectively, and ***pallet recovery in 2011 was projected to be approximately 43% greater than pre-ban figures of 2008*** (Figure 3). Since the law went into effect, private industry pallet recovery rates have increased annually and are expected to continue growing. Additionally, the study showed that average wood pallet recovery rates per business steadily grew each year as well.

It appears that the disposal ban aided private pallet recyclers in North Carolina by helping their businesses to grow, despite a decrease in total pallet manufacturing as a result of the recession. Over half (51%) of respondents in the study indicated that the disposal ban helped their business grow, while 49% indicated stability or no growth as a result of the ban, and none of the respondents indicated that the ban negatively affected their business.[117] Of those who stated positive benefits, a majority said that the ban increased pallet tonnage at their facilities, increased overall revenue and increased their total number of customers (Figure 4).

Figure 5. How Wood Pallets are Reused and Recycled by NC Private Businesses After the Materials Ban



Source: NCDENR Division of Environmental Assistance and Outreach. *"Report on the Effects of the North Carolina Wood Pallet Disposal Ban."* March 2011.

Respondents were also asked what their businesses do with the recovered wood pallets (Figure 5). Approximately 44% of the respondents stated that they refurbish and reuse pallets, and 51% stated they grind them for fuel. Approximately 39% of respondents reported grinding pallets on-site for mulch while 41% reported grinding for other uses such as landfill cover, composting operations, and as raw material for sale to flake board and plywood manufacturers. Neither wood pallet recovery rates (reused verse recycled) nor total annual volumes for either practice were tracked as part of this study. This data is also not currently calculated or tracked by the state.

[117] NCDENR Division of Environmental Assistance and Outreach. *"Report on the Effects of the North Carolina Wood Pallet Disposal Ban."* March 2011.

Pallet Tracking

The state requires local governments and private C&D facilities[118] to complete annual C&D recovery tonnage reports. In these reports C&D materials are broken down into general categories, including aggregate/concrete, gypsum/drywall, shingles, carpet, vinyl, wood, cardboard and metal (Appendix IV). Wood pallets are grouped into the broader "wood" category, which includes products such as dimensional lumber and plywood in addition to wood pallets.[119] Neither local governments nor private C&D facilities specifically track wood pallets or other individual building materials in their annual rates.[120] Additionally, private pallet manufacturers and remanufacturers are not required to submit annual tonnage reports to the state.[119] As a result of these reporting mechanisms, it is difficult to comprehensively track wood pallet disposal volumes.

The table in Appendix IV depicts a large variance in annually recorded wood rates over the past seven years. Of note, the reported annual rates for wood in the years following the wood pallet ban, 2011 and 2012 in particular, are significantly lower than prior to its inception. It can be speculated that the wood rates have been lower the past two years because more wood pallets have been sent to private pallet manufacturers and remanufacturers. However, this cannot be verified due to a lack of wood pallet-specific tracking. Also, it is likely pallet use declined in recent years due to changes in the economy. Some private C&D landfills also recover a portion of wood pallets on-site to save landfill space and to create value added products, but neither private operators nor the state currently tracks these activities either.[119]

Compliance & Aid

The North Carolina legislature and local government departments wanted to make sure that they provided information to encourage and promote compliance with the disposal ban since it affects every city, county and most industries that utilize wood pallets in the state. To aid this, the NCDENR compiled case studies of counties that recovered, recycled and reused wood pallets at MSW landfills (Appendix V). These examples depict how various municipalities have successfully reduced the volume of wood pallets in their respective waste streams, as well as providing the partners they've worked with, the types of value added products they've produced from recovered pallets, and the financial incentives they've offered to promote wood pallet recycling and reuse.

The NCDENR also provides a number of wood pallet management resources online to aid disposal compliance. Available resources include a local government toolkit with tips for municipalities, a pallet recyclers' toolkit, a toolkit for businesses generating pallets, tips for small wood pallet generators, and a contract grinding fact sheet. THE NCDENR has also created a North Carolina Recycling Markets Directory that lists available

[118] Includes C&D landfills, C&D transfer stations and C&D recycling/processing facilities
[119] Phone conversation with Sherry Yarkosky, NCDENR Recycling Business Development Specialist, on 2/5/13
[120] Phone conversation with Michael Scott, Solid Waste Section Chief for the NCDENR Division of Waste Management, on 2/25/13

statewide wood pallet recyclers, and an online waste exchange marketplace named the North Carolina Waste Trader.[121]

The Bottom Line

The North Carolina wood pallet landfill disposal ban is an example of a legislative measure that has significantly reduced the total amount of wood in a state's waste stream over a very short time period by focusing on one of the major wood products typically found at MSW landfills. It was critically important that time and resources were provided to research existing industry capacities and positions, compliance levels, and disposal ban impacts prior to implementation since the law was so far-reaching and touched many parties. The North Carolina ban serves as a model for other states seeking to encourage the recovery of wood waste, reduce overall waste stream volumes, preserve landfill space, create job growth and promote green business practices.

