



# WOOD PROCESSING & FURNITURE MAKING

## RESOURCE EFFICIENT AND CLEANER PRODUCTION BRIEFING AND RESOURCE GUIDE FOR MICRO & SMALL ENTERPRISES



### PURPOSE

**Issue.** Certain process, technique, and management deficits are commonly found in micro- and small-scale wood processing and furniture making operations. These deficits can have serious adverse effects on short- or long-term business performance---AND, on the local environment and on community health and safety. Among the most significant areas where economic savings can be realized through cleaner production are management actions that address **air pollution from adhesives, air pollution from coating materials, noise pollution, contamination of soil and water, generation of hazardous waste, and excess wood waste.**

**Response.** Addressing these deficits by adopting resource-efficient and cleaner production (RECP) processes, techniques, and management practices can reduce costs and improve business performance and, at the same time, avoid or minimize adverse impacts on the local environment and on community health and safety. RECP approaches generally focus on improving resource and production efficiency which saves physical and energy resources, time, and money needed in production—and results in less waste and pollution. This briefing supports the application of RECP solutions in these six key areas.

**Contents.** This briefing addresses each deficit area in turn. General business, environmental and health and safety issues are identified first. Then, a question and answer format is used to identify specific deficits and potential RECP solutions. The References and Resources section at the end of this briefing provides more detailed and quantitative information on these solutions.

**Audience.** This briefing is intended for business development services providers working directly with wood processing and furniture making MSEs, for those designing MSE strengthening projects, and for USAID staff (and the staff of other funding organizations) charged with overseeing projects in the wood processing and furniture making sector.

**Scope.** This briefing focuses on MSEs that are in the wood processing and furniture making industry. However, some of the solutions outlined in this briefing could also be applied to MSEs that are using similar processes for similar materials or parts.

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## THE PROVEN BENEFITS OF RESOURCE EFFICIENT AND CLEANER PRODUCTION (RECP)

In 1990, UNEP defined Cleaner Production (CP) as “*The continuous application of an integrated environmental strategy to processes, products and services to increase efficiency and reduce risks to humans and the environment*”. The CP concept is widely accepted and promoted internationally, including by USAID. The strategies used to implement CP can be as simple as following the guidance in this briefing, or more complex and formal Environmental Management Systems (e.g., ISO 14001 standard) utilized by medium and large enterprises. UNEP is now advancing the concept of Resource Efficient and Cleaner Production, updating CP with additional emphasis on efficient utilization of resources in product and service enterprises.

This briefing is specifically concerned with RECP/CP technical and management interventions in production operations. Such interventions focus on (1) increasing the efficiency with which resources are utilized and/or (2) assuring that resources are utilized “cleanly”—without incurring costs and impacts that adversely affect the bottom line of the enterprise, the environment, and worker and community health and safety. Typical RECP interventions include:

- substituting different materials
- modifying processes
- improving process management
- upgrading equipment
- redesigning products

Inefficient use of resources like fuel, water and raw materials incurs both business and environmental costs. Experience shows that by reducing inefficiencies, RECP interventions in many cases substantially improve business performance AND deliver environmental, health and safety benefits—sometimes with little or no investment.

Is this always true? No. Some RECP interventions may not improve business performance. But RECP approaches offer the most cost-effective way to improve environmental or social performance when required by project implementation conditions, local regulations, or simply to preserve community goodwill.

For more information see <http://www.usaidgems.org/sme.htm>.

# AREA 1: CONTROL AIR POLLUTION FROM ADHESIVES

**Business Issues:** Adhesives, either synthetic or natural, are used in assembling wooden furniture parts. Adhesive formulations used in this industry contain toxic solvents (for upholstered wood furniture) and hot melts (for non-upholstered wood furniture). Adhesives are also used to apply veneer (a thin piece of wood of uniform thickness) to pieces of furniture. Alternative approaches to adhesive application could reduce both production costs and environmental harm<sup>1</sup>.

**Environmental Issues:** For both assembly and veneer, the use of adhesives releases solvents into the air, and can damage the health of workers and ecosystem services.

