Entrepreneurs, Enterprises & the Environment Study Guide Series

Resources & Recycling

No. 1 PERC and the Foundation for Economic Education Study Guide

Buried alive or rubbish?

The chronicles of discarded goods

Buried Alive! cried the *Newsweek* magazine cover story. Published in 1989 when landfill shortages were widely reported, the story cited facts, figures and experts on the garbage "crisis." *Newsweek* quoted government officials (9), private industry spokesmen (5), academics (5), and even cited a movie and cartoon strip. Landfill sites for American's garbage were filling up fast, *Newsweek* reported and experts doubted new sites could be opened in time. Americans were producing too darned much garbage, *Newsweek* argued, and were not recycling nearly enough trash to head off catastrophe.

At about the same time a far more in-depth and substantive investigation into garbage, landfill, and recycling issues was published in the *Atlantic Monthly* (and later *National Geographic*). Written by anthropologist William Rathje, and later expanded into a book (*Rubbish!* written with Cullen Murphy), Rathje takes readers on a fascinating tour of what we do know and don't know about garbage.

No ivory-tower intellectual, Rathje obtained his knowledge of his subject by actually sorting through garbage dumps across the country for a firsthand look at what gets thrown away. Rathje's findings suggest that much of the content of recent garbage and landfill debates is, well, rubbish.

Amazingly, Rathje explains, Americans today not only create less garbage per person than they did in the past (though more overall since there are more Americans), but also create less garbage per person than people in less developed countries like Mexico.

Rathje notes that advancing technology has reduced the average individual's production of garbage. For example, frozen orange juice makers sell orange rinds as feed, while our grandparents tossed them in the garbage, and many Mexicans do today. Rathje further argues that modern packaging prevents food waste, while *Newsweek* labels "excess" packaging as a big part of the problem. Eastern Europeans, for example, have long suffered from inadequate packaging, with tons of food and other products spoiled or damaged each year in poorly-made and poorly-designed containers.

Rathje discovered that a number of assumptions people make about garbage aren't sup-

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Resources & Recycling notes

To teachers and students

This *Resources & Recycling* study guide is self-contained and designed to help students better understand three related environmental issues: recycling, solid waste disposal, and natural resource depletion. You may want to use it to supplement a textbook discussion on these issues, or as a stand-alone guide for discussion.

The growing interest in recycling offers an excellent opportunity for interdisciplinary study and discussion of the science, economics and history of recycling, natural resources, and garbage.

Part of the general enthusiasm for recycling comes from the fear that the Earth's resources are being rapidly depleted. Many are concerned that the growing consumption of resources in wealthy countries leaves fewer resources for poorer countries, and

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Inside

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will leave still fewer resources for future generations. This guide will review major natural resource issues, encouraging students to consider the economic perspective on whether resources are dwindling fast—and whether increased recycling is the best way to conserve resources for the future.

Another part of the enthusiasm for recycling follows from fears that we are running out of landfill space to safely bury the garbage we now produce. Some current and past landfills have proven unsafe, and more and more communities object to new landfills being located near their homes. So increased recycling is proposed as a way to reduce the need for future landfills.

This study guide will give an overview of recycling and solid waste issues. But it is also designed to encourage students to investigate these issues on their own. Sources are included which should be available in your library, or that can be obtained by calling or writing outside organizations.

There are no easy answers to recycling and natural resource debates. Thoughtful people and organizations often make contradictory claims and recommendations. Such controversy creates some confusion for students, but can also stimulate curiosity and make these subjects more interesting.

Environmental issues bring together many separate disciplines, including science, politics, ecology, economics and history. For students, environmental issues provide an opportunity to glimpse interconnections between these separate disciplines. Environmental research also allows students to apply classroom studies to real world social issues and policy debates.

Ecology and economics are closely related words, both meaning the study of interrelationships and connections—the study of complex cause and effect. Economic analysis can contribute valuable insights to environmental education and research.

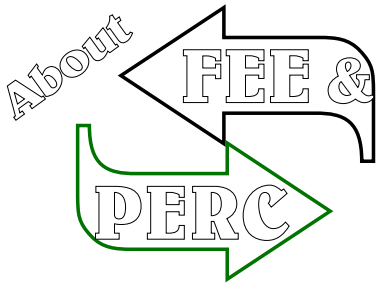
Entrepreneurs, Enterprises and the Environment takes its title from the understanding that it is human beings, individually and organized in enterprises, that will find solutions to today's most pressing environmental problems. People are blamed for all manner of environmental degradation. But it is people too—with their skills as engineers, ecologists and entrepreneurs—who will steadily discover solutions to today's pressing environmental problems.

As individual entrepreneurs and as part of larger enterprises, people devise and develop, invent and innovate, make and market, thousands of new technologies that increase productivity as they reduce resource consumption and pollution. Advancing technology attacks waste.

New knowledge substitutes for resources as more efficient technologies replace less efficient ones. Modern market-oriented economies have far less polluting manufacturing processes than do the stagnant state-controlled economies of the former Soviet Union, China and Eastern Europe.

There are no easy answers to resource and recycling debates. But it is our hope that these diverse and thoughtful articles will spark student's curiosity about both recycling and economics.

Resources & Recycling *was prepared and edited by Gregory F. Rehmke, with the assistance of Jane S. Shaw.*



Nations around the world are recognizing that a growing reliance on entrepreneurship, markets and property rights improves living standards. As one businessman recently noted, "You have maybe 75 percent of the world's population emerging from state control and trying to catch up with the rest."

Here in America, environmental issues are also emerging from "state control"—with a growing interest among the news media, politicians and the general public in market-oriented reforms. This increasing interest in market-reforms and in environmental issues has made research organizations like PERC (the Political Economy Research Center) more visible.

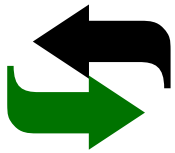
PERC researchers, led by economists Terry Anderson and Richard Stroup, have been pioneers in understanding the role of property rights in environmental stewardship. Private ownership leads to good environmental stewardship because it makes people accountable for their actions. Such accountability is often missing when government owns or controls property. To develop sound policies for recycling, natural resource conservation and other environmental issues, PERC researchers argue we must identify areas where property rights can be enhanced or encouraged.

PERC is an independent nonprofit research and educational organization. For more information write: PERC, 502 South 19th Ave., #211, Bozeman, MT 59715. Telephone: (406) 587-9591.

This version of *Entrepreneurs, Enterprises & the Environment* series is a joint project of PERC and The Foundation for Economic Education (FEE). FEE, a nonprofit educational organization, provides educational services to through seminars, workshops and publications. FEE's flagship publication is *Ideas on Liberty*, and FEE's web sites—www.fee.org, www.cliches.org, and www.freespeaker.org, provide articles, lesson plans, and research materials for students and teachers. For more information contact: grehmke@fee.org.

by Jane S. Shaw

The economics of recycling



Recycling is the process of converting waste products into reusable materials. It differs from reuse, which simply means using a product again. According to the Environmental Protection Agency, about 13 percent of the nation's solid waste (that is, the waste that is normally handled through garbage collection systems) is recycled. This compares with 14 percent that is incinerated and 73 percent that goes into landfills.

