



# Pollution Prevention Concepts and Principles

*By Erica Phipps, NPPC Research Assistant. This document introduces the concepts and principles of pollution prevention (P2) and gives a brief overview of P2 activities of government, industry, and the general public. University faculty and other educators should find this document useful in preparing lectures on P2, or in incorporating P2 concepts into their specific disciplines. In addition, this document may serve as useful introductory reading for students.*

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## **Pollution Prevention: An Emerging Approach**

During the first few decades of environmental protection regulation in the United States, the focus was on containing or cleaning up pollution after it was generated. Since the 1960s and 1970s, these strategies have resulted in significant improvement in many aspects of environmental quality. However, regulations that focus on the end of the pipe or the top of the stack do little to prevent pollution or avert future impacts — often, they just cause the pollution to be shifted from one environmental medium (air, water, or land) to another. The “command-and-control” nature of the regulatory system (in which government sets prescriptive standards and in some cases dictates methods for compliance) also has contributed to this emphasis on after-the-fact pollution control.

Faced with the limitations inherent in such pollution management strategies as containment and remediation, many sectors of government and industry are shifting toward a more preventive, proactive approach. This emerging approach, referred to as *pollution prevention*, offers a promising means for protecting the environment and achieving more efficient use of resources.

But prevention is not something that can be simply added on to existing practices and systems. It involves identifying the root causes of waste and figuring out ways to minimize its creation, often by using energy and materials more efficiently. Pollution can result from virtually all human activities. Therefore, pollution prevention represents a challenge that is open to all members of society, at all levels of activity and decision-making. The role of education is crucial: pollution prevention requires having the skills, creativity, and mindset to holistically identify options for improvement and innovation.

### **Defining Pollution Prevention**

*Pollution prevention* (P2) is the reduction or elimination of wastes and pollutants at their sources. For all the pollution that is avoided in the first place, there is that much less pollution to manage, treat, dispose of, or clean up. P2 can encompass activities such as:

- redesigning products to cause less waste or pollution during manufacture, use, or disposal

- altering production processes to minimize the use of toxic chemicals
- implementing better housekeeping practices to minimize leaks and fugitive releases from manufacturing processes
- taking steps to reduce energy consumption

Pollution prevention within industry generally receives the most attention. However, P2 efforts in other sectors are equally important. For example, planting pest-resistant crops can reduce or eliminate the need for chemical pesticides, thereby reducing the water, air, and soil pollution that results from the manufacture and use of agricultural chemicals. In office settings, simple steps such as making double-sided copies and printing drafts on the back sides of discarded paper can substantially reduce the consumption and disposal of paper products. In the home, minimizing the use of toxic household chemicals such as drain cleaners and herbicides will reduce the amount of hazardous chemicals that eventually end up in the environment. The range of P2 opportunities is constrained only by the limits to our imagination and ingenuity, and the strength of our commitment to improving our relationship with the environment.

### **The Pollution Prevention Act of 1990**

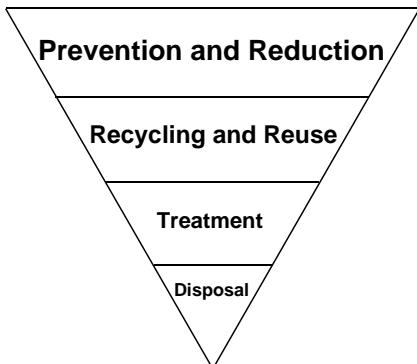
Following passage of the *Pollution Prevention Act of 1990*, the U.S. Environmental Protection Agency developed a formal definition of P2 and a strategy for making it a central guiding mission. Under Section 6602(b) of the Pollution Prevention Act, Congress established a national policy that:

- pollution should be *prevented* or *reduced* at the source whenever feasible;
- pollution that cannot be prevented should be *recycled* in an environmentally safe manner whenever feasible;
- pollution that cannot be prevented or recycled should be *treated* in an environmentally safe manner whenever feasible; and
- *disposal* or other *release* into the environment should be employed only as a last resort and should be conducted in an environmentally safe manner.<sup>1</sup>

This hierarchy of preferred options for dealing with environmental pollution officially places prevention at the top of the list.

### POLLUTION PREVENTION HIERARCHY

as established by Congress in the  
Pollution Prevention Act of 1990



According to the EPA's official definition, *pollution prevention* means "source reduction" as defined in the Pollution Prevention Act (see below), but also includes "other practices that reduce or eliminate the creation of pollutants through (1) increased efficiency in the use of raw materials, energy, water, or other resources, or (2) protection of natural resources by conservation."

The Act defines *source reduction* as any practice that:

(1) reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and

(2) reduces the hazards to public health and the environment associated with the release of such substances, pollutants, or contaminants. Source reduction includes equipment or technology modifications, process or procedure modifications, reformulation or redesign of products, substitution of raw materials, and improvements in housekeeping, maintenance, training, or inventory control.

Thus, P2 can be thought of as roughly synonymous with source reduction — reducing the generation of wastes or contaminants at the source, and thereby reducing releases to the environment that could pose hazards to the environment and public health. Like source reduction, P2 as defined by the Pollution Prevention Act does not include out-of-process recycling, waste treatment, or combustion of wastes for energy recovery.

The exclusion of out-of-process recycling from the official definition of P2 activities has been a source of controversy. Strictly speaking, recycling is not a form of prevention. However, recycling can confer substantial environmental improvements and can aid in conserving valuable resources. Thus, industry has argued that recycling should be on par with pollution prevention, because it represents progress toward reducing environmental pollution and achieving greater efficiency in resource use.

The EPA has held fast to the narrower interpretation of P2, which excludes recycling because even wastes that are effectively recycled have not been *prevented*. Besides being indicative of an inefficient use of materials, wastes — once they have been generated — have the potential to harm workers, the environment, and public health. However, the position of recycling as the second highest option in Congress's and the EPA's P2/waste management hierarchy (**see box**) attests to its desirability as a goal in cases where waste cannot feasibly be prevented.\* Furthermore, in some cases *in-process recycling* — in which materials are directly reincorporated into the same process — is considered a form of P2.

### Related Concepts and Terminology

Pollution prevention is a newly developing field, thus there is a lot of terminology being used by different groups and individuals, not all of which is yet well defined or consistently used. Some of the terms, such as *source reduction*, are essentially synonymous with P2, as discussed above. However, there are many other terms that, although related to P2, have specific meanings or usages. The following is a brief explanation of some of the more common terms. A note of caution: the definitions provided here may not coincide in all cases with the meaning intended by some authors or sources.

\*David Kling, director of the Pollution Prevention Division within EPA's Office of Pollution Prevention and Toxics, notes that, while "source reduction is a distinct approach," it is "rarely 'pure' in application — instead, it is often associated with recycling, treatment, and other activities." ("The Agency Definition of Pollution Prevention," memorandum to Regional OPPT Toxics Branch Chiefs, February 17, 1995.)

