

Energy Efficiency, Water and Waste-Reduction Guidebook for Manufacturers

Proven Ways To Reduce Your
Costs and Improve Operations

Energy Efficiency, Water and Waste-Reduction Guidebook for Manufacturers

Proven Ways To Reduce Your Costs and Improve Operations

Table of Contents

Preface	2
John Engler, President and CEO, National Association of Manufacturers	
Jerry Jasinowski, President, The Manufacturing Institute	
Acknowledgments	3
Introduction: Overview of Sustainability for Manufacturers	4
John Kennedy, President, Controls Group, Johnson Controls, Inc.	
Manufacturing Resource Use	
Manufacturing Energy and Fuel Use	5
Manufacturing Energy Sector Inputs	6
Manufacturing Water Use	6
Manufacturing Waste Disposal	6
Energy, Water and Waste-Reduction Opportunities	
Summary	9
Increase Energy Efficiency To Reduce Costs	10
Riverdale Mills Corporation	11
Finance Energy Efficiency Upgrades	12
Centura Health Medical Center	13
Increase Water Efficiency To Reduce Costs	14
General Dynamics C4 Systems	15
Improve Waste Management Through Waste Reduction, Reuse, Sale and Donation . .	16
ACE Clearwater Enterprises	17
Improve Waste Management Through Recycling	18
Vermeer Manufacturing Co.	19
Improve Indoor Environmental Quality To Increase Productivity	20
Knoll, Inc.	21
Reduce Transportation Impacts	22
Bayer Corporation	23
Reduce Environmental Impacts and Potential Business Liabilities	24
Ford Motor Company	25
Identify Marketing Opportunities Presented By Increased Environmental Procurement Standards	26
Toyota Manufacturing North America	27
Resources To Make Your Facilities More Efficient and Less Wasteful	28-33

Preface

If you're like most manufacturers, there aren't enough hours in a day to complete everything you absolutely have to do. No doubt there are many things you'd like to do if only you had the time, such as figuring out ways to increase the energy, water and waste efficiency of your plants and offices. You know that investments in these areas can save your firm money and contribute to its positive environmental public image. Still, unless you're faced with the immediate need to replace a motor or light fixture that doesn't work, there always seems to be something more pressing or of greater priority in the capital budget.

The purpose of this guidebook from the National Association of Manufacturers and its research and education arm, The Manufacturing Institute, is to make saving energy and reducing water and waste expenses so simple and natural that it becomes part of a manufacturer's daily routine. This is important because there are opportunities for significant cost savings. According to latest U.S. Department of Energy figures, manufacturers can realize steam savings of up to 20 percent just by improving steam systems. If steam system improvements were adopted industry-wide, the annual benefits would amount to \$4 billion in fuel cost reductions and 32 million metric tons of emission reductions. Likewise, motor-system energy use could be reduced by as much as 18 percent by applying proven efficiency technologies and practices. Similar savings are also available in both compressed air and process heating.

As the examples in this guidebook from large and small companies alike and from all across the country show, energy efficiency and water and waste reduction can and should be a "team" pursuit throughout your organization. We specifically added real-life stories from diverse manufacturers such as Riverdale Mills, General Dynamics and Vermeer Manufacturing to show how they have achieved their efficiency goals.

This guidebook is not just for you but for all of your company's employees, suppliers and customers. Distribute copies of it. Post it on bulletin boards. Even send it to your local media and government agencies. Empowering everyone you work with will lead to the exchange of great ideas to save your company energy and money, making it more profitable as you mold a positive environmental corporate image.

The material in this guidebook is posted on our Web site—www.nam.org/efficiency—to facilitate its use in every plant and office of every manufacturer who wants to succeed in this cost-conscious, competitive marketplace.



John Engler, President and CEO
National Association of Manufacturers



Jerry Jasnowski, President
The Manufacturing Institute

Acknowledgments

Many people helped develop this booklet, and The Manufacturing Institute and the NAM are grateful for their help, which was rendered each step of the way.

First and foremost we thank the companies that supplied the information in each of the best practices sidebars:

- ACE Clearwater Enterprises
- Bayer Corporation
- Ford Motor Company
- General Dynamics
- Knoll, Inc.
- Riverdale Mills Corporation
- Centura Health Medical Center
- Toyota Motor Manufacturing North America, Inc.
- Vermeer Manufacturing Company

Their success stories clearly illustrate for all manufacturers what steps they took to become more efficient with energy, water and waste removal. These companies are communicating their innovations to their employees and communities.

We thank Johnson Controls, Inc., for its generous support towards the development, printing and distribution of this booklet. Johnson Controls is a Fortune 150 company that develops and implements cost-effective strategies to make buildings more comfortable, productive, safe and energy efficient. Johnson Controls helps deliver lower costs to manufacturers by making their facilities more productive assets, allowing them to focus on their core mission of manufacturing.

Michael Army, Steve Olson and Jenny Carney at the Leonardo Academy in Madison, Wis., wrote and edited this publication and interviewed many of the companies. Leonardo Academy is an independent nonprofit organization that runs the national Cleaner and Greener program. Leonardo Academy provides and supports programs that put the competitive marketplace to work on improving the environment. Environmental improvement vehicles include education, analysis, consumer programs and the development of innovative approaches to public policy implementation.

Thanks also go to Barb Haig, president of Barbara Haig Communications, for writing and editing assistance.

We also want to thank Mark Whitenton, the NAM's vice president for Resources & Environmental Policy for his guidance and many good suggestions. Thanks also to Kevin Sullivan at the NAM for the layout and design and Marissa Gandelman for the final editing and proofreading. Bill Canis, executive director of The Manufacturing Institute, supervised the project, with responsibility for budget, content and editorial direction, coordination with other departments and print production. Slade House, an intern at the institute, assisted with the research and interviewing of companies for the "Best Practices" sidebars.

Introduction

The significant increase in energy prices over the past year, plus events that highlighted the vulnerability of our energy supply, has led many manufacturers to look for ways to reduce energy use, purchase energy more efficiently and manage energy more intentionally over the long term. Beyond the financial necessity to reduce energy use, many manufacturers have also come to understand that conserving scarce resources and limiting their impact on the environment is simply the right thing to do. This booklet provides practical suggestions, real case studies and many useful resources to help companies reduce costs and improve operations while limiting our impact on the environment. We commend the National Association of Manufacturers for their commitment to helping manufacturers understand this issue and we are pleased to underwrite the effort.

By their very nature, the businesses of Johnson Controls, Inc., contribute to energy conservation and environmental quality. The

products we make and the services we provide help our customers save energy, reduce pollution, purchase energy effectively and manage energy efficiently. We have been on the forefront of developing high-performance “green” buildings for more than 15 years. We were pleased to receive the 2004 World Environment Center Gold Medal for “International Corporate Achievement in Sustainable Development.” We also operate more than 200 manufacturing plants of our own. We have worked hard to conserve resources and improve facility effectiveness in our own plants and for many of our manufacturing customers. We would be pleased to have the opportunity to work with you as well.



John Kennedy
President, Controls Group
Johnson Controls, Inc.

