Environmental Protection Agency

Region 9

FINAL

Pilot Project to Help Companies Identify Alternative Wood Waste Market Options

Exploring Economic and Environmental Impacts of Wood Waste Partnerships in Alameda County, CA

Final Report and Hypothetical Case Study

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Final Report and Hypothetical Case Study

1.0 Introduction

Although Alameda County, California boasts strong recycling programs for many materials, finding viable markets for reuse of wood waste has presented challenges for local businesses. The U.S. Environmental Protection Agency (EPA) Region 9 became aware of the need for additional data and information regarding wood waste recycling and reuse markets in Alameda County due to the ongoing work of *StopWaste*, which is a local, public organization that provides free assistance and resources to Alameda County businesses that are looking to reduce waste streams and improve business efficiencies. EPA also solicited data and input from the California Integrated Waste Management Board (CIWMB). Through collaboration with these stakeholders, EPA completed a Pilot Project to better understand wood waste materials generated by businesses in Alameda County and to help businesses identify markets for reuse of wood waste. As part of the Pilot Project, a robust list of facilities was developed and used to contact businesses that may be interested in learning more about wood waste recycling/reuse opportunities and developing partnerships. The list comprised both generators of wood waste in Alameda County and potential end users of the material located in the San Francisco Bay Area and in sufficiently close proximity to form feasible partnerships with generators of wood waste.

2.0 Pilot Project Approach and Partnership Results

The ultimate goal of the Pilot Project was to gather data on wood waste markets in Alameda County and decrease the likelihood of landfill disposal of industry-generated wood waste by fostering reuse partnerships between businesses. To accomplish this goal, the following tasks were completed:

1. EPA contacted local businesses that generate or reuse wood waste and gathered information about the current barriers and state of wood waste recycling/reuse in Alameda County. This information was documented in a report entitled *Disposal and Reclamation Options for Wood Waste in Alameda County* completed on February 11, 2009.
2. EPA developed outreach materials for distribution to potential partners outlining the benefits of wood waste reuse partnerships and the goals of the Pilot Project.
3. EPA researched relevant organizations and compiled a database of potential partners, including their contact information and waste management activities.
4. EPA conducted outreach via phone and email to obtain information about business practices and waste/material specifications of potential partners. Businesses interested in a partnership with another organization were provided contact information to assess partnership feasibility and to begin the partnership process.

While several of the businesses contacted during the Pilot Project have successfully avoided landfilling almost all of their wood waste material, many other businesses continue to landfill material that could be diverted. Once EPA identified disposal and reclamation options in Alameda County, outreach information was provided to local businesses that either generate wood waste or reuse wood waste materials. When organizations expressed an interested in participating in the pilot project, contact information for other potential partner organizations was provided if a potential partnership appeared feasible. Although no partnerships were finalized by the end of the Pilot Project in January 2009, several businesses were assessing the feasibility of partnerships at the time of the project's official end.

As a goal of the pilot project, EPA wanted to determine the actual environmental and economic impacts of wood waste diversion from landfills because very few case studies document wood waste recycling/reuse in Alameda County. However, because no viable partnerships were in place by the end of the Pilot Project, no concrete data were available to illustrate the environmental and economic impacts of wood waste reuse partnerships. Therefore, a case study based on a hypothetical partnership was developed to depict the impacts of wood waste diversion and to illustrate the potential economic benefits to partners and the environment that occur simultaneously when reuse markets are identified for wood waste materials in Alameda County.

3.0 Hypothetical Case Study Summary

To illustrate the economic and environmental benefits of wood waste reuse partnerships, actual data from a wood waste generator and companies that reuse wood waste in their processes were used in a hypothetical partnership. As is evident in the following report, the impact of wood waste reuse is dependent on numerous variables, such as the amount of wood saved from landfill disposal, the end market for the material, the type of wood, the industries involved in a partnership, distance to and from end markets, size of the businesses, and several economic factors. Some of the highlights that emerged from the hypothetical partnerships featured in the case study include:

- Identification of three feasible end use markets for wood pine boxes discarded by a local furniture company: a manufacturer of small wooden gift boxes, a manufacturer of medium density fiberboard (MDF)/particleboard, and a cogeneration plant.
- Annual diversion of approximately 396 tons of wood materials from local landfills.
- Approximately $9,165 per year in savings realized by the wood waste generator through diverting materials from landfills and sourcing them to three new markets.
- Approximately $30,195 per year in savings realized by a gift box manufacturer that reuses 84 tons of wood boxes per year.
- Approximately 50 percent reduction in the gasoline required by, and carbon emitted from, vehicles to transport wood waste to landfills when wood waste was transported to reuse partners.
- Greenhouse gas reduction equivalent to removing 100 passenger vehicles from the road due to recycling and reusing the 396 tons of wood waste generated by the furniture company.
- An energy savings equal to 8,244 gallons of gas over the course of a year due to the recycling and reuse of all 396 tons of wood waste generated by the furniture company.

It should be noted that some aspects of the case study are based on hypothetical data. Notes are provided to document real versus hypothetical data. It is important to reiterate that the following hypothetical case study depicts only one facet of the current wood waste market. Should another business that generates varying amounts of material with different specifications try to set up a partnership, the results could change significantly. In general, the greater the amount of material diverted from disposal in landfills, the greater the environmental and economic benefits realized. However, factors such as long distances and type of end use market (e.g., biomass, furniture, animal bedding, compost, particle board plants) can negate any achieved economic or environmental benefits.

