



Manufacturing & Industrial: Waste Minimization

Each year, companies in the United States generate and dispose of 7.6 billion tons of non-hazardous industrial solid waste.ⁱ In light of rising raw material and disposal costs, existing and pending regulatory pressures and changing consumer preferences, companies in the manufacturing and industrial sector are seeking ways to minimize their waste streams and maximize their cost savings. Waste minimization strategies present companies with a true sustainability advantage in the form of economic, environmental and social benefits.

What is Waste Minimization?

There are several definitions of waste minimization promoted by governing bodies in the international community. The United States Environmental Protection Agency (EPA) defines the concept as follows:

Waste minimization refers to the use of source reduction and/or environmentally sound recycling methods prior to energy recovery, treatment, or disposal of wastes. Waste minimization does not include waste treatment, that is, any process designed to change the physical, chemical, or biological composition of waste streams. For example, compacting, neutralizing, diluting, and incineration are not typically considered waste minimization practices. EPA's preferred hierarchical approach to materials management includes source reduction, recycling, energy recovery, treatment, and finally, disposal.ⁱⁱ

In contrast, the United Nations Environmental Programme (UNEP) uses the following definition:

Waste minimization refers to strategies that are aiming to prevent waste through upstream interventions. On the production side, these strategies are focusing on optimizing resource and energy use and lowering toxicity levels during manufacture. Strategies that are considered to minimize waste and thus improve resource efficiency in or even before the manufacturing process are, for example, product design, cleaner production, reuse of scrap material, improved quality control, waste exchanges, etc. On the consumption side, waste minimization strategies aim to strengthen awareness and prompt environmentally conscious consumption patterns and consumer responsibility to reduce the overall levels of waste generation.ⁱⁱⁱ

While the exact language used to define the concept and its scope may vary among regulatory bodies, all definitions emphasize the importance of avoiding the creation of waste rather than focusing on the management of residuals after they are generated.

Benefits

There are multiple benefits to a minimized waste stream. Not only is it considered a best management practice, but it is the law for

manufacturers regulated under the United States Resource Conservation and Recovery Act (RCRA) (as per Section 1003[b] of that statute). All Large Quantity Generators (LQGs) of hazardous waste must have a formal waste minimization plan in place as per the regulations under 40 CFR § 262.27. A comprehensive waste minimization plan helps ensure that facilities remain in compliance with federal regulations. In fact, an effective waste minimization plan may help facilities reduce their hazardous waste streams to the point where they can "downgrade" their generator status, or even prevent regulation under RCRA altogether.^{iv}

Minimizing waste often provides economic benefits such as using inputs more efficiently to reduce purchases of raw materials. Manufacturers will see a reduction in waste spend as the volume of non-product outputs (NPOs) decreases. Additional cost savings can be realized through reduced expenditures for costly hazardous material management and disposal.



Waste minimization programs can also contribute to measurable successes in terms of market share, revenue growth and cost savings. Robust recycling programs often convert themselves from a cost into a revenue stream when volumes warrant commodity rebates.

Reductions in hazardous waste volumes can also have the effect of reducing the overall toxicity of the manufacturing process and final product, which can result in fewer employees and consumer exposure to toxins and an overall improvement in workplace health. These factors typically lead to increased employee satisfaction and retention, not to mention the reduction of potential risks and liabilities associated with the use, storage and disposal of hazardous materials.

The environment can also benefit when companies implement waste minimization strategies. Potential environmental benefits include reductions in carbon, air and water emissions as well as the conservation of natural resources that are usually associated with raw materials extraction and waste disposal. This additionally conserves energy and water used for the processing of wastes and raw materials.

Consumer preferences are shifting towards products and manufacturers that can demonstrate environmental benefits. Consumers are willing to pay price premiums for products that

demonstrate these attributes.^v ^{vi} If consumers perceive that a manufacturer is serious about sustainability (which includes waste minimization efforts), this can create a “halo effect” for the entire brand.^{vii} In other words, consumers with a favorable opinion of the manufacturer are more likely to purchase products from that manufacturer, and not necessarily based on the individual product’s attributes.

Waste minimization can be seen as an act of foresight. Reducing waste both in the final product and the manufacturing process may reduce regulatory burdens associated with disposal and helps manufacturers stay ahead of the curve.