**Community & Occupational Health & Safety Issues:** Poor working conditions can adversely affect workers' health. Increased air emissions from the use of adhesives can cause and worsen respiratory illnesses in workers and the surrounding community. An unhealthy workforce may be unproductive, miss work often and make costly mistakes.

Use the following questions and answers to identify specific causes of excessive air pollution from adhesives and the corresponding RECP methods that address them.

## **Which methods of adhesive application are most efficient and result in the least amount of waste?**

Utilize methods that minimize the overspray of adhesives. Of the four conventional ways that glue is applied to wood, foam extrusion, a technique in which foamed adhesive is forced under pressure to the extrusion head, results in the least amount of wasted adhesive.

Employ techniques, such as the variable application rate strategy (VARS), which decrease adhesive consumption. The VARS adjusts the glue-spread rate for each individual plywood panel according to its moisture content. Reducing adhesive consumption reduces both input costs and emissions.

## **Are there less toxic substitutes for existing adhesives?**

Replace existing adhesives with less toxic substitutes: e.g., substitute naturally derived adhesives for petroleum-derived chemicals currently used in the manufacture of wood adhesives. Two non-petroleum options that are currently in the experimental phase are furfuryl alcohol resin and lignin adhesives, both of which reduce harmful pollution. The naturally derived adhesives may also be more cost-effective than their petroleum-based counterparts.

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<sup>1</sup> This briefing specifically discusses air pollution from adhesives and coating materials. Readers should also recognize that similar air pollution can be caused by poor handling and inefficiency related to wood preservatives and industrial solvents. Many of the mitigation strategies presented for adhesives and for coating materials are also relevant to wood preservatives and industrial solvents.

### What safety measure options are available to protect workers from air emissions?

Equip workers with masks or respirators. Masks and respirators help prevent workers from inhaling toxic emissions from adhesives and coating material (as discussed in next section), as well as protect them against the inhalation of small airborne particles, that damage the lungs, e.g., wood dust.

## AREA 2: CONTROL AIR POLLUTION FROM COATING MATERIALS

**Business Issues:** Applying coating materials (i.e., stains, paints and finishes) in furniture making generates air emissions that can cause potentially serious health problems. The solvents in the coating material are the source of these air emissions, which produce volatile organic chemicals (VOCs). The VOCs escape into the air when the coating is applied or when containers of liquids containing VOCs are left open. There are various options that could reduce VOC emissions and thereby reduce harm to workers' health, as well as reduce production costs and environmental harm.

**Environmental Issues:** The use of coating materials releases VOCs into the air, causing damage to the environment (ecosystem services) and health of workers.

**Community & Occupational Health & Safety Issues:** Poor working conditions can damage workers' health. VOC emissions from the use of coating materials can cause and worsen respiratory illnesses in workers and the surrounding community. An unhealthy workforce may be unproductive, miss work often, and make costly mistakes.

Use the following questions and answers to identify specific causes of air emissions from coating materials and the corresponding RECP methods that address them.

### Which methods of coating material application are most efficient and result in the least amount of waste?

Implement alternative methods to compressed air spray gun systems in the application of finish and pre-finish coatings. Alternative methods include airless and air-assisted airless electrostatic spray systems, and flat line finishing. The benefits from utilizing these methods include reductions in material consumption and waste volumes, and increased cost savings.



Young men building wood cabinets in Jamaica.

### **Are there coating materials that can be applied that contain lower amounts of VOCs?**

Use reformulated coating materials that contain fewer VOCs to finish wood furniture. Alternatives include waterborne, ultraviolet-curable, polyurethane, and polyester coatings.<sup>2</sup>

### **Which methods of coating application generate the least amount of VOCs?**

Employ methods that use less coating material, such as a high-volume low-pressure (HVLP) spray system for spray coating. This system uses a high volume of air delivered at low pressure to turn the coating material into a very fine spray. The use of low pressure results in less overspray, thus reducing the amount of coating material needed and emission of fewer VOCs.