4.0 Conclusions

Although no partnerships were solidified by the end of the Pilot Project, the Pilot Project afforded numerous businesses the opportunity to share their concerns and successes with EPA, *StopWaste*, and CIWMB. Since many businesses have adopted creative strategies and solutions for their wood waste problems, the information provided by these businesses was compiled, analyzed, and developed into a comprehensive fact sheet aimed at helping other businesses identify new waste management alternatives for their wood waste.

By keeping wood out of landfills and in the hands of others that can continue the lifecycle of the wood, numerous parties can benefit. The generator can often cut disposal costs, the reuse partner can avoid the cost of purchasing raw materials, and virgin materials can be conserved. Conserving virgin materials further reduces the amount of greenhouse gases emitted by processing and transportation, and through the deforestation of trees.

To further cultivate the development of partnerships between industry generators of wood waste and end users, end markets for harder-to-recycle materials, such as painted, pressure-treated, petromat, small dimensional, melamine-containing, and processed wood waste need to be explored and expanded. Improved education, outreach, and awareness targeted toward the wood waste industry regarding wood waste markets is also a key component to ensure that all salvageable, recyclable, and reusable wood waste is diverted from landfills.

Hypothetical Case Study

A Furniture Manufacturer Identifies
New End Markets for Discarded Pine Boxes

1.0 Introduction

The following case study explores the economic and environmental impacts of recycling and reusing wood waste material by a custom furniture manufacturer that has identified alternative methods of disposal for several tons of pine wood boxes. The featured case study follows the manufacturer, also referred to as "Manufacturer A," as it identifies new markets and alters traditional waste management practices. The case study analysis includes the following components:

Section	Title
2.0	Case Study Summary
3.0	Profile of the Wood Waste Generator
4.0	Profiles of the End Users
5.0	An Overview of the Partnerships Created
6.0	An Overview of Partnership Cost Considerations
7.0	Before and After Economic Impact of Partnerships
8.0	Indirect Economic Impacts
9.0	Environmental Impacts of the Waste Management Alternatives
10.0	Environmental Impacts of the Hypothetical Case Study Partnerships
11.0	Overall Comparison of the Environmental Impacts of Various Waste Management Scenarios
12.0	Conclusions

2.0 Case Study Summary

The following hypothetical case study is based on wood waste generation data provided by a local manufacturer of custom furniture, Manufacturer A. Due to the custom nature of the products produced, Manufacturer A builds pine boxes of varying sizes to transport furniture from the production facility to the warehouse. Once the furniture is unwrapped, the boxes are disposed of in a 20-yard roll-off container. Since Manufacturer A's current waste hauler has not presented any recycling options, the case study assumes that all 396 tons of wooden boxes are disposed in a landfill 50 miles away that is operated by the waste hauler.

Manufacturer A is motivated to reduce the overhead costs associated with of disposing large quantities of potentially reusable wood boxes, and has explored several options for managing its wood waste stream. Based on some of the local options available to the furniture manufacturer, the following partnership scenario was evaluated for the purposes of this report, as illustrated in Figure 1:

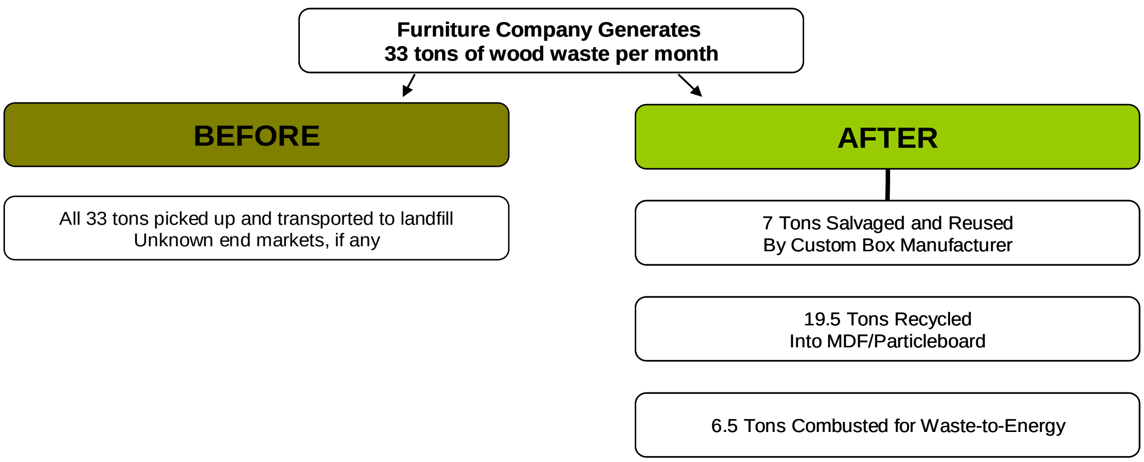
- Manufacturer A has identified a local manufacturer of custom wood gift boxes that can salvage boxes with specific dimensions. For the purposes of this report, the gift box manufacturer will be referred to as "End User B." End User B has agreed to pick up approximately 7 tons of wooden boxes per month, or 84 tons per year.