In the absence of government regulation, the economics of each material determines how much of it is recycled.

Easy recycling: aluminum cans

About 55 percent of all aluminum cans are recycled. This relatively high percentage reflects the fact that recycling aluminum is often cheaper than producing new aluminum. Recycling aluminum cans requires less than 10 percent of the energy required to produce aluminum from bauxite. The recycling of cans has grown along with the popularity of aluminum in the beverage can market. In 1964 only 2 percent of beverage cans were made of aluminum; by 1974 the share was nearly 40 percent, and by 1990 it was about 95 percent. In 1968 Reynolds Metals Company started a pilot can recycling center. The chief motivation was to respond to public concerns about litter, reflected in proposed and actual laws requiring deposits on beverage containers. But it was the rapid rise in energy prices during the seventies, plus fears of energy cutoffs, that made recycling economically attractive.

Recycling paper & cardboard

Paper and cardboard, the largest components of municipal solid waste, are also extensively recycled. Because cardboard can be made from a wide variety of used paper, the costs of separating different kinds of paper are low, and because many places (such as grocery stores) use large quantities of corrugated boxes, collection can be efficient. As a result 45 percent of all corrugated boxes were recycled in 1988.

Difficult recycling: plastics

In contrast, the high costs of collecting and separating plastics have limited their recycling. People have not shown a willingness to clean and separate their discarded plastic. In fact, a study by the Plastic Recycling Foundation concluded that voluntary drop-off or buy-back centers will not bring in enough plastics to make nationwide recycling economically viable. Also, different plastic resins cannot be mixed together and reprocessed. (To deal with this problem, the plastics packaging industry has developed symbols for marking different kinds of resins, a step that could lower the costs in the future.) In spite of the limitations, 20 percent of plastic soft drink bottles are now recycled.

Recycling consequences

Ironically, recycling does not eliminate environmental worries. Take newspapers, for example. First, recycled newspapers must be de-inked, often with chemicals, creating a sludge. Even if the sludge is harmless, it too must be disposed of, probably in a landfill. Second, recycling more newspapers will not necessarily preserve trees, because many trees are grown specifically to be made into paper. A study prepared for the environmental think tank Resources for the Future estimates that if paper recycling reaches 40 percent (compared with the current 30 percent), demand for virgin paper will fall by about 7 percent. "Some lands now being used to grow trees will be put to other uses," according to economist A. Clark Wiseman. The impact would not be large, but it is the opposite of what most people expect. Finally, curbside recycling programs usually require more trucks that use more energy and create more pollution.

Jane S. Shaw is a senior associate at PERC in Bozeman, Montana. She was formerly associate economics editor with Business Week.

BY GREGORY F. REHMKE

ECONOMICS, RESOURCES & RECYCLING

From the dirt of the earth to the shirt on your back, the production process transforms raw materials into finished goods. And when your shirt or shoes or socks wear out they are tossed back toward the earth again.

We might as well begin at the beginning. First there was dirt, water and sunlight. Then *voilà*! this stuff of the earth gets magically transformed into our lunch, our shirts and our CD players. This, briefly stated, is the production half of the story of the world. The economics part of this story is the "*voilà*!" part, the process whereby the dirt of the earth gets turned into things we eat, put on, look at, read, hold, rip open and throw away each day.

All things we use must first be produced by people using their hands and knowledge, usually with the help of tools. Step by step cotton seeds are nurtured into plants that produce cotton, are picked, cleaned, shipped, spun, woven, dyed, shipped again, cut and sewn into shape, and shipped yet again to the mall where we try them on and maybe take them home. From raw materials to finished goods, dozens or hundreds or thousands of people bring their specialized knowledge and machinery to bear producing the products we rely on each day for sustenance, shelter, and to help us look cool.

This production process is the daily activity of billions of people worldwide. People *produce* goods and services—they add value to raw materials through their focused efforts in assembly, design, management, transportation, sales, or whatever part they play in the production enterprise. We, the people that use the goods they produce, are the *consumers*. In a sense we *subtract* value from the things we use. We buy a new and brightly colored shirt and wear it and wear it, and eventually wear it out. Months or years after our purchase we lose interest in this now dully-colored and perhaps ragged shirt—so we discard it.

This epic drama—the life and death of an American shirt—has a couple of themes and a dozen subplots. It's a big story, a gripping melodrama. But let's focus on one corner of the big picture, the part about discarding goods we have used up.

Whether milk cartons, broken-down bicycles, read newspapers or old shirts, most of these things are only partly used up, only partly worn out. The long production process of adding value to raw materials is followed by a consumption process of *subtracting* value as the things we use gradually wear out.

We send worn-out shirts to St. Vincent dePaul or Value Village, give them to a less well-off relative, or recycle them ourselves into rags to wax the car.

Some goods are reused at home. Brown bags that carry groceries home become garbage bags to carry trash out. Some containers are useless the minute we empty them, milk cartons for example. Cans and bottles can be reused if they can be sorted, sent back into the production stream and melted into reusable glass, plastic or aluminum.

All the goods we use, wear out, and don't want anymore reach a crossroads when we finish with them. Someone takes this used stuff when we are through with it. And this can happen in only two or three ways. If we can locate someone who wants what we no longer want—that is, someone who sees value in the goods we no longer see value in—they will take it off our hands for free or even buy it from us. Such a deal. But a lot of the stuff we use up or wear out doesn't have much deal left in it. It's very hard, for example, to convince someone that he or she should want our milk carton once the milk is gone.

Our old worn-out shoes draw few offers from passersby at sidewalk sales. So when we can't sell our used stuff, and we can't give it away, we are stuck with option three—we have to pay someone to take it away. We throw it in the trash, which, for a fee, gets picked up in the garbage truck and taken to a landfill. Stuff that started the cycle pulled from the earth by some plant root, or fixed from the air or the rain, ends the cycle thrown back into the earth again.

Just dumping our trash, however, doesn't quite turn this cycle full circle. We rarely plant cotton fields on landfill sites.

For reasons of ethics as well as economics, it matters whether the things we throw out end up harming other people, or other people's property. Concerns about garbage tend to center on the availability and safety of landfill sites, and on the availability to future generations of the resources we throw out with our garbage.

We began by discussing the process whereby raw materials are

transformed into goods, things we want and need. Then as we used these goods they were gradually drained of value. At some point our old shirt or shoe or milk carton is no longer a *good*—we might call it a *bad*. It is so bereft of value that it becomes a negative value. Now things with negative value are interesting, just like things with negative gravity would be.