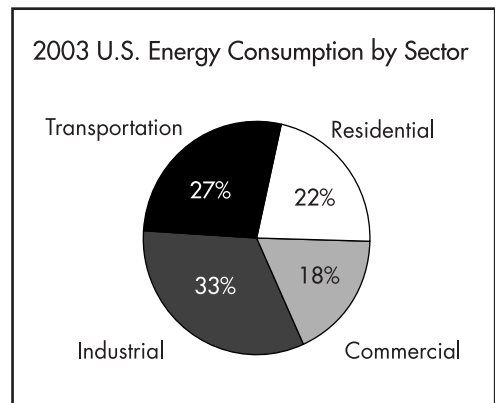
Manufacturing Resource Use

No segment of American society has as much to gain from efficiency and waste-reduction measures as the manufacturing sector. Manufacturers are directly affected by the energy cost of making products (industrial), as well as by the cost of maintaining office operations (commercial). They are further affected by the cost of receiving raw materials and delivering finished goods (transportation). Indirectly, an employee's household energy costs (residential) have further impact on a manufacturer's wage scales.

Manufacturing Energy and Fuel Use

Credit must be given to the continuous improvements in energy efficiency, particularly in the manufacturing sector, which has led the country to be 46 percent more efficient in energy use per unit of GDP versus 30 years ago. Despite these general improvements, high energy prices are still devastating to manufacturers. The prices for natural gas and oil-based products have risen significantly in recent years, making it more costly for U.S.-based manufacturers. In fact, the results of a poll taken at the September meeting of the National Association of Manufacturers (NAM) Board of Directors revealed that 93 percent of directors from small and medium manufacturing companies believe that higher energy prices are having a negative impact on their bottom line. A recent study by the NAM and the Manufacturers Alliance (MAPI) found that U.S. companies have a 22 percent unit-cost disadvantage compared with overseas competitors in a number of non-production areas, including energy.

Natural gas is a good example of the challenges manufacturers face. Since the beginning of 1999, manufacturers have seen natural gas prices climb by 119 percent. Over the same five-year period, the prices for manufactured products increased by only 14 percent and overall inflation ran at only 11 percent. Just in the past two years, gas prices have risen from \$2 per MMBtu (million BTUs) to more than \$6 per MMBtu, with some spikes close to \$10 per MMBtu. With natural gas prices running 10 times higher than overall inflation, it is no wonder that manufacturers have relocated some production to other markets or cut costs elsewhere to stay competitive with overseas producers that have not experienced these same increases in natural gas pricing. Rising fuel costs are of particular concern to manufacturers since the industrial sector is the largest energy consumer in the United States. The pie chart below illustrates U.S. energy consumption by sector.



Source: Prepared by the Leonardo Academy from U.S. DOE/EIA data, *Annual Energy View 2003*, published September 2004.

Manufacturing Energy Sector Inputs

The process energy used by a manufacturer to produce goods or products dwarfs all other direct end uses combined (see **Table 1** on page 7). This suggests that manufacturers have the greatest opportunity to make energy efficiency improvements in the areas of process heating and machine drive. Of nearly equal magnitude, however, is boiler fuel. To maximize cost effectiveness, all other direct end improvements (such as HVAC and lighting) can be combined into one all-encompassing efficiency improvement project.

Manufacturing Water Use

With water becoming a scarce commodity in parts of the United States, manufacturers can expect to see their water bills continue to climb steadily. In 2000, industrial water use (19,700 million gallons per day [Mgal/d]) was estimated to account for approximately 9 percent of total withdrawals for all categories, excluding thermoelectric power (USGS, *Estimated Use of Water in the United States in 2000*). Industrial water use has actually been falling since 1980, but because of competing demands for water among sectors, including agricultural and municipal uses, and uncertainty about future water supply and quality, many organizations are increasingly interested in water efficiency. Water-reuse and efficiency measures reduce water supply and disposal costs. Reducing

water use also decreases the energy needed to pump, heat or chill water. For manufacturers using large volumes of water or located in regions with high water demand and low supply, water efficiency measures can have large economic benefits.

Manufacturing Waste Disposal

According to the Environmental Protection Agency, industrial facilities in the United States generate and dispose of nearly 7.6 billion tons of industrial solid waste annually. Data from the National Solids Waste Management Association's (NSWMA) *2002 Tipping Fee Survey* shows average national landfill tipping fees have increased substantially since 1985, rising from \$8.20/ton to \$33.70/ton. Regional variation in tipping fees is also significant, with fees in the northeast (\$69.07/ton) more than twice the U.S. national average in 2002. For manufacturers generating large volumes of waste or facing high regional tipping fees, waste reduction, recycling and reuse can have major benefits. Reusing, reducing or source prevention of waste cuts down raw materials costs and reduces disposal costs. Waste management practices may even generate revenue. Henry Ford demonstrated this in the 1920s when he developed a process for turning wood scraps from his Model T production line into a useful product: the charcoal briquette.

Table 1: Manufacturing Sector Inputs for Heat, Power and Electricity Generation by End Use

Industrial Sector End Use Category	Trillion Btu	Percent of Total Direct End Use
Indirect End Use (Boiler Fuel)	3,635	
Direct End Use	7,655	100.0%
All Process Uses	6,323	82.6%
Process Heating	4,055	53.0%
Machine Drive	1,691	22.1%
Electrochemical Processes	298	3.9%
Process Cooling and Refrigeration	210	2.7%
Other Process Uses	69	0.9%
All Non-Process Uses	1,314	17.2%
Facility Heating, Ventilation and Air Conditioning	692	9.0%
Facility Lighting	211	2.8%
Conventional Electricity Generation	243	3.2%
Other Facility Support	96	1.3%
Onsite Transportation	69	0.9%
Other Non-Process Uses	3	0.0%
End Use Not Reported	157	
Total	11,447	

Source: Prepared by the Leonardo Academy from U.S. DOE/EIA data, 1998 Data from *Annual Energy View 2003*, published September 2004.

Summary: Energy, Water and Waste-Reduction Opportunities

This is a summary of how to improve energy efficiency and water and waste reduction throughout your organization. The following pages describe each of these ways to reduce costs and improve operations in depth, including case studies from various manufacturers that have achieved their own efficiency goals.

1. Increase Energy Efficiency. Objective: Raise energy efficiency to above-average levels in the areas of motors and pumps, compressed air, steam, process heating or other building systems, and develop cost savings and reduced emissions associated with energy efficiency.

2. Finance Energy Efficiency Upgrades. Objective: Identify innovative funding approaches to energy efficiency upgrades.

3. Increase Water Efficiency. Objective: Employ systems and operational practices that minimize potable water consumption and deliver cost savings associated with water efficiency.

4. Improve Waste Management (Waste Reduction, Reuse, Sale and Donation). Objective: Implement practices and equipment that reduce waste generation through material source reduction, reuse, sale and donations.

5. Improve Waste Management (Recycling). Objective: Apply practices that divert generated waste from the disposal process through the recycling of materials.

6. Improve Indoor Environmental Quality To Increase Productivity. Objective: Install systems and implement practices that maximize indoor environmental quality and provide an optimal work environment, thus enhancing the well being and productivity of building occupants.

7. Reduce Transportation Impacts. Objective: Reduce the environmental and economic costs of transporting goods and people to and from facilities.