- On an annual basis, 312 tons of boxes remain in Manufacturer A's waste stream after the 84 tons of boxes are salvaged by End User B. Manufacturer A opted to hire a local recycler (referred to as "Recycler C") to manage the remaining boxes. Recycler C reprocesses the wood waste and grinds the material at a remote location approximately 20 miles from Manufacturer A. Once the wood waste is reprocessed, Recycler C sends approximately 78 tons of wood chips to a waste-to-energy plant (located 20 miles from Recycler C) for combustion over the course of the year and 234 tons of wood chips to a local 100% recycling plant (also located 20 miles from Recycler C) that manufactures medium density fiberboard (MDF) and particleboard.

Based on these assumptions, the following sections analyze the estimated efforts required by all parties to create a successful partnership. The analysis begins by examining the details about each partner and delves into the impacts of such a partnership, specifically looking at the economic requirements for each party, and then explores the environmental impacts of such a partnership.

Figure 1 depicts the end state of the wood waste prior to a partnership and after a partnership relationship is created between Manufacturer A and End User B and Recycler C.

Figure 1 – Before and After End Use of Wood Waste (by Month)



3.0 Profile of the Wood Waste Generator

Manufacturer A is located in Berkeley, California and manufactures high-end furniture with custom dimensions and styles. The information provided in this section is based on an actual company facing the dilemma of diverting large quantities of wood boxes from local landfills.

Table 1 – Information on Manufacturer A

Manufacturer A Profile:	
Type of Business	A national manufacturer of custom furniture
Type of Wood Generated	Protective pine boxes for furniture transport, Average dimensions of a box = 6'W x 2'L x 4'H
Manufacturer A Baseline Data:	
Amount of Wood Generated Per Month/Year	Approximately 33 tons/396 tons
Percentage Landfilled	100%
Cost to Transport and Dispose by Landfill	Total Cost of Disposal: $2,750 per month (according to average price per month from waste hauler)
Container Used for Disposal	20-yard roll-off bin
Distance to Landfill	Approximately 100 miles to and from company-operated landfill (approximately 50 minutes both ways)
Number of Pickups Per Month	2-3 dumps per week; up to 12 dumps per month

4.0 Profiles of the End Users

Manufacturer A has identified two separate vendors to pick up wood waste from its facility: End User B and Recycler C.

End User B

End User B is a custom manufacturer of wooden gift boxes and sources various wood types in various dimensions. End User B takes custom orders for large quantities of cigar, wine, and holiday boxes from customers nationwide. Many of the boxes currently manufactured by End User B utilize board feet of pine, which are also used in the boxes generated by Manufacturer A.

Table 2 – Information on End User B

End User B Profile:	
Type of Business	A manufacturer of custom gift and product boxes (wine/cigar/holiday)
Type of Wood Used	Pine and other wood species
End User B Baseline Data:	
Amount of Wood Accepted Per Month/Year	Approximately 7 tons/84 tons of pine boxes per month to convert into refurbished board feet of pine
Current Supplier of Material	Supplier of virgin wood products
Cost to Purchase Same Tonnage of Material	$3,402.52 *Based on online floor purchasing tool for White Pine Board Foot flooring (unfinished); shipping/tax not estimated

Recycler C

Recycler C is located approximately 20 miles from Manufacturer A, and has the capability to reprocess and grind the wooden boxes that cannot be salvaged by End User B.

Table 3 – Information on Recycler C

Recycler C Profile:	
Type of Business	Wood waste recycler; the majority of materials are combusted for energy or sent to MDF/particleboard plants
Type of Wood Used	Both end markets accept various clean wood waste (recycler would have to chip and reprocess wood waste to remove nails and dirt)
Recycler C Baseline Data:	
Amount of Wood Accepted Per Month/Year	Estimated tonnage sent to end markets: 19.5 tons/234 tons recycled into MDF/particleboard 6.5 tons/78 tons combusted for energy

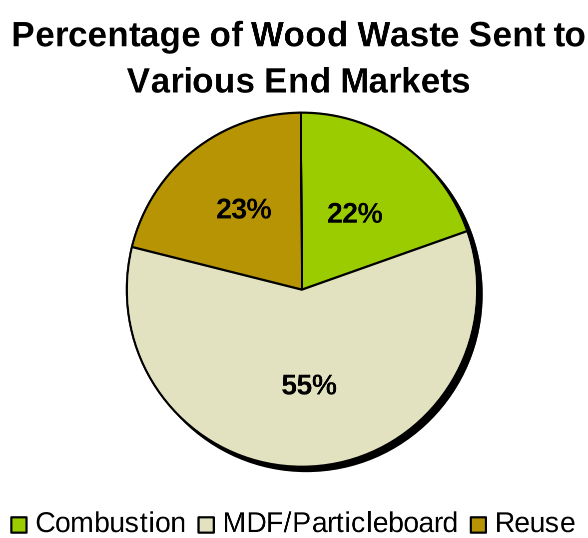
5.0 An Overview of the Partnerships Created

Instead of being disposed in landfills, 55% of the wood waste generated by Manufacturer A will be utlized by local MDF and particleboard plants. About 23% will be sourced to other manufacturers for reuse, and nearly 22% will end up being combusted at local waste-to-energy cogeneration plants.

Reuse by End User B will require extra labor to pick up materials from Manufacturer A and deconstruct the boxes for reuse in new boxes. Some boxes may be reused or simply refurbished. Recycler C will upgrade Manufacturer A's 20-yard container to a 40-yard container in an effort to reduce the number of trips required each month and transportation costs. Although reprocessing will cost Recycler C an average of $8 per ton to prepare for market, Recycler C will make an average take-home profit of $15 per ton when the material is sold to both the particleboard market and the cogeneration market.[1]

Figure 2 represents the portion of Manufacturer A's wood waste that will be sourced to new markets.

