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III

AN EXCITING NEW OPTION

Building a New Economy

In Chapter 1 we concluded that the western economic model—the fossil-fuel-based, automobile-centered, throwaway economy—was not viable for the world. Instead, the new economy will be powered by renewable sources of energy, will have a more diverse transport system—relying more on rail, buses, and bicycles and less on cars—and will recycle materials comprehensively.

We can describe this new economy in some detail. The question is how to get from here to there quickly enough to avoid economic decline and collapse. In our favor, we do have some assets that earlier civilizations did not, including archeological records, more advanced scientific knowledge, and, most important, a sense of how to use economic policy to achieve social goals.

The key to building a global economy that can sustain economic progress is the creation of an honest market, one that tells the ecological truth. The market is an incredible institution, allocating resources with an efficiency that no central planning body can match. It easily balances supply and demand, and it sets prices that readily reflect both scarcity and abundance.

The market does, however, have some fundamental weaknesses. It does not incorporate into prices the indirect costs of providing goods or services into prices, it does not value nature's services properly, and it does not respect the sustainable-yield thresholds of natural systems. It also favors the near term over the long term, showing little concern for future generations.

Throughout most of recorded history, the indirect costs of economic activity were so small that they were rarely an issue and, even then, only at the local level. But with the sevenfold global economic expansion since 1950, the failure to address these market shortcomings and the irrational economic distortions they create could be fatal.¹

As noted in Chapter 1, accounting systems that do not tell the truth can be costly. Faulty corporate accounting systems that leave costs off the books have driven some of the world's largest corporations into bankruptcy. Unfortunately, our faulty global economic accounting system has potentially far more serious consequences. Our modern economic prosperity is achieved in part by running up ecological deficits, costs that do not show up on the books, but costs that someone will eventually pay.

Once we calculate the indirect costs of a product or service, we can incorporate them into market prices in the form of a tax, offsetting them with income tax reductions. If we can get the market to tell the truth, then we can avoid being blindsided by faulty accounting systems that lead to bankruptcy. As Øystein Dahle, former Vice President of Exxon for Norway and the North Sea, has pointed out: "Socialism collapsed because it did not allow the market to tell the economic truth. Capitalism may collapse because it does not allow the market to tell the ecological truth."²

Shifting Taxes

The need for tax shifting—lowering income taxes while raising levies on environmentally destructive activities—in order to get the market to tell the truth has been widely endorsed by economists. For example, a tax on coal that incorporated the increased health care costs associated with breathing polluted air, the costs of damage from acid rain, and the costs of climate disruption would encourage investment in renewable sources of energy such as wind or geothermal. With this concept in hand,

it is a short step to tax shifting. A number of countries in Western Europe are already shifting taxes in a process known there as environmental tax reform, to achieve the environmental goals outlined in preceding chapters.³

Among the various environmentally damaging activities taxed in Europe are carbon emissions, the generation of garbage (so-called landfill taxes), and the excessive number of cars in cities. A four-year plan adopted in Germany in 1999 systematically shifted taxes from labor to energy. By 2001, this plan had lowered fuel use by 5 percent. It had also accelerated growth in the renewable energy sector, creating some 45,400 jobs by 2003 in the wind industry alone, a number that is projected to rise to 103,000 by 2010.⁴

In 2001, Sweden launched a bold new 10-year environmental tax shift designed to convert 30 billion kroner (\$3.9 billion) of taxes on income to taxes on environmentally destructive activities. Much of this shift of \$1,100 per household is levied on road transport, including substantial hikes in vehicle and fuel taxes. Electricity is also picking up part of the shift. As of 2005, Sweden is running slightly ahead of its 10-year tax-shifting plan, making it the world leader in environmental tax reform.⁵

Among the other European countries with strong tax reform efforts are Spain, Italy, Norway, the United Kingdom, and France. There are isolated cases elsewhere. A number of countries, including Malaysia, Thailand, and Turkey, have used a tax on lead emissions to eliminate lead as an additive in gasoline. The United States imposed a stiff tax on chlorofluorocarbons to phase them out in accordance with the Montreal Protocol of 1987 and its subsequent updates. At the municipal level, when Victoria, the capital of British Columbia, adopted a trash tax of \$1.20 per bag of garbage in 1992, it reduced its daily trash flow 18 percent within one year.⁶