8. Reduce Environmental Impacts and Potential Business Liabilities. Objective: Adopt policies and enhance building systems to actively mitigate the environmental impacts of a facility, thus improving relations within the community, providing marketing opportunities and decreasing liability risks.

9. Identify Marketing Opportunities Presented By Increased Environmental Procurement Standards. Objective: Minimize environmental impacts and position your company to meet expanding quality and environmental standards such as ISO 9001 and ISO 14001.

1. Increase Energy Efficiency To Reduce Costs

Energy efficiency actions offer one of the best opportunities to reduce costs in manufacturing facilities. In addition to reduced operating costs, energy efficiency actions reduce pollution such as greenhouse gas emissions and enhance the comfort of building occupants. Because of the rising cost of energy, most energy efficiency investments have a rapid payback period due to lower energy use over the building's lifetime, downsized equipment, reduced space needs for mechanical equipment and utility rebates.

Energy efficiency strategies can include improvements in both manufacturing equipment and building systems. As Table 1 on page 7 shows, building systems such as process heating, motors and pumps, compressed air and steam can account for a large part of the energy used in manufacturing processes. HVAC and lighting equipment are also significant energy users. Therefore, concentrating your building equipment and system upgrade efforts in these areas can really pay off.

Best Practice Actions

Implement energy efficiency retrofits, effective building and equipment maintenance, and other energy-saving techniques to reduce energy use on an ongoing basis.

Recommended measures include:

- Use higher efficiency lamps and/or ballasts and use daylighting where practical.
- Eliminate leaks in inert gas and compressed air lines/valves.
- Use the most efficient type of electric motors and know ahead of time where to

find high-efficiency replacement motors so that you can get them quickly when existing motors break down.

- Install compressor air intakes in the coolest locations.
- Install occupancy sensors.
- Reduce the pressure of compressed air to the minimum required.
- Use energy-efficient belts and other improved mechanisms.
- Reduce HVAC output on weekends, holidays and at night.
- Purchase and install ENERGY STAR® rated equipment whenever possible. *ENERGY STAR is a government-backed program helping businesses and individuals protect the environment through superior energy efficiency.*
- Use an effective, consolidated utility-bill pay system that is linked to energy-use monitoring provided by a building automation system.
- Assess the economic and environmental impacts of adding insulation to your facility to help reduce energy consumption, save costs and minimize emissions output.
- Conduct a plantwide energy efficiency assessment or energy audit. Based on results:
 - identify systems and operations that are good candidates for energy efficiency and waste minimization improvements;
 - plan and implement specific energy and cost-saving projects; and
 - contact an energy service company and consider an energy-savings performance contract, if warranted.



Best Practice #1 Case Study

Riverdale Mills Corporation, a Massachusetts-based manufacturer with 105 employees, makes steel welded wire mesh for use in security fences, lobster traps, crab traps, erosion-control gabions, aquaculture, poultry farms and many other applications. Its product, AquaMesh®, revolutionized the lobster and crab industry. The company is dedicated to harnessing energy efficiency throughout all of its operations to enhance its competitiveness.



Among the many innovative applications adopted by President & CEO James Knott, Sr., are natural-gas-powered generators that make electricity for one-half the cost the public utility charges. A combination of natural-gas-fired generators and a hydropower turbine allows Riverdale Mills to make their electricity for about \$400,000 a year, compared to the cost of buying it at approximately \$800,000 a year. These internal combustion generators also provide space heating that Riverdale uses for the building and in their manufacturing processes. The process for capturing heat from the generator involves sending the engine exhaust through a boiler to make steam and delivering hot water from water jackets to space heaters and process heat plates. Without this generator heat, Riverdale would have to run

costly boilers for the manufacturing processes and space heating.

Located on the Blackstone River, Riverdale Mills restored a 1901 hydropower turbine and its civil works at a cost of \$130,000. The turbine saves Riverdale \$100,000 a year in electricity costs, which resulted in a payback period of only 1.3 years. A new turbine would have produced similar electricity and cost savings but cost \$300,000 with a three-year payback period.

Knott acknowledges the importance of Riverdale Mill's energy-efficient features. "The lower my energy costs, the lower my selling prices; and that's why we're able to compete with other foreign and domestic manufacturers."

2. Finance Energy Efficiency Upgrades

Lack of capital should not be a constraint for facility upgrade projects. Energy projects are often more financially attractive when financed through multiple investment-financing instruments. For example, utility incentives can be combined with debt financing. The most appropriate set of options will depend on the type of organization, size and complexity of the projects, internal capital constraints, in-house expertise and other factors. The most common financing alternatives are—

- **grants**: federal, state and local;
- **internal financing**: Improvements are paid for by direct allocations of revenues from an organization's currently available operating or capital funds;
- **debt financing**: Capital is acquired through simple loans, bonds or other debt instruments; and
- **lease and lease purchase agreements**: Equipment and improvements are acquired from a private vendor such as an energy service company (ESCO) that may finance them internally or through a third party. Up-front outlays are not required from the building owner.

One increasingly popular vehicle for financing energy efficiency upgrades is the energy savings performance contracts (ESPC). ESPCs are an affordable way to make investments in new energy-efficient equipment. ESPCs are unique contracts through which private ESCOs provide energy-efficiency improve-

ments to facilities at little or no up-front capital cost to the manufacturer.

ESPCs can be structured to take advantage of any combination of financing alternatives described above. Manufacturers can make the upgrades they need now and pay for them later through the resulting energy savings. Facilities owners and operators benefit immediately through new equipment, expertise from energy service professionals, ongoing maintenance services and the ability to accomplish many projects all at once. Best of all, these savings can be guaranteed. The manufacturer also retains any savings that exceed the ESPC payments during the duration of the contract, and retains all savings once the contract is complete.

After you enter into an agreement with an ESCO, the ESCO will identify and evaluate energy-saving opportunities and then recommend a package of improvements to be paid for through the savings. The ESCO will guarantee the energy savings and work to structure the project so the energy bill cost savings meet or exceed the annual payments to cover all the project costs. These contracts and guarantees usually last 7 to 15 years. If the energy savings don't materialize, the ESCO pays the difference for the energy savings shortfall, not you. To ensure savings, the ESCO offers staff training and long-term maintenance services.

Best Practice #2 Case Study

Centura Health's St. Mary-Corwin Medical Center in Pueblo, Colo., found that reducing energy costs was a relatively painless operation. The 523,877-square-foot, 400-bed hospital was already working with an energy service company (ESCO) for preventive maintenance of its heating, cooling and ventilation systems. When the ESCO suggested a package of equipment upgrades that would pay for itself through energy savings, facility supervisor Joe Colistro and manager Jim Skelly realized it was an excellent way to extend the capabilities of an already approved federal grant.

An energy audit of St. Mary's showed that modifications to its cooling system would increase the comfort of both patients and staff and result in big cost savings. The energy-efficient features of the building upgrade included new starters and two-speed motors for 20 air-handling units, cooling tower modifications, a new high-efficiency chiller and an improved chilled water delivery system.

In addition to mechanical modifications, the company installed a new computerized energy management system, allowing the hospital staff to monitor and control the chilled water system, air handling systems and boilers from a central location. The energy management system provides instantaneous readings of room temperature, humidity and energy use throughout the facility and automates many of the systems.