Figure 2



6.0 An Overview of Partnership Cost Considerations

Every partnership relationship is different. In this scenario, Manufacturer A and End User B both make adjustments to business as normal in an effort to create a successful partnership that benefits both parties. Manufacturer A will absorb certain costs to ensure that salvageable boxes are separated and stored in a separate container from other wood waste that will be picked up by Recycler C.

Table 4 – Manufacturer A Breakout of Costs

<table>
<tr><td rowspan="4">Cost to Sort Materials</td><td>Sorting is required to remove reusable pine boxes from the recycling bin and place them into a covered trailer for transport to End User B. Salvaging of boxes fitting the end user's dimensions is required by workers.</td></tr>
<tr><td>One-Time Trailer Cost:
Approximately $1,600 (Absorbed by end user)</td></tr>
<tr><td>Training: Employee training would need to be incorporated into daily operations to provide initial awareness of waste management changes. Training must be reinforced by managers to become part of plant practices and policy. Minimal additional cost. (Not included in analysis)</td></tr>
<tr><td>Signage: With ample training and easy access to a trailer, sorting costs would be minimal. Signage is recommended, however, to improve employee knowledge about recycling and ensure compliance.
Total Signage Cost: $75 (Generator-absorbed cost)</td></tr>
<tr><td>Cost to Pay Recycler for Pickup</td><td>Cost: Roughly $495 per tip of a 40-yard container*
Trips Required: Roughly 4 tips per month with upgrade to a 40-yard container from a 20-yard container
Total Estimated Cost to Recycle:
$495 (40-yard container) x 4 = $1,980 per month

* Price based on quote from a local wood waste recycler. This price can vary depending on end market value of material recycled and ability to easily remove nails and any other "contaminant."</td></tr>
</table>

End User B will invest in a used trailer to transport the boxes to and from the generator. Reusing the boxes will also require labor costs to deconstruct the boxes and prepare them for reuse. Table 5 details the hypothetical costs absorbed by End User B as it works to reuse Manufacturer A's wooden boxes.

Table 5 – End User B Breakout of Costs to Reuse Boxes

Cost to Transport Salvaged Boxes to End User Per Month (End User)	Owner instructs employee to pick up trailer and transport to facility for unloading and subsequent return of trailer. **Distance Traveled to Pick Up Materials:** 10 miles (one-way)
	Fuel Cost Per Round Trip: 4 one-way trips to pick up and then return trailer = $8.24* **MapQuest Fuel Calculator, based on February 2009 prices, based on a 15 miles-per-gallon vehicle.*
	Monthly Fuel Cost: $8.24 * 4 trips per month = $32.96
	Labor Cost Per Round Trip: 1 employee for 3 hours @ $20/hour Round Trip Labor Cost: $60
	Total Transport Labor Cost Per Month: $60 x 4 pickups per month Monthly Labor Cost: $240
	One Time Fee for Used Trailer: $1600 (Roughly $133.33 per month for 12 months) Monthly Trailer Cost: $133.33
	Total Cost to Transport to End User* (Labor) + (Fuel Costs) = $68.24 per round trip $68.24 * 4 roundtrips per month Monthly Labor + Monthly Fuel Costs: $272.96
	Totally Monthly Transport Costs for First Year: $133.33 (Trailer) + $272.96 (Labor/Fuel) = $406.29* **Total Monthly Transport Cost Post First Year:** Monthly Transport Costs: $272.96* ** Does not factor in vehicle cost/maintenance*
Cost to Deconstruct Boxes to Manufacturer Specifications	24 employee hours @ $20 per hour (per month) Total Monthly Cost to Deconstruct Boxes: $480
Total Costs for End User	**Monthly Transport + Deconstruction Costs** 1st Year: $886.29 per month Post 1st year**:** $752.96 per month
	Yearly Transport + Deconstruction Costs Total First Year Costs to Reuse Wood: $10,635.52 Total Yearly Costs Post First Year to Reuse Wood: $9,035.52

7.0 Before and After Economic Impact of Partnerships

Although Manufacturer A and End User B must absorb upfront costs from increased labor to signage and trailer purchases, identifying an alternative waste management scenario allows each party to save money. While it is understood that wood waste materials salvaged and deconstructed by end users cannot always be reused, for the purposes of this report and to simplify the examples provided, it was assumed that all material was reused. The estimated material costs for End User B are based on rough approximations. A calculator conversion tool from New Hampshire was used to approximate the tonnage of wood reused to board feet.[2] An online purchasing website for unfinished pine flooring was used to calculate the approximate costs of the converted amount of board feet lumber (flooring size dimensions). Table 6 outlines the cost savings realized by both parties.