Just as it is wrong to take goods that belong to others without their permission (that is stealing), it is also wrong to force *bads* upon others without their permission. That is, it is wrong to dump your old shirts and other trash on someone else's lawn. To do so is a *tort*. (Tort means "any wrongful act that does not involve a breach of contract and for which a civil suit can be brought" *Amer. Herit. Dict.*)

Our discussion of garbage therefore involves ethics as well as economics. In fact there is a smooth continuum from ethics to jurisprudence (legal philosophy) to economic theory. Modern societies rely on stable and predictable legal systems. And the legal system is also the key to reducing pollution and protecting the environment.

The question about our garbage is whether these *bads*, these husks of stuff devoid of value, will at any time in the future harm other people or their property. A part of the interest in recycling is the fact that some past landfills—full of the trash thrown out by past generations—are now causing problems. Poisons sometimes leach out of these landfills and contaminate ground water and nearby streams. New landfills are much safer but still, given the track record of many municipalities, doubts still exist about how safely today's garbage is being buried or burned.

A second source of the interest in recycling is concern about the raw materials, the natural resources that are used to make all the stuff we use in our day-to-day lives. Will there be enough, some people ask, of the minerals, iron, copper and other ores, enough coal, oil, and other energy sources, enough topsoil for future crops and trees for future houses and hiking?

All raw materials, or natural resources, are scarce; that is, they are not available free in unlimited quantities. So people naturally wonder if we are about to run out of oil or rare minerals or topsoil for crops. The idea of recycling is to conserve scarce resources, to reuse them so that new amounts of ores need not be dug out of the earth.

Recycling and conserving natural resources is a value, but it is one of many values.

Economy as ecosystem

In the ecosystem, resources flow up the food chain. Sunlight powers the entire system. Energy flows from plants to herbivores to predators. Completing the materials cycle, bacteria break down dead tissues and excrete chemical wastes that become nutrients for plants.

In the economy, resources flow up the value-added chain from mines and farms to fabricators, assemblers, and service firms. Human work powers the system. The economy's end products are used up by individual consumers. And, now that our awareness of environmental destruction finally is maturing, consumer wastes are beginning to be recycled to the bottom of the value-added chain.

From* Bionomics: Economy as Ecosystem *by Michael Rothschild, Henry Holt & Co,. 1992, p. 213

Pollution & progress

Pollution is a byproduct of wasteful, inefficient machines. Pollution is waste—wasted raw materials and wasted energy. The "unburned hydrocarbons" that escape a car's tailpipe also lower its miles-per-gallon. Smarter, better-designed engines will not let those hydrocarbons escape so easily. Car drivers will save on fuel and less gunk will escape to pollute the air.

A cascade of new technologies offer ways to deal with today's pollution problems. Engineers also search for better and cheaper ways to clean air, water and soil. New tracing chemicals, for example, can now be added to industrial processes so that later pollutants can be traced to the individual factories that released them into the atmosphere or water.

The steady advance of technology is not automatic, however. It depends on free people and market processes. Industrial technology in Eastern Europe, Russia and China, for example, was generally frozen at heavily polluting nineteenth century levels, when war and then communism blocked manufacturing enterprises from deploying improved technologies.

Outdated factories still spew pollutants across the cities and countrysides of formerly communist Europe and Asia. Technology has been severely limited, too, in other regions of the world, including India and Latin America, with correspondingly high rates of poverty and pollution.

Complicated regulations, heavy taxes, and cumbersome import restrictions have long prevented people in these countries from gaining access to technologies that would improve their daily lives as well as their environment.

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ported by the detailed measurements his research team made at numerous landfill sites. Plastics turn out to make up a small percentage of the solid waste stream, for example (5 percent by weight, 12 percent by volume), and fast food packaging even less (1/10th of 1 percent by weight).

The major culprit, both Rathje and *Newsweek* agree, is paper, which fills 40-50 percent of landfills. Rathje's explorations into old landfills have unearthed "layers of phone books, like geological strata...." Newspapers, observes Rathje, make up 10-18 percent of municipal landfill by volume.

Interestingly, both phone books and major sections of daily newspapers are technologically obsolete, and continue to flow through our lives into our landfills only because they are protected by special-interest lobbying in Congress. Newspaper lobbies have for years campaigned hard to block phone companies from supplying integrated telephone/computer services. Such terminals, far more advanced that those now popular in France, would likely replace phone books and the classified sections in daily newspapers with richly detailed and fast on-line databases. Newspapers lobby to protect themselves from competition, since the classified sections are major profit centers. Electronic phone books and newspapers, if eventually legalized, will significantly shrink America's solid waste stream.

Newsweek notes that "two-thirds of the nation's landfills have closed since the 1970s; one third of those remaining will be full in the next five years." Such figures are not so shocking, notes Rathje. "As it happens, that has always been true—it was true in 1970 and in 1960—because most landfills are designed to be in use for only about ten years."

Four ways to deal with garbage:
1. dump it 2. burn it
3. convert it into something that can be used again
4. reduce the material source before it's garbage

The big problem is the delay in opening new landfills. These delays are partly the result of the NIMBY syndrome (Not In My Back Yard), and partly the result of poor siting and management of past landfills. City and county officials in the 1950s and 60s charged enthusiastically into the land reclamation business, wanting to do more than just bury garbage safely. They envisioned using garbage to "reclaim thousands of acres of otherwise 'waste' land...", says Rathje, turning it into parks and municipal developments.

Unfortunately the "waste land" often chosen for these reclamation projects was a swamp, which today we call wetlands. Wetlands turned out to be poor places to bury garbage—since toxic substances are more likely to leach out when garbage is buried below the water table.

Many of these land reclamation projects from the 50s and 60s are now polluting rivers and groundwater, and millions of dollars are being spent trying to clean them. Residents near sites of proposed landfills listen skeptically to the explanations of municipal garbage authorities who say they now know what they are doing.

During the energy crisis, enthusiasm for land reclamation was replaced by enthusiasm for energy production. Again, instead of focusing on the safe disposal and storage of garbage, cities and counties around the country spent millions constructing trash-to-energy plants. These plants burn trash and generate energy.

"Dumping, slopping, and scavenging [garbage] were the norm in Europe and the United States until the late 1800s. It is difficult for anyone alive now to comprehend how appalling—as recently as a century ago—the conditions of daily life were in all the cities of the Western world, even in the wealthiest parts of … town."
—William Rathje

Unfortunately, these new plants are now running into trouble, in part because too many were built and in part because energy prices did not rise as expected. Now municipal garbage officials around the country are bidding against each other to attract enough garbage to keep their very expensive trash-to-energy plants going.

For further reading see: William Rathje & Murphy Cullen, Rubbish! The Archaeology of Garbage, *Harper Collins, 1992.*

Running out of resources?

Will mankind crash into a natural resource wall in the not too distant future? An entry in the *Random House Encyclopedia* on "Earth's dwindling resources" pictures a dump truck and charts the dates that reserves of key resources used to construct it "may be exhausted" (Third Edition, 1990, p. 290). Platinum and lead may be gone in 2000, mercury and zinc in 2010, silver and tin in 2015, copper in 2030. Reserves for thirteen metals are shown running out before 2050, with the implication that this dump truck and the rest of modern society may collide with natural resource limits in our lifetime.