BENEFITS OF THE WOOD PALLET BAN

- Increased wood pallet recovery rates
- Aided wood pallet recyclers' and helped their businesses grow
- Reduced a major source of wood waste from landfill

Future projects in other states that seek to emulate the North Carolina model should be aware of potential pitfalls or challenges.

WOOD PALLET BAN CHALLENGES

- Difficulty tracking wood pallet recovery (or certain segments of "wood waste")
- Less than ideal response rates for "before" and "follow-up" industry surveys

[121] Wood pallet management resources can be found on the NCDENR website at: http://portal.ncdenr.org/web/deao/recycling/wp

North Carolina House Bill 1465

GENERAL ASSEMBLY OF NORTH CAROLINA
SESSION 2005

SESSION LAW 2005-362
HOUSE BILL 1465

AN ACT TO PROHIBIT THE DISPOSAL OF MOTOR VEHICLE OIL FILTERS, RIGID PLASTIC CONTAINERS, WOODEN PALLETS, AND OYSTER SHELLS IN LANDFILLS.

The General Assembly of North Carolina enacts:

SECTION 1. G.S. 130A-290 reads as rewritten:

"**§ 130A-290. Definitions.**

(a) Unless a different meaning is required by the context, the following definitions shall apply throughout this Article:

...

~~(18)~~(17a) "Medical waste" means any solid waste which is generated in the diagnosis, treatment, or immunization of human beings or animals, in research pertaining thereto, or in the production or testing of biologicals, but does not include any hazardous waste identified or listed pursuant to this Article, radioactive waste, household waste as defined in 40 Code of Federal Regulations § 261.4(b)(1) in effect on 1 July 1989, or those substances excluded from the definition of "solid waste" in this section.

(18) 'Motor vehicle oil filter' means a filter that removes impurities from the oil used to lubricate an internal combustion engine in a motor vehicle.

...

(44a) 'Wooden pallet' means a wooden object consisting of a flat or horizontal deck or platform supported by structural components that is used as a base for assembling, stacking, handling, and transporting goods."

SECTION 2. G.S. 130A-309.10(f) reads as rewritten:

"(f) No person shall knowingly dispose of the following solid wastes in landfills:

(1) Repealed by Session Laws 1991, c. 375, s. 1.
(2) Used oil.
(3) Yard trash, except in landfills approved for the disposal of yard trash under rules adopted by the Commission. Yard trash that is source separated from solid waste may be accepted at a solid waste disposal area where the area provides and maintains separate yard trash composting facilities.
(4) White goods.
(5) Antifreeze (ethylene glycol).
(6) Aluminum cans.
(7) Whole scrap tires, as provided in G.S. 130A-309.58(b). The prohibition ~~against landfilling~~ on disposal of whole tires in landfills applies to all whole pneumatic rubber coverings, but does not apply to whole solid rubber coverings.
(8) Lead-acid batteries, as provided in G.S. 130A-309.70.
(9) Motor vehicle oil filters.

(10) Recyclable rigid plastic containers that are required to be labeled as provided in subsection (e) of this section, that have a neck smaller than the body of the container, and that accept a screw top, snap cap, or other closure. The prohibition on disposal of recyclable rigid plastic containers in landfills does not apply to rigid plastic containers that are intended for use in the sale or distribution of motor oil.

(11) Wooden pallets, except that wooden pallets may be disposed of in a landfill that is permitted to only accept construction and demolition debris.

(12) Oyster shells."

SECTION 3. G.S. 130A-309.10 is amended by adding a new subsection to read:

"(k) A county or city may petition the Department for a waiver from the prohibition on disposal of a material described in subdivisions (9), (10), (11) and (12) of subsection (f) of this section in a landfill based on a showing that prohibiting the disposal of the material would constitute an economic hardship."

SECTION 4. This act becomes effective 1 October 2009.