The energy savings performance contract (ESPC) was financed by the ESCO



through shared savings with a guaranteed payment of financed amount. The ESPC projected energy savings of \$161,500 per year. More importantly, the ESCO agreed to accept 95 percent of the hospital's actual savings over a seven-year period as payment for all costs not covered by the grant. The project actually delivered energy savings of \$178,077 per year and, in the end, St. Mary's was able to keep the equipment and use all of the post-contract energy savings to make further improvements to its facility.

Colistro found that energy performance contracting can be a satisfactory experience that frees up hidden resources for much-needed capital improvements. Even without grants or utility rebates, energy-saving projects generate their own capital. Additional project benefits included the elimination of chlorofluorocarbons (CFCs), improved comfort for patients and reduced maintenance of aging equipment.

“It was definitely worth it for us to do the performance contract. We really benefited from the timely work, good subcontractors and the expertise of the energy service company.”

3. Increase Water Efficiency To Reduce Costs

Water efficiency has many benefits in manufacturing facilities. Efficient water use reduces operating costs, water use fees, wastewater treatment expenses and energy costs for heating, chilling and pumping.

Additionally, minimizing water volumes reduces maintenance and life-cycle costs of building equipment. Water-efficient manufacturing processes will also help meet drought allotments and lessen burdens on community water supplies and treatment facilities.

There are a number of water-efficiency actions that can easily be incorporated into manufacturing facilities. Equipment and practices that use less water or recycle water through capture and reuse can be introduced to existing manufacturing processes. Other strategies for conserving water can be implemented throughout the building, such as low-flow fixtures and automatic controls in lavatories. In situations where high-quality water is unnecessary (toilet flushing, janitorial tasks, irrigation and building systems), water collection systems or graywater can be used.

Best Practice Actions:

Manufacturing Process

- Conduct an audit of water use in manufacturing processes and use data to determine ways to minimize or eliminate water demands.

- Install closed-loop systems that reuse water over and over again.
- Develop systems that treat industrial wastewater that can then be reused in the manufacturing, building or irrigation systems.
- Consider ways to simultaneously improve water and energy efficiency, particularly through recycling or heat recovery from warm water.

Building Systems

- Install water-efficient plumbing fixtures that, at a minimum, meet the requirements of the Energy Policy Act of 1992.
- Use graywater collected from showers, sinks and lavatories for use in water closets.
- Install waterless urinals in male restrooms.
- Use automatic faucets with sensors in high-use public areas where faucets might otherwise be left running.
- Use onsite treated wastewater for sewage conveyance.

Grounds Irrigation

- Feed irrigation systems with captured rainwater, appropriate graywater or onsite treated water.
- Landscape with native or adaptive plants that do not require additional water inputs to survive in local climate conditions.
- Use high-efficiency irrigation technologies, including micro-irrigation, moisture sensors or weather data-based controllers.

Best Practice #3 Case Study

General Dynamics C4 Systems has taken a comprehensive approach to water efficiency at its Scottsdale, Ariz., facility by reducing or recycling water used for manufacturing processes, building systems and grounds maintenance.

The use of water reclamation technology within the facility's cooling tower system has reduced water consumption and diverted water from entering the municipal sewage system. Annually, approximately 5 million gallons of water are recycled through the use of this system.

By upgrading restrooms to feature faucet aerators, retrofitting diaphragm valves in urinals and water closets, and installing sensors on fixtures, General Dynamics has also reduced fixture water use in its Scottsdale facility by 26 percent. The company has also begun to install waterless urinals, capable of saving 45,000 gallons of water annually. Not only will the site save about 1 million more gallons of water annually after all existing urinals are upgraded, but the fixtures also will reduce maintenance costs by about \$38,000 annually.

General Dynamics has also taken measures to reduce water use for landscaping. Instead of maintaining turf grass in a climate ill-suited for such purposes, the company is in the process of converting its six-acre lawn back to desert landscaping. The conversion to desert landscaping is being done in stages, and the project is expected to be complete by the end of 2006. Until that



time, General Dynamics is discontinuing winter seeding of the lawn, which previously had required potable water irrigation practices. These combined measures will save nearly 14 million gallons of potable water annually.

To date, overall water efficiency efforts have saved approximately 21 million gallons of water each year, which equates to about a 22 percent reduction of annual site consumption. Overall, the site has the capability to save more than 24 million gallons of water annually for about a 26 percent annual site consumption savings.

The facilities management team at General Dynamics has monitored the site's water consumption since 1991, and the process uncovered the fact that the company was operating 26 percent below the Energy Policy Act baseline. From a community prospective, General Dynamics initiatives have aligned with the governor and city mayors' objectives to conserve water use statewide.

4. Improve Waste Management Through Waste Reduction, Reuse, Sale and Donation

Effective waste stream management can reduce raw material and waste disposal costs, create revenue streams and improve the environment by conserving natural resources and reducing the pollution associated with transporting waste and disposing of it in landfills and incinerators. The best approach to managing solid waste and reducing costs is to avoid creating it in the first place. Source reduction and waste prevention (*e.g.*, reuse) reduce the amount of trash discarded without the additional energy investment required for recycling activities.

Changes in the design, manufacture, purchase or use of materials can lead to significant reductions in the amount of waste generated in a manufacturing facility. One major source reduction strategy is waste reduction through improved design and manufacturing processes. Another component of waste reduction is reusing materials. That prolongs the useful life of these materials, thus delaying final disposal and the production of more waste. For example, provide coffee mugs to employees instead of disposable cups.

Another option is to donate unused office or building supplies to charity or sell or exchange materials through a commercial materials exchange. Donations can generate additional tax write-offs for your organization.

Best Practice Actions:

Reduction, Reuse, Sale and Donation

- Analyze your facility's waste stream to understand the waste production patterns in the building and onsite and establish a current building waste baseline.

- Evaluate how each type of waste in the waste stream can be reduced through source reduction, reuse, donation or sale.
- Develop, implement and maintain a waste-reduction plan for your building that includes procurement/management policies and annual waste-reduction goals.
- To minimize packaging waste, eliminate unnecessary packaging; switch to reusable materials; redesign packaging to eliminate excess material while maintaining strength; work with customers to develop a packaging return program; and switch to reusable transport containers.
- Align your waste hauler's financial incentives with your facility's waste-reduction goals.
- Encourage practices that reduce and reuse materials before the recycling stage to reduce the amount of recyclable volumes handled. For instance, building occupants can use reusable bottles, ceramic coffee mugs, bags and other containers.
- Reduce office paper waste by implementing a formal policy to use both sides of the paper when duplicating all draft reports, and make training manuals and personnel information available electronically.
- Improve product design to use less material.
- Purchase products in bulk to reduce the packaging brought into the building.
- Reuse office furniture and supplies, such as interoffice envelopes and file folders.
- Donate unwanted supplies to local schools or nonprofit organizations.
- Aggressively research potential markets for waste such as cement, paving or fiber board manufacturing. Seek opportunities to sell waste as raw materials.