If these and other similar projections are true, they give us powerful reasons to expand recycling efforts immediately. But such doomsday prophesies are misleading for a number of reasons. Such projections usually misrepresent the meaning of "proven reserves" of resources. Proven reserves are simply the amount of a resource so far discovered and available for mining. As new, more efficient mining technologies are developed by engineers, and innovations in exploration uncover new resource deposits, "proven reserves" steadily expand. In fact, even as world population grew and the consumption of most resources increased during the 1980s and 1990s, the reserves of most mineral ores and sources of energy like coal, oil and natural gas, have become *more* plentiful.

How long, though, can new technologies keep mankind ahead of the natural resource curve? Surely natural resources must be finite, since they come from the Earth and the Earth's diameter is finite. There are weaknesses even to this finite Earth argument. Though there is an absolute limit for all resources, some are so plentiful we are unlikely to ever run out. There is a finite amount of sand on the seashores, but more than enough for mankind to make all the silicone chips and fiber optic cables we will ever need.

A second and far more important issue is the way we use resources in a market economy. Market economies rely on prices to direct the use of resources and to provide signals both to resource producers and resource consumers. If a resource becomes harder to find and extract with current technology, its supply or "proven reserves" begin to dwindle. As reserves of this resource decline, users begin to bid up the price of what is left. This higher price sends signals to both resource producers and consumers.

For producers, the higher price encourages investment in more engineering and innovation to discover new reserves and develop new technologies to increase yields from current reserves. For consumers the higher price spurs efforts to use less of this now more-expensive resource. Producers will look for ways to reduce waste in the production process, for ways to increase recycling, and for ways to substitute less expensive resources for this now more expensive one.

All through the production process, prices serve this powerful

continued next page

From rocks to resources...

Part of the general enthusiasm for recycling comes from fear that the Earth's resources are being rapidly depleted. Modern industrial economies are burning fossil fuels, minerals and other nonrenewable resources far faster than ever before. Advocates of recycling argue that if our generation depletes all Earth's natural resources, we will leave a barren planet for our descendants.

While it is true that industrial societies are consuming natural resources in stunning quantities it is also true that modern economies are discovering and developing new resources at even faster rates. Entrepreneurs and enterprises discover significant new deposits of oil, gas, ores and various minerals each year. Yet far more important are natural resources not yet discovered and technologies not yet imagined.

Prehistoric hunting and gathering societies survived without resources we consider "natural" today. Edible wild animals and plants were scarce and would support only scattered communities. When early men (or, more likely, women) learned to domesticate wild grasses, the agricultural revolution was launched, open fields were transformed with new seeds and irrigation into a natural resource that allowed civilization to flourish. Gradually accumulated knowledge and new tools and technologies enabled further natural resource development and allowed civilization to steadily develop and expand.

Natural resources aren't really "natural." Their usefulness to mankind started only when past entrepreneurs discovered and developed the necessary skills and tools. Before early men (or women) discovered smelting technology, copper, tin and iron ores were just rocks, not resources.

Petroleum is today a scarce and valuable natural resource, and develop-

function of coordinating the activities of tens of thousands of people. Prices do not force people to act in certain ways, like government mandates or regulations would, but they provide subtle pressure for entrepreneurs and enterprises as well as consumers to alter their behavior either to consume less of a resource or to work on ways to produce more.

In addition to theoretical explanations of how the market system works, we have decades, even centuries, of experience with steadily declining prices for nearly all natural resources.

In one study, economist Stephen Moore tracked the prices of thirty-eight natural resources between 1980 and 1990. Of these, thirty-three declined in price, after adjusting for inflation; three were unchanged, and only manganese and zinc had higher prices in 1990 than in 1980. The most impressive gains, notes Moore, "were in agriculture: on average, food prices declined by more than 30 percent in the 1980s.…" Average prices for minerals fell by 20 percent, while energy and forest products fell by 15 percent. ("So much for scarce resources," *The Public Interest*, Winter, 1992, p. 98)

Moore and other economists argue that we can expect these long-term trends of falling prices to continue for both non-renewable resources (minerals and energy) and renewable resources (agricultural and forest products).

Looking beyond the Earth

Even more optimistic scenarios for future resource availability come from outer space. Space scientists suggest we can search for additional natural resources on asteroids and other planets, and in the very long term, even in the sun itself.

Futurists also note that the sun could also serve someday as an ultimate recycling center. Once we have the technology to cheaply blast Earth garbage to escape velocity, we can rely on the sun's free trash-to-plasma vaporizing service.

Long before we send our garbage to the sun, however, we are likely to be bringing minerals mined in space back to Earth. Near-Earth asteroids are the first place to prospect for outer-space resources, since they contain billions of dollars worth of rare earth minerals. When space transportation finally drops enough in cost, space mining enterprises will be able to process billions of tons of space ores and drop the refined mineral to the earth's surface.

Even a future asteroid and planet shortage shouldn't darken our natural resource supply. According to one scientist, David Criswell, we will eventually want to turn to the sun for resources. The sun contains 99 percent of the solar system's mass. Criswell has a plan for a *very* large-scale mining operation that would use Mercury to spin matter out of the sun. As an added benefit, Criswell argues, shrinking the sun will stabilize it and enable it to shine millions of years longer.

Save the solar system!

Environmentalists and space scientists may disagree about mining the solar system. Some environmentalists want the solar system left alone, while some scientists look forward to disassembling planets to build broader living spaces. Freeman Dyson suggests we could crumble and reshape Jupiter into a thin sphere that would circle the entire sun and capture all its solar energy. Dyson's sphere would create living space for trillions of people.

Such space projects may be a long way off, but they offer further evidence that natural limits to natural resources are a long, long way in the future.

—*Gregory F. Rehmke*

From rocks to resources, continued

ing America's dwindling petroleum reserves is a sore spot for many environmentalists. But until 1859, petroleum was useless disgusting muck, bubbling up in salt marshes and ruining water wells. American lamps burned whale oil from a rapidly dwindling world whale population. (Today we complain about Japanese whalers, but in the 1830s and 40s up to 100 American ships hunted whales along the coast of Japan.) The price of whale oil rose as whales were slaughtered faster than they could reproduce. And in response to higher whale oil prices, entrepreneurs began searching for whale oil substitutes.

In August of 1859 Edwin Drake sank a 69-foot well into Pennsylvania farmland and out gushed oil. Drake supplied this oil to other entrepreneurs who were learning how to distill the stink out of petroleum (the sulphur) and transform it into a usable lamp oil and lubricant. "Natural" resources are those raw materials our ancestors have learned to use.

Sand has stretched over endless miles of beaches since the beginning of the world. But until the knowledge and technology was developed to melt sand into glass, and later use silica (made from sand) to fashion computer chips and fiber optic cables, sand was not a natural resource. Even now superabundant sand replaces scarce copper as fiber optic cables (and satellite transmissions) substitute for uncounted tons of copper ores once needed for wire.