In the General Assembly read three times and ratified this the 23rd day of August, 2005.

s/ Beverly E. Perdue
President of the Senate

s/ James B. Black
Speaker of the House of Representatives

s/ Michael F. Easley
Governor

Approved 1:51 p.m. this 7th day of September, 2005

Source: http://portal.ncdenr.org/c/document_library/get_file?uuid=0b36878f-2d2d-443a-8cf4-af7bf4e96099&groupId=38322

Private Pallet Recycling Market Assessment Study

North Carolina Pallet Recycling Survey
(Fall 2003)

North Carolina State University respectfully requests a few minutes of your time to answer each of the following questions based on your company's circumstances. Completed questionnaires should be returned in the accompanying envelope by November 1. All of the information provided will be held in strict confidence.

1. How many employees does your facility have? _____

2. Does your company have other facilities in NC? _____

□ Yes □ No

If yes, where are they located?

---

3. How many pallets do you recycle in a typical year?

_____Tons _____# of Pallets

4. Of pallets received, what percentage falls into these categories?

_____ % Reused (e.g. no parts are exchanged, pallet is only cleaned and minor fixes done)

_____ % Refurbished (e.g. some parts exchanged, pallet is not disassembled)

_____ % Recycled (e.g. a new pallet built from disassembled parts from used pallets)

_____ % Ground (e.g. pallet could not be used for anything due to damage or size)

_____ % Other, please specify _____

5. What percentage of incoming pallets are non-standard pallets? _____%

6. Which products do you make with your pallet residuals (percentage)?

_____ % Mulch _____ % Boiler Fuel _____ % Animal Litter

_____ % Other, please specify _____

7. To whom do you sell your recycled pallets and in what percentage?

□ Mfg. Industry _____ % □ Government _____ %

□ Food Retailers_____ % □ Private Customers_____%

□ Other_____ % please specify _____

8. What is your plant capacity per year (recycled pallets only)?

_____Tons _____# of Pallets

9. Could you sell more pallets if you had them?

□ Yes □ No

10. How many more pallets could you sell if you had them (best estimate)?

□ 5% more
□ 10% more
□ 20% more
□ 50% more
□ 100% more
□ 200% more
□ Other percentage, please specify _____%

11. Do you currently have plans to expand your pallet recycling operations?

□ Yes □ No

12. What is your opinion on a ban of pallets at landfills?

□ Good idea
□ Do not care one way or another
□ Not a good idea
□ Other ideas or opinions

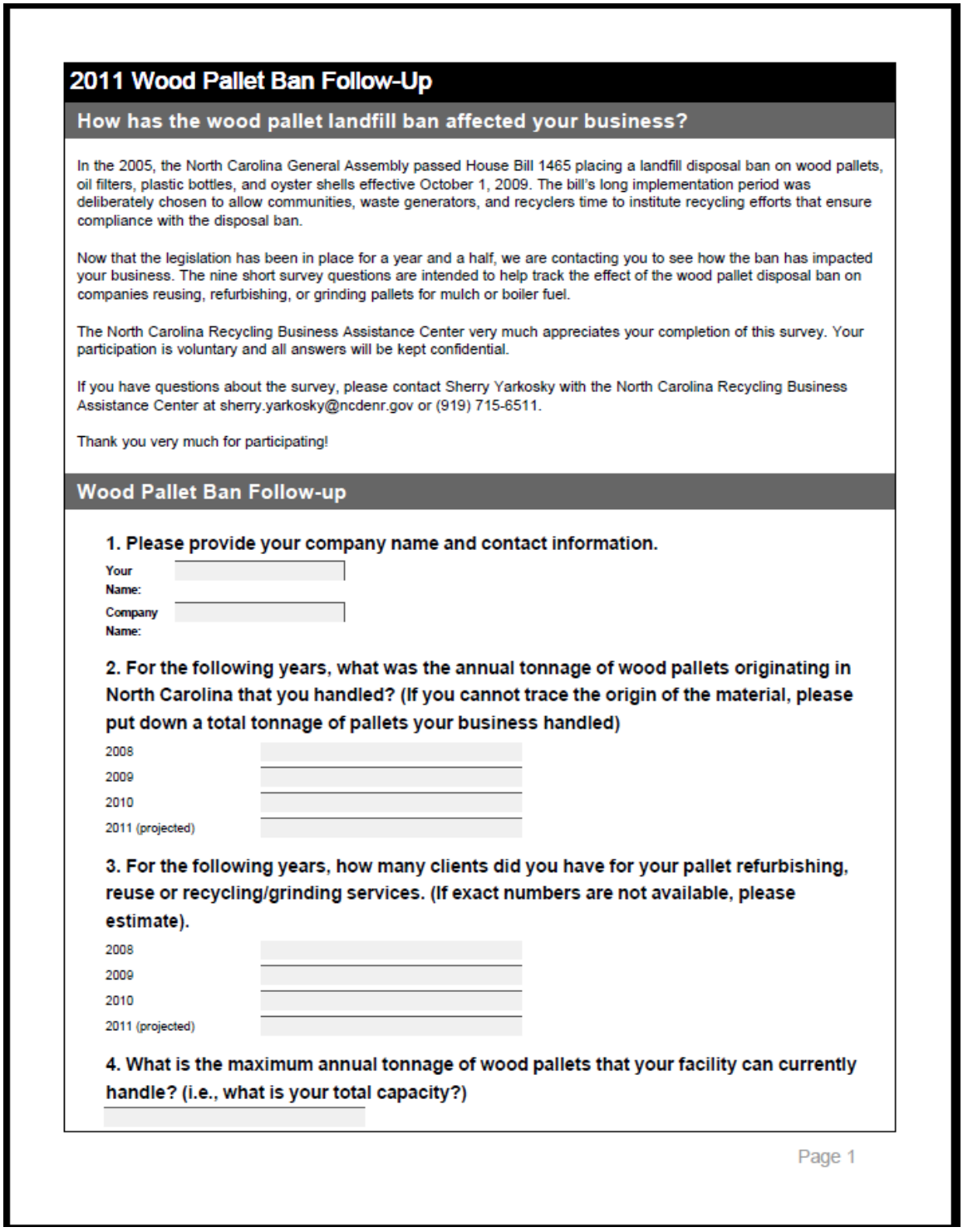
13. Please provide a brief justification of your answer in question 12?

