US EPA ARCHIVE DOCUMENT

Beneficial Reuse of Materials

INTRODUCTION Almost everything we do leaves something behind, from household trash – often referred to as municipal or "post-consumer" solid waste – to industrial waste. Industrial waste, which includes both nonhazardous materials and hazardous waste, is a major component of landfills. In fact, for every ton of municipal solid waste there are more than 30 tons of industrial waste in the nation's landfills.[1] Waste can be expensive for industry and difficult for states and local governments to manage, and can impact the health of communities and ecosystems.

Many industries are finding new ways to use materials that would otherwise be discarded. Facilities are reusing byproducts or waste materials in their own operations or sending them elsewhere for reuse as a fuel or substitute raw material. This process is known as beneficial reuse – turning would-be waste into a valuable commodity.

To fulfill the objectives of beneficial reuse, recyclable materials must perform well, and they must be at least as safe for human health and the environment as the materials they replace. Companies can benefit from reuse by minimizing the fees they pay to dispose of waste, reducing the cost of purchasing virgin materials, lowering the cost of complying with waste regulations, and improving their public image.

The concept of beneficial reuse is quite simple; however, companies must overcome a number of real barriers in order to keep useful, valuable materials out of landfills. The barriers include:

- A lack of awareness regarding existing and new end-use opportunities;
- Variation in state and local waste regulations (some of which discourage reuse); and
- The cost of investing in and adapting to new processes and operations.

Additionally, the costs of transporting, processing, and using these materials must be low enough to stimulate market demand, and projects must yield economic benefits to both material generators and users. Reuse may require upfront changes in industry operations, but such investment costs often can be recovered over time.

Treating waste materials as potential resources means changing our thinking from *waste management* to *materials management*. The shift is underway at EPA. As Tom Dunne, former acting assistant administrator for EPA's Office of Solid Waste and Emergency Response, observed, "Materials management is now the tail on the dog of waste management. In the future, it must be the dog itself."[2] Several EPA programs, such as the Resource Conservation Challenge and the Sector Strategies Program, are working collaboratively with industry to facilitate the reuse of industrial materials where it is safe.[3]

Sectors participating in the Sector Strategies Program are currently engaged in at least three forms of recycling:

- Material reuse within a facility or sector;
- Use of another sector's byproducts; and
- Use of post-consumer materials.

Where recycling is a well-established practice in a sector, as is the case with forest products and iron and steel, data on beneficial reuse are often available. Data are not, however, readily available for those sectors where material recycling is only emerging or where small businesses predominate. In these cases, we have relied on examples to illustrate the potential for recycling. Over time, as recycling practices grow and better data become available, we hope to provide a more comprehensive picture of the beneficial reuse of materials by and from the sectors participating in the Sector Strategies Program.

Material Reuse Within a Facility or Sector

Many of the sectors in the Sector Strategies Program, including construction, paint and coatings, shipbuilding and ship repair, colleges and universities, and cement, have found ways to circulate byproducts back into use within their own (or similar) operations.

Construction Construction & demolition (C&D) debris refers to waste materials generated during the process of construction, renovation, or demolition of buildings, roads, and bridges. Most C&D debris can be reused or recycled. EPA estimates that 136 million tons of building-related C&D debris were generated in the U.S. in 1996, and 20% to 30% of this material was recycled.[4] Although no national trend data are available, data collected by the Florida Department of Environment Protection show a steady rise in recycling of residential C&D debris in the state between 1999–2002.[5]

C&D debris can be reused at the same job site or sent to recycling facilities for reuse by other contractors or even other sectors. For example, during the building of its new headquarters on the site of an old manufacturing facility in St. Louis, MO, Alberici Constructors reused 93% of the debris, including gypsum board, clean lumber, metal, glass, and cardboard. Alberici built a retaining wall out of salvaged materials, reused overhead crane rail beams in an existing warehouse as the support structure for part of a new parking garage, and deconstructed an old office building on the site in a way that allowed most of the brick and concrete to be used as structural fill.[6]

Paint & Coatings Paint and coatings manufacturers use solvents both as a formulation ingredient and to clean equipment. Much of the waste solvents can be recovered for reuse. According to data from EPA's *National Biennial RCRA Hazardous Waste Report*, in 2001 paint and coatings manufacturers managed more than 37,000 tons of waste solvents. Of this quantity, 62% was reclaimed and reused as solvent, and 34% was used as fuel.[7]