*Pollution prevention* itself is a term that can have a variety of meanings, depending upon who is using it. Although the EPA's definition is perhaps the most widely known, others have defined P2 to include recycling and reclamation activities (which Congress and the EPA specifically exclude). For example, a draft standard being prepared by American Society for Testing and Materials on the development and implementation of P2 programs defines P2 as "the act of reducing or eliminating the use, release or generation of a pollutant or potential pollutant through source reduction, recycling, reuse, reclamation or modification of existing practices."<sup>2</sup>

*Waste minimization* was one of the first initiatives in the area of P2, and focused almost exclusively on solid wastes regulated under the Resource Conservation and Recovery Act (RCRA) — particularly hazardous wastes.<sup>3</sup> Thus, in one sense waste minimization is defined much more narrowly than P2, which focuses on reducing the entire spectrum of pollution and waste released to air, land, and water through any process. Waste minimization has been controversial because, unlike strictly prevention-oriented concepts, it has often included treatment methods that reduce the volume or toxicity of existing waste, rather than focusing solely on minimizing the amount of waste being generated at the source. Recent RCRA reporting requirements now exclude treatment and energy recovery from the definition of waste minimization activities. However, recycling is still included.<sup>4</sup>

*Waste reduction* is a term that falls somewhere between waste minimization and P2. While it has a broader focus than waste minimization (which, again, emphasizes RCRA hazardous wastes), it implies a narrower perspective than P2's holistic approach (preventing all types of pollution released to all environmental media from products as well as from industrial processes). Use of the term "waste reduction" is not widespread, perhaps in part due to its ambiguity.

*Toxics use reduction* means eliminating or avoiding toxic substances in products or processes; the goals are to reduce health risks for workers, consumers, and the general public and adverse effects on ecosystems and the environment.<sup>5</sup> *Toxic chemical use substitution* refers to the substitution of less harmful substances in products or processes; it can also include efforts to reduce or eliminate the use of specific chemicals or categories of toxic substances through development of appropriate substitutes or alternative technologies.<sup>6</sup>

## **Pollution Prevention and Sustainable Development**

*Sustainable development*, a term popularized in 1987 by the United Nations' World Commission on Environment and Development (the "Brundtland Commission"), is defined as **meeting the needs of the present global population without impeding the ability of future generations to meet their needs.**<sup>7</sup> The goal is for humans to live within the carrying capacity of the earth — which means not depleting resources or degrading the environment through excessive waste and pollution — so as to leave things in at least as good a condition as we found them. The notion of intergenerational equity is central: it implies an ethical obligation to protect the environment and conserve resources so future generations will be able to meet their material and energy needs and live healthy, productive lives.

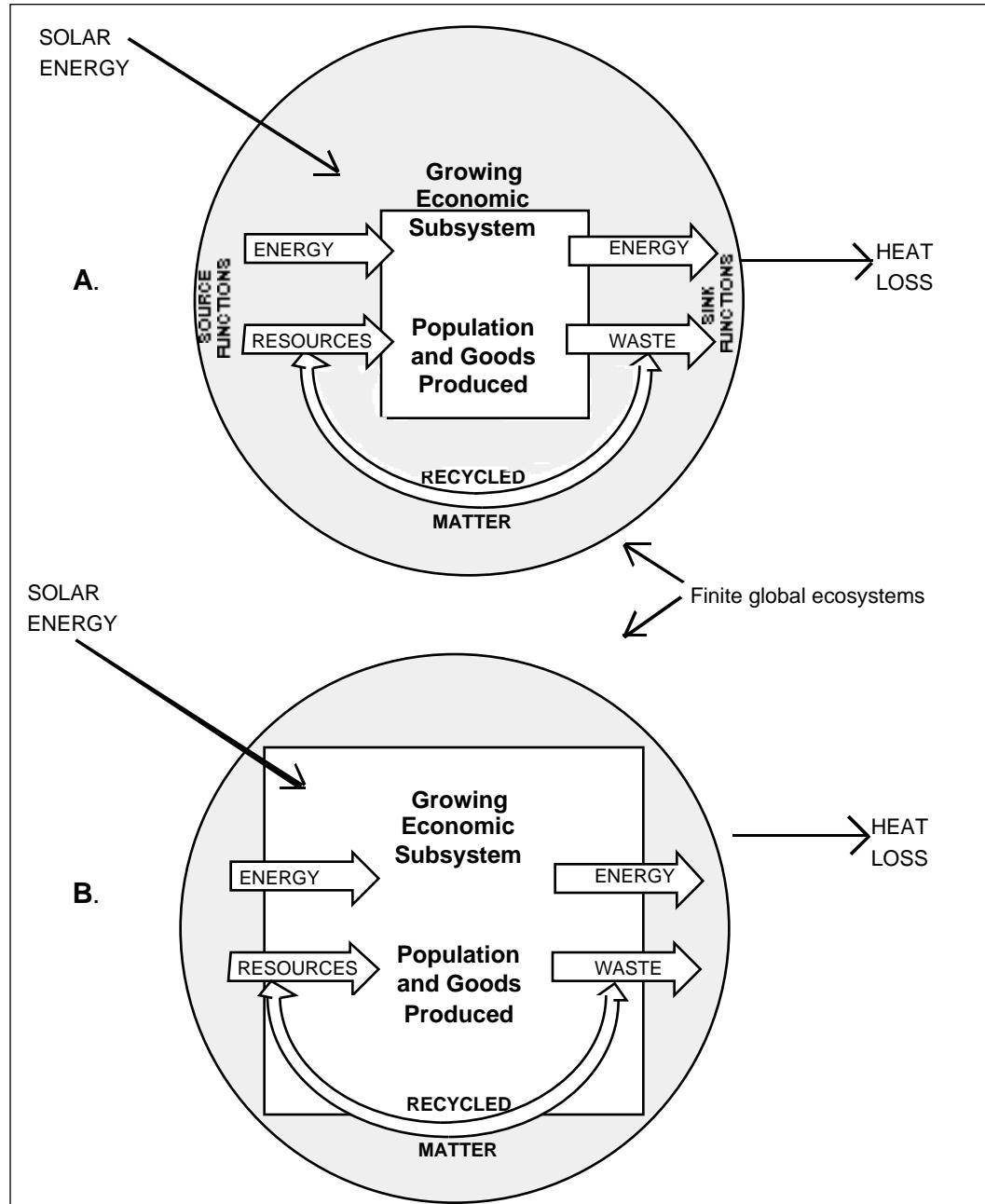
**Figure 1** figuratively depicts how a combination of unchecked population growth and ever-expanding economic consumption could dominate and eventually overwhelm the finite global ecosystem.

Pollution prevention has an important role in efforts to achieve global sustainable development. The essence of P2 is this: to *reduce* the overall environmental burden associated with meeting our needs and carrying out our activities (including economic production, transportation, communication, recreation, etc.) and *increase* the efficiency with which we use materials and energy. This is clearly consistent with sustainable development. P2, combined with stabilization of world population, sustainable resource management, and reduced reliance on nonrenewable energy sources, represents the path toward sustainable development.

## **The EPA's Approach to Pollution Prevention**

The U.S. Environmental Protection Agency has been increasingly tailoring its goals and activities to incorporate pollution prevention principles. The EPA is developing regulatory strategies that encourage P2 and creating incentives for industry to surpass simple compliance and reach for optimal environmental management. This signals two things: (1) movement from the end-of-pipe, single-media regulations of the past few decades to more holistic, proactive strategies that anticipate and prevent negative environmental impacts,

**FIGURE 1: THE FINITE GLOBAL ECOSYSTEM RELATIVE TO THE GROWING ECONOMIC SUBSYSTEM**



Source: Goodland, et al., eds. *Population, Technology, and Lifestyle*, p. 5. Washington: Island Press, 1992.

and (2) shifting from the traditional command-and-control model of environmental regulation toward a more incentive-based, partnership approach.

Notwithstanding these shifting priorities, however, pollution control and strong regulatory standards remain as important elements of environmental regulation. P2 is a great help in addressing multimedia concerns, since pollution that is never created cannot

be shifted from one environmental medium to another (as often occurs as a result of the existing, regulatory approach that deals separately with releases to air, water, and land). Institutional reorganization, strong leadership from the EPA Administrator and other top-level officials, reevaluation of existing regulatory and permitting strategies, and development of voluntary P2 programs are the major ways in which the EPA is responding to the mandate of P2.