_____

_____

Source: Received from Urs Buehlmann, Associate Professor in the Department of Sustainable Biomaterials at Virginia Tech – lead on the pre-legislation study and its assessment (was a faculty member at NCSU when the study was conducted)

2011 NCDENR Wood Pallet Ban Follow-Up Survey



2011 Wood Pallet Ban Follow-Up

How has the wood pallet landfill ban affected your business?

In the 2005, the North Carolina General Assembly passed House Bill 1465 placing a landfill disposal ban on wood pallets, oil filters, plastic bottles, and oyster shells effective October 1, 2009. The bill's long implementation period was deliberately chosen to allow communities, waste generators, and recyclers time to institute recycling efforts that ensure compliance with the disposal ban.

Now that the legislation has been in place for a year and a half, we are contacting you to see how the ban has impacted your business. The nine short survey questions are intended to help track the effect of the wood pallet disposal ban on companies reusing, refurbishing, or grinding pallets for mulch or boiler fuel.

The North Carolina Recycling Business Assistance Center very much appreciates your completion of this survey. Your participation is voluntary and all answers will be kept confidential.

If you have questions about the survey, please contact Sherry Yarkosky with the North Carolina Recycling Business Assistance Center at sherry.yarkosky@ncdenr.gov or (919) 715-6511.

Thank you very much for participating!

Wood Pallet Ban Follow-up

1. Please provide your company name and contact information.

Your Name:

Company Name:

2. For the following years, what was the annual tonnage of wood pallets originating in North Carolina that you handled? (If you cannot trace the origin of the material, please put down a total tonnage of pallets your business handled)

2008

2009

2010

2011 (projected)

3. For the following years, how many clients did you have for your pallet refurbishing, reuse or recycling/grinding services. (If exact numbers are not available, please estimate).

2008

2009

2010

2011 (projected)

4. What is the maximum annual tonnage of wood pallets that your facility can currently handle? (i.e., what is your total capacity?)

Page 1

2011 Wood Pallet Ban Follow-Up

5. What does your business do with wood pallets (check all that apply).

- ☐ Refurbish Pallets
- ☐ Reuse Pallets
- ☐ Grind Pallets for Boiler Fuel
- ☐ Grind Pallets for Mulch
- ☐ Other (please specify)

6. Please estimate the percentage of each listed use that you checked in question number 5?

Refurbish Pallets	
Reuse Pallets	
Grind Pallets for Boiler Fuel	
Grind Pallets for Mulch	
Other	

Wood Pallet Ban Impacts

7. Did the ban help your business grow?

- ◯ Yes
- ◯ No
- ◯ Neutral/stayed the same

How did the Wood Pallet Ban Help Your Business?