Table 6 – Cost Savings to Manufacturer A and End User B

<table>
<tr><th>Before Partnership</th><th>After Partnership</th></tr>
<tr><td rowspan="2">Landfill Disposal (Pickup, Transport and Tipping Fees)

Currently paying approximately $2,750 per month to dispose 200 cubic yards of wood waste boxes

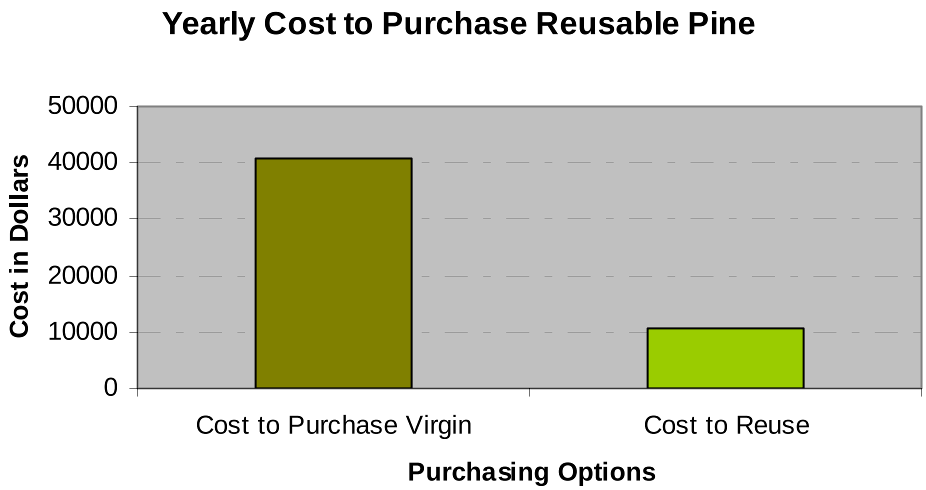
Cost to Landfill Per Month: $2,750</td><td>Average Yearly Cost Savings:
$2,750 Original Cost to Landfill
- $1,980 Recycling Costs
$770 Cost Savings Per Month
x 12 Months
$9,240 per year saved</td></tr>
<tr><td>First Year Savings:
$9,240 Cost Savings
- 75 Signage Costs for Recycling Bins
$9,165 First-Year Cost Savings</td></tr>
<tr><td colspan="2">Note: Costs may vary depending on quality of material recycled and relationship with recycler. An extra cost savings was also realized through the upgrade of a 20-yard container to a 40-yard container, which requires fewer pickups.</td></tr>
<tr><td rowspan="4">End User Material Costs

Average Cost Per Month: $3,402.52
Average Cost Per Year: $40,830.24</td><td>Cost to Reuse Material:
$886.29 Per Month (First Year)
$752.96 Per Month (Subsequent Years)</td></tr>
<tr><td>Total Cost of Reused Material <u>Per Year</u>:
$10,635.52 (First Year)
$9,035.52 (Subsequent Years)</td></tr>
<tr><td>Monthly Cost Savings From Reuse:
$3,402.52
- $886.29
$2,516.23 Per Month (First Year)

$3,402.52
- $752.96
$2,649.56 Per Month (Subsequent Years)</td></tr>
<tr><td>Yearly Cost Savings From Reuse:
$30,194.72 (First Year)
$31,794.72 (Subsequent Years)</td></tr>
<tr><td colspan="2">Materials costs represent a rough estimate. Not all material salvaged will be reused. Shipping costs may represent an additional savings; however, tax was not included (not applicable for purchases out of state).</td></tr>
</table>

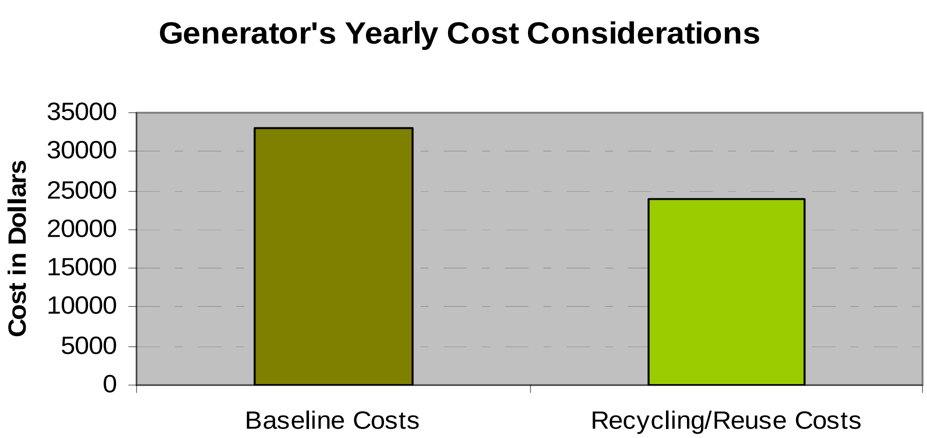
Overall Potential Economic Cost Savings: By forming a partnership with Manufacturer A, End User B anticipates a $30,194.72 per year (based on first year) cost savings. See Figure 3 for a graphic comparing the costs of purchasing virgin pine versus purchasing deconstructed used pine boxes.

Figure 3



Manufacturer A also stands to avoid costs by recycling and reducing wood waste through reuse. A majority of the cost savings for Manufacturer A are derived from upgrading from a 20-yard container to a 40-yard container. Recycler C makes fewer trips with a 40-yard container, although the cost to tip each bin of recyclable wood waste is roughly the same as having a traditional waste hauler service the facility. The better the quality of the wood waste, the more likely Manufacturer A can receive reduced tipping fees from Recycler C. Figure 4 displays a comparison between the costs absorbed by Manufacturer A prior to instituting a new waste management scenario and the costs absorbed after waste management changes have occurred. The cost considerations are based only on the first-year costs, since the first-year costs are slightly more per month than the subsequent years due to the implementation of signage.