The Starting Line

According to the EPA, effective waste minimization programs follow the below process^{viii}:

1. Obtain Management Commitment and Organize Teams

Management support demonstrates organizational commitment to goals and can help reduce the tendency for employees to disregard procedural changes.

2. Divide Facility into Logical Areas and Identify Raw Materials and Wastes (Materials Accounting)

Waste and resource mapping will determine the quantity and locations where raw materials are used, along with the quantities and locations of waste generation. This information can help design waste out of the manufacturing process.

3. Identify Full Spectrum of Operating Costs (Environmental Cost Accounting)

Environmental cost accounting helps companies calculate the overall impacts of their products and processes. This information can serve as a baseline to measure progress towards goals and cost savings after the waste minimization program is implemented.

4. Establish Goals and Priorities and Develop a Waste Management Plan

The waste minimization plan will become a more useful tool if it is framed within the context of facility-specific waste goals. These should be established before the waste minimization plan is developed, with input from senior management and employees, to ensure that priorities are aligned. The collaborative formulation of goals and priorities ensures that a waste minimization plan is an effective roadmap.

5. Implement the Waste Management Plan and Follow Up on Recommendations/Implement Continuous Improvement

Finally, the plan should be implemented at the facility. Soliciting feedback and recommendations for improvement helps guarantee that the waste minimization plan is as effective as possible, while engaging employees and demonstrating how their expertise is valued. Striving to continuously improve the waste minimization plan will keep manufacturers a step ahead of their competition.

Overcoming Barriers

Obstacles remain for companies seeking to minimize their waste streams. In difficult economic times, it can be a challenge to secure the necessary resources to redesign products and processes with the aim of minimizing wastes. There are additional difficulties if a manufacturer’s supply chain is complex or lacking in transparency.

Any difficulty in locating or securing alternate raw materials for the

manufacturing process can hinder efforts to reduce the toxicity of process wastes.

Finally, inertia and the status quo can foil efforts at waste minimization. Undergoing a process redesign is much more challenging than continuing business as usual.

Companies can address these hurdles in a number of different ways. For example, it is important to communicate and maintain a long-term perspective. Although some investments in waste minimization require an upfront cost, they often become cost neutral after a short period of time, and save the company money thereafter. Project Return on Investment (ROI) calculations should not only include the financial piece of the puzzle, but also account for intangible benefits like worker retention and environmental conservation to determine the true return on investment.^{ix}

Vendors should help manufacturers attain their waste minimization goals, not hinder them. Companies must collaborate with vendors to ensure that purchased materials arrive in minimal packaging or reusable packaging to avoid disposal costs. Vendors can also help minimize waste by supplying inputs of specific sizes or shapes to avoid excess material scrap in the manufacturing process. Use of contract language can also help ensure that vendors positively contribute toward organizational goals.



To fight the power of the status quo, it is essential to display top-down support of waste minimization strategies and engage employees in the planning and implementation processes. Management support and employee engagement strategies can help reduce the tendency for employees to resist change. Regularly communicating program highlights and progress toward goals helps with employee behavior changes and demonstrates that new efforts actually have an impact.

Waste Minimization Strategies

There are multiple tools and techniques that manufacturers can apply to their operations in order to minimize their waste streams. For example, representatives from each area of operations can form a “green team” to communicate ideas and progress up to senior leadership and down to department employees, ensuring an integrated and comprehensive approach to waste minimization throughout the facility.

The reduction of packaging materials can also affect the overall waste stream volume. Manufacturers can redesign their product packaging to minimize the amount of material used and to maximize the amount of recyclable or degradable packaging content. For example, air packs or corn-based “peanuts” can be selected instead of expanded polystyrene to provide cushioning.

The use of “green chemistry” is another effective way to minimize the toxicity of a process along with the potential for releases to the environment. By designing chemical products and processes that minimize the generation of hazardous wastes, companies using “green” or “sustainable chemistry” products also have opportunities to reduce waste volumes and toxicities along with energy and other resources.^x

A large component of many manufacturers’ waste streams is wastewater and industrial sludge. These materials are often costly to treat and dispose of or discharge. In order to minimize this element of the waste stream, manufacturers should consider ways to reduce the amount of water needed for manufacturing processes; gains in water efficiency also reduce costs associated with the purchase of fresh water. Wastewater sludge should be profiled as to their constituents. Some sludge is high in organic content or other materials that could be beneficially reused by other firms. Decreasing the volumes of wastewater and wastewater sludge helps to conserve natural resources and reduces the potential for environmental contamination.