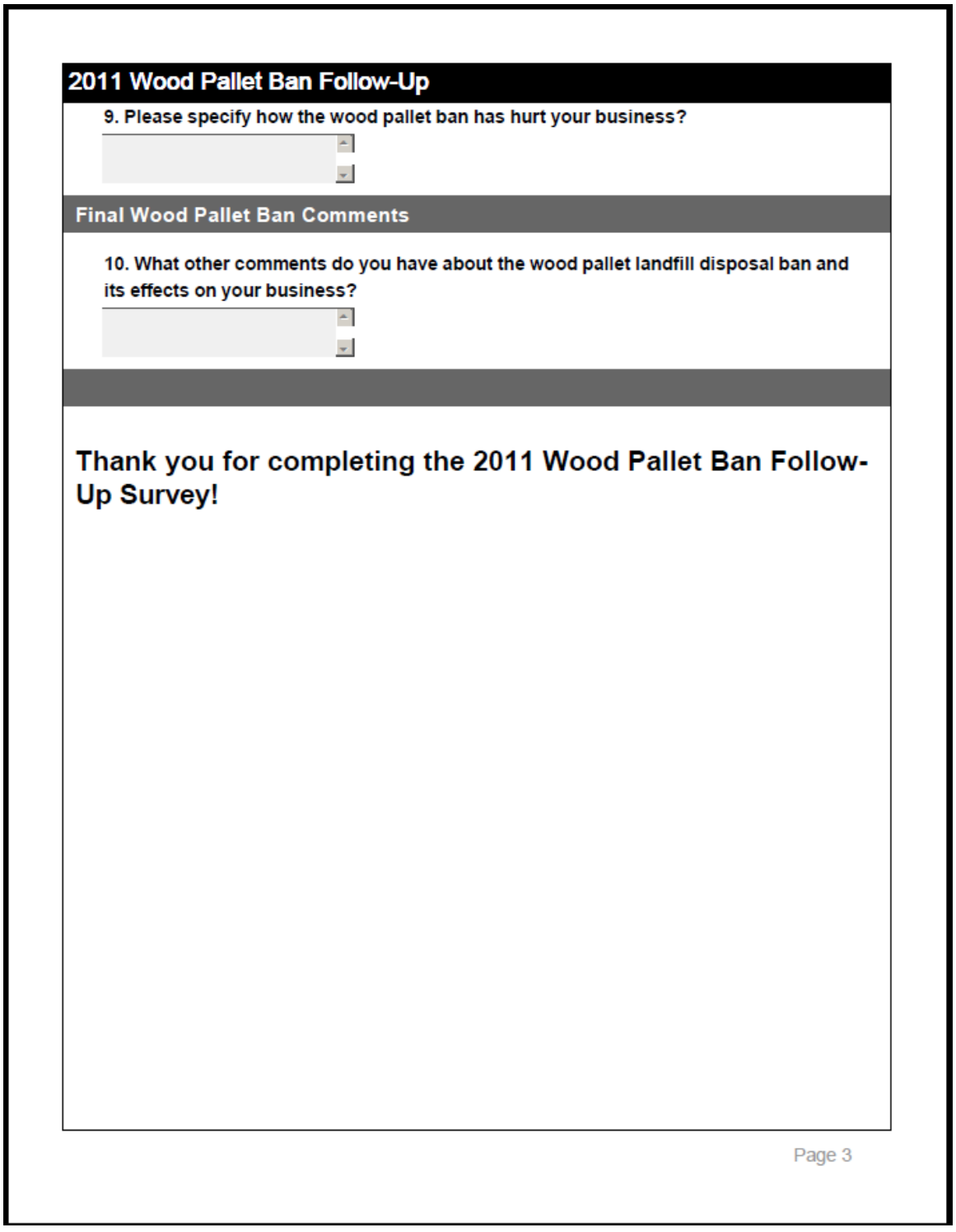
8. How did the wood pallet landfill ban help your business? Please check all that apply.

- ☐ Increased tonnage of pallets handled
- ☐ Increased revenue
- ☐ Increased customers
- ☐ Hired more workers

Other (please specify)

How did the Wood Pallet Ban Hurt Your Business?

Page 2



2011 Wood Pallet Ban Follow-Up

9. Please specify how the wood pallet ban has hurt your business?

Final Wood Pallet Ban Comments

10. What other comments do you have about the wood pallet landfill disposal ban and its effects on your business?

Thank you for completing the 2011 Wood Pallet Ban Follow-Up Survey!

Page 3

Source: NCDENR Division of Environmental Assistance and Outreach. *"Report on the Effects of the North Carolina Wooden Pallet Disposal Ban."* March 2011.