Rocks become natural resources only when their value is transformed by the pioneering work of entrepreneurial scientists, researchers and engineers.

by Lynn Scarlett

Sorting through the trash

In recent years, numerous groups, including federal agencies, have offered advice on how Americans can be "good environmentalists." Through broadcast and print media, consumers, legislators and even children are told what products and what actions are environmentally "good" and "bad."

Although frequently well-intentioned, the advice is all too often based on little more than the simple-minded application of such core beliefs as "recycling is good," "disposables are bad," "packaging is bad," "plastics are bad," etc. In many cases the advice-givers focus on only one environmental concern (such as the volume of solid waste) while ignoring all others (such as air pollution, water pollution and energy use).

From the perspective of the total environment, the advice is often wrong. Consumers who try to follow simplistic advice when they shop may end up harming the environment.

This article is drawn from a more detailed report which examines common environmental myths, especially those relating to solid waste ("A Consumer's Guide to Environmental Myths and Realities" reprinted in *NCPA Progressive Environmentalism, Trade & Aid Resource Book*. This longer report also proposes a market-based approach to public policy issues—one which is environmentally sound and economically sensible.)

Lynn Scarlett is vice-president for research at the Reason Foundation and is the author of many studies and articles on solid waste and recycling.

MYTH 1 We are running out of landfill space

We are reminded almost daily that American households dispose of a great deal of trash. A 1987 *Newsday* article reprovingly reported that each American household discards an average of 13,000 paper items, 500 aluminum cans and 500 glass bottles annually.

A 1988 Franklin Associates study prepared for the Environmental Protection Agency (EPA) estimated that Americans throw away 157.7 million tons of solid waste annually, or about 3.5 pounds of trash per day per person. Another report says, "The total annual U.S. collection of 150 million tons would fill a convoy (of ten-ton garbage trucks) 140,000 miles long, over five times the distance around the Earth's equator and over half way from here to the moon."

But are we running out of places to put the garbage we generate? The answer is "no." In many parts of the country, potential landfill space is abundant.

All of the garbage Americans will produce for the next 1,000 years would fill an area 44 miles on each side and about 120 feet deep. A super landfill this size would occupy less than one-tenth of 1 percent of the surface area of the continental United States. Anyone who has looked from an airplane at the western part of the United States knows there is plenty of land where we might store the next 1,000 years' worth of garbage with little inconvenience or health hazard to nearby residents. But we do not have to ship all of our garbage to Arizona or Nevada in order to bury it. For example, New York, a state some think has an especially serious landfill capacity shortage, has identified about 200 square miles of land suitable for landfills. In the Pacific Northwest, five landfills in the process of being sited in the dry, eastern part of the region could handle 80 to 100 years of the area's entire solid waste stream. Nor do we have to force communities to create landfills. In many parts of the country, people are willing in principle to provide landfill space for the right price.

Moreover, once lined and covered, a landfill is not permanently unusable. Parks, golf courses and buildings cover the surface areas of some covered landfills—although many people using these facilities are unaware of the landfill beneath them. Properly sited and operated, landfills pose little threat either to human health or to the environment.

MYTH 2 Americans are especially wasteful

In the preface to a book on the garbage crisis, former Texas Commissioner of Agriculture Jim Hightower complains, "We have been taught to be wasteful. Today, our durable goods are anything but durable, designed as they are for planned obsolescence, and nearly

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all our nondurable goods are sold in throwaway packaging. We produce enormous quantities of waste, then try to bury it or burn it and forget it."

No doubt about it, Americans throw away a lot of stuff. Annually, we produce some 180 million tons of municipal solid waste, which includes household, commercial and light industrial waste. But are we overly wasteful? How do we rank compared with other nations, rich and poor?

Several reports comparing U.S. per capita waste production with that of other affluent nations show the U.S. leading the pack. But statistics comparing national garbage distort comparisons in a number of ways. For example, Japan and some European countries define municipal solid waste as including only those materials sent to waste treatment or disposal facilities. In the United States, we include recycled materials in our definition.

Interestingly, researchers have discovered that the amount of solid waste we generate is falling in relation to the amount of goods and services we produce. As the nation becomes wealthier, we consume more goods and services. But the percentage of these new goods that become trash is decreasing. Failure to recognize this fact produced some notoriously incorrect predictions about the future. For example, in the 1970s the Environmental Protection Agency estimated that by the mid-1980s per person generation of solid waste would be nearly 60 per-cent greater than it turned out to be.

Packaging is bad

In its 1990 report on solid waste, the Council of Northeast Governors concluded that "no packaging is the best packaging." In order of descending preference, the council proposed (1) no packaging, (2) minimal packaging, (3) returnable, reusable and refillable packaging, and (4) recyclable packaging. Similar ideas are widely accepted by consumers who are concerned about the environment.

Yet to argue that no packaging is the best option neglects the role of packaging in actually preventing waste. Nowhere is this more evident than with food packaging. For example, packaging represents from 30 to 40 percent of the solid waste disposal in the United States, but only 20 percent in Mexico. Yet despite the fact that Americans throw away more packages, the average Mexican household throws away three times more food debris. As a result, the average Mexican household throws away 40 percent more total refuse than the average U.S. household—an amount equal to 1.6 pounds per household each day.

Mexico's greater amount of solid waste is directly related to its lack of packaging. In the United States, when food is processed and packaged, the unused parts (rinds, peels, etc.) are often used as fuel, animal feed or some other economically useful by-product. In Mexico, by contrast, unused food by-products become garbage.

The extra 1.6 pounds per household per day disposed of in Mexico City is food debris—the skins, rinds, peels, tops and other inedible parts discarded in food preparation and portions of edible food discarded. The average Mexican household throws away daily more than half the amount of food required to provide an adult with a nutritionally sound diet for one day.

Another reason why food packaging reduces waste is that it reduces spoilage. In general, as the use of packaging materials increases, the fraction of food waste decreases.

Overall, for every 1 percent increase in packaging, there is a 1.6 percent decrease in food waste. This relationship holds for data from many countries, over a considerable range of waste composition and perhaps a broad period of time.

For example, the exotic layering of metals and plastics that keeps Keebler cookies fresh for as long as nine months after they leave the oven lets the company distribute them throughout the United States

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Case study: subsidizing garbage

Despite the fact that disposal costs are rising, most consumers in most cities are not charged prices that reflect the social cost of disposing of the garbage:

- ❍ **A survey of 246 cities with populations ranging from 5,000 to 1.75 million showed that 39 percent did not charge any user fee for garbage collection.**
- ❑ **Of those that did, about half charged a flat fee, regardless of the amount or weight of the garbage collected.**
- △ **Thus, in more than two-thirds of the cities surveyed, households had no financial incentive to reduce the amount of garbage they produce.**

In general, we get what we subsidize; and since we subsidize solid waste disposal, we are getting more solid waste.

without having a plant in every city. Packaging meets consumer needs and economizes on the use of resources at the same time.

Precisely because of state-of-the-art packaging, the United States wastes less food than any other part of the world except Africa, where the threat of starvation means that even rotten food is consumed. Because of packaging, we can meet our domestic consumption needs with fewer resources—less pesticides, less pollution and less energy use.