The EPA's P2 efforts have been bolstered by enactment of some prevention-oriented federal legislation, most notably the Pollution Prevention Act of 1990; the Emergency Planning and Community Right-to-Know Act (EPCRA), which created the Toxic Release Inventory (TRI) program; and components of the 1990 reauthorization of the Clean Air Act (CAA), including the air toxics program and the emissions trading system for coal-fired power plants. The EPA has also met with some success in incorporating P2 requirements into criminal and civil enforcement settlements.

In addition, President Clinton has issued prevention-oriented executive orders, including one that requires federal facilities to develop P2 plans and report releases of toxic substances in accordance with TRI requirements (see next section); federal facilities had previously been exempt from TRI reporting.<sup>8</sup> The President also issued an order in October 1993 that requires government to undertake "green" procurement practices.<sup>9</sup> The EPA is currently developing guidelines for "environmentally preferable products" to fulfill this mandate. This could have a significant beneficial impact, not only because the government is one of the largest purchasers of goods and services, but because it sets an example for corporations and other organizations to follow.

The following are brief descriptions of the EPA's major efforts to incorporate P2 into its regulatory and permitting functions, followed by a listing of the EPA's voluntary programs that have P2 components.

## **Regulatory, Programmatic, and Funding Initiatives**

### **SOURCE REDUCTION REVIEW PROJECT**

The goal of the EPA's *Source Reduction Review Project* (SRRP) was to ensure that source reduction measures and multimedia issues are considered when environmental regulations are written, and that prevention becomes a primary means of achieving compliance with federal environmental laws. The SRRP was initiated to fulfill the requirement contained in the 1990 Pollution Prevention Act that the EPA "review regulations of the Agency prior and subsequent to their proposal to determine their effect on source reduction."<sup>10</sup> When the Common Sense Initiative (described next) was launched in 1994, the SRPP was folded into that effort.

### **COMMON SENSE INITIATIVE**

The most recent of the EPA's initiatives, the *Common Sense Initiative* represents a new industry-by-industry approach to environmental policy centered around P2 and regulatory flexibility. Rather than regulating on a pollutant-by-pollutant basis or according to environmental media, the idea is to develop comprehensive, industry-specific regulations. The purpose of the Common Sense initiative is to achieve greatest environmental protection at least cost, emphasizing prevention.

Six industries have been selected for the pilot phase: (1) auto manufacturing, (2) computers and electronics, (3) iron and steel, (4) metal finishing and plating, (5) petroleum refining, and (6) printing. EPA is convening stakeholders — industry, environmental and public interest groups; state and local government; labor unions; and other federal agencies — in order to develop comprehensive strategies for "cleaner, cheaper, smarter" environmental regulation for these industry sectors.

### **TOXIC RELEASE INVENTORY (TRI)**

The Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986, also referred to as Title III of the Superfund Amendments and Reauthorization Act (SARA), directed the EPA to collect information from manufacturers on the toxic substances they are releasing into the environment, and to make that information available to the public. The resulting *Toxic Release Inventory* (TRI) program requires certain industrial sectors to report annually on the amount of toxic chemicals they release to air, water, and land. This information is then compiled into a database that is made available to the public.

The impact of the TRI has been significant. The public has been empowered with information on the toxic chemical releases occurring in their communities, and in many cases has successfully used this information to pressure industry to clean up its act. Likewise, industry has a greater incentive to use P2 initiatives to minimize its toxic chemical releases and thus improve its image and credibility with consumers and stakeholders. With the passage of the 1990 Pollution Prevention Act, the TRI reporting requirements have been expanded to include reporting on recycling and progress on source reduction.

## Federal Partnerships

*Agriculture in Concert with the Environment* (ACE), a cooperative effort between the U.S. Department of Agriculture and the EPA, provides grant money for research, education, and demonstration projects on sustainable agricultural practices. The focus of the ACE program is to minimize pollution from soluble fertilizers and pesticides and to safeguard wetlands and other environmentally sensitive ecosystems.<sup>11</sup> Through this program, the EPA promotes the incorporation of P2 principles into agricultural practices, which can be a major source of adverse environmental impacts and non-point source pollution.

The *National Industrial Competitiveness through Efficiency, Energy, Environment, and Economy* (NICE<sup>3</sup>) project is another federal partnership program focusing on P2 and efficient use of resources. The Department of Energy and the EPA provide grants for the development and demonstration of new technologies that prevent pollution through source reduction and energy efficiency.

## Other Activities

In addition to the programs described above, the EPA also provides technical assistance and information to industries, citizens, and the states on P2 methods and state-of-the-art technologies, conducts and provides funding for scientific research and development, and provides grants to the states for P2 and multimedia programs. The EPA also has set up various education and outreach programs to promote P2 activities.

Development of guidelines and tools such as *life cycle assessment*, *environmental labeling criteria*, *environmentally preferable procurement guidance*, *environmental auditing guidelines*, and *voluntary standards* on P2 and environmental management are other activities that are carried out and/or supported by the EPA. A listing of contacts and hotlines pertaining to the EPA's various programs and initiatives is provided at the end of this document.

## Voluntary Programs

Following are descriptions of a few of the programs EPA has set up in recent years to work with industry on a cooperative basis.

## 33/50

The 33/50 program is a voluntary program in which major industrial sources agreed to contribute reductions in their generation of 17 targeted chemicals in support of national reduction goals of 33% by the end of 1992 and by 50% by the end of 1995 as measured by data reported under TRI. The program appears to have been a success, although the progress achieved in P2 is difficult to assess. Approximately 1,300 companies have signed on, and the 33% reduction goal for 1992 was exceeded by more than 100 million pounds. The targeted chemicals are highly toxic and pervasively used (e.g., benzene, cadmium, chloroform, lead, mercury, and carbon tetrachloride). The program's ultimate 50% goal is projected to be achieved a full year ahead of schedule in 1994 TRI reporting.<sup>12</sup>

## DESIGN FOR ENVIRONMENT (DfE)

DfE is a term that is derived from the engineering concept of "design for X," with "X" being any characteristic or quality that the designer wants the product to have, such as manufacturability, durability, energy efficiency, etc. "Design for Environment," therefore, means designing products and services with the environment in mind. An important goal of the DfE construct is to consider the environmental impacts of the entire life cycle — from raw material extraction through the manufacturing, use, servicing, and retirement of the product — so that the overall environmental burden associated with the product or activity can be minimized.

The EPA's *Design for Environment* program involves helping industry design products and services with reduced environmental impacts. The DfE program provides industry with standardized analytical tools to be used in making environmentally sound design decisions, as well as information on the comparative risks and performance of various chemicals, processes, and technologies. To date, the DfE program has worked with the dry cleaning industry to explore alternative processes such as "wet cleaning," and with the printing industry to explore ways to reduce the use of hazardous chemicals. The DfE program is also working with the finance community to encourage the incorporation of environmental considerations and costs into accounting, insurance, and investment decisions.

## **GREEN LIGHTS**

Lighting accounts for nearly a quarter of U.S. electricity use. Improving the energy efficiency of lighting systems reduces energy consumption and therefore lowers utility bills and reduces the environmental impacts from power generation. The EPA estimates that replacing a single incandescent bulb with a compact fluorescent saves enough energy to reduce carbon dioxide (CO<sub>2</sub>) emissions by 300 pounds a year.<sup>13</sup> More efficient lighting technologies can sometimes cut a company's lighting electricity usage in half, meaning significant savings and short pay-back periods for system modification costs. In addition, the newer lighting technologies often provide improved lighting quality.