2006-2012 NC Statewide Annual C&D Recovery Rates by Category

Name	Year	Total Recovered	General C&D	Aggregate/Concrete	Gypsum/Drywall	Shingles	Carpet	Vinyl	Wood	Cardboard	Metal
LG and Private C&D Recovery	2006	116566.39	36304.31	47346.63	1738	0	0	9.15	26911.26	714.02	3543.02
LG and Private C&D Recovery	2007	233279.472	119618.85	43618.94	0	0	0	0.25	60541.081	755.911	8744.44
LG and Private C&D Recovery	2008	173000.3	96624.04	32911.21	73.84	0	0	27.91	37755.82	634.52	4972.96
LG and Private C&D Recovery	2009	226480.4	47003.87	97408.19	8076.73	20.42	0	21.37	62822.43	1901.2	9226.19
LG and Private C&D Recovery	2010	237224.08	62309.57	75064.93	7956.06	8107.25	75.99	0	73833.71	1459.1	8417.47
LG and Private C&D Recovery	2011	287649.57	71347.99	83616.8	12202.74	25679.66	158.5	17.28	86497.7	1446.07	6682.83
LG and Private C&D Recovery	2012	361191.33	87799.49	122839.49	10953.21	56006.38	280.89	28.94	73141.4	1903.73	8237.8

* LG stands for local government
* Since pallet manufacturers/remanufacturers do not have to report recovery rates to the state the above table does not include these entities' activities

Source: Data above is compiled from annual statewide solid waste reports; table was received from personal contact with Sherry Yarkosky, Recycling Business Development Specialist, NC Department of Environment and Natural Resources

LOCAL GOVERNMENT CASE STUDY:

CATAWBA COUNTY – PALLET RECYCLING

Population:	157,034
Contact:	Amanda Kain (828) 465-8217 amandak@catawbacountync.gov

Catawba County began offering pallet recycling services to the public in 1989 at the Blackburn Landfill. A designated area with appropriate signage is dedicated to pallet recycling. Scale attendants give customers directions to the pallet area. Area industries and commercial companies bring pallets to the site for recycling and are not charged a tipping fee for clean pallet loads. The disposal fee for municipal solid waste or mixed loads is $31.00 per ton + $2.00 per ton state tax = $33.00 per ton, giving a strong financial incentive to separate and recycle the pallets.

All pallet recycling operations are managed internally by Catawba County. Mixed with other clean wood waste, pallets are ground and used with dirt as daily cover for the county's landfill. In addition, Catawba also uses some of the ground wood on roadways in rainy weather for traction. Pallets comprise approximately 21 percent of the total wood waste stream in the county.

A grinder, front loader and labor represent the major costs for the program. Pallets are managed with other wood waste and, therefore, costs for the two are combined at approximately $30,000 per year.

Approximately 2,826 tons of pallets are recycled each year through the county's program.

Area industries and commercial companies bring pallets to Catawba County's designated area at the Blackburn Landfill for recycling.

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LOCAL GOVERNMENT CASE STUDY:

MACON COUNTY – PALLET RECYCLING

Population:	33,626
Contact:	Joel Olstroff (828) 349-2252 jostroff@maconnc.org

Macon County began offering pallet recycling services to the public in 1998, making program improvements three years later. Rather than using collection containers, the county designates a specific area for pallets with simple signage at two locations: the county's municipal solid waste landfill, and the Highlands Transfer Station. To provide an incentive for recycling, the tip fee for separated pallets is $30 per ton, while the tip fee for mixed waste is $66 per ton.

Macon County uses a contract grinder, Desoto Trail Construction, to grind the pallets and other yard waste on site. The resulting mulch product is used as alternative daily cover on the county's landfills. Whole pallets are available to the public free of charge.

A front loader and labor from other landfill operations are used to minimally manage the pallet and mulch piles. As these were capital expenses necessary for the operation of other landfill services, overall cost to implement and manage the program is minimal. Signs designating the pallet recycling area cost about $30 each. Grinding services were negotiated at a competitive rate. Before the current negotiated rate with Desoto Trail Construction, Macon was paying about $7 per ton for the onsite grinding service.

Of the total 3,053.8 tons of brush and pallets recycled each year, Macon County estimates that approximately 11 percent, or 335.4 tons, are pallets.

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February 2012

LOCAL GOVERNMENT CASE STUDY:

NEW HANOVER COUNTY – PALLET RECYCLING

Population:	202,667
Contact:	Lynn Bestul (910) 798-4410 LBestul@nhcgov.com

In July 2005, New Hanover County began offering pallet recycling services as part of its C&D recycling efforts. Pallets are accepted at the C&D recycling area at the New Hanover County Landfill. There is signage at the landfill's entrance and a concrete pad located on the back side of the landfill where mixed C&D can be dumped. Customers are charged $59 per ton to dump mixed C&D material, including pallets. Small amounts of pallets & lumber can be dropped off at the customer convenience site in the front of the landfill rather than having residential vehicles travel to the back of the landfill where the C&D pad is located.