Figure 4



Recycler C's Perspective: Since Recycler C is able to reprocess the materials and send them to cogeneration plants and MDF/particleboard plants, it is likely that Recycler C could take home approximately $15-20 per ton of clean, dry wood chip material. If Recycler C sells all 312 tons of material at an average rate of $15, the business could reach sales of approximately $4,680 for the material. These prices are based on local reported prices for the Bay Area. Using an approximate cost of $8 per ton to reprocess the material, Recycler C is estimated to take home a profit of $2,184 for reprocessing the material and selling to end markets over the course of a year.[1]

8.0 Indirect Economic Impacts

Companies realize an economic value for recycling their materials beyond tipping and hauling fees. Companies who can show a greener product often have access to a larger share of the market. Why? In their September 2008 article for *Environmental Leader*, authors and branding experts Paula Oliveira and Andrea Sullivan explain this trend by citing a study from Carbon Trust, a UK-based consultancy that helps businesses reduce their carbon emissions. The authors indicate that social and environmental concerns can result in changes in consumer behavior. Among several factors that cause this shift are "issues of immediate personal impact" and "realistic available choices."
The business world understands the economic power of green – both in savings and sales. Many resources are available to help companies green products, from national programs such as GreenerDesign.com to the local Alameda Center for Environmental Technologies.

In addition to the greening impact of recycling and reuse, Manufacturer A also has an opportunity to connect to the community. Providing resources to the business community and providing reusable pine boxes to community organizations are a great way for Manufacturer A to show its commitment not just to the environment, but to the community at large. Serving as a good corporate citizen can only bolster the company's image, which helps the company win the affection and favor of local consumers. Also, nationwide and local awards programs are available to Alameda County organizations that exhibit superior environmental programs and meet landfill diversion goals.

9.0 Environmental Impacts of the Waste Management Alternatives

Many reuse and recycling options exist for wood in Alameda County. Evaluating the environmental impact of each of those options varies by wood specifications, distance the material must be shipped, and type of reuse or recycling. The focus of this section will be to evaluate the impact of the presented hypothetical case scenario on the custom furniture designer that generates 396 tons (approximately 200 cubic yards) of pine wood waste boxes per year and the hypothetical end users of that material. Using EPA's Waste Reduction Model (WARM), various waste management scenarios can be evaluated based on material type. For the purpose of this report, the "dimensional lumber" category was chosen based on the closest available fit for pine wood boxes. The default landfill scenario was used. A 50-mile distance to the landfill was used to calculate transport emissions, while the default values of 20 miles were used for combustion and recycling.

The following scenarios will begin with the baseline impact of landfilling all 396 tons of wood waste over the course of a year and continue with other hypothetical end use scenarios for the wood waste. The final scenario outlines the actual environmental impacts presented by our featured hypothetical case study.

9.1 Environmental Impacts of Landfilling All 396 Tons of Wood Waste

Energy (BTU) Consumed: 171 Million BTU[3]
Equivalent to Approximately 30.5 Barrels of Oil[4]

Summary: To landfill all 396 tons of wood waste without any other alternative waste management scenario, approximately 171 million British Thermal Unit (BTU) of energy are consumed each year. This amount is roughly equivalent to 30.5 barrels of oil. Since the WARM model is a baseline tool and landfilling is the baseline, greenhouse gas emissions could not be calculated.

9.2 Environmental Impacts of Recycling All 396 Tons of Wood Waste[a]

Table 7 – Recycling Versus Landfilling 396 Tons of Wood Waste

Total Change in Greenhouse Gas (GHG) Emissions	-209 Metric Tons of Carbon Equivalent (MTCE)[3]
Total Change in Energy (BTU) Consumed	An increase of 62 million BTU[3]
Reducing GHG emissions by 209 MTCE is roughly equivalent to[5]: • Removing 127 passenger vehicles from the road • Carbon sequestered by 158 acres of pine or fir forests • Carbon sequestered by 4.8 acres of forest preserved from deforestation	

Summary: When all materials are recycled over the course of a year, the furniture company realizes a 209 MTCE reduction in greenhouse gas emissions; however, the inputs specifically required for recycling dimensional lumber may lead to an increase of 62 million BTU of energy when compared with landfill disposal.

9.3 Environmental Impacts of Combusting All 396 Tons of Wood Waste

Table 8 – Combustion Versus Landfilling 396 Tons of Wood Waste

Total Change in Greenhouse Gas (GHG) Emissions	-29 Metric Tons of Carbon Equivalent (MTCE)[3]
Total Change in Energy (BTU) Consumed	-3,700 million BTU [3]
Reducing GHG emissions by 29 MTCE is roughly equivalent to[3]: • Removing 18 passenger vehicles from the road • Carbon sequestered by 21.9 acres of pine or fir forests • Carbon sequestered by 0.67 acres of forest preserved from deforestation **Reducing energy consumption by 3,700 million BTU is roughly equivalent to[3]:** • 34 households' annual energy consumption • 638 barrels of oil • 29,767 gallons of gasoline	

Summary: When combusting all materials over the course of a year, the furniture company realizes a 29 MTCE reduction (hence the minus sign) in greenhouse gas emissions. Due to the combustion for energy, combusting the wood actually provides an energy reduction of 3,700 million BTU when compared with landfilling.