Cities that are being suffocated by cars are using stiff entrance taxes to reduce congestion. First adopted by Singapore some two decades ago, this tax was later introduced by Oslo, Melbourne, and, most recently, London. The London tax of £5, or nearly \$9, first enacted in February 2002 by Mayor Ken Livingstone, was raised to £8, more than \$14, in July 2005. The resulting revenue will be invested in improving the bus network, which carries 2 million passengers a day. The goal of this con-

gestion tax is a total restructuring of the London transport system to reduce congestion, air pollution, and carbon emissions and to increase mobility.⁷

While London and other cities are taxing cars that enter the central city, others are simply imposing a tax on automobile ownership. In Denmark, the tax on the purchase of a new car is larger than the price of the car itself. A new \$25,000 car costs the buyer more than \$50,000! In 2000, partial rebates were introduced for energy-efficient vehicles. Other governments are moving in this direction. *New York Times* reporter Howard French writes that Shanghai, which is being suffocated by automobiles, “has raised the fees for car registrations every year since 2000, doubling over that time to about \$4,600 per vehicle—more than twice the city’s per capita income.”⁸

For some products where the costs to society are large and obvious, pressure is mounting to impose taxes. By far the most dramatic example of this was the agreement negotiated between the tobacco industry and all the state governments in the United States. After numerous state governments launched litigation to force tobacco companies to reimburse them for the Medicare costs of treating smoking-related illnesses, the industry decided to negotiate a package reimbursement, agreeing in November 1998 to pay the 50 state governments some \$251 billion—nearly \$1,000 for every person in the United States. This landmark agreement was, in effect, a retroactive tax on cigarettes smoked in the past, one designed to cover indirect costs. To pay this enormous bill, companies boosted cigarette prices, further discouraging smoking.⁹

A study by the Centers for Disease Control and Prevention (CDC) in the United States calculated the social costs of smoking cigarettes at \$7.18 per pack. This not only justifies raising taxes on cigarettes, which claim 4.9 million lives per year worldwide, but it also provides guidelines for how much to raise them. In 2002, a year in which state governments faced fiscal deficits, 21 states in the United States raised cigarette taxes. Perhaps the biggest jump came in New York City, where smokers paid an additional 39¢ in state tax and \$1.42 in city tax—a total increase of \$1.81 per pack. Since a 10-percent price increase typically reduces smoking by 4 percent, the health benefits of this tax increase should be substantial.¹⁰

If the cost to society of smoking a pack of cigarettes is \$7.18,

how much is the cost to society of burning a gallon of gasoline? Fortunately, as noted in Chapter 1, the International Center for Technology Assessment has done a detailed analysis, entitled “The Real Price of Gasoline.” The group calculates several indirect costs, including oil industry tax breaks, oil supply protection costs, oil industry subsidies, and health care costs of treating auto exhaust-related respiratory illnesses. The total of these indirect costs centers around \$9 per gallon, somewhat higher than the social cost of smoking a pack of cigarettes. Add this external or social cost to the roughly \$2 per gallon average price of gasoline in the United States in early 2005, and gas would cost \$11 a gallon. These costs are real. Someone bears them. Now that these costs have been calculated, they can be used to set tax rates on gasoline, just as the CDC analysis is being used to raise taxes on cigarettes.¹¹

Asia’s two leading economies—Japan and China—are now considering the adoption of carbon taxes. For the last few years, many members of the Japanese Diet have wanted to launch an environmental tax shift, but industry has opposed a carbon tax. China, which is experiencing near-record explosive growth in energy use and carbon emissions, is working on an environmental tax restructuring that will discourage fossil fuel use. Wang Fengchun, an official with the National People’s Congress, says, “Taxation is the most powerful tool available in a market economy in directing a consumer’s buying habits. It is superior to government regulations.” If Chinese policymakers can engineer an environmental tax reform, it will be a landmark development not only for China but for the world.¹²

Environmental tax shifting usually brings a double dividend. In reducing taxes on income—in effect, taxes on labor—labor becomes less costly, creating additional jobs while protecting the environment. This was the principal motivation in the German four-year shift of taxes from income to energy. By reducing the air pollution from smokestacks and tailpipes, the incidence of respiratory illnesses, such as asthma and emphysema, is reduced—and thus overall health care costs are as well.¹³