Case study: The orange juice squeeze

In Mexico City, most consumers squeeze fresh oranges to make orange juice and throw away the peels. Many U.S. households, by contrast, buy frozen juice concentrate. The result? The typical Mexican household tosses out 10.5 ounces of orange peels each week while the typical American household throws out only a 2-ounce cardboard or aluminum container. In the United States, the peels discarded from the oranges are used by the orange juice industry for animal feed and other products.

But even that does not provide the full picture. To yield the same quantity of orange juice, a consumer uses 25 percent more oranges than does an industrial processor. This means that fresh oranges require about 25 percent more fertilizer, water, fuel and other resources to produce a given quantity of juice. The case for food packaging becomes stronger if one includes transportation for fresh oranges in contrast to frozen o.j.:

- **In the United States, fresh oranges are transported in containers requiring nearly nine times more corrugated cardboard waste at the retail level than the 12-ounce frozen concentrate alternative.**
- **And it takes 6.5 times more truckloads of fresh oranges to produce equal quantities of orange juice—resulting in 6.5 times more energy consumption and 6.5 times greater pollution.**

4 MYTH Plastics are very bad

State legislators increasingly pass laws that limit consumers' choices over the products they buy and the packages that contain those products. Yet picking "winners" through the political process is fraught with peril. To most advocates of "green consumerism," aluminum containers are best, glass containers are second best and plastic containers are the least preferred.

Yet, in order to make containers holding an equal volume of liquid, glass requires one-third more energy than plastic and aluminum requires twice as much. So if the goal is to reduce energy consumption, plastic containers are best, glass is in second place and aluminum is a distant third (without recycling)—exactly the reverse of the normal ranking.

If all three containers are used once and thrown away, plastic containers conserve the most energy. If recycling is possible, the rankings change—depending on what can be recycled. A recycled aluminum can requires less energy than either a glass or plastic container produced for one-time use. On the other hand, if the glass container can also be recycled, it requires less energy than a recycled aluminum can. If the plastic container can be refilled, in principle it can be reused dozens of times—it becomes again the most energy-conserving container.

Much product-banning legislation is directed at plastics, particularly polystyrene foam packaging (such as Styrofoam). Such legislation assumes that plastics contribute significantly to our waste problem, that they are nonrecyclable and therefore wasteful relative to available alternatives. In fact, all plastic materials combined comprise only 8 percent of municipal solid waste and the introduction of plastic packaging appears to be a beneficial development.

Even though we consume more products over time, the percent of packaging materials in our solid waste stream by weight has been declining (from 33.5 percent in 1970 to 30.3 percent in 1980) and plastics may be the principal reason.

Plastics are lighter in weight and more efficient than other packaging. A German research organization examined the effects of eliminating all plastic packaging in Germany. The results were stunning:

- If alternatives replaced plastic packaging whenever available, materials usage by weight in Germany would increase fourfold and packaging costs would more than double.
- Energy consumption would almost double from the current levels, and solid waste would increase by 256 percent.

The report concludes that "all of the cost-intensive endeavors, over many years, to reduce the use of material through more suitable packaging and 'slimming down' individual packaging materials would be [reversed] with one stroke."

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MYTH 5 Disposables are bad

To some environmentalists, anything "disposable" is bad and "recycling" or "reusing" is always good. In recent years, this idea has dominated public policy debates and produced numerous laws and regulations designed to discourage disposable products. Maine banned aseptic juice boxes except those containing Maine apple juice (though the ban was later repealed). Portland, Oregon, and Newark, New Jersey, have effectively banned polystyrene food packaging, and if polystyrene is not being recycled at a 25 percent rate, proposed North Carolina legislation would ban it. Finally, an Oregon proposal would make possession of disposable diapers a crime.

But is it really true that disposables are always more environmentally harmful than other products? The evidence suggests otherwise.

Consumer preferences play a role in making trade-off decisions about resource use. Disposable diapers may result in more solid waste than reusable alternatives, but other values—convenience, sanitation, health and comfort—are also important to users of these products. Proposals to ban or regulate such products override the preferences of individuals and replace them with politically determined choices, and with little evidence that the political prescription produces real environmental benefits.

MYTH 6 Recycling is always good

In principle, most waste products—iron and steel, aluminum, glass, oil, paper and even tires and plastic—can be recycled into some other product. And far more recycling takes place than most people are aware of—largely in response to marketplace incentives rather than government regulations. Over half of all the aluminum cans in the United States are currently recycled.

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Case study: plastic grocery bags

Typically composed of polyethylene, plastic grocery bags actually stack up quite well against the leading paper bag alternative in terms of energy use, air and water emissions in the production process, and even in solid waste impact.

Using a 2:1 ratio of plastic to paper bags (since a typical consumer will use more plastic bags than paper ones for a given volume of groceries), Franklin Associates found that plastic sacks require 20 to 40 percent less energy to produce than their paper counterparts.

Plastic sacks produce 74 to 80 percent less solid waste by volume than the paper sacks, with the difference decreasing as recycling increases. The production of plastic sacks also results in less air and water pollution than paper sacks.

Case study: fast-food packaging

Several cities have essentially banned polystyrene food packages—used until a few years ago, for example, to hold McDonald's hamburgers. Yet studies indicate that fast-food plastic packaging is not the "villain" its critics have claimed. Indeed, such packaging may actually conserve resources relative to the standard alternatives.

A Franklin Associates "life-cycle study" of a set of paper and plastic fast-food products looked at energy use, air and water emissions and solid waste. Comparing the foam polystyrene "clamshell" hamburger container with a coated, bleached paperboard alternative, the study found that although the paperboard contributes 29 percent less solid waste by volume than polystyrene clamshells, the clamshells require 30 percent less energy to produce. The clamshell production results in 46 percent less air pollution and 42 percent less water pollution.

Many of the same comparisons apply to the debate over polystyrene cups versus paper cups. For example, a study published in *Science* argued that:

(1) The average 10-gram paper cup consumes 33 grams of wood and uses 28 percent more petroleum in its manufacture than the entire input in a polystyrene cup.

(2) The paper cup requires 36 times as much chemical input as the polystyrene cup, partly because it weighs seven times as much.

(3) It takes about 12 times as much steam, 36 times as much electricity, and twice as much cooling water to make the paper cup, and,

(4) About 580 times as much waste water, 10 to 100 times the residual effluents of pollutants, and three times the air emission pollutants are produced in making the paper cup.

In addition, paper cups cost the consumer about two-and-one-half times as much as polystyrene cups. And polystyrene is recyclable—not always true of the paper used in cups.

About 80 million tons of iron and steel are recycled each year—more than three times the amount by weight of all other materials recycled. Most glass containers currently produced contain at least 25 percent recycled glass. Despite popular perceptions, plastic can also be recycled and about 23 percent of all the plastic used in soft drink containers is recycled into other products.