*Green Lights*, which is perhaps the best-known of the EPA's "green" programs, promotes the adoption of energy-efficient lighting systems by businesses, governments, universities, and other organizations of any size. Through voluntary agreements with the EPA, organizations that sign on to the program agree to upgrade their lighting systems by installing more efficient fixtures and bulbs (such as compact fluorescents) and motion sensors. As of August 1995, nearly 2,000 organizations had signed onto the program, representing more than five billion square feet of facility space (over three times the total office space in New York, Los Angeles, and Chicago combined!).<sup>14</sup> According to EPA figures, Green Lights participants are saving nearly two billion kilowatt-hours (kWh) of electricity annually. The cumulative reductions in CO<sub>2</sub> emissions (2.3 billion pounds) are equivalent to removing 221,000 cars from the road annually.

## **ENERGY STAR BUILDINGS**

The purpose of the *Energy Star Buildings* program is to encourage investment in energy-efficient equipment and operations in commercial buildings. Facilities are encouraged to follow a progression of improvements. They start with Green Lights and a general building "tune-up." This is followed by steps to reduce heating and cooling requirements, installation of improved air handling systems, and, finally, installation of improved heating and cooling plants. The reductions in energy use realized during the first three steps are expected to reduce the size and cost of the heating and cooling systems that will be required by the facility once the final stage of the process is reached. Participation in Green Lights is a prerequisite for the Energy Star Buildings program.<sup>16</sup>

## **ENERGY STAR COMPUTERS**

*Energy Star Computers* is a partnership between the EPA and manufacturers of computers and laser printers with the goal of improving the energy efficiency of computer systems. The companies (which account for nearly two-thirds of all desktop computer sales and nearly 90% of all laser printer sales in the U.S.) have begun to introduce machines that automatically power down when not in use, thereby saving electricity and preventing the environmental impacts of power generation. Products that comply with the program's guidelines bear the EPA's *Energy Star* logo, which attracts environmentally aware consumers and businesses that are interested in lower energy costs.<sup>15</sup>

## **NATURAL GAS STAR**

*Natural Gas Star* was started by the EPA in 1993 to help the U.S. meet its Rio Earth Summit commitment to reduce the emission of greenhouse gases, which contribute to global climate change. Through the program, EPA works with members of the natural gas industry to help them voluntarily reduce the release of methane — a potent greenhouse gas — by implementing improved technologies, better work practices, and improved maintenance and inspection of distribution networks in order to minimize leaks and emissions.

## **GOLDEN CARROT**

*Golden Carrot* refers to a \$30-million-dollar pool set up by the "Super Efficient Refrigerator Program" (SERP, a consortium of 24 electric utilities) to spur development of energy-efficient, CFC-free refrigerators. SERP members worked closely with EPA, the Natural Resources Defense Council, the Electric Power Research Institute, and the American Council for an Energy-Efficient Economy, among others, in developing the program. The purpose of the \$30 million "golden carrot" was to help overcome the price gap that many manufacturers feared would prevent consumers from buying new, more efficient refrigerator models. The prize money partly subsidizes the cost of research and development. This allows the manufacturer to offer the new units at competitive prices, thereby ensuring that the investment in the new technology will be profitable.

Whirlpool, the winner of the contest, will be awarded the prize money in the form of rebates as the new refrigerators reach consumers. The new super-efficient Whirlpool refrigerators are expected to save consumers

\$240–\$480 million in annual electricity bills and cut emissions of carbon dioxide by 650,000 tons per year.<sup>17</sup>

### **WASTEWI\$E**

The *WasteWi\$e* program is similar to Green Lights in that it is aimed at reducing the environmental impact of businesses and other organizations while helping them save money. By committing to the *WasteWi\$e* program, companies agree to undertake municipal solid waste prevention, improve or implement recycling efforts, and purchase and/or manufacture recycled products. Companies set their own goals and report progress to the EPA. The EPA, in turn, provides technical assistance via an information hotline, publications, and referrals; it also provides public recognition for companies that achieve significant waste reduction.<sup>18</sup>

### **CLIMATEWISE**

*ClimateWise* is a joint EPA/Department of Energy program to reduce greenhouse gas emissions from industry, as a step toward global warming prevention. Industry is invited and challenged to come up with innovative ways to reduce greenhouse gas emissions (including carbon dioxide, methane, nitrous oxides, and halocarbons such as CFCs) by changing production processes, substituting materials, improving housekeeping practices, increasing energy efficiency, etc. Companies that successfully curb emissions of greenhouse gases are publicly recognized for their achievements.<sup>19</sup>

### **WAVE**

WAVE, the *Water Alliances for Voluntary Efficiency* program, targets the water-use efficiency of hotels and motels across the nation. Participants agree to install water-efficient equipment and water-saving devices to cut down on water consumption from plumbing, laundry, food services, pools, fountains, cooling systems, and grounds-keeping. The program will eventually be expanded to include businesses, government facilities, and other institutions. The Metropolitan Water District of Southern California, in cooperation with the WAVE program, has announced the development of computer software that will aid hotel engineers and decision-makers in improving water-use efficiency.<sup>21</sup>

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In addition to the EPA's P2 initiatives and voluntary programs, other federal agencies and institutions such as the Departments of Energy, Defense, and Agriculture;

the Post Office; and the General Services Administration are also gearing efforts and programs toward P2. Proposed congressional legislation and debate is another interesting source of information on P2 policies and ideas. Furthermore, a great deal of P2 action is occurring at the state, regional and local levels, both through government initiatives and legislation, and as a result of community involvement. The following sections provide examples of P2 efforts at the state level as well as P2 activities within industry. While the scope of this document does not permit comprehensive coverage of all areas in which P2 is occurring, readers are encouraged to explore these areas by contacting governmental agencies and legislators, environmental organizations, and other citizen-action groups.

## **Pollution Prevention at the State Level**

States are well-positioned to further the goals of P2 due to their direct interactions with the regulated community. In addition, states are responsible not only for their own environmental regulations but many of the federal programs as well. Some states fund P2 activities with revenues from "polluter-pay" fees based on facilities' emissions.

More state environmental agencies are developing P2 programs. Some offer grants and incentive programs to encourage P2 activities; many offer education and outreach and provide technical assistance to help the regulated community comply with environmental laws through preventive means. Often the education and technical assistance functions are offered through a local university, or are at least housed separately from the regulatory functions, so that industry is not inhibited from seeking assistance. Or, the regulatory agencies themselves offer the services, often incorporating P2 into the planning and permitting processes.

Some state environmental agencies are integrating their air, water, and waste divisions. Multimedia inspections and permitting processes make it harder for polluters to just shift wastes from one medium to another; the attention of both industry and the regulators focuses on P2 opportunities instead.

Several states, including Massachusetts and New Jersey, have passed legislation that enables them to collect toxic chemical use information that goes beyond the scope of the federal TRI program. These states don't just collect data on the amounts of certain chemicals released or otherwise disposed of by manufacturing

facilities — they also collect information on amounts brought and stored on-site and how the chemicals are used. By tracking this “throughput data,” including both inputs and outputs, facilities are able more thoroughly account for the toxic chemicals used in their processes. This type of information is useful in identifying potential risks to workers and the community, and for identifying opportunities for P2.

## **Pollution Prevention in Industry**

The focus of much of the research, public attention, and governmental action regarding P2 has been on industry. This is not surprising, since industry is a major contributor to environmental problems and, as such, is often targeted to “clean up its act.” Further, it is industry, not government, that implements P2. While the following section focuses solely on the P2 activities being undertaken by industry, it should be understood that other economic sectors such as agriculture and transportation also impose tremendous environmental burdens and thus are ideal candidates for P2 activities as well.

Pollution prevention is often touted as an economically advantageous, strategically wise way for companies to protect the environment while protecting themselves (from liability, legal infractions, and unforeseen or unnecessary costs). P2 actions also have many barriers. To provide a balanced view, the following sections discuss P2’s potential benefits; examples of successful programs; and the institutional, cultural, legal, technical, and financial impediments that can make implementation difficult.