Shipbuilding & Ship Repair Shipyards across the country are looking for ways to reuse materials. For a number of years, shipyards have recovered and reused the blasting grit used to remove paint. Recently shipyards have begun to look at other processes that lend themselves to material reuse. For example, Bath Iron Works in Bath, ME, utilizes a solvent segregation and distillation process to recover wash solvent for continuous reuse to clean paint lines, pots and guns, and other wastewaters. In 2004 the company recovered 38,800 pounds of solvent.[8] Another shipyard, Atlantic Marine in Jacksonville, FL, has developed a method for onsite reuse of its wastewater. Nearly 1 million gallons per year of bilge and blasting wastewater are used to irrigate the facility's grounds after they have been treated to meet Florida's drinking water standards.[9]

Colleges & Universities Colleges & universities are increasingly recycling organic materials by composting manure, coal ash, food scraps, and lawn waste. For a large campus, the volume of recycled material can be equivalent to that of a small city. For example, Washington State University's (WSU) Pullman Campus, with 18,690 students, composted 138.7 tons of material between July 2004 and June 2005. WSU uses a portion of the finished compost on its golf course, grounds areas, and agricultural land, as well as for animal bedding. The remainder is sold to local garden stores, landscapers, and hydroseeders.[10]

Cement Cement kiln dust (CKD) consists of the particles released from the pyroprocessing line at cement plants. It includes partially burned raw materials, clinker, and eroded fragments from the refractory brick lining of the kilns. Recycling CKD reduces the amount of raw materials needed for cement production, and because CKD is already partially processed, recycling it also reduces energy consumption. The industry recycles more than 75% of its CKD, nearly 8 million tons, each year.[11] When normalized by annual clinker production, the amount of CKD sent to landfills has declined by 49% since 1995.[12] Newer plants (typically dry-kiln operations with preheater and precalciner technologies) are more effective at recovering CKD and reusing it in the manufacturing process.

There are limits, however, to recycling CKD in the manufacturing process, because contaminants can build up in the CKD and compromise the quality of the clinker. The CKD that is not recycled is either disposed of at a landfill or sold to other sectors for beneficial reuse applications, such as road fill, liming agent for soil, or as stabilizer for sludge and other wastes.

Use of Another Sector's Byproducts Reuse of materials across sectors opens additional avenues for reducing costs and conserving resources. Trade associations and government agencies are collaborating to discover opportunities for one sector's trash to become another's treasure.

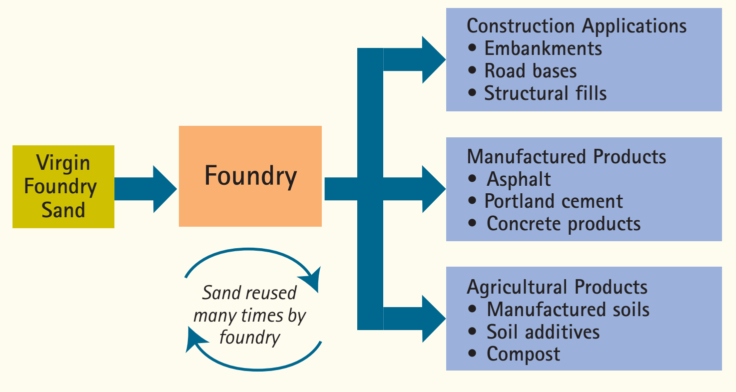
Industries participating in the Sector Strategies Program illustrate the potential for a sector to provide materials to another sector for reuse (e.g., metal casting, iron and steel, and metal finishing) and to take in materials from another sector for use as fuel or substitute raw materials (e.g., cement).

Metal Casting Foundries in the metal casting sector produce castings from sand molds. This sand can be reused several times within a facility to make new molds. In time, though, the sand deteriorates and is no longer useable by the foundry. Nearly all of this sand (98%) is a nonhazardous byproduct that could be used for other purposes, yet 9 to 13 million tons are discarded in landfills each year. Only one million tons per year are currently put to productive use.[13]

As shown in the *Beneficial Reuse of Foundry Sand from the Metal Casting Sector* figure, foundry sand can be used almost anywhere virgin sand is used. Construction contractors use it for structural fill, backfill, and pipe bedding. The cement sector uses it as an ingredient in cement. It can be used to make asphalt, bricks, concrete blocks, and other products. The agricultural sector is starting to use it in manufactured soils and for other purposes.