More than ten million tires are recycled each year, making possible the retreading of 20 million truck tires and 17 million passenger car tires and a 30 percent reduction in energy use relative to the amount of energy needed to produce a new tire.

About 10 percent of post-consumer oil is recycled, of which 57 percent is reused for fuel, 26 percent is used to produce lubrication oil, and 17 percent is placed on roads for dust control or is used as a wood preservative.

Almost 30 percent of all post-consumer paper used in the United States is now recycled.

But are we doing enough? Would universal recycling be better for the environment? Many environmentalists think so. And in response to this attitude, cities and states are turning to mandatory recycling programs.

Studies show that recycling itself has environmental side effects. Curbside garbage recycling programs often require more collection trucks—one set for recyclables, the other for the remaining waste—which means more fuel consumption and more air pollution. Some recycling programs produce high volumes of water waste and use large amounts of energy. Recycling requires production facilities—which may be located hundreds of miles from cities where garbage is collected. Simply getting the product to the facility requires other scarce resources.

One indicator of the environmental cost of recycling is its economic cost. In general, the higher the economic cost of recycling, the more labor, energy, capital and other scarce resources that are being used. Thus, cities where recycling costs far exceed the full costs (including environmental protection costs) of ordinary disposal may be doing more environmental harm than good by recycling.

Recycling laws sometimes backfire. Cradle-to-grave studies show that sometimes recycling makes sense and sometimes it does not. One area where recycling seems to make both economic and environmental sense is in the disposal of aluminum cans.

Since recycling requires only 5 percent of the energy needed to transform bauxite ore into aluminum, it pays for producers to use recycled cans, and a market for these cans encourages entrepreneurs to collect them efficiently. Energy savings are achieved, even taking into account transportation of the cans to the reprocessing facility. But some recycling doesn't make sense. And mandatory recycling and other government regulations are often worse than the disease they seek to cure.

Recycling newsprint requires de-inking—involving the use of toxics, which create other disposal problems. Some states, including California, insist that used oil be treated as a hazardous waste—thus raising the cost and inhibiting the use of recycled oil. In the absence of such regulation, motor oil can be recycled efficiently and safely.

MYTH 7 Products not bio-degradable are bad

To some consumers, anything that degrades (nature's recycling) is "good"; anything that does not is "bad." The facts say otherwise. Most modern landfills (about one-third of all landfills) are sealed, thus inhibiting biodegradation of anything. In the landfills that are not sealed, the items that don't degrade (such as plastic) do not break down and release chemicals into the soil. By contrast, products that do degrade can threaten the environment if they are disposed of improperly. Degradation can leach chemicals into our water supplies and endanger fish, wildlife and humans.

MYTH 8 Recycling paper saves trees

Proponents of paper recycling argue that recycling a ton of newsprint saves 17 trees. Yet most of the trees used to make paper are not virgin forests, but trees planted explicitly for manufacturing paper. Thus, if we use less paper, fewer trees will be planted and grown by commercial harvesters. An analogy is Christmas trees. Most Christmas trees are grown explicitly for Yuletide and would not otherwise exist. The net effect of widespread paper recycling, according to economist A. Clark Wiseman, would actually be a decline in tree planting and tree coverage as lands were converted to other uses.

Moreover, harvesting and planting trees may have other environmental benefits. A study by the Goddard Space Institute and Columbia University shows that

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trees consume large amounts of carbon dioxide. In fact, U.S. forests could be consuming as much carbon dioxide as the U.S. emits. But that is true only of growing forests. Mature forest ecosystems—made up of a combination of growing trees and dead material—give off as much carbon dioxide as they consume.

MYTH 9 We cannot safely dispose of solid waste

Much of the public opposition to landfills stems from concerns that they represent a threat to health and safety. With respect to older landfills, some of these concerns are justified. According to the Office of Technology Assessment about 70 percent of existing landfills are older landfills that lack pollution control features or are improperly sited. The biggest risk is water pollution. If a landfill is in an area with a high water table, or is improperly lined, chemicals can leach out, reach ground water or surface water and create a health risk. Another risk is the emission of volatile gases into the atmosphere.

Most new landfills, however, comply with regulations which prohibit them from being located in permeable soils or shallow water tables or near wetlands and require chemical collection system liners and landfill cover. Provided the technological and operational tools now available are properly used—new landfills can be operated safely without threat to the environment.

Ironically, efforts to prevent the siting of new landfills may actually result in attempts to expand and prolong the use of older, less environmentally sound facilities, with the perverse result that environmental safety and health goals are undermined. Even so, the EPA estimates that the aggregate risk from all operating municipal solid waste landfills in the United States is at most one cancer death every 23 years.

MYTH 10 We are running out of resources

Aside from concerns about limited landfill space, the argument for mandatory recycling is motivated by the assumption that we are running out of scarce resources. Some environmentalists have for decades predicted that we will run out of food and other natural resources.

However, in almost every field of human endeavor, technologies make it possible to use resources without exhausting them. For example, despite 20 years of predictions that the world was running out of oil, oil prices continue to fall, and the price of gasoline (in real terms) hit an all-time low. One reason is innovations which allow us to economize on oil. Oil consumption over the past decade fell 9.3 percent in the United States and 15.8 percent in Western Europe and Japan—despite economic growth.

Similarly, despite the finite amount of copper in the world, copper prices are down, not up. One reason is the development of fiber optic cable, made of silica (sand), which can carry one thousand times more messages than copper wire. In telecommunications, wire requiring one ton of copper can now be replaced by a fiberglass cable requiring only 25 kilograms of silica, which can be produced with only 5 percent of the energy needed to produce the copper wire it replaces.

Excerpted from "A Consumer's Guide to Environmental Myths and Realities," published by the National Center for Policy Analysis, and included in NCPA Progressive Environmentalism, Trade & Aid Resource Book, *available from the Free Enterprise Institute.*

Sources for further reading on trash & recycling…

Sources and footnotes for "Sorting through the trash claims" are included in the longer versions of this study. See also Lynn Scarlett and Virginia Postrel's article "Talking Trash" in *Reason*, August/Sept., 1991, and Rathje and Reilly, *Household Garbage and the Role of Packaging* (Univ. of Ariz., July 1985).

In 1994 recycling and solid waste stories shifted from landfill shortages to unexpected surpluses of landfill space and overcapacity in advanced recycling centers. See, for example, "Recycling Mania Crashes and Burns in California" (*Wall Street Journal*, April 26, 1994, p. B1). See also "Recycling: What a Waste?" in the March/April 1994 issue of *The American Enterprise*.

A good source for in-depth articles on garbage and recycling is, not surprisingly, *Garbage* magazine. See especially "Time to Dump Plastics Recycling?" in the Spring, 1994 issue, and "Is Garbage an Environmental Problem?" in the November/December 1993 issue. Educators should also find interesting the *Garbage* April/May 1993 cover story "Enviro Education: Is it Science, Civics, or Just Plain Propaganda?" This article provides a critical review of popular environmental education texts and materials, including those about recycling and natural resource scarcity.