## **Potential Benefits**

### **COST SAVINGS**

Perhaps the most attractive benefit of P2 to industry is the potential for cutting costs and saving money. Source reduction, in-process recycling, and improved energy efficiency can reduce the amounts of raw materials and energy required, thereby cutting back on expenses. Substituting hazardous chemicals with safer alternatives can cut procurement expenses and greatly reduce pollution control costs, especially with the way the capacity of waste management facilities in some regions of the country is dwindling. Likewise, reducing nonhazardous wastes can also reduce procurement and disposal costs. Furthermore, P2 activities can cut down on the costs of complying with federal and state

regulations and reporting requirements. For example, if a waste or emission is eliminated from a production process, the compliance and reporting activities associated with that pollutant may also be eliminated.

### **REDUCED LEGAL LIABILITY**

Preventing the generation of wastes and emissions that could end up harming the environment and/or human health is a logical way for a company to protect itself from future liability. The strict liability contained in the Superfund law has made it so that companies — even those that may not have been acting contrary to the existing laws of the time — can be held liable for the environmental damage caused by the release of their wastes into the environment. Enforcement actions through Superfund and other environmental laws have made industry wary of incurring environmental liability that could cost millions of dollars in remediation costs. Criminal penalties (in which corporate leaders can be thrown into jail or personally fined), in addition to civil penalties and corporate fines, have made businesses even more aware that environmental degradation is not to be tolerated.

### **IMPROVED CORPORATE IMAGE**

Pollution prevention can also serve as an effective public relations tool. A company that demonstrates an active commitment to reducing its environmental impacts will have a more positive relationship with the local community and with its customers. While the average consumer still does not consider environmental performance to be as important a product criterion as price, aesthetics, or manufacturer reputation, more consumers are becoming aware of the environmental impacts of the products they buy. A company can use its environmental performance and its demonstrated concern for the health of people and the environment to improve its marketing efforts, and to establish itself as a responsible, reputable member of the community.

### **IMPROVED WORKER SAFETY**

Pollution prevention can be an important component of efforts to improve worker health and safety. Substituting less harmful substances for hazardous chemicals, cutting down on fugitive releases of solvents from manufacturing processes, and minimizing the amount of waste that must be handled and disposed of are examples of the ways in which P2 activities can improve the occupational environment.

## **Corporate Programs**

A growing number of companies are developing structured programs to facilitate the incorporation of P2 activities into their operations and decision-making, and to spur the active participation of their employees. Increasingly, P2 is becoming an important component of corporate environmental management, and is viewed as an effective corporate strategy for reducing financial costs and increasing efficiency. Most of the better-known examples of successful P2 programs are from large corporations that have environmental management staff and sufficient resources to focus on the development of such programs. Small companies are less likely to have structured P2 programs, since most have fewer resources and staff for such activities.

The keys to successful industry P2 programs include:

- Top-level commitment and leadership
- Education and incentives to obtain the involvement of all employees
- Strategic, long-term planning.
- Commitment of sufficient resources for implementing P2 improvements.
- Periodic measurement of P2 progress and inclusion of environmental criteria in more traditional measures of corporate performance.
- Effective communication between employees and management.
- Outreach/communication with external community.

Following are brief descriptions of three private-sector P2 programs. Note that, unlike the EPA's statutorial definition of P2, which excludes open-loop (out-of-process) recycling, many industrial programs include recycling as a form of P2. Some also include energy recovery from combustion of wastes and residuals as a waste reduction strategy.

### **THE DOW CHEMICAL COMPANY: WASTE REDUCTION ALWAYS PAYS (WRAP)**

In 1986 Dow Chemical started its Waste Reduction Always Pays (WRAP) program. This was not long after a leak at the Bhopal Union Carbide facility heightened public and corporate concern about chemical hazards, and passage of Title III of the Superfund Amendments and Reauthorization Act (SARA) marked the beginning of toxic chemical release reporting through the TRI program. WRAP's goals are to reduce waste, improve productivity, reduce waste management costs, and improve Dow's public image. Through WRAP, individual facilities track waste generation and develop waste

reduction proposals, which are then evaluated on their potential for significantly reducing the release of waste into the environment. Projects can include capital equipment modifications as well as changes in maintenance, operational, or administrative procedures. Ideally the projects should also offer a return on investment, but Dow recognizes that not all projects will offer quantifiable economic benefits. Facilities and employees who are involved in successful waste reduction projects are given awards and recognition. WRAP has led to substantial improvements in Dow's environmental performance and has helped make waste reduction a pervasive corporate ethic.

In addition to demonstrating its commitment to reduce its environmental impacts, Dow also has been a leader in improving communications with local communities through its Community Advisory Panels, which meet regularly with Dow personnel to discuss environmental performance and emergency preparedness as well as other concerns the community may have regarding Dow's practices.<sup>21</sup> Dow also started the ChemAware program, which provides customers with information on proper use and handling of its products for the purpose of protecting public health and the environment.<sup>22</sup>

### **THE 3M CORPORATION: POLLUTION PREVENTION PAYS (3P)**

3M has long been recognized as a leader in corporate environmental management and P2. In a 1993 *Fortune* survey, 3M was ranked as the fourth most admired company, and came in first in terms of environmental reputation. While most companies have just recently begun formalizing their waste reduction efforts, 3M's *Pollution Prevention Pays* (3P) program has been in operation since 1975. The three goals of the program are (1) achieve environmental improvement, (2) lower the company's costs, and (3) provide a means for employees at all levels to get creatively involved in P2. Pollution and waste are viewed as undesirable not only because of the damage caused to the environment, but because they represent non-productive capital costs and indicate inefficiency. At 3M, all P2 activities (except those that have been mandated by corporate leaders) must be economically justifiable. Successful programs are recognized through employee awards.

A main focus of the company's environmental philosophy is to achieve source reduction through product design. 3M commits about \$200 million of its billion-dollar annual research and development budget to P2

research. It is continually redesigning products or coming up with new ones, so that cutting-edge technologies that reduce toxicity and environmental impacts can be quickly incorporated into evolving product designs.<sup>23</sup>

### **THE XEROX CORPORATION: ASSET RECYCLING PROGRAM**

In 1990, the Xerox Corporation, a major manufacturer of copy machines and office equipment, initiated a program aimed at recycling used equipment and parts to maximize material-use efficiency and reduce waste. Although the company had long been in the practice of taking back used equipment from its customers, this new program marked a commitment to DfE principles, in which products are designed to facilitate equipment remanufacture and recycling of parts and materials. To focus design and engineering staff on environmentally improved designs, the company formally designated environmental considerations as a product requirement.

After the first year of the *Asset Recycling Program*, Xerox had saved over \$50 million in logistics, inventory and raw material costs. The program also has significantly reduced the amount of waste being sent to landfills.

As an added benefit, Xerox has become well-positioned for the potential enactment of take-back legislation, such as that which has already been proposed in Germany. Such legislation requires manufacturers to take back used products after they reach the end of their useful life or when the customer no longer has a use for them.