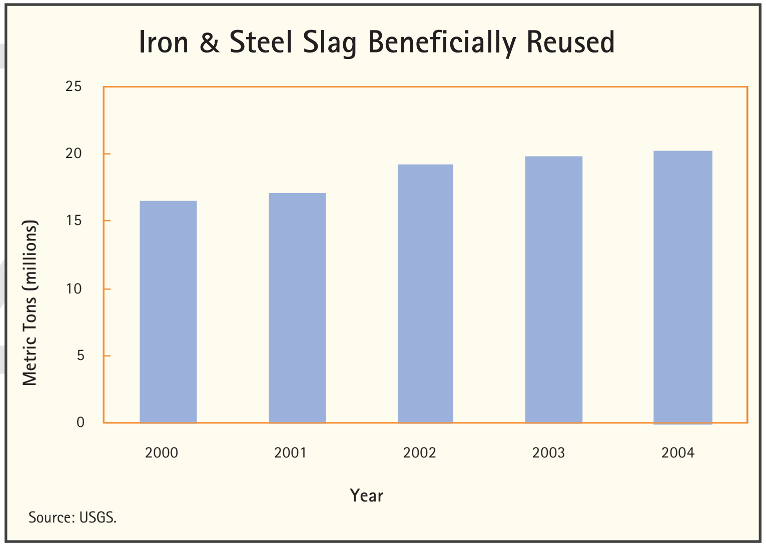
EPA is now working with the metal casting industry and key states to identify innovative approaches for improving rates of foundry sand reuse.

Beneficial Reuse of Foundry Sand from the Metal Casting Sector



Iron & Steel Iron and steel slags are co-products of iron and steel manufacturing, produced when slagging agents such as limestone or dolomite and/or fluxing materials are added to blast furnaces and steel furnaces to strip impurities from iron ore, steel scrap, and other raw materials. The molten slag floats atop the molten crude iron or steel and is tapped from the furnace separately from the liquid metal. After cooling, the slag is processed and may then be sold.[14]

Most iron and steel slags have reuse value. As shown in the *Iron & Steel Slag Beneficially Reused* bar chart, slag consumption has risen in recent years, corresponding to increases in steel production and scrap consumption overall. In 2005, about 21 million tons of domestic iron and steel slag, valued at about $326 million, were consumed.[15] Iron or blast furnace slag accounted for about 60% of the tonnage sold and was worth about $290 million; about 85% of this value was granulated slag. Steel slag produced from basic oxygen and



electric arc furnaces accounted for the remainder.[16] Ferrous slags are sold for cement kiln feedstock and other uses such as aggregate for asphalt paving, fill, road base, and concrete. Ground granulated blast furnace slag, valued at more than $60 per ton, is used as a partial substitute for portland cement and blended cements. Some iron and steel slags are returned to the furnaces as ferrous and flux feed.

Steelmakers, iron and steel slag producers, and government agencies – including transportation departments – are partnering to identify more and better opportunities for using these materials.[17] One cement manufacturer, Texas Industries, Inc. (TXI), developed the CemStar℠ process for reusing steel slag in high quantities. By 2002, two TXI facilities were able to reuse 340,000 tons of steel slag from Chaparral Steel.[18]

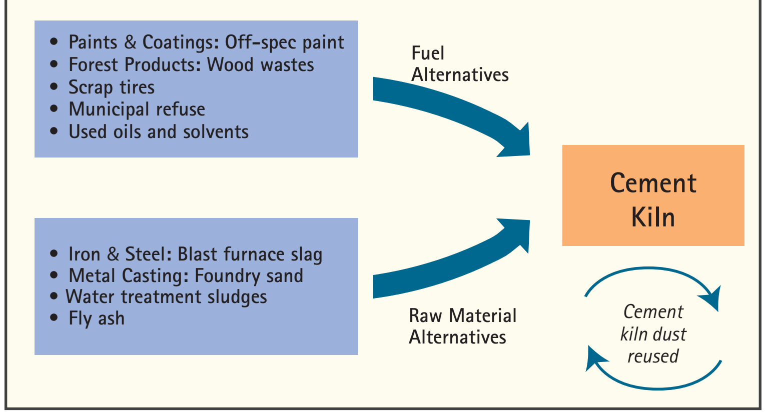
Metal Finishing Wastewater sludge from metal finishing operations is a hazardous waste that contains recoverable concentrations (up to 40%) of copper, nickel, chromium, tin, zinc, and other metals.[19] Permitted hazardous waste recycling facilities can use technologies such as ion exchange canisters to recover economically valuable metals from the wastewater treatment sludges generated by the metal finishing sector. These metals can then be returned for use in metal finishing operations or sold to other industries.

EPA estimates that 76,700 tons of this sludge was generated in 2003, but only 18% was reclaimed or recovered.[20] EPA is currently exploring options for removing regulatory barriers to additional metals recovery from this sludge.

Cement Cement manufacturing uses industrial byproducts from other sectors both as production ingredients and as fuel. As shown in the *Beneficial Reuse of Materials by the Cement Sector* figure, cement production ingredients may include foundry sand and steel slag (as presented earlier in this chapter), as well as coal fly ash and other materials.