If green chemistry cannot be used to reduce the volume and toxicity of wastewater, the EPA Sustainable Chemistry Hierarchy suggests establishing closed loop manufacturing systems.^{xi} This technique can also be applied to other parts of the manufacturing process where wastes (such as solvents) are generated. Using closed loop systems minimizes the amount of new chemicals that must be purchased by maximizing their efficiency and prolonging their useful life. It also reduces losses due to accidental releases or evaporation, along with the potential for soil or groundwater contamination and air emissions.

Additional Tools and Techniques

Companies should optimize diversion through comprehensive reuse or recycling programs to avoid disposal costs, minimize waste and avoid unnecessary purchases of raw materials. Additionally, companies should attempt to procure raw materials with recycled content wherever possible. Purchasing recycled content closes the loop on the manufacturing process and generates demand for recycled materials, making them attractive to produce and providing outlets for recyclable byproducts. Procuring raw materials in bulk (where possible) will reduce the amount of packaging materials that enter the waste stream.

After completing an environmental cost accounting of their own products and processes, manufacturers should utilize the same techniques, along with life cycle assessment (LCA), to assist with the selection of alternative raw materials or technologies that reduce waste and have less environmental impact.

Improved housekeeping practices ensure that raw materials are used efficiently. For example, material handlers can make sure to keep bulk containers closed. Not only will this help keep the facility in regulatory compliance, but this practice also prevents material loss due to spills, evaporation or volatilization. Manufacturers should take precautions to avoid processes that cause hazardous waste to be mixed with non-hazardous waste as well. This minimizes the amount of hazardous waste that must be stored, treated and disposed of, which will reduce the costs associated with hazardous materials management accordingly.

Maintaining an accurate inventory of raw materials and use of appropriate container labels also helps to avoid material waste by helping to ensure that the minimal amount of raw materials are purchased and that perishable materials are used before they reach their expiration date.

In order to identify areas for collaboration with vendors, companies may wish to undertake a supply chain analysis. This will assist with determining the impacts of a supply chain on the manufacturing process and may generate ideas on how to mitigate any concerns.

The EPA offers a free, voluntary program for businesses wishing to embark on the journey to minimize their waste burdens. The EPA’s WasteWise program provides participants with tools and techniques to eliminate the generation of municipal solid wastes and select industrial wastes. Among the available resources are planning tools, calculators to measure progress, platforms to communicate results and a helpline providing free technical assistance.^{xii}

Following a comprehensive exercise to map out waste generation points throughout the manufacturing process, companies can consider modifications to these processes to reduce or eliminate waste. In some cases, simply adjusting a setting on a piece of equipment or using a more durable process component can result in significant reductions in waste volumes.

In other cases, companies may wish to modify the product itself so that waste can be eliminated before it is generated. Strategies like material substitution or redesigning the product through a process such as Design for Environment can accomplish this goal. Defective products also add to a company’s waste stream. Practicing quality control strategies like ISO 14001 and Six Sigma can minimize product defects that can cause increases in waste.

Other methods to reduce the overall toxicity and volume of waste include on-site and off-site treatment processes for wastewaters and sludge. Closed loop systems for wastewater can return this valuable resource to the manufacturing process rather than discharge it as a waste. By establishing closed-loop systems, manufacturers can reduce the amount of wastewater generated and seek out opportunities for the beneficial reuse of non-hazardous filter cakes and sludge, benefitting both the environment and the bottom line.

Helping Alcoa Pick up Value Right Off the Floor

Alcoa understands the value of recovering excess aluminum oxide, a fine, powdery material and key component in aluminum production. Without a procedure to safely capture this material and re-introduce it back into the manufacturing process, this reusable and valuable raw material was being swept off the factory floor and thrown away.

Together with Waste Management, Alcoa designed and implemented a comprehensive resource recovery plan that now enables Alcoa to reclaim 20 to 25 tons of aluminum oxide each week. In addition, this waste stream diversion helps the company work toward reaching its landfill reduction goals.

Currently, the program generates an estimated \$500,000 annually in discovered value. Alcoa is making money off of what used to be swept away.

Conclusion

From regulatory compliance to positioning the company as an industry leader of the future, there are many reasons to implement a waste minimization strategy. The benefits range from cost savings to risk avoidance to carbon reductions and more. With so much to gain, the only thing manufacturers have to lose is waste.

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