Best Practice #4 Case Study

ACE Clearwater Enterprises installed its first eco-friendly clean line in 2001 following internal discussions noting the workplace dangers and disposal costs of perchlorethylene (perc). With more than 180 employees, ACE is a manufacturing facility specializing in “complex formed and welded assemblies” for the aerospace, automotive and power generation industries. Their formed details must be cleaned to stringent specifications prior to welding, end processes requiring grease-free surfaces and some machining operations.

While the perchlorethylene system fit customer requirements, ACE was not comfortable with the environmental hazards. ACE contracted with Hydro-Blast (www.hydro-blast.com) to assess their needs and develop a solution.

ACE's first machine was a custom-built washer using a closed-loop system. The only byproduct is pure steam, meaning nothing goes into the wastewater system and, ultimately, the environment. By using mild, biodegradable detergents and high temperatures, greasy parts are cleaned and dried in less than four minutes. The micron water filters are the only waste generated. Following the success at its Torrance, Calif., facility, ACE installed a larger washer at its metal-forming facility in Compton, Calif.



Costs for cleaning have been reduced and perc system waste-disposal hazmat charges were eliminated. Quarterly testing of clarifier chemicals, independent lab analyses expenses and special breathing equipment requirements were also eliminated. This has produced annual facility cost savings of approximately \$37,000.

Ace Clearwater's facilities are no longer listed as having hazardous waste. This has greatly reduced time spent on local EPA reporting requirements and brought praise from local officials who recognize the value of an environmentally conscious business. “Our investment in these two machines was more than \$600,000,” says Gary Johnson, vice president of Ace Clearwater Enterprises, “however, the savings gained for a healthier workplace and to the environment is priceless.”

5. Improve Waste Management Through Recycling

After source reduction, the second-best strategy to reduce solid waste is recycling. Recycling involves the segregation, collection, storage and removal of recyclable or compostable materials. In addition to reducing waste and the associated disposal costs, recycling collection can generate substantial revenue for organizations. Although recycling metal, glass, plastic, paper and other waste expends energy and is therefore less effective than reuse, the process of recycling allows the materials within those products to be reused.

The costs and returns of recycling programs depend on local resources and market demand for specific materials. By investigating local market conditions, organizations can develop a recycling program that is economically beneficial. The environmental benefits of recycling include saving energy and preventing pollution associated with the extraction and processing of raw materials, reducing the need for landfilling and incineration, and conserving natural resources.

Best Practice Actions:

- Put your larger volume waste to work to earn money instead of being a disposal expense by identifying local waste handlers and buyers for glass, plastic, office paper, newspaper, cardboard, metals and organic wastes.
- Have in place a building occupant recycling program that addresses the separation, collection and storage of materials for recycling including (at a minimum) paper, glass, plastics, cardboard/OCC, metals, batteries and fluorescent lamps and diversion from landfill disposal.
- Place recycling containers throughout the building and conduct occupant and maintenance personnel awareness campaigns on building recycling procedures.
- Research local recycling efforts to find the best method of diverting recyclable materials from the waste stream.
- Consider employing cardboard balers, aluminum can crushers, recycling chutes and other waste-management techniques to further enhance the recycling program.
- Investigate external markets for recyclables and expand collection to include new, marketable materials.
- Increase the recycled content of materials in your manufactured goods.

Best Practice #5 Case Study

“Bad press can make your neighbors nervous,” says Terry Butler, director of environmental health and safety of Vermeer Manufacturing Co.

Headquartered in Pella, Iowa, Vermeer believes in protecting the environment and preserving the company’s reputation. In today’s Internet world, anyone can view a company’s environmental track record. That’s why Vermeer continually minimizes the environmental impact of its operations through waste recycling programs.

Promoting these programs by giving factory tours and visiting with local school groups boosts Vermeer’s public image, giving it the double advantage of both cost savings and public relations benefits.

“Recycling pays, and if people don’t think you can save money by reusing, they’re not looking hard enough,” says Butler. Their solvent recycling program required an investment of \$142,000, but had a payback period of just six to eight months and continues to pay for itself year after year. The company inventoried the hazardous and non-hazardous wastes generated at the facility, assessed their disposal costs and explored the options and costs for recy-



cling or reusing the wastes. The result: Vermeer saves between \$135,000 and \$175,000 annually just from recycling one waste stream.

Vermeer’s other environmental protection efforts include recycling pallets by grinding them into wood chips with a Vermeer chipper and selling them as feedstock for boilers or mulch. Their processed water treatment exceeds allowable industry levels. Vermeer prevents pollution of nearby waterways by sampling for pollutants during rainstorms and appropriately storing hazardous material. These programs help keep the waterways around Vermeer’s plant pristine, while saving them money.

6. Improve Indoor Environmental Quality (IEQ) To Increase Productivity

Indoor environmental contaminants can originate within the building or be drawn in from outdoors. Poor indoor air quality can increase occupant illnesses, absenteeism and health care costs. A lack of natural lighting and views to the outdoors can also negatively affect productivity and health.

Maintaining optimal IEQ reduces liability for building owners, increases building valuation and improves the health and productivity of building occupants. Liability issues are especially significant in manufacturing processes that involve chemicals or processes that could potentially endanger worker health. Because employee salaries and benefits represent a significant portion of operating costs, actions that improve employee attendance and productivity are highly beneficial.

IEQ problems can be a result of ventilation system deficiencies; overcrowding; offgassing materials; mechanical equipment or manufacturing processes; tobacco smoke; microbiological contamination; or outside air pollutants.

Indoor environment problems are preventable and solvable. Nevertheless, maintaining a healthy and comfortable indoor environment in any building requires integrating many components into a complex system.

Best Practice Actions:

- Take a proactive approach to indoor air quality rather than reacting to problems as they occur.
- Approach IEQ improvement in a comprehensive manner that considers ventilation effectiveness, moisture management and control of contaminants.
- Integrate permanent monitoring and control technology into HVAC systems to maintain optimal temperature, humidity and ventilation and to detect air contaminants.
- Use high-quality outdoor air and ensure adequate ventilation rates to maintain superior indoor air quality.
- Locate fresh air intakes away from possible sources of contamination.
- Ensure that potential air contaminants from manufacturing processes are properly controlled by providing appropriate storage and disposal systems, training workers for proper handling and routinely testing air and surfaces to ensure acceptable exposure levels.
- Minimize the use of volatile organic compounds (VOCs) in your building by minimizing their use in manufacturing processes and by preferentially purchasing low-VOC content materials for cleaning, construction and maintenance.
- Use entryway systems (grills, grates, mats, etc.) to reduce the amount of dirt, dust, pollen and other particles entering the building at all entryways.
- Consider the use of low-impact environmental cleaning products and provide training for the janitorial staff on how to use the new products better to be more cost effective.

Best Practice #6 Case Study

Knoll, Inc., a furniture producer with four manufacturing sites in North America, strives to design its manufacturing processes to protect the health of its employees, the communities they reside in and the environment. One element of this is maintaining high indoor environmental quality in all their facilities by minimizing the use of hazardous chemicals in its manufacturing processes.