[a] Using a baseline of all 396 tons landfilled

According to the US Forest Service, "Wood combustion produces little net (~5%) carbon dioxide (CO2), the major greenhouse gas, because the CO2 generated during combustion of wood equals CO2 consumed during the lifecycle of the tree. Transporting wood using petroleum generates some excess CO2. Wood fuel contains minimal heavy metals and extremely low levels of sulfur; therefore, combusting wood fuel will not create acid rain pollution through sulfur emissions. However, burning wood in the forest does emit significant amounts of nitrous oxide, a greenhouse gas, if either by wildfire or broadcast burning for stand improvement. Particulate emissions from wood are controllable through standard emission control devices such as bag houses, cyclone separators, fly-ash injectors, and electronic precipitators. Bottom ash is minimal. Usually, wood ash is less than 1% of the weight of the wood, and sometimes ash may be used as a fertilizer."[6] This excerpt helps explain the rationale behind the use of wood combustion for energy production in many waste-to-energy plants. Once the wood is combusted and used, however, the lifecycle of the wood ends.

9.4 Environmental Impacts of Source Reduction (i.e., switching to a reusable alternative) or Avoiding the Use of All 396 Tons of Wood Waste

Table 9 – Source Reduction Versus Landfilling 396 Tons of Wood Waste

Total Change in Greenhouse Gas (GHG) Emissions	-162 Metric Tons of Carbon Equivalent (MTCE)[3]
Total Change in Energy (BTU) Consumed	-1,568 million BTU[3]
Reducing GHG emissions by 162 MTCE is roughly equivalent to[3]: • Removing 99 passenger vehicles from the road • Carbon sequestered by 122 acres of pine or fir forests • Carbon sequestered by 3.8 acres of forest preserved from deforestation **Reducing energy consumption by 1,568 million BTU is roughly equivalent to[3]:** • 15 households' annual energy consumption • 270 barrels of oil • 12,619 gallons of gasoline	

Summary: Should the company no longer use wood boxes that become wood waste, the furniture company could realize a 162 MTCE reduction (hence the minus sign) in greenhouse gas emissions. An energy reduction of 1,568 million BTU when compared with landfilling may also occur. To accomplish this, the company may consider turning to a one-time purchase of reusable transport crates or re-think their packaging options to eliminate the use of expended wood boxes.

10.0 Environmental Impacts of the Hypothetical Case Study Partnerships

The environmental impacts presented in the above scenarios are based on choosing one waste management alternative versus another. Currently, it is not realistic for Manufacturer A to eliminate the use of pine boxes for transporting their custom furniture. However, Manufacturer A can source some of the boxes to local end user, End User B. For the purpose of this case study, the scenario below assumes that the material sourced to End User B represents a source reduction by Manufacturer A. Ideally, the source reduction option on EPA's WARM model best represents a company's decision to no longer use certain materials, thus preventing the materials from being processed in the first place. Since the salvaged boxes represent a source reduction to End User B, this report will rely on the source reduction calculations provided by WARM as an alternative waste management scenario. Table 10 displays the data that were used to assess the environmental impacts of Manufacturer A's new alternative waste management approach.

Table 10 – Before and After Breakout of Material Market

Baseline	Alternative Waste Management Scenario
All 396 tons were disposed through landfills	78 tons of wood waste combusted[b]
	84 tons of wood waste reused[c]
	234 tons of wood waste recycled

Table 11 – Environmental Impacts of Alternative Waste Management Scenario

Total Change in Greenhouse Gas (GHG) Emissions:	-164 Metric Tons of Carbon Equivalent (MTCE)[3]
Total Change in Energy (BTU) Consumed:	-1,025 million BTU[3]

Reducing GHG emissions by 164 MTCE is roughly equivalent to[3]:

- Removing 100 passenger vehicles from the road
- Carbon sequestered by 124 acres of pine or fir forests
- Carbon sequestered by 3.8 acres of forest preserved from deforestation

Reducing energy consumption by 1,025 million BTU is roughly equivalent to[3]:

- 10 households' annual energy consumption
- 177 barrels of oil
- 8,244 gallons of gasoline

Summary: By salvaging 84 tons of boxes each year for reuse, sending the remaining wood waste to a recycler that will reprocess the material, and selling 78 tons to combustion (cogeneration) facilities and 234 tons to MDF/particleboard recyclers, an approximate 162 MTCE reduction in greenhouse gas emissions will occur. An energy reduction of approximately 1,025 million BTU when compared with landfilling may also occur.

10.1 Additional Environmental Impacts of the Hypothetical Case Study Scenario

Trucking emissions: The EPA WARM Model can be used to evaluate the greenhouse gas production associated with disposing, incinerating or recycling a material. While this model incorporates emissions considerations from transport, it is of interest to compare the possible trucking implications of wood waste recycling as a stand-alone issue. Table 12 displays the total gallons of gasoline required to truck materials to a landfill 50 miles away (based on real data) before the partnership and to the various end markets selected by Manufacturer A after the partnership has begun. Even though there are more transport destinations in the after scenario, the amount of gas required is half the gas required for eight trips to the landfill. Part of this reduction is based on the fact that Recycler C was able to install a 40-yard roll-off bin, thus resulting in a reduction of weekly pickups.

[b] Combustion is used to represent the sale of wood chips to waste-to-energy plants, although the actual savings will vary depending on the process used.
[c] Although not a perfect fit, the source reduction category on WARM was used to denote reused materials.