### **What equipment is available or what safety measures can be taken to contain or control air emissions?**

Install suitable ventilation systems in workshops, including fans and extractors.

Invest in a spray booth equipped to recirculate air in order to decrease the volume of exhaust emitted to the atmosphere. This process has lower operating costs than other VOC control systems. Replace water-based paint booth filters with dry filters, as dry filters double paint booth life and allow more efficient treatment of wastewater.

Ensure that containers of coating material are tightly sealed when not in use and that containers are not rusting, leaking, or damaged in order to minimize emissions.

Check air filters regularly in order to protect the health of workers and the environment.

## **AREA 3: REDUCE NOISE POLLUTION**

**Business Issues:** Noise pollution is caused by mechanically driven transport, cutting, milling, shaping, and dust extractor installations. Noise impacts are related to the frequency and intensity of the noise, and the nature of hearing protection. Noise pollution poses a health and safety risk for workers, and safety measures should be implemented within the work environment to minimize this hazard.

**Environmental Issues:** Noise pollution from the use of machinery in wood processing and furniture making operations can have adverse effects on the working environment and health of workers.

**Community & Occupational Health & Safety Issues:** Workers may suffer hearing loss and stress related to noise emissions with adverse impacts on worker health. An unhealthy workforce may be unproductive, miss work often and make costly mistakes. Nearby communities may also suffer from the negative effects noise pollution, including decreased quality of life.

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<sup>2</sup> These options are described in EPA (1995a), page 58.

Use the following questions and answers to identify specific causes of noise pollution and the corresponding RECP methods that address them.

#### **What measures can be implemented to manage noise levels?**

Install noise reduction equipment, such as mufflers, silencers, enclosures, or barriers on or around noisy equipment and machinery.

Locate noisy machinery away from doorways to contain noise within the facility.

Use low-noise tools where possible and seek alternative options for louder tools.

Plan regular maintenance of machinery and tools.

#### **What safety measure options are available to protect workers from noise pollution?**

Equip workers with earplugs or mufflers to protect workers from noise pollution.

Train staff in the risks of noise exposure and systems of work to reduce noise exposure.

## **AREA 4: PREVENT SOIL AND WATER CONTAMINATION**

**Business Issues:** Furniture making requires the use of wood preservatives and coating materials, all of which contain solvents. Both preservatives and coating material can contaminate wastewater and soils if they drip from the wood surface, leak from the drums where they are stored, or are discarded after use. Surface contamination resulting from drippage and surface runoff may occur near process areas and the treated wood storage areas. Major contaminants from wood preserving processes in drips include, but are not limited to, polynuclear aromatic hydrocarbons, pentachlorophenol, pesticides, dioxins, chrome, copper, and arsenic.

In the long run, contaminated wastewater can raise the concentration of toxins in local water supplies to levels that harm people's health and the firm's productivity. This may require wood processing operations to pay for the clean water they need or to clean and recycle their used water on-site.

**Environmental Issues:** Contamination of water raises the concentration of toxins in local waters, creating adverse environmental effects to local waters, land, and ecosystem services, requiring MSEs to pay for abatement.

**Community & Occupational Health & Safety Issues:** Water and soils contaminated by the use of wood preservatives and coating materials may affect local drinking water supplies and impair the health of the community.

Use the following questions and answers to identify specific causes of soil and water contamination and the corresponding RECP methods that address them.

### **What application methods or other practices can be employed to prevent or minimize drippage?**

Increase efforts to dry the wood before finishing. This will lessen the need for surface treatment because high water content leads to sap stain. When drying wood, try to choose the most energy-efficient option, including passive solar options.

Spray preservatives or coating materials on the wood using a high-velocity spray system. This system results in fewer process residuals and less drippage.

Minimize drippage from sprayed-on preservatives or coating materials in two ways: (1) by mechanically shaking the furniture piece to remove extra preservatives/coating from the wood surface, and/or (2) by allowing enough time for dripping in a catchment area after the preservatives/coating is applied. The drippage should be recaptured so that it does not eventually enter the drainage system. Place treated wood in storage once dripping has stopped.