Volatile organic compounds (VOCs) are commonly used in paints, solvents, adhesives and other materials used during the manufacture of furniture. Exposure to VOCs, either during the manufacturing process or due to outgassing from the final product, can cause human health problems such as eye, nose and throat irritation; headaches; loss of coordination; nausea; organ and central nervous system damage; and cancer. Knoll has altered its manufacturing process to minimize the use of these harmful compounds. Strategies for achiev-



ing this have included converting to formaldehyde-free glues; replacing solvent-based finishing materials with water-based alternatives; and providing safe, above-ground storage tanks for solvents to prevent contamination.

These actions have reduced VOC emissions by 75 percent in wood-finishing operations, 99 percent in metal-coating operations and 99 percent in adhesive operations.

7. Reduce Transportation Impacts

Transportation of goods and people can be costly and affect air quality. Freight transportation costs directly affect the price of goods and the profits realized by manufacturers and shippers. An efficient transportation system spurs economic growth, reduces environmental impacts and gives product manufacturers and shippers a competitive edge.

In addition to directly addressing freight transportation procedures, companies can relieve pressure on the local transportation infrastructure by encouraging alternative commuting opportunities for employees. Of the 520 million cars worldwide, Americans own 200 million. Choosing environmental transportation options improves the quality of life for employees and employers by reducing motor fuel use, reducing the emission of pollutants from vehicles, preventing congestion on roadways and minimizing the number of parking spots needed on facility grounds. Company-sponsored commuting programs can be an appealing benefit to employees, aiding in the recruitment and retention of high-quality workers.

Best Practice Actions:

Freight Transport

- Optimize the use of existing transportation networks to minimize the need for new transportation lines.
- Preferentially purchase materials from local sources that require less transport.
- Consider packaging options that minimize materials use and, therefore, weight and size of products.
- Invest in or contract with companies that own fleet vehicles with high fuel efficiency,

low emissions and advanced systems for reducing idling time.

- Use information technology for inventory control and managing shipping logistics to ensure the most efficient transport of goods and reduce unnecessary shipments.
- Investigate ways to reduce the weight and distance traveled by cargo leaving and arriving at your facility.

Commuter Transport

- Survey building occupants to determine how mass transportation options might meet their needs, and if mass transit incentives would be a valuable benefit to employees.
- Facilitate employee access to mass transit stops with walkways or shuttles.
- Provide incentives to minimize the use of single-occupant vehicles, such as mass transit passes, preferred or discounted parking for carpoolers, and storage and changing facilities for bicycle commuters.
- Support the use of alternative fuel or hybrid vehicles by offering alternative fuel refueling stations, preferred or discounted parking for drivers of alternative vehicles, or by purchasing alternative vehicles for the company fleet.
- Encourage telecommuting for eligible employees to reduce commuting frequency. Provide the necessary infrastructure in the building and in homes of telecommuters and provide incentives for telecommuting.
- Develop a communications program to make employees aware of alternative transportation options and incentives, including a system for setting up carpools for employees traveling to work from the same areas.

Best Practice #7 Case Study

Bayer Corporation sites—and other companies, from small businesses to multi-national corporations—are signing on as partners in the EPA's voluntary transportation and air quality programs. By providing resources, promoting best practices and encouraging partnerships, the EPA hopes to encourage efficient use of the nation's transportation system, higher air quality and reduced greenhouse gas emissions.

The EPA's voluntary transportation programs seek non-regulatory opportunities to recognize leaders in protecting the environment. The EPA's **Best Workplaces for CommutersSM** program recognizes employers that provide exemplary commuting options for their employees that reduce traffic congestion, protect air quality and reduce greenhouse gas emissions. Bayer Corporation received this distinction in 2003 by making the San Francisco Bay Area's Best Workplaces for Commuters list. The EPA estimates that nationwide, program participants are reducing the number of miles driven daily by 3 to 6 million, annually saving between 35 and 70 million gallons of gasoline, and preventing the emission of 300,000 to 600,000 metric tons of carbon dioxide (CO₂) each year.



Another voluntary opportunity from the EPA, the **SmartWaySM Transport Partnership** is a collaborative voluntary program between freight carriers, manufacturers and retailers. The program is designed to encourage cooperation between shippers and carriers to reduce emissions from the freight transport sector that cause air pollution and contribute to climate change. In addition to the environmental benefit, the EPA estimates that by 2012, the program will save approximately \$9 billion in fuel costs by reducing the need for as much as 150 million barrels of oil annually.

8. Reduce Environmental Impacts And Potential Business Liabilities

Most efficiency improvements in equipment and processes have economic as well as environmental advantages. Reducing environmental impacts improves public relations within the local community and may enhance the marketing appeal of your products. Additionally, companies can reduce the risk of potential liabilities through manufacturing practices that mitigate the environmental and human health impacts of their facility.

To maximize the benefits to your company, consider doing a comprehensive assessment of the environmental impacts associated with your facility. Determine how efficiency improvements could lessen these impacts, how you can make further improvements and how environmental initiatives can enhance relations with your community and customers.

Best Practice Actions:

- Keep score and report your resource consumption, emissions and waste production before and after efficiency improvements.
- Establish a program for communicating your environmental achievements to employees, community members and customers.
- Adopt a comprehensive plan for making continued improvements in environmental protection by identifying opportunities, setting target goals and implementing practices and improvements that achieve those targets.
- Investigate environmental certification and award programs that will recognize the achievements of your facility.
- Release an Annual Corporate Environmental Report that highlights your environmental performance and improvements.

Best Practice #8 Case Study

Ford Motor Company has revitalized its historic 750,000 square foot River Rouge Plant in Dearborn, Mich., so that it now handles three different vehicle platforms and nine different models. Chairman Bill Ford, Jr., wanted to “transform a 20th-century industrial icon into a model of 21st-century sustainable manufacturing.” The new facility includes a wide range of features that mitigate its environmental impacts.

Ford’s use of vegetation in its natural storm-water management system helps protect the nearby Rouge River while saving the company money on operating costs. The centerpiece of this system is the world’s largest living roof. The 10.4-acre roof can absorb up to 4 million gallons of water per year while filtering out pollutants that normally run off into the Rouge River. In addition to filtering and retaining rainwater, the maintenance-free roof will last twice as long as a traditional roof and provides natural insulation.

Energy efficiency is another prominent feature of the Rouge plant. Daylighting, heat wheel recovery systems and jumbo HVAC units in the assembly plant reduce utility expenses. Indoor air quality initia-



tives, materials recycling/reuse programs, reduced consumption of potable water, porous parking areas and the creation of a wildlife habitat are some of the other features of the Rouge facility.

Ford highlights the facility to communicate its commitment to social responsibility and environmental leadership. As part of a tour program that showcases its innovative manufacturing facility, Ford invites visitors to view its green roof from the 80-foot-high Observatory Deck. Interactive exhibits, touch-screen kiosks and hands-on displays explaining the facility’s environmental features are also located on the Observation Deck.

9. Identify Marketing Opportunities Presented By Increased Environmental Procurement Standards

Companies Setting Standards For Suppliers

Many companies on a voluntary basis are including requirements in their procurement policies that set standards for the practices of their suppliers. They are doing this because they have decided it is good for their business and results in improving relations with employers, customers and the public. These companies recognize that the practices of their suppliers affect the quality of their products and are part of their overall footprint. Given this growing practice among purchasers, it makes sense for manufacturers to prepare themselves to make these supplier standards a marketing opportunity rather than a barrier.