Table 12 – Emissions Generated From Transportation, Before and After Partnership

Destination	Before Partnership		After Partnership	
	Gallons of Diesel (Monthly)	Carbon Emitted (Monthly/Yearly)	Gallons of Diesel (Monthly)	Carbon Emitted (Monthly/Yearly)
Landfill (8 roundtrips per month, 100 miles)	80	1,760 Pounds/ 10.56 Tons	NA	NA
Recycler C (4 roundtrips per month, 40 miles)	NA	NA	16	352 Pounds/2.22 Tons
MDF Plant (2 roundtrips per month, 40 miles)	NA	NA	8	176 Pounds/1.11 Tons
Cogeneration Plant (2 roundtrips per month, 40 miles)	NA	NA	8	176 Pounds/1.11 Tons
End User B (4 roundtrips per month, 20 miles)	NA	NA	8	176 Pounds/1.11 Tons
Totals:	**80**	**1,760 Pounds/10.56 Tons**	**40**	**880 Pounds/35.22 Tons**

Note: It is estimated that a diesel truck hauling a 20-yard or 40-yard roll-off container would average 10 miles per gallon. EPA figures were used for evaluating carbon production per gallon of diesel fuel.[7]

Avoided Procurement: Since Recycler C will sell approximately 234 tons of wood waste to a local particleboard plant to be recycled into MDF and particleboard products, the plant is able to avoid the additional purchase of virgin wood products. By reducing the demand for virgin wood, the plant is able to prevent the additional need for more trees to be cut down.

While trees are a renewable resource, prolonging the life cycle of a tree allows for the plant to deliver a greater positive environmental impact. The United States Department of Agriculture (USDA) reports that trees filter pollutants from the air. In fact, 100 trees remove five tons of CO_2 per year in addition to annually removing 400 pounds of ozone and 300 pounds of particulates. Assuming that the average pine tree weighs roughly 2.5 tons, an estimated 94 pine trees, close to USDA's baseline for trees, can be saved through diverting pine wood waste to an MDF/particleboard recycler each year.[8] This reduction in tree removal means a greater reduction in air pollutants.

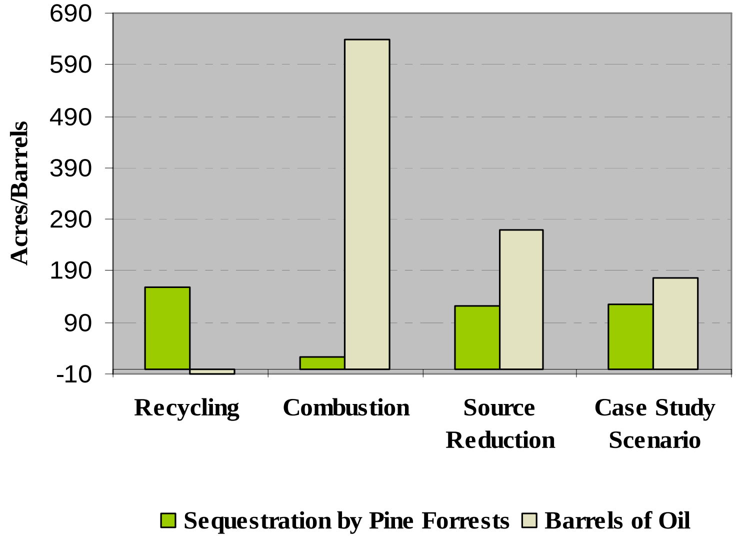
The ReCon Tool developed by EPA helps buyers to understand the value of recycled content material. This tool shows that buying one ton of recycled content lumber (instead of virgin) has the energy benefit of 1.06 million British Thermal Units (MMBTUs) or the equivalent of 8.55 gallons of gas. Buying one ton of recycled content MDF will see a reduction of 2.02 million tons of CO2 equivalent (MTCE) or the equal of removing one car off the road for six months.[9] Consumers can feel assured that buying green will have a tangible positive impact on the environment.

11.0 Overall Comparison of the Environmental Impacts of Various Waste Management Scenarios

As shown in Figure 5, each waste management scenario leaves its unique imprint on the environment. According to EPA's WARM calculator, wood waste recycling actually requires an input of energy; however, a greater savings is achieved when looking at the greenhouse gases saved in comparison to all other scenarios. Keep in mind that WARM is a comparison tool for assessing alternative management scenarios to the baseline. The baseline in all scenarios presented in Figure 3 is 100% landfilling of wood waste. While combustion provides a large energy output that can be harnessed by waste-to-energy plants, the greenhouse gas savings are fairly limited. By reusing all of the wood waste material, the combined benefit of greenhouse gas savings and energy savings is preferable to the other scenarios. The hypothetical Case Study scenario, while based on actual options available to Manufacturer A, reflects a fairly balanced savings in terms of greenhouse gases and energy.

Figure 5

Comparison of Carbon Sequestration and Energy Savings Via Various Scenarios for 396 Tons of Wood Waste



12.0 Conclusions

The presented case study elucidates the point that each and every Alameda County business working with wood products has an opportunity to positively impact the environment through smart waste management choices. Although the best alternative for Manufacturer A would have been to eliminate the use of wood boxes altogether, the company was not positioned to scale back to that level. Instead, by orchestrating partnerships with relevant vendors in the San Francisco Bay Area, Manufacturer A was able to improve their waste management activities and reap the economic and greening benefits of instituting a wood recycling/reuse program. Regardless of the size of business or the challenges faced by local businesses that generate wood waste, it is worth the effort to explore viable partnerships and experiment, if necessary, with local partners in an effort to reduce loads of wood disposed in landfills. The benefits to the generator, end user(s), community at large, and ultimately the environment are likely to outweigh the efforts associated with researching, planning, and implementing wood waste partnerships.

13.0 References

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