With forests, ecologists can calculate the values of services that trees provide. Once these are determined, they can be incorporated into the price of trees as a stumpage tax of the sort that Bulgaria and Lithuania have adopted. Anyone wishing

to cut a tree would have to pay a tax equal to the value of the services provided by that tree, such as flood control. The market for lumber would then be telling the ecological truth. The effect of this is to reduce tree cutting and to encourage wood reuse and paper recycling.¹⁴

Tax shifting also helps countries gain the lead in producing new equipment, such as new energy technologies or those used for pollution control. For example, the Danish government's tax incentives for wind-generated electricity have enabled Denmark, a country of only 5 million people, to become the world's leading manufacturer of wind turbines.¹⁵

Some 2,500 economists, including eight Nobel Prize winners in economics, have endorsed the concept of tax shifts. Harvard economics professor N. Gregory Mankiw wrote in *Fortune* magazine: "Cutting income taxes while increasing gasoline taxes would lead to more rapid economic growth, less traffic congestion, safer roads, and reduced risk of global warming—all without jeopardizing long-term fiscal solvency. This may be the closest thing to a free lunch that economics has to offer."¹⁶

The Economist strongly endorses environmental tax shifting: "On environmental grounds, never mind energy security, America taxes gasoline too lightly. Better than a one-off increase, a politically more feasible idea, and desirable in its own terms, would be a long-term plan to shift taxes from incomes to emissions of carbon." In Europe and the United States, polls indicate that at least 70 percent of voters support environmental tax reform once it is explained to them.¹⁷

Tradable permits are sometimes a sensible alternative to environmental taxes. Both are economic instruments that can be used to reach environmental goals. The principal difference between them is that with permits, governments set the amount of a given activity that is allowed, such as the harvest from a fishery, and let the market set the price of the permits as they are auctioned off. With environmental taxes, in contrast, the price of the environmentally destructive activity is set by government in the tax rate, and the market determines the amount of the activity that will occur at that price. Both economic instruments can be used to discourage environmentally irresponsible behavior.¹⁸

The decision of when to use which instrument is not always clearcut. Governments have much more experience with envi-

ronmental taxes than with tradable permits. It is also clear that such taxes work under a wide range of conditions. Still, permits have been used successfully in widely differing situations, ranging from restricting the catch in an Australian fishery to reducing sulfur emissions in the United States.

For example, concerned about the overfishing of its lobster fishery, the government of Australia estimated the sustainable yield of lobsters and then issued permits totaling that amount. Fishers could then bid for these permits. In effect, the government decided how many lobsters could be taken each year and let the market decide how much the permits were worth. Since the permit trading system was adopted in 1986, the fishery has stabilized and appears to be operating on a sustainable basis.¹⁹

Perhaps the most ambitious effort to date to use tradable permits was the U.S. effort to reduce sulfur emissions from power plants by half from 1990 to 2000. The goal was reached in 1995, well ahead of schedule and at a minimal cost. One of the weaknesses of tradable permits is that in some communities emissions might not be reduced at all.²⁰

Although tradable permits are popular in the business community, permits are administratively more complicated and not as well understood as taxes. Edwin Clark, former senior economist with the White House Council on Environmental Quality, observes that tradable permits “require establishing complex regulatory frameworks, defining the permits, establishing the rules for trades, and preventing people from acting without permits.” In contrast to restructuring taxes, something with which there is wide familiarity, tradable permits are a concept not widely understood by the public, making it more difficult to generate broad public support.²¹

Shifting Subsidies

Each year the world’s taxpayers provide an estimated \$700 billion of subsidies for environmentally destructive activities, such as fossil fuel burning, overpumping aquifers, clearcutting forests, and overfishing. An Earth Council study, *Subsidizing Unsustainable Development*, observes that “there is something unbelievable about the world spending hundreds of billions of dollars annually to subsidize its own destruction.”²²

Iran provides a classic example of extreme subsidies when it

prices oil for internal use at one tenth the world price, strongly encouraging car ownership and gas consumption. The World Bank reports that if this \$3.6-billion annual subsidy were phased out, it would reduce Iran's carbon emissions by a staggering 49 percent. It would also strengthen the economy by freeing up public revenues for investment in the country's economic development. Iran is not alone. The Bank reports that removing energy subsidies would reduce carbon emissions in Venezuela by 26 percent, in Russia by 17 percent, in India by 14 percent, and in Indonesia by 11 percent.²³