Pallets and clean wood waste are sorted from the mixed C&D material and stacked until approximately 800 tons accumulate. A contract grinder, A-1 Sand Rock, grinds and markets the mulched wood material as boiler fuel. New Hanover negotiated a highly competitive rate for the contract grinding services.

Other costs to run the program are embedded in the total cost to manage a low-level C&D recycling operation. Supplies represent a nominal cost, as old equipment from the landfill are used. The C&D pad is operated with two landfill employees.

In fiscal year 2010-11, New Hanover recycled 3,911 tons of wood waste. Of that total, approximately 20 percent (or 782 tons) is estimated to be pallets.

New Hanover also reuses pallets for special projects like Household Hazardous Waste and E-waste collection events. It is estimated that 1 ton of pallets are recovered for use during those events.

Lumber and pallets are stored on one corner of the New Hanover County landfill C&D pad until the material is scheduled for grinding.

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February 2012

LOCAL GOVERNMENT CASE STUDY:

PITT COUNTY – PALLET RECYCLING

Population:	151,970
Contact:	Paula Clark (252) 902-3353 ppclark@co.pitt.nc.us

Pitt County began offering pallet recycling services in 1991 as part of its yard waste diversion program. To provide a financial incentive to recycle and separate these items, tipping fees were waived for both yard waste and pallets. A designated area at the yard waste site is dedicated to pallet recycling. Although no specific sign is posted for the pallet recycling area, a sign at the entrance to the facility indicates that "yard waste, pallets and unpainted, untreated wood" are accepted for recycling. Customers are simply asked to stack the pallets in the designated area.

Pitt County uses a private contract grinder to grind the pallets and other yard waste on site. The ground material is sold to various end-markets, the majority of which is goes to Weyerhaeuser for boiler fuel. Some of the ground material is held by the county and made available free to citizens for use as mulch.

A front loader and labor from other landfill operations are used to minimally manage the pallet and mulch piles. As these were capital expenses necessary for the operation of other landfill services, overall cost to implement and manage the program is minimal. Grinding services were negotiated at a competitive rate and the county currently pays $13.50 per ton ($11,500 per year) for that service.

Pitt County estimates that the county recycles approximately 850 tons of pallets each year.

Pallets to be ground are stacked by customers in the designated area shown above at Pitt County's yard waste processing facility.

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February 2012

Source: http://portal.ncdenr.org/web/deao/recycling/wp/case-studies

Reclaimed Barnwood Goes Mainstream

Weyerhaeuser partners with Barnwood Industries

Introduction

The recycling and reuse of solid wood products has occurred on an ad hoc basis for centuries. Historically the primary limit to reuse and recycling of wood has been destruction through combustion. In recent years recycling and reuse have become more economically visible through organization such as "Lumber Liquidators" and "the ReStore." However traditional channels have yet to fully embrace the unique needs of recycled and reused products for a variety of logistical reasons. In the past year the partnership between Weyerhaeuser in Northern California and Barnwood Industries of Bend, Oregon may be a sign that this trend is beginning to change.

Background

There are two old sayings that come to mind regarding this case study. First, "you can't sell off an empty wagon" refers to the old peddler days when retail salesmen used to tour the countryside with a wagon full of everything from tools, to pots and pans, to clothing and shoes, thus providing for the needs of a mostly rural population. Peddlers were also always on the lookout for new things to sell as they constantly needed to refill, and rejuvenate, their stock. The recognition that you have to offer a wide array of goods and constantly update your stock has never been more true than today, as retail and distributor markets have grown larger and larger and the players in those markets have built bigger and bigger buildings to house the broad range of products necessary to attract and retain customers. Some businesses, like Fleet Farm in the Midwest, make a living out of having virtually everything a "farmer" might need. The ability to ensure that a business is able to provide the current and future wants and desires of customers is what distinguishes successful businesses from those that fail.

The second applicable saying is "we'll sell anything that makes a buck." In general, businesses distributing to customers trying to keep their stores full are constantly seeking new and profitable product lines to both retain and gain market share in the highly competitive market of today. Successful companies are constantly seeking a competitive edge through careful identification of those lines most likely to be successful, which are unique, and are able to clearly provide differentiation from the competition. The key is that the distributor must see the possibility that the line can be successful before fully committing to it.