The range of topics included in supplier standards set by customer companies is

expanding over time. These standards for suppliers initially focused on product quality, but have expanded over time to include business practices and environmental impacts.

For example, many manufacturers require suppliers to be ISO 9001 compliant and are now expanding those requirements to ISO 14001 as well. ISO 9001 addresses manufacturing quality, while ISO 14001 addresses environmental issues in manufacturing.

Based on current trends, major manufacturers are projected to continue expanding their environmental standards for suppliers. Manufacturers that reduce energy use, water use, waste and other environmental impacts will be well positioned to remain competitive as suppliers to these companies.

Best Practice #9 Case Study

In Toyota's view, environmental stewardship is not only the practice of a good corporate citizen, it is good for business. To that end, the Environmental Action Plan implemented by Toyota Motor Manufacturing North America demands that the company achieve the highest level of environmental performance in the auto industry.

Recognizing the environmental impact beyond its own facilities, Toyota encourages and supports its parts and materials suppliers' efforts to protect the environment as part of the action plan.

For example, following Toyota's issuance of Green Supplier Guidelines in 2000, 98 percent of its North American suppliers became ISO 14001 certified/registered. Toyota, which set an example by reducing water and energy consumption 15 percent per unit of



production since 2000, also shares best practices and ideas with its suppliers.

Toyota's Green Supplier Guidelines also require the elimination of chemicals included on Toyota's global chemical ban list and that suppliers create their own compliance systems for the handling and transportation of hazardous materials.

Resources To Make Your Facilities More Efficient and Less Wasteful

Many resources are available to help manufacturers increase energy efficiency. Selected resources are listed below.

General Resources

Alliance to Save Energy (ASE)

www.ase.org/section/topic/industry

Phone: (202) 857-0666

This organization promotes energy efficiency worldwide to achieve a healthier economy, a cleaner environment and greater energy security. ASE supports industrial performance improvements through energy efficiency and energy management.

The alliance's **Industrial Energy Efficiency Clearinghouse** provides information that plant managers can put to immediate use. The clearinghouse is an Internet platform that provides many downloadable documents, and includes links to other Internet sites.

The alliance's **Industrial Sector** conducts program marketing, communications and publications. The team also produces a variety of workshops and seminar presentations.

The alliance's **Industrial Sector Publications** are updated monthly.

Alliance for Sustainable Built Environments

www.sustainablebuiltenvironments.org

A group of business leaders dedicated to helping the business community make wise decisions that preserve our natural resources. Their goal is to inform decision-makers at every level that the choices they make in regard to their facilities can be both economically and environmentally sustainable.

Energy Services Coalition (ESC)

www.energyservicescoalition.org

ESC is a coalition of representatives of energy services companies (ESCOs), facility owners, finance companies and state energy offices. The Web site includes a guide to using energy service companies and a listing of which ESCOs serve each state.

Industrial Energy Efficiency Clearinghouse

www.ase.org/section/topic/industry/clearinghouse

This site offers information regarding free energy audits, energy accounting and checklists for plant managers who want to take action immediately. Material also includes guides for selecting an energy services company, purchasing energy in today's restructured markets and tips for gaining management approval for energy improvement projects.

Leonardo Academy

www.leonardoacademy.org

Phone: (608) 280-0255

A nonprofit organization to help you find the resources you need to increase the efficiency and sustainability of your facility.

The Manufacturing Extension Partnership (MEP)

www.mep.nist.gov

Phone: (301) 975-5020; (1-800) 637-4634

A nationwide network of more than 400 not-for-profit centers whose purpose is to provide small and medium manufacturers with the help they need to succeed in a wide range of areas. Most MEP centers are equipped to advise manufacturers on energy efficiency, providing links to local resources and expertise.

The Manufacturing Institute

www.nam.org/institute

Phone: (202) 637-3107

The research and education arm of the National Association of Manufacturers, established to educate policymakers, manufacturers and the media about the role of manufacturing in the nation's economy and to help make efficiency a part of manufacturers' daily routine.

Department of Energy's Industrial Technologies Program (ITP)

www.eere.energy.gov/industry

Phone: (1-877) 337-3463

A program to help companies reduce the energy requirements of manufacturing while stimulating economic productivity and growth. Their "Best Practices" program helps industrial manufacturing plants identify opportunities to save substantial amounts of energy and money, increase production, reduce harmful emissions and enhance global competitiveness.

U.S. Green Building Council (USGBC)

www.usgbc.org

Phone: (202) 828-7422

The USGBC is a coalition of building industry leaders working to promote buildings that are environmentally responsible, profitable and healthy places to live and work. The USGBC recently developed the Leadership in Energy & Environmental Design (LEED) Green Building Rating System (LEED-EB), a set of performance standards for the sustainable upgrades and operation of buildings not undergoing major renovations.

Topic-Specific Information

Increase Energy Efficiency To Reduce Costs

Steaming Ahead: Energy-Efficiency Resources for Industrial Steam Plant Managers

www.steamingahead.org

Phone: (202) 857-0666

An organization dedicated to raising the awareness of energy efficiency opportunities in industrial steam systems. Steaming Ahead supports the U.S. Department of Energy's Best Practices Steam Program.

North American Insulation Manufacturers Association (NAIMA)

www.naima.org

Phone: (703) 684-0084

NAIMA provides a full breadth of information on building and industrial insulation. NAIMA also provides details on environmental aspects of fiber glass, rock wool and slag wool insulations, as well as health and safety and specification information. Their Web site includes an online literature library of more than 150 free and low-cost publications on insulation.

U.S. EPA ENERGY STAR Buildings and Products

www.energystar.gov

Phone: (1-888) STAR-YES

This Web site includes energy-efficient product lists with store locators and guidelines for reducing building and facility energy use.

The Department of Energy's Industrial Technologies Program (ITP) Best Practices Program

www.oit.doe.gov/bestpractices/software_tools.shtml

Phone: (1-877) 337-3463

Best Practices has a varied and expanding software collection to help identify and analyze energy system savings opportunities in plants:

- **AIRMaster+**— provides comprehensive information on assessing compressed air systems, including modeling, existing and future system upgrades, and evaluating savings and effectiveness of energy efficiency measures.
- **ASDMaster: Adjustable Speed Drive Evaluation**—helps determine the economic feasibility and electrical energy savings of an ASD application and includes a searchable database of standard drives.
- **Fan System Assessment Tool (FSAT)**—helps quantify the potential benefits of optimizing fan system configurations that serve industrial processes.
- **MotorMaster+ 4.0**—an energy-efficient motor selection and management software tool that includes a catalog of more than 20,000 AC motors.
- **Process Heating Assessment and Survey Tool (PHAST)**—provides an introduction to process heating methods and tools to improve the thermal efficiency of heating equipment.
- **Pumping System Assessment Tool (PSAT)**—helps industrial users assess the efficiency of pumping system operations.
- **Steam System Tool Suite**—offers a suite of tools for evaluating and identifying steam system improvements.

Insulation Thickness Computer Program

www.pipeinsulation.org

This Web site provides case studies and background information on industrial insulation benefits. It also serves as an access point to download NAIMA's free software program, 3E Plus, to calculate the appropriate thicknesses of pipe insulation to specify in order to achieve desired emissions levels, energy savings and thermal performance.