The name of Xerox's program, *Asset Recycling*, reflects the company's decision to consider all equipment and parts — including equipment out on lease or products that have been returned to the company — as assets to be maximized. The program established a hierarchy of objectives: (1) redistribute returned equipment to new customers (provided the machines are still in good working order), (2) remanufacture used equipment for redistribution, (3) convert equipment or components into other products, (4) salvage parts from dismantled equipment for use in new equipment or for use as spare parts, and (5) recycle source materials within the company, by returning them to suppliers, or sending them to recycling facilities. While the program has been very successful in achieving its environmental and waste reduction goals, it still faces external barriers such as consumers' reluctance to buy remanufactured goods, even though such products must meet the same quality standards as those made entirely from new components.<sup>24</sup>

## **Barriers**

### **CORPORATE CULTURE & INSTITUTIONAL NORMS**

Corporate culture and norms can often be difficult hurdles to overcome in initiating P2 activities. Commitment and strong leadership from corporate executives and top-level management is critical in establishing P2 as a company priority. The involvement of workers at all levels is also absolutely crucial. Many of the ideas for ways to cut down on waste and pollution arise not from the corporate boardrooms, but from people on the shop floor who work with the processes every day, and are thus in the best position to identify means for improvement. Breaking down hierarchical barriers at all levels is often a prerequisite to successful company-wide P2. Educating employees about the linkages between their day-to-day activities and the quality of the environment, and establishing channels of communication through which P2 ideas can be expressed, are important steps in establishing prevention as a guiding principle within a company. Implementing a Total Quality Management (TQM) approach to environmental performance is one way of motivating the entire workforce to focus on P2.

## **COST**

While P2 is often touted as a means of saving money, those savings are usually not realized until capital investments and production changes have been made. Switching to less hazardous materials, improving energy efficiency, and reducing process leaks and emissions are all activities that can require substantial capital investment. Especially for small companies that do not have a deep resource base, these investments are not usually viewed as top-priority.

In some cases the best opportunities for P2 exist in product design. Redesigning a product so that it is

- made from only renewable resources,
- more energy efficient during use,
- able to be remanufactured or recycled at the end of its useful life, or
- down-sized so as to require fewer materials and lower transportation costs

are important means of reducing the overall environmental burden associated with a product's entire life

cycle. Such design changes can be expensive, however, and may require changes in production machinery, marketing, packaging design, and materials procurement. The lost production time that can be associated with implementing these changes may also be an expense that a company is not eager to incur.

### **PREScriptive, TECHNOLOGY-SPECIFIC REGULATIONS OR MINDSETS**

Although some government regulations require the use of specific pollution *control* technologies, most are flexible enough to allow pollution *prevention*. Nevertheless, when the time comes to decide how to meet a governmental regulation about pollution, both the regulators and the regulated parties tend to go with what they know — the traditional pollution control technologies — rather than pollution prevention. To overcome this barrier, the government can create incentives for industry to implement alternative, prevention-oriented compliance schemes; another helpful strategy is to increase training, education, and awareness for both regulators and the regulated.

### **DIFFICULTIES IN IDENTIFYING P2 OPPORTUNITIES**

Environmental protection from an industry standpoint has traditionally meant complying with government regulations that focus on pollution control and waste management. The idea of preventing the generation of waste and pollution in the first place, while certainly not new, has not yet become second nature in most industries. Often, P2 activities are seen as optional and perhaps desirable activities that are undertaken only if extra resources exist or the opportunities are readily apparent. While companies may be accustomed to spending on environmental compliance and pollution control devices, most are not yet used to investing time and resources into identifying prevention opportunities. Furthermore, P2 is not a discrete activity that is started and completed, but rather represents an ongoing commitment to reducing environmental impacts within all aspects of a business's activities, from the office to the shop floor. It is vitally important to instill the mindset and awareness that is necessary to identify P2 opportunities at all levels of operation.

Traditionally, environmental engineers or health and safety personnel have been responsible for management of waste and compliance with environmental regulations. These personnel have developed expertise

in pollution control technologies that focus on the end of the pipe, dealing with the residuals that remain after all the decisions that go into a product and production line have already been made. These environmental management staff may be unfamiliar with P2 concepts, or may not be in a position to implement product or production line changes.

A shift toward P2 represents a fundamental change in how a company deals with environmental issues. Environmental protection is no longer solely the concern of environmental management. P2 requires that environmental considerations become a part of everyone's job, from product designers to purchasers, marketers, and accountants.

A related barrier to identifying P2 opportunities is that, because many of them are specific to a particular process, facility, or product, they can't usually be "taken off the shelf" and installed like pollution control devices, which are usually just added on to a process. Thus, the identification and development of prevention strategies may require a greater commitment of staff time, money, and research than conventional control technologies. However, the results achieved by prevention-oriented strategies are often far more significant, and the costs are generally lower in the long run.

### **Lack of Measurement Tools and Methodologies**

The difficulty associated with measuring a company's environmental performance can be an impediment to justifying and implementing P2 activities, and can hinder evaluation of their effectiveness in reducing environmental impacts.

Unlike traditional performance criteria such as costs, profitability, sales, or production levels, environmental performance is not well defined and is less readily measured. Simply quantifying the amounts of waste generated or the level of pollution emitted is obviously a start. But such measures fail to capture environmental impacts associated with unsustainable resource extraction (e.g., deforestation) or inefficient energy sources. Furthermore, it may be harder for a firm to justify the effort and expense of measuring types of waste that are not subject to government regulation.

In addition, measuring the physical quantities of waste generated does not reflect the toxicity or relative impact

of different types of waste. Perhaps even more significantly, the environmental impacts associated with a product once it goes out the door are rarely considered part of the company's environmental performance, even though decisions made during the design and development stages largely determine what impacts the product will have when it is used, maintained, and "retired." Finally, there is a lack of standardized analysis tools and metrics that facilitate comparison between incommensurate environmental impacts (e.g., carbon dioxide emissions, habitat degradation, use of toxic chemicals that bioaccumulate in the environment, cancer risk, etc.); this often makes it very difficult to prioritize P2 and environmental protection strategies.

Some tools have been developed (or are in the process of being developed) that can aid in evaluating environmental impacts and measuring P2 progress. *Life Cycle Assessment* (LCA) can identify the environmental impacts associated with all stages of the product life cycle, and the resulting information can be used to identify means for improvement.<sup>25</sup> *Throughput data* can be an important source of information in assessing inefficiency, waste, and toxic chemicals in products and measuring P2 progress. Throughput data includes the amounts of materials brought on-site, the amounts incorporated into products or otherwise consumed, the amount that leaves the facility as waste, and the amount stored on-site. By accounting for the fate of all materials flowing through an industrial process, unaccounted-for waste and fugitive emissions can be identified, better quantified, and addressed.

Normalizing the amount of waste generated by a process or facility to the level of production or output can help ensure that waste reduction figures are not distorted by changes in production activity. Calculating percent change in waste, normalized to the number of units produced, prevents year-to-year fluctuations in production levels from obscuring or distorting P2 progress.<sup>26</sup> The same approach can be used to assess generation of pollutants, energy-efficiency improvements, and other environmental performance measures.

Measuring costs avoided — through materials or energy conserved, disposal costs reduced, liability averted, or environmental damage prevented — is another challenging area of performance assessment. Estimating the savings derived from the *absence* of something that has been successfully avoided, whether it be pollution, waste, or public health impact, is difficult but necessary if P2 activities are to receive economic justification.

## Externalities

*Externalities* are costs (or benefits) resulting from producer or consumer actions that are not reflected in market values. Pollution is a classic example of a negative externality. In the absence of government regulations (or consumer response) that force a company to consider the social costs of its environmentally damaging activities, the costs of that damage remain external to the company and are not reflected in the price of products. In other words, unless a company is forced to be accountable for the pollution it generates, that pollution is "free." The company lacks a financial incentive to control or prevent the pollution. It is able to reap the economic benefits of production without paying for the costs to the environment, or for the costs felt by others who depend upon a non-degraded environment for life and livelihood.