To minimize free liquid, allow for sufficient holding time after application of preservatives.

Switch to water-based preservatives, which are less toxic and damaging than typical solvent-based preservatives.

Minimize surface water run-on by diverting storm water away from process areas.

### **How and where are chemicals stored? Are methods in place to control spills and leaks?**

Store additives, solvents, wood treatment chemicals and fungicides in drums with a spill collection system to reduce the risk of leakage. An effective way to collect spills is to build a berm (e.g., a mound of earth) around the floor of the storage area that could potentially contain more than the stored volume of liquids. Recaptured spills can most likely be reused, if the spill collection system is non-porous (e.g., with a plastic lining on the berm).

Do not store materials in sites that are prone to flooding or that are next to water intake points or groundwater resources.

Use concrete pads for the wood treatment area and intermediate storage areas to ensure that all drippage is collected. Treated wood should only be stored after drippage has completely stopped.

### **How should wastewater be managed?**

Treat wastewater before discharging. Recycle water when lower quality wastewater can be utilized in certain rinsing or washing processes.

Install a drainage collection device on rooftops to divert rainwater away from process wastes to avoid mixing.

## AREA 5: IMPROVE THE MANAGEMENT OF HAZARDOUS WASTE

**Business Issues:** The waste from wood processing and furniture making is often thrown away like trash—but should not be, because of its hazardous nature. Hazardous waste cannot be safely disposed of without carefully following procedures for protecting the environment. Unfortunately, proper hazardous waste disposal facilities are typically unavailable in many developing countries. Therefore, preventing or recycling such waste is most desirable. Two prominent sources of this waste are paints and industrial solvents.

The spray-painting of furniture objects has a transfer efficiency of approximately 40 to 65 percent (depending on the spraying technique, the shape of the object and whether it is sprayed manually or automatically). The remaining paint—“overspray”—is considered hazardous waste.

In wood-coating and painting operations, industrial solvents (e.g., lacquer thinner, xylene, or isopropyl acetate) are used to clean application equipment, such as spray guns, spray nozzles, etc. Such equipment must be cleaned often, including each time there is a color change. Contaminated solvents are a by-product of cleanup operations and are considered hazardous. Processing contaminated solvents using recovery units can allow the solvent to be reused, which lowers supply costs and lessens the volume of hazardous waste that must be dealt with.

**Environmental Issues:** When poorly managed, materials used in wood processing and furniture making processes that generate hazardous waste can damage the health of workers and the environment.

**Community & Occupational Health & Safety Issues:** Hazardous waste can cause illnesses in the local community.

Use the following questions and answers to identify specific causes of excess generation of hazardous waste and the corresponding RECP methods that address them.

### **What are strategies for reducing paint waste or recycling paint?**

Place a recovery screen behind the object when spray painting. The overspray can be captured onto the screen, scraped off with a special knife, and deposited in a container. This recovered paint can be reused without further processing.

Save unused or lower-grade paint for application as undercoat in future jobs.

Train spray gun operators in proper spray techniques that minimize paint waste generation.



Wood is loaded onto trucks in Southern Africa.

Provide written instructions, posters and signage to workers and spray gun operators on reducing paint and other wastes, employing effective visual messaging techniques.

#### **Are solvent containers secured when not in use in order to minimize evaporation and color change?**

Keep solvent containers and equipment containing solvents covered as often as possible to reduce loss of solvent through evaporation. For example, if equipment is soaked in a solvent bath, place an airtight cover over the bath to minimize evaporation. This makes solvent last longer and reduces environmental and health damage from airborne VOCs.

Plan the painting process to minimize color changes, if possible, by (1) doing all work related to one color at once, and (2) if possible, finishing a color before the shop closes for the day. The latter suggestion allows end-of-day cleaning to also serve as a color-change cleaning. Such strategies will decrease waste, increase productivity by decreasing the time spent cleaning, and decrease the amount of money spent on both paint and solvents.