Recycling requires...

Knowledge, incentives, coordination

Knowledge incentives coordination

Effective recycling requires at least three key elements: knowledge, incentives and coordination. These may sound fairly abstract, but without them recycling programs will remain more like hobbies than major industrial enterprises.

Good intentions, sincerity, and splashy advertising campaigns won't help recycling efforts survive and evolve unless market prices and property rights exist to: 1) create and popularize recycling knowledge, 2) create and sustain incentives to recycle, and 3) coordinate the plans and actions of millions of current and future resource users and recyclers.

We often take knowledge for granted. We too easily assume that current understanding of resources, materials and recycling technology just exists—rather than realizing that this knowledge has accumulated gradually over decades and centuries from the focused efforts of tens of thousands of engineers, inventors, researchers, innovators, entrepreneurs and workers.

Second, people often think of this knowledge as static and complete rather than dynamic and growing. New recycling ideas, technologies and strategies emerge all the time, sometimes making older materials and recycling technologies obsolete. New technologies for disposing of toxic wastes, for example, may lead us to reexamine expensive toxic waste recycling programs. If these wastes can be stored safely, permanently and relatively inexpensively, then we have less reason to worry about them. Or if they can be completely disassembled into their constituent atoms by the "ultimate recycler" (discussed below) then we should turn to other recycling challenges.

This stream of new knowledge and new technologies means that some environmental problems that seem critical today—the disposal of toxic wastes, for example—might be solved by tomorrow's discoveries and inventions. The key is to have a system that makes the most effective use of the knowledge and technologies we have today, and also encourages the search for and adoption of new solutions and new technologies.

New knowledge and new technology do not come to us freely. Engineers, scientists, inventors, innovators and entrepreneurs are essential for the discovery and development of new recyclable products and recycling processes. But how do these engineers and inventors decide which recycling challenges to tackle first? That is, of the tens of thousands of products that might be designed differently to make them easier to recycle, which should have the highest priority?

Even if recycling priorities could be made clear without reference to markets, how would entrepreneurs and engineers decide whether to invest their time and effort to attack recycling problems rather than working on other problems (designing safer cars, airplanes or rollerblades, for example)? And who pays for this recycling research, who pays the salaries so engineers can support their families while they search for new technologies (many of which will likely be dead ends)?

These decisions, economists argue, are best made by the subtle signals that prices give in the marketplace. Potential profits from new recycling ideas and processes

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Case study: betting the planet—Julian Simon vs. Paul Ehrlich

Ecologist Paul R. Ehrlich insists population growth is outstripping the earth's resources. Economist Julian L. Simon replies that human ingenuity will keep the planet's resources from being depleted as long as property rights are enforced and markets are allowed to function. In 1980, they put their money where their mouths were and made a bet. Simon offered to let anyone pick any natural resource and any future date, and he bet that the price would decline by that date. If the resource really became scarcer as the world's population grew, he reasoned, then its price should rise.

Ehrlich picked quantities of five metals—chrome, copper, nickel, tin and tungsten—then worth a total of $1,000, and chose a ten-year period. If combined prices of the metals were higher in 1990 than in 1980 (in real terms), Simon agreed to pay the Ehrlich group the difference in cash; if the combined prices were lower, they would pay him the difference. Without ceremony, Ehrlich sent Simon a sheet of calculations and a check for $576.07.

Prices of food and most resources have been falling for decades because of entrepreneurship and continuing technological improvements. Ehrlich, who predicted that "before 1985 mankind will enter a genuine age of scarcity" including food shortages, now says crises will come sometime in the next century.

Recycling requires..., continued from page 15

draw investments from venture capitalists or from large companies. These investments are repaid if new recycling ventures and technologies develop as expected. If they develop better than expected, investors make a big profit; if they develop worse than expected or don't work at all, investors lose their shirt. For this reason everyone involved is keen to pursue the most promising ventures first.

Effective recycling requires more than encouraging people to "think globally" or to sort their trash. Recycling requires the incentives and coordination created by market prices. Consider the case of aluminum recycling, for example. Because aluminum is expensive to make from bauxite, aluminum made from recycled cans is an attractive alternative. This reality is reflected in the prices offered for a pound of empty aluminum cans.

The price paid to dispose of a ton of used concrete contains information about how difficult it is to recycle. Recycled concrete competes with other road building materials. *C&D Debris Recycling* reports on companies, products and technologies involved in recycling everything from wood chips to concrete and asphalt. The July 1994 issue contains an article on portable concrete recycling plants. The author points out that many of those entering the concrete recycling business really don't know what kinds of recycling machinery to purchase and how to organize their plants. The article suggests how important actual real-world experience is with recycling materials like concrete. The people running these enterprises have strong monetary incentives to discover better ways to recycle concrete and new uses for recycled concrete.

Reuse, refashion, recycle

There would be very little recycling without new technologies. Before the technological advances of the twentieth century there was plenty of reuse of resources, but not much recycling.

Reuse means using the same things over and over, like taking your old brown grocery bag back to the grocery store a second, third or fourth time. Or using it for a trash bag after it seems too crumpled to use as a grocery bag. It is easy to reuse a grocery bag as a trash bag.

A more advanced recycling is refashioning used products into other types of products. The July 1994 *National Geographic* cover story on recycling recounts a number of such ventures, some refashioning old tires and textile scraps into high fashion.

Even more advanced recycling turns used materials back into their original form—aluminum cans into molten aluminum, old newspapers back into wood pulp, and iron scrap back into molten iron. A new recycling technology now may be able to perform this magic to nearly all metals and materials. This ultimate recycler is a super-hot furnace that can recycle anything thrown into it. Anything dropped into the furnace is heated until it breaks down into molecules and atoms.

The ultimate recycling machine

The ultimate recycling furnace is still in the design stage, and the inventor is now raising money for a full-scale model. Even when it is fully operational it will be an expensive way to recycle. But this new technology means that everything can be recycled via one technology or another.

What's worth recycling?

So now that the technology will soon exist to recycle virtually anything, what should be recycled? We could, in theory, recover every atom we now throw away and bring those atoms back as new resources in new products. This would be hugely expensive but possible. Ultimate recycling technology will exist, but it must have price signals to guide it.

— Gregory F. Rehmke

Mr. Rehmke has an economics degree from the University of Washington and has published numerous articles on environmental issues. Mr. Rehmke directs Educational Programs at the Free Enterprise Institute.

Further reading on resources and recycling...

The ideas and analysis in this introductory study guide on resources and recycling are drawn from a number of other research materials and studies. Many of these longer and more in-depth materials are available from the Political Economy Research Center (PERC) or from the Free Enterprise Institute. Collections available from the Free Enterprise Institute include: *PERC Resource Book on Trade, Aid, and the Environment*, *NCPA Progressive Environmentalism*, *Trade & Aid Resource*, *E/A Environmental Resource Book: Entrepreneurs, and Enterprises & the Environment*.

For a listing of recent publications on environmental issues from PERC, please write to the address listed on page two.