Some countries are eliminating or reducing these climate-disrupting subsidies. Belgium, France, and Japan have phased out all subsidies for coal. Germany reduced its coal subsidy from \$5.4 billion in 1989 to \$2.8 billion in 2002, meanwhile lowering its coal use by 46 percent. It plans to phase out this support entirely by 2010. China cut its coal subsidy from \$750 million in 1993 to \$240 million in 1995. More recently, it has imposed a tax on high-sulfur coals.²⁴

A study by the U.K. Green Party, "Aviation's Economic Downside," describes the extent of subsidies currently given to the U.K. airline industry. The giveaway begins with \$17 billion in tax breaks, including a total exemption from the federal tax. External or indirect costs that are not paid, such as treating illness from breathing the air polluted by planes, the costs of climate change, and so forth, adds nearly \$7 billion to the tab. The subsidy in the United Kingdom totals \$391 per resident. This is also an inherently regressive tax policy simply because a substantial share of the U.K. population cannot afford to fly very often if at all, yet they help subsidize this high-cost mode of transportation for their more affluent compatriots.²⁵

While some leading industrial countries have been reducing subsidies to fossil fuels—notably coal, the most climate disrupting of all fuels—the United States has been increasing its support for the fossil fuel and nuclear industries. A Green Scissors report from 2002, a study supported by a coalition of environmental groups, calculated that over the past 10 years subsidies for the energy industry totaled \$33 billion. Of that, the oil and gas industry got \$26 billion, coal \$3 billion, and nuclear \$4 billion. At a time when there is a need to conserve oil resources, U.S. taxpayers are subsidizing their depletion.²⁶

The environmental tax shifting just described reduces taxes on wages and encourages investment in such activities as wind electric generation and recycling, thus simultaneously boosting employment and lessening environmental destruction. Eliminating environmentally destructive subsidies reduces both the burden on taxpayers and the destructive activities themselves.

Subsidies are not inherently bad. Many technologies and industries were born of government subsidies. Jet aircraft developed with military R&D expenditures led to modern commercial airliners. The Internet was the result of publicly funded links among computers in government laboratories and research institutes. And the combination of the federal tax deduction and a robust state tax deduction in California gave birth to the modern wind power industry.²⁷

But just as there is a need for tax shifting, there is also a need for subsidy shifting. A world facing the prospect of economically disruptive climate change, for example, can no longer justify subsidies to expand the burning of coal and oil. Shifting these subsidies to the development of climate-benign energy sources such as wind, solar, biomass, and geothermal power is the key to stabilizing the earth's climate. Shifting subsidies from road construction to rail construction could increase mobility in many situations while reducing carbon emissions.

In a troubled world economy facing fiscal deficits at all levels of government, exploiting these tax and subsidy shifts with their double and triple dividends can help balance the books and save the economy's environmental support systems. Tax and subsidy shifting promise both gains in economic efficiency and reductions in environmental destruction, a win-win situation.

Ecolabeling: Voting with Our Wallets

Yet another instrument for environmental restructuring of the economy is ecolabeling. Labeling products that are produced with environmentally sound practices lets consumers vote with their wallets. Ecolabeling is now used to enable consumers to identify energy-efficient household appliances, forest products from sustainably managed forests, fishery products from sustainably managed fisheries, and "green" electricity from renewable sources.

Among these ecolabels are those awarded by the Marine

Stewardship Council (MSC) for seafood. In March 2000, the MSC launched its fisheries certification program when it approved the Western Australia Rock Lobster fishery. Also earning approval that day was the West Thames Herring fishery. In September 2000, the Alaska salmon fishery became the first American fishery to be certified. Among the key players in the seafood processing and retail sectors supporting the MSC initiative were European-based Unilever, Youngs-Bluecrest, and Sainsbury's.²⁸

To be certified, a fishery must demonstrate that it is being managed sustainably. Specifically, according to the MSC: "First, the fishery must be conducted in a way that does not take more fish than can be replenished naturally or [that] kills other species through harmful fishing practices. Secondly, the fishery must operate in a manner that ensures the health and diversity of the marine ecosystem on which it depends. Finally, the fishery must respect local, national, and international laws and regulations for responsible and sustainable fishing." By mid-2005 there were over 46 certified fisheries worldwide supplying some 2 million tons of seafood.²⁹