#### **How can emissions, solvents, and wastes be treated and recycled?**

Use distillation equipment to treat contaminated solvents. Distillation involves heating the contaminated solvent until it boils and then evaporates. The evaporated solvent is cooled and recovered as clean product. The residue should be removed and handled as hazardous waste. (See the chapter on solid waste in USAID's Environmental Guidelines for Small-Scale Activities.) Regular distillation is capable of treating solvents with a boiling point of 40°–200° C. Vacuum distillation can treat those with a boiling point of 140°–250° C. For flammable solvents, the equipment should be explosion-safe. Recycling solvent in this way may be more cost-effective than purchasing new solvent.

Main treatment processes for liquid effluents include recycling drips and surface runoff after evaporation, detoxification (using ultraviolet oxidation), and precipitation /stabilization of heavy metals.

Exhaust streams can be treated to reduce VOCs using carbon filters (which enable the reuse of solvents) to acceptable levels before venting back into the atmosphere. Combustion devices of bio-oxidation systems can be used to carry out destruction of VOCs when recovery is not feasible.

Use treatment methods that include incineration of toxic organics and stabilization of heavy metals. Because contaminated soils may contain heavy metals or toxic organics, they should normally be managed as hazardous waste.

Use small on-site solvent recovery stills to recycle spent lacquer thinners, methylene chloride, and paint thinner. Use batch distillation to recover xylene and isopropyl acetate from cleaning processes. Solvent recovery systems can be used to recover and reuse solvents contained in air emissions, and spent methyl ethyl ketone.

Flush equipment first with dirty solvent before final cleaning with virgin solvent, and use cleanup solvents in formulation of subsequent batches of paint.

## AREA 6: IMPROVE THE MANAGEMENT OF WOOD WASTE

**Business Issues:** Wood waste is largely created by inefficient sawing and cutting of wood, as well as improper storage practices. This wood waste includes sawdust and end pieces of various materials, including wood, particleboard, and various types of fiberboard. Waste wood also results from inadequate drying of the wood, causing boards to split and reducing their usefulness. Improvements in all of these areas can enhance the cost-effectiveness of operations while reducing environmental impacts.

**Environmental Issues:** Wood waste in wood processing and furniture making operations may contribute to unsustainable timber extraction. If wood is used as a fuel, excess consumption may also contribute to deforestation and associated environmental impacts.

**Community & Occupational Health & Safety Issues:** Wood wastes require significant amounts of space, leaving less land available for other uses.

Use the following questions and answers to identify specific causes of excess wood waste and the corresponding RECP methods that address them.

### How can production processes be changed to reduce waste?

Train workers in efficient wood-cutting techniques.

Consider redesigning the product so that wasteful cuts may become unnecessary.

Order for inventory only wood products that are commonly used or needed for a specific job. Avoid over-ordering. Return unused, damaged or obsolete materials to the supplier for a refund, if possible.

To avoid spoilage, store wood so that it is protected from the elements.

### In what ways can wood scrap be reused/ recycled?

Designate a central cutting area at the work site so reusable wood pieces can be collected easily and stored for future use.

Find new, productive uses for wood scrap. For instance, dry wood residues can be bonded together with a synthetic resin to form particleboard.

Identify and segregate scrap wood available for other uses, e.g., fuel use. However, avoid using laminated materials for fuel use, as the glue may form toxic emissions when burned. Use sawdust and log ends as fuel for boilers to fire up drying kilns or ovens used to dry raw lumber.

## REFERENCES AND RESOURCES

- EPA Office of Compliance Sector Notebook Project: Profile of the Lumber and Wood Products Industry (1995a). U.S. Environmental Protection Agency (EPA). September.  
<http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/lmbrwdsnpt1.pdf>.

This sector notebook provides a comprehensive assessment of the lumber and wood products industry. The publication is one of a series of sector publications published by the EPA and posted on the EPA Web site.

- EPA Office of Compliance Sector Notebook Project: Profile of the Wood Furniture and Fixtures Industry (1995b). U.S. Environmental Protection Agency (EPA).  
<http://www.epa.gov/compliance/resources/publications/assistance/sectors/notebooks/wdfurnsn.pdf>.