While environmental regulations have increased industry's accountability in terms of the pollution and wastes it generates, not all environmental costs imposed by industry are accounted for. Industry generally is not accountable for its use of non-renewable resources, for its release of non-regulated pollutants, for the ecological effects associated with its use of land, or for the pollution it creates that falls within the acceptable range of the regulatory standards. While other incentives for a company to become cleaner and more efficient exist, such as consumer pressure and the desire for a "green" corporate image, these other factors are often insufficient motivation for a company to seriously commit to reducing its environmental impacts, through pollution prevention or other measures, in the absence of a demonstrable economic payback or other incentive.

## Lack of Long-Term Planning and Decision-Making

A near-term focus in decision-making can be a barrier to P2. Often it takes a while for the time and money invested in P2 changes to be paid back and a return on investment realized. Thus, implementing P2 or efficiency improvements may not seem economically advantageous to a company that is focused solely on its margin of profitability in the next quarter or within the current fiscal year. Generally speaking, a longer-term focus will reveal the benefits of P2 improvements in terms of reduced costs and greater profitability, as well as in reduced liability and lower compliance costs. Furthermore, P2 can be seen as a strategic move to

anticipate and eliminate the need to comply with future environmental regulations (e.g., by eliminating a particular pollutant or substance from a product system).

A long-term planning and decision-making framework is an important component of sustainable development. Short-sighted decisions may reap short-term financial gains, but they spell eventual doom for an industry or business that has not paid sufficient attention to the sustainability of its resource base or long-term trends in energy and resource availability. Pollution prevention, improved efficiency, source reduction, and use of renewable energy and materials are all vital to a sustainable economic future and a healthy environment.

## **Consumer Expectations**

While there is some evidence consumers are beginning to base at their purchasing decisions at least in part on environmental criteria, a product that is environmentally improved but does not meet consumers' other needs and requirements will benefit no one. Consumers have come to expect certain levels of quality, convenience, reliability, and appearance in products they purchase. Manufacturers committed to reducing the environmental burden associated with a product are often constrained by the narrow bounds of these expectations.

For example, products containing recycled materials may be less aesthetically appealing (because they look "different") and thus not sell. In an effort to overcome this obstacle, a manufacturer may bleach or treat the materials, but doing so may negate the environmental benefits of using recycled materials in the first place.

Convenience is another critical issue. Products that are meant to be reused may not be as attractive to someone interested in time-savings and ease of use.

Remanufactured products provide another example of consumer resistance. Even though a remanufactured product may be tested just as stringently as new equipment and have the same quality guarantees, a consumer may view it as inferior and decide to purchase a unit that has not been previously used, even at a significantly higher cost.

Companies that are redesigning products to reduce pollution and conserve resources are finding that educational campaigns about the environmental superiority of their products can be excellent marketing strategies.

## **Pollution Prevention and the Individual**

While P2 initiatives at the corporate or industry level may have a far greater impact on reducing the generation of pollution and waste than the actions of individuals, the importance of P2 at the individual level should not be underestimated. Awareness of the environmental impacts associated with purchasing decisions, lifestyles and behaviors — and a commitment to act upon that knowledge in order to reduce resource consumption and waste — will help guide our society toward a more sustainable future.

Individuals can contribute to P2 and environmental protection at many levels:

- By reducing consumption of energy and resources through conservation, recycling, and reuse of products and materials, and by minimizing reliance on automobiles and throw-away products, each person can reduce his or her net impact on the environment.
- Our individual efforts to conserve resources and prevent waste can serve as examples to our families and friends, thereby perpetuating an ethic of conservation and environmental awareness.
- By expressing a preference for environmentally improved goods through our purchasing decisions, we can send a message to manufacturers that they must focus on reducing the environmental impacts of their goods in order to remain competitive.
- In the workplace, we can strive to find ways to reduce the environmental impacts associated with whatever industry, economic activity, or service we are involved in.
- As voters and citizens, we can support political leaders who will be proactive on environmental issues, and who will help ensure that laws are passed to protect environmental quality and spur prevention-oriented actions within all economic sectors. We can also become active in grassroots efforts to ensure that industry and other pollution sources remain accountable to communities, pressuring them when necessary to maximize their efforts to reduce environmental impacts and protect human health. The availability of toxics release information through the TRI program, along with information obtained through other community-right-to-know legislation at the state and local levels, represents an important empowerment tool.

## **Future Challenges**

We have begun a shift from the environmental strategies of the past, which focused on end-of-pipe controls and after-the-fact cleanups, toward a more preventive, proactive approach to managing our relationship with the environment. The prevention-oriented activities that are taking place within both government and industry provide evidence that this shift is underway.

With the development of tools such as pollution prevention, we have the opportunity to minimize our adverse impacts on the environment and become more efficient in our use of materials and energy. Achieving a sustainable relationship between human populations and environmental systems will mean designing our activities, products, and lifestyle decisions to fit within the limits of our environmental life-support systems. A holistic, prevention-oriented approach to managing our interactions with the environment is the key to a sustainable, healthy future.

Achieving further progress in P2 will require the development of analytical tools and methodologies for assessing the impact of our activities on the environment. Life cycle assessment (LCA) is one promising tool that is being developed, but others will be needed. For instance, decision-making tools can help us compare disparate environmental impacts, prioritize our actions, and address the most serious environmental and public health concerns first. Effective analysis tools can help us uncover the root causes of our environmental problems so that we can focus on solving the problems rather than merely treating the symptoms. Tools for measuring our progress in P2 can tell us if our actions are sufficient to safeguard environmental quality and ensure a sustainable future.

A prerequisite to the widespread adoption of a preventive, holistic approach to environmental protection within industry and in other economic sectors is a regulatory climate that will foster the development of P2 activities. Our laws, institutions, financing mechanisms, and policies must encourage rather than inhibit the development of innovative, prevention-oriented solutions to environmental problems. Strategic, long-term planning and decision-making is another important facet of sustainable development.

A preventive approach to environmental protection and sustainable development requires the involvement and action of all sectors of society. Pollution prevention cannot be top-down, nor can it be simply added on as an afterthought. It must be built into our activities, processes and products through informed design and decision-making. Educating people within all occupations and academic disciplines on the concepts and principles of P2 is thus a critical foundation for success.

The first step in this educational process is to teach students how to approach problems with a holistic perspective, and to critically search for the underlying causes of a problem in order to develop effective solutions. Helping people understand the linkages between their activities and decisions and the resulting impacts on the environment is another important step. Pollution prevention is not merely a set of actions or programs — it is a way of thinking and an approach to problem-solving. Providing the workers and decision-makers of tomorrow with the tools and understanding necessary for this approach is perhaps the most important prerequisite to achieving a sustainable future.

## ENDNOTES

<sup>1</sup> F. Henry Habicht II. *Memorandum: EPA Definition of Pollution Prevention*. U.S. Environmental Protection Agency, May 28, 1992.\*

<sup>2</sup> American Society for Testing and Materials, E50.03 Subcommittee on Pollution Prevention, Reuse, Recycling and Environmental Efficiency. *Standard E50.03.1: Guide for Development and Implementation of a Pollution Prevention Program*. Working Document, Jan. 24, 1994. (Available from ASTM Customer Service by calling 215/299-5585.)

<sup>3</sup> U.S. Environmental Protection Agency, Office of Pollution Prevention. *Pollution Prevention 1991: Progress on Reducing Industrial Pollutants*. EPA 21P-3003. Washington: U.S. EPA, October 1991, pp. 6-7.\*

<sup>4</sup> Harry Freeman et al. "Industrial Pollution Prevention: A Critical Review." *Journal of Air and Waste Management* 42, no. 5 (May 1992): 619-620.

<sup>5</sup> U.S. EPA, *Pollution Prevention 1991*, pp. 6-7.

<sup>6</sup> Ibid.