Increase Water Efficiency To Lower Costs

WATERGY version 3.0

www.eere.energy.gov/femp/information/download_watergy.cfm

WATERGY is a spreadsheet model that uses water/energy relationship assumptions to analyze the potential of water savings and associated energy savings.

Water Wiser: The Water Efficiency Clearinghouse

www.awwa.org/waterwiser/

Phone: (1-800) 926-7337

This Web clearinghouse contains articles, reference materials and papers on all forms of water efficiency.

Water Efficient Landscaping

<http://muextension.missouri.edu/xplor/agguides/hort/g06912.htm>

Phone: (573) 882-7477

This Web site contains general descriptions and strategies for water efficiency in gardens and landscapes.

U.S. EPA Water-Saving Tips

www.epa.gov/OW/you/chap3.html

This Web site provides guidance for commercial, industrial and residential water users on saving water and reducing sewage volumes.

Water Efficiency Guide for Business Managers and Facility Engineers

www.owue.water.ca.gov/docs/water_efficiency_guide.pdf

A resource developed by the California Department of Water Resources that offers specific measures for industrial and commercial site managers to improve water efficiency.

Improved Waste Management Through Waste Reduction, Reuse, Donations and Recycling

EPA Industrial Waste Management

www.epa.gov/epaoswer/non-hw/industd/index.htm

This Web site offers tools and recommendations for reducing waste specific to manufacturing processes.

Recycling at Work

www.usmayors.org/USCM/recycle

Phone: (202) 293-7330

This program from the U.S. Conference of Mayors provides information on workplace recycling efforts.

Waste at Work

www.informinc.org/wasteatwork.php

Phone: (212) 361-2400

This online document from Inform, Inc., and the Council on the Environment of New York City provides strategies and case studies to reduce workplace waste generation.

Small Business Waste Reduction Guide

www.uwex.edu/ces/ag/sus/sbdc/tocdetl.htm

This resource from the University of Wisconsin-Extension identifies waste-reduction opportunities and strategies for small businesses, including manufacturing firms. It includes a number of case studies, including electronics manufacturing, plastics manufacturing, printing and wood products companies.

Business Waste Reduction

www.ciwmb.ca.gov/bizwaste

Phone: (916) 341-6000

This program from the California Integrated Waste Management Board assists in office recycling and waste-reduction efforts.

National Recycling Coalition

www.nrc-recycle.org

Phone: (202) 347-0450

This Web site provides information on recycling ranging from “how to set up a recycling program” to “where to find buyers/markets for recycled goods.”

EPA WasteWise Program

www.epa.gov/wastewise/about/index.htm

Phone: (1-800) 372-9473

This is a free, voluntary EPA program to help U.S. organizations eliminate costly municipal solid waste, which benefits their bottom line and the environment.

Improve Indoor Environment Quality And Increase Productivity

National Institute for Occupational Safety and Health (NIOSH)

www.cdc.gov/niosh/topics/indoorenv/

Phone: (1-800) 356-4674

NIOSH is the federal agency responsible for conducting research and making recommendations for the prevention of work-related injuries and illnesses. NIOSH is part of the Centers for Disease Control and Prevention (CDC).

Indoor Air Quality Association (IAQA)

www.iaqa.org

Phone: (301) 231-8388

IAQA is a nonprofit organization that disseminates information about indoor environmental quality.

EPA Indoor Air Quality Web Site

www.epa.gov/iaq

Phone: (202) 343-9370

This site offers a wide variety of tools, publications and links to address IAQ concerns in schools and large buildings. The downloadable *IAQ Building Education and Assessment Model (I-BEAM)* software program provides comprehensive IAQ management guidance and calculates the cost, revenue and productivity impacts of planned IAQ activities.

Reduce Transportation Impacts

DOE: Energy Efficiency Transportation Sector

www.eia.doe.gov/emeu/efficiency/ee_ch5.htm

Phone: (202) 586-7237

This article analyzes transportation in the United States, including information about freight and passenger transportation, trends and projections for transportation-related energy consumption, and economic implications or transport.

EPA SmartWay Transport Partnership

www.epa.gov/otaq/smartway/index.htm

Phone: (734) 214-4767

This voluntary program, sponsored by the EPA, offers resources and support in adopting freight industry practices and technologies that increase energy efficiency, improve energy security, reduce air pollution and the emission of greenhouse gases, and reduce transportation costs. This is a good resource for companies with their own transportation fleet or customers of freight services.

Best Workplaces for Commuters

www.bestworkplacesforcommuters.gov/index.htm

Phone: (1-888) 856-3131

A program established by the EPA and the Department of Transportation that publicly

recognizes employers for exemplary commuter benefits programs. It provides tools, guidance and promotion to help employers incorporate commuter benefits into their employee benefits plan, reap financial benefits and gain national recognition.

The Department of Energy's Clean Cities Vehicle Buyer's Guide For Fleets

www.eere.energy.gov/cleancities/vbg/fleets

A site designed to educate fleet managers and policymakers about alternative fuels and vehicles. The site provides pricing and technical specifications for light and heavy-duty AFVs, a directory of alternative fueling stations and state AFV purchasing incentives and laws.

The Department of Energy's Fuel Economy Web Site

www.fueleconomy.gov/feg

Phone: (1-800) 423-1363

A site that allows comparisons of cars based on gas mileage (mpg), greenhouse gas emissions, air pollution ratings and safety information for new and used cars and trucks.

The Telework Collaborative

www.teleworkcollaborative.com

This organization combines the expertise and resources of five western states (Texas, Arizona, California, Oregon and Washington) to deliver some of the most respected telework program implementation materials in the field.

Reduce Environmental Impacts And Potential Business Liabilities

Global Reporting Initiative (GRI)

www.globalreporting.org/

A multistakeholder process and independent institution, GRI's mission is to develop and disseminate globally applicable Sustainability Reporting Guidelines.

**The Cleaner and Greenersm
Certification Program**

www.cleanerandgreener.org

Phone: (608) 280-0256

A whole company certification program that helps businesses communicate their energy efficiency and environmental achievements to their customers.

**International Organization
For Standardization (ISO)**

www.iso.org

ISO is the world's largest developer of standards. **Simply Quality** (formerly ISO Easy)—www.isoeasy.org—and **ISO Online**—www.iso.ch/—provide guidance for ISO certification.

- **ISO 9000** standards are management-system standards that state requirements for what an organization must do to manage the processes influencing quality.
- **ISO 14000** standards are management system standards that state requirements for what an organization must do to manage the processes influencing the impact of the organization's activities on the environment (ISO 14000). "Environmental management" in ISO 14000 is defined by the management processes companies have in place to minimize harmful effects on the environment caused by its activities.

EPA Climate Leaders

www.epa.gov/climateleaders

This new, voluntary EPA industry-government partnership encourages companies to develop long-term comprehensive climate change strategies.

Notes

Notes

Notes

JOHNSON
CONTROLS

M THE
ANUFACTURING
INSTITUTE

MANUFACTURING MAKES AMERICA STRONG

1331 Pennsylvania Avenue, NW • Washington, DC 20004-1790
www.nam.org/institute