This is another of the EPA's series of sector publications.

- "Improved Wood Processing Saves Money and Forest Resources." Winrock International <http://www.winrock.org/volunteer/reed/fff/mercury.htm>.

This success story was culled from the Winrock Volunteer News and Information section of the Web site. The feature articles provide useful information about Winrock's volunteer projects.

- "Integrated Life Cycle of Wood: Tree Quality, Processing and Recycling." U.S. Department of Agriculture, Forest Service.  
[http://www.srs.fs.usda.gov/research/rwud/rwud/rwud\\_4702.pdf](http://www.srs.fs.usda.gov/research/rwud/rwud/rwud_4702.pdf).

This project description is structured as a government report. The scope of the project is national, but the themes addressed could be relevant to other countries that have a substantial wood processing industry.

- Pollution Prevention and Abatement Handbook: Wood Preserving (1998). World Bank Group. July. This handbook was prepared to update and replace the 1988 World Bank Environmental Guidelines.  
<http://www.miga.org/documents/WoodPreserving.pdf>.

This handbook can be downloaded, section by section, from the above Web site. The Industry Sector Guidelines cover 40 industries, including wood preserving.

- Sub-sectoral Environmental and Social Guidelines: Wood Processing (2010). European Bank for Reconstruction and Development (EBRD).  
<http://www.ebrd.com/downloads/policies/environmental/Wood.pdf>.

This sector brief provides a comprehensive environmental and social guidelines for the wood processing industry. The publication is one of a series of sector publications published by the EBRD and posted on the EBRD Web site

- Environmental Health and Safety Guidelines: Sawmilling and Manufacture Wood Products Industry (2007). International Finance Corporation (IFC).  
<http://www1.ifc.org/wps/wcm/connect/ce72a58048855ac48704d76a6515bb18/Final%2B-%2BSawmills%2Band%2BMWP.pdf?MOD=AJPERES>.

This sector brief provides a comprehensive environmental, health, and safety guidelines for the sawmilling and manufacture wood products industry. The publication is one of a series of sector publications published by the IFC and posted on the IFC Web site

### Other Resources:

- Best Practices in Wood Waste Recycling (1997). Clean Washington Center.  
[http://www.cwc.org/wood\\_bp.htm](http://www.cwc.org/wood_bp.htm).

This note offers detailed and technical information on wood waste recycling as it relates to sourcing, processing and product manufacturing.

- Susilo, Kasru and Achmad Djani. Cleaner Production Assessment at an Indonesian Plywood Facility: A Case Study (1997). Forum KMB Indonesia (Indonesian Pollution Prevention Roundtable).  
[http://www.encapafrika.org/documents/Cleaner\\_Production\\_Plywood\\_fac.pdf](http://www.encapafrika.org/documents/Cleaner_Production_Plywood_fac.pdf).

This paper discusses how cleaner production diagnosis and assessment was conducted for one of six plywood facilities, located in East Kalimantan, Indonesia.

- Environmental Guidelines for Planners: Wood Processing Works (2007). Environmental Protection Authority (EPA).  
[http://www.epa.sa.gov.au/xstd\\_files/Industry/Guideline/ea\\_wood.pdf](http://www.epa.sa.gov.au/xstd_files/Industry/Guideline/ea_wood.pdf).

This briefing offers information, guidelines, and conditions for environmental issues, associated with the wood processing industry.

- Code of Practice for Wood Processing Facilities (Sawmills & Lumberyards) (2012). Guyana Forestry Commission.  
[http://www.forestry.gov.gy/Downloads/Code\\_of\\_Practice\\_for\\_Wood\\_Processing\\_Ver\\_2.pdf](http://www.forestry.gov.gy/Downloads/Code_of_Practice_for_Wood_Processing_Ver_2.pdf).

This report offers detailed and technical information on the processes of wood processing, as well as the environmental, social, health, and safety requirements associated with operations.