Cement manufacturing is energy-intensive, requiring thermochemical processing of raw materials in huge kilns at very high and sustained temperatures. A medium-sized cement kiln consumes up to 300 million Btus of fuel per hour.[21] However, cement manufacturers can use a variety of industrial byproducts as fuel, including scrap tires, off-specification oil-based paints, byproducts from refineries, wood wastes, aluminum potliners, spent solvents, and used carpets. The industry's use of these materials as fuel has increased over the last decade. For example, in 1998, 30 cement manufacturing facilities burned approximately 38 million scrap tires as fuel; by 2003, 43 facilities burned 53 million tires. The Rubber Manufacturers Association predicted that 50 out of 114 cement facilities would be using scrap tires by 2005.[22]

Beneficial Reuse of Materials by the Cement Sector

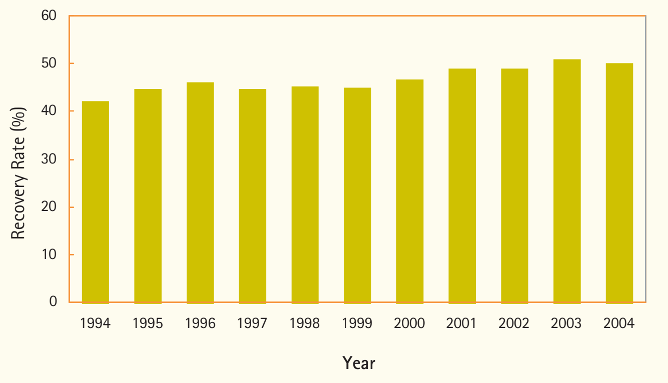


Cement trade associations, EPA, state programs, and other stakeholders are collaborating to find sensible ways for preventing potential kiln fuels from going to waste.

Use of Post-Consumer Materials Manufacturing facilities in several Sector Strategies sectors, including forest products, iron and steel, and paint and coatings, can obtain feedstock for their products from materials discarded by consumers.

Forest Products Paper manufacturing provides a well-known example of post-consumer recycling. As shown in the *Paper & Paperboard Recycling* bar chart, the paper recovery rate reached an all-time high of greater than 50% in 2003, decreasing slightly in 2004.[23] For some grades such as corrugated boxes and newspapers the recovery rate was over 70%.[24] Data available for 1994 and 2004 show a 27% increase in paper and paperboard recovery – from 40 million tons to more than 50 million tons.[25]

Paper & Paperboard Recycling



Source: AF&PA.

Iron & Steel Iron and steel manufacturers have a rich history of recycling scrap from used products of all kinds. All new steel is made using at least some recycled steel, and the industry's use of post-consumer scrap, rather than just industrial scrap, continues to climb.[26]

Recent increases in demand for steel have accelerated steel recycling. Since 2002, the overall recycling rate for steel has remained at a 20-year high of almost 71%.[27] Obsolete automobiles are the most recycled consumer product. Each year, the steel industry recycles more than 14 million tons of steel from end-of-life vehicles. This is equivalent to nearly 13.5 million new automobiles.[28] In 2004, the recycling rate for automobiles was 102%, indicating that the steel industry recycled more steel from automobiles than was used in the domestic production of new vehicles.[29]

Between 2003 and 2004, the use of recycled steel increased by more than 10% to 76 million tons, which for 1 year was the most scrap recycled in the United States in more than 20 years.[30] Driven by the high demand for steel and the sector's increasing efficiency, the iron and steel sector continues to expand its recycling of industrial scrap, steel from building demolition, and obsolete products such as appliances and cars. Steelmakers are exploring additional opportunities to improve recycling rates and efficiency, such as product designs that encourage and enable future dismantling and recycling.[31]

Paint & Coatings Of all household hazardous wastes, paint represents the largest cost for local governments to collect and manage.[32] In a draft report, EPA estimates that 9% to 22% of paint sold could become leftover paint.[33]

The paint and coatings industry is participating in a national product stewardship initiative to address the challenges of reducing and managing leftover paint. One of the goals is to increase reuse and recycling opportunities. There are three ways to reuse and recycle leftover paint: exchanges, consolidation, and reprocessing. Exchanges (or swaps) are a way to make unused paint available to other consumers. Consolidation entails combining leftover paints that have similar characteristics, and then mixing, filtering, and packaging the product for distribution or sale. In most cases consolidated paint has at least 95% recycled content. Reprocessed paint is a completely remanufactured product that uses leftover paint as a primary ingredient; it generally contains at least 50% recycled content. In the U.S., reprocessing is currently limited to latex paints.[34]

Moving Forward As demonstrated in this chapter, environmentally sound beneficial reuse opportunities are abundant and often underutilized. These win-win opportunities for business and the environment represent one of the paths that EPA encourages for businesses to become better environmental stewards. Through the Resource Conservation Challenge and the Sector Strategies Program, EPA will continue to provide a forum for collaboration to identify potential new uses for industrial byproducts and innovative approaches to overcome barriers to beneficial reuse.