The Companies

Weyerhaeuser (www.weyerhaeuser.com) is a $6 billion global forest products company established in 1900, that today truly represents the "old guard" forest products traditionalist marketplace as well as being an innovator in how traditional markets are approached. Barnwood Industries (www.barnwoodindustries.com) salvages and reclaims wood from old buildings in the Pacific Northwest of the U.S. and ships those materials nationally, primarily through online sales.

Reclaimed materials have clearly come of age. Weyerhaeuser's partnership in the summer of 2012 with Barnwood Industries as an exclusive stocking distributor of Barnwood reclaimed

materials is a clear demonstration that reclaimed wood has gained enough market recognition and interest for the products to go through traditional distribution channels. Although this is a strategic move on the part of Weyerhaeuser, and Weyerhaeuser could be considered a market leader in many ways, this is clearly a sign that major players in traditional industry are aware of this growing market for reclaimed materials, interested in broadening their offerings in this regard, and have evaluated the profit potential of this new market and are ready to give it a try.

According to Weyerhaeuser staff, Barnwood Industries' products are being stocked in Weyerhaeuser's Northern California distribution facility and being offered as a special order purchase through all their distribution facilities. A customer can have the product delivered as part of a broader purchase of Weyerhaeuser's full line of products or the reclaimed materials can be shipped directly from Barnwood to the end user.

At this time Weyerhaeuser reports they are not offering reclaimed materials from other vendors, and that current supply from Barnwood is sufficient to meet the demand they are experiencing in the marketplace. They have yet to set any specific sales goals for the new product line, but may at some point in the future.

Recycled/reused materials offer some unique challenges to a large traditional commodity distributor such as Weyerhaeuser. Unlike most commodity items offered by Weyerhaeuser, each Barnwood product has its own unique characteristics – that also are a significant component of the attraction, and price premium, of this product. However this uniqueness conflicts with the traditional distributor's need to standardize. Weyerhaeuser's attempt to address this issue can be seen (See Weyerhaeuser product list next page) in their development of the unique color descriptors "Grey Patina, Brown Patina, Mixed Patina" which clearly require samples to be available in stores for inspection by customers. This product type and issue are more common to specialty distributors such as Stone Source (www.stonesource.com) or to specialty retail locations.

The Barnwood-Weyerhaeuser relationship is a new one, and time will tell how economically successful it will turn out to be. It offers an example of how large traditional wood products businesses are becoming both more aware of and more involved in what were once considered non-traditional forest products. It is also an indicator that reclaimed wood is not only accepted but in some cases preferred in the marketplace. By partnering with a skilled "producer" of reclaimed materials Weyerhaeuser has provided their customers access to a unique and growing segment of the wood products market while still maintaining their professional standards of service, reliability, and quality.

Bottom Line

It is too early in the relationship to determine if reused/recycled materials are going to be successful for Weyerhaeuser's distribution division. As mentioned earlier, there are a number of unique challenges raised by one-of-a-kind products that this product line entails; challenges that large distribution facilities tend to avoid like the plague. However, it is clear that market demand for these unique reused/recycled products is loud enough that a traditional distributor such as Weyerhaeuser has heard, and heeded, that call.

Barnwood Industries
History Salvaged. Beauty Reclaimed.

Weyerhaeuser

May 20, 2012

Environmentally Responsible Building Products
History Salvaged – Beauty Reclaimed

Barnwood Bundles- Varied Lengths – From 2' to 8'
Widths are Random – 3" – 5" – 7"
Colors – Gray Patina – Brown Patina – Mixed Patina

Sizes			
½ " Bundles - 112 Sq Ft			
½" Bundles - 206 Sq Ft			
½" Bundles - 500 Sq Ft			
¾" Bundles – 112 Sq Ft			
¾" Bundles – 206 Sq Ft			
¾" Bundles – 500 Sq Ft			

Uses and Products Include: Wainscoting/Wall & Ceiling Paneling/Flooring/Beams/ Wraps/ Siding/ Timbers/Cabinetry / Furniture/ Millwork & Fireplace Mantels.

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BSLC Binational Softwood Lumber Council
www.softwoodlumber.org

Forestry Innovation Investment
www.bcfii.ca

FOREST SERVICE USDA
www.fpl.fs.fed.us

This institution is an equal opportunity provider.

The Current State of Wood Reuse and Recycling in North America and Recommendations for Improvements

Dovetail Partners
528 Hennepin Ave, Suite 703
Minneapolis, MN 55403
Tel: 612-333-0430
Fax: 612-333-0432
Email: info@dovetailinc.org

www.dovetailinc.org