<sup>7</sup> U.N. Commission on Environment and Development, *Our Common Future*. United Nations, 1987.

<sup>8</sup> U.S. President. Executive Order #12856, August 3, 1993. "Federal Compliance With Right-to-Know Laws and Pollution Prevention Requirements." *Federal Register* 58, no. 150 (6 August 1993): 41981-41987.\*

<sup>9</sup> U.S. President. Executive Order #12873, October 20, 1993. "Federal Acquisition, Recycling and Waste Prevention." *Federal Register* 58, no. 203 (22 October 1993): 54911-54919.\* Section 503 pertains to procurement of environmentally preferable products and services.

<sup>10</sup> U.S. Environmental Protection Agency, Office of the Administrator and Office of Pollution Prevention and Toxics. *Source Reduction Review Project*. EPA 100/R-92/002. Washington: U.S. EPA, August 1992.\*

<sup>11</sup> "New ACE Grants Awarded." *Pollution Prevention News*. Washington, DC: U.S. EPA, January-February, 1993. p. 2.

<sup>12</sup> Michael Burns, 33/50 Program, U.S. EPA. 1993 *Toxics Release Inventory Public Data Release*. March 1995.

<sup>13</sup> "Voluntary Programs." *Pollution Prevention News* (June-July 1994): 2-3. Washington: U.S. EPA.

<sup>14</sup> David Kling, Director, Pollution Prevention Division, U.S. EPA. "Pollution Prevention: Our Progress in Advancing EPA's New Central Environmental Ethic." Remarks to the Environmental Executive Advisory Committee, Edison Electric Institute, February 17, 1994.

<sup>15</sup> David Kling and Eric Schaeffer. "EPA's Flagship Programs." *EPA Journal* (July-September 1993): 27.\*\*

<sup>16</sup> "EPA Program Seeks to Reduce Energy Use in Commercial Buildings." *Pollution Prevention News* (November-December 1993): 5. Washington: U.S. EPA.

<sup>17</sup> "Whirlpool Wins \$30M 'Golden Carrot.'" *Pollution Prevention News* (July-August 1993): 4. Washington: U.S. EPA.

<sup>18</sup> "WasteWi\$e." *EPA's Voluntary Programs*. (draft factsheet) U.S. Environmental Protection Agency, 33/50 Program. February 1994.

<sup>19</sup> See note 14 above.

<sup>20</sup> See note 13 above.

<sup>21</sup> Stephan Schmidheiny, with the Business Council for Sustainable Development. *Changing Course: A Global Business Perspective on Development and the Environment*. Cambridge, MA: MIT Press, 1992. pp. 264-269.

<sup>22</sup> Dow Chemical Company, *ChemAware: Enhanced Product and Environmental Stewardship*. Midland, MI; Dow Chemical Company, Chemicals and Metals Department.

<sup>23</sup> Tom Zosel, Pollution Prevention Program Manager, 3M Corporation, St. Paul, MN. Guest lecturer, University of Michigan School of Natural Resources and Environment, February 16, 1994.

<sup>24</sup> Jack Azar. "Asset Recycling at Xerox." *EPA Journal* (July-September 1993): 14-16.\*\*

<sup>25</sup> See EPA's guidance manual, *Life-Cycle Assessment: Inventory Guidelines and Principles* (February 1993; EPA / 600/R-92/245\*); or the Society of Environmental Toxicology and Chemistry (SETAC)'s *Guidelines for Life-Cycle Assessment: A Code of Practice* (available for \$25 for non-members, \$15 for members; call 904/469-1500 or fax -9778).

<sup>26</sup> Robert B. Pojasek and Lawrence J. Cali. "Measuring Pollution Prevention Progress." *Pollution Prevention Review* (Spring 1991): 119-130.

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\*Available from the U.S. EPA's Pollution Prevention Information Clearinghouse: call 202/260-1023 or send e-mail to [ppic@epamail.gov](mailto:ppic@epamail.gov)

\*\*Available from the U.S. EPA Public Information Center: call 202/260-7751.

## **Hotlines and Additional Resources**

### **U.S. ENVIRONMENTAL PROTECTION AGENCY**

**Building Air Quality Alliance:** 800/438-4388

**Energy Star Computers:** 202/233-9114

**Energy Star Buildings:** 202/233-9146

**Global Climate Change Action Plan:** 202/233-9190

**Green Lights:** 202/775-6650

**Mobility Partners** (transportation planning and air quality issues): 202/260-1126

**Office of Water Information:** 202/260-2814

**Pollution Prevention Division, Office of Pollution Prevention & Toxics:** 202/260-3557; fax 202/260-0178

**Pollution Prevention Information Clearinghouse:** 202/260-1023; e-mail ppic@epamail.gov

**Pollution Prevention Research Branch, Risk Reduction Engineering Lab:** 513/569-7215; fax 513/569-7111

**Public Information Center:** 202/260-2080

WWW locator: <http://gopher.epa.gov/PIC.html>

**RCRA:** 800/424-9346

**Stratospheric Ozone Hotline:** 800/296-1996

**Toxic Release Inventory:** 800/535-0202

**WasteWi\$e:** 800/EPA-WISE

**WAVE:** 202/260-7288

**33/50 Program:** 202/554-1404

The EPA has information available on the World-Wide Web. The location is <http://www.epa.gov>. This home page links to many other resources, such as the online version of the *EPA Journal* (<http://www.epa.gov/News.html>).

### **OTHER RESOURCES**

American Institute for Pollution Prevention. *A Primer for Financial Analysis of Pollution Prevention Projects*.

EPA/600/R-93/059. Provides guidance and terminology on performing financial analyses of proposed P2 activities, geared toward non-financial personnel; available from the Center for Environmental Research Information (513/569-7562).

Dow Chemical Company's Waste Reduction Always Pays (WRAP) Program — contact The Dow Chemical Company, Environmental Quality Department, 2030 Willard H. Dow Center, Midland, MI 48674 (phone: 517/ 636-2538).

National Pollution Prevention Center for Higher Education. *Pollution Prevention Educational Resource Compendium for Environmental Science*. Ann Arbor, MI: NPPC, 1994.

Curriculum materials for college instructors. (See contact information below.)

Xerox Corporation's Asset Recycling Program — contact Jack Azar, Xerox Corporation, 800 Phillips Rd., Building 317-14S, Webster, NY 14580 (716/422-8217).

3M Corporation's 3P Program — contact Joanne Broom, 3M Environmental Engineering & Pollution Control, Box 33331, St. Paul, MN 55133-3331 (phone: 612/778-4791).



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### **The National Pollution Prevention Center for Higher Education**

University of Michigan, Dana Building  
430 East University Ave.

Ann Arbor, MI 48109-1115  
• Phone: 734-764-1412

• Fax: 734-647-5841  
• E-mail: [nppc@umich.edu](mailto:nppc@umich.edu)

The mission of the NPPC is to promote sustainable development by educating students, faculty, and professionals about pollution prevention; create educational materials; provide tools and strategies for addressing relevant environmental problems; and establish a national network of pollution prevention educators. In addition to developing educational materials and conducting research, the NPPC also offers an internship program, professional education and training, and conferences.

### **Your Input is Welcome!**

We are very interested in your feedback on these materials. Please take a moment to offer your comments and communicate them to us. Also contact us if you wish to receive a documents list, order any of our materials, collaborate on or review NPPC resources, or be listed in our *Directory of Pollution Prevention in Higher Education*.

### **We're Online!**

The NPPC provides information on its programs and educational materials through the Internet's Worldwide Web; our URL is: <http://www.umich.edu/~nppcpub/>

Please contact us if you have comments about our online resources or suggestions for publicizing our educational materials through the Internet. Thank you!