The MSC's counterpart for forest products is the Forest Stewardship Council (FSC), which was founded in 1993 by the World Wide Fund for Nature (WWF) and other groups. It provides information on forest management practices within the forest products industry. Some of the world's forests are managed to sustain a steady harvest in perpetuity; others are clearcut, decimated overnight in the quest for quick profits. The FSC issues labels only for products from the former, whether it be lumber sold at a hardware store, furniture in a furniture store, or paper in a stationery store.³⁰

Headquartered in Oaxaca, Mexico, the FSC accredits national organizations that verify that forests are being sustainably managed. In addition to this on-the-ground monitoring, the accredited organizations must also be able to trace the raw product through the various stages of processing to the consumer. The FSC sets the standards and provides the FSC label, the stamp of approval, but the actual work is done by national organizations.³¹

The FSC has established nine principles that must be satisfied if forests are to qualify for its label. The central requirement

is that the forest be managed in a way that ensures that its yield can be sustained indefinitely. This means careful selective cutting, in effect mimicking nature's management of a forest by removing the more mature, older trees over time.³²

The FSC label provides consumers with the information they need to support responsible forestry through their purchases of forest products. By identifying timber companies and retailers that are participating in the certification program, socially minded investors also have the information they need for responsible investing.

In March 1996, the first certified wood products were introduced into the United Kingdom. Since then, the certification process has grown worldwide. As of August 2005, some 57 million hectares of forests in 65 countries had been certified under the auspices of the FSC.³³

To support this certification program, forest and trade networks have been set up in some 35 countries, including Austria, Brazil, Canada, France, Germany, the Nordic countries, Russia, Spain, Switzerland, the United Kingdom, and the United States. These networks are part of the vast support group of companies that adhere to the FSC standards in their marketing. The world's three largest wood buyers—Home Depot, Lowe's, and Ikea—all preferentially buy FSC-certified wood.³⁴

In June 2001, the Natural Resources Ministry in Moscow announced that it was introducing national mandatory certification of wood. Although a small portion of its timber harvest was already certified, buyers' discrimination against the rest of the harvest costs Russia \$1 billion in export revenues. The ministry estimates that its uncertified wood sells for 20–30 percent less than certified wood from competing countries.³⁵

Another commodity that is getting an environmental label is electricity. In the United States, many state utility commissions are requiring utilities to offer consumers a green power option. This is defined as power from renewable sources other than hydroelectric, and it includes wind power, solar cells, solar thermal energy, geothermal energy, and biomass. Utilities simply enclose a return card with the monthly bill, giving consumers the option of checking a box if they would prefer to get green power. The offer specifies the additional cost of the green power, which typically is from 3 to 15 percent.³⁶

Utility officials are often surprised by how many consumers sign up for green power. Many are apparently prepared to pay more for their electricity in order to help stabilize the climate for future generations. Local governments, including, for example, those in Santa Monica, Oakland, and Santa Barbara in California, have signed up to use green power exclusively. This includes the power they use for municipal buildings as well as that required to operate various municipal services, such as street lights and traffic signals. Other city and state governments committed to purchasing a portion of their electricity from green sources include Chicago, Portland, New Jersey, and New York.³⁷

Many corporations are signing up as well. Johnson & Johnson, Whole Foods Market, and Staples all rank among the top 25 green power purchasers, according to the Environmental Protection Agency's Green Power Partnership. Literally scores of companies in California and Texas are subscribing.³⁸

The net effect of these growing numbers of green power proponents is a tidal wave of demand that is forcing many utilities to scramble for an adequate supply of green electricity. One reason wind farms are springing up in so many states is that this is one of the fastest ways to bring new green power online. While green power marketing is now quite advanced in the United States, it is now also well established in Japan, where the rapidly growing purchases of green power threatened to outrun the supply in 2004, forcing utilities to quickly invest in more wind turbines.³⁹

Other types of ecolabeling include the efficiency labels put on household appliances that achieve a certain electricity efficiency standard. These have been in effect in many countries since the energy crisis of the late 1970s. There are also green labels provided by environmental or governmental groups at the national level. Among the better-known environmental seal of approval programs are Germany's Blue Angel, Canada's Environmental Choice, and the U.S. Environmental Protection Agency's Energy Star.⁴⁰

A New Materials Economy

In nature, one-way linear flows do not long survive. Nor, by extension, can they long survive in the expanding economy that is a part of the earth's ecosystem. The challenge is to redesign the materials economy so that it is compatible with nature.

The throwaway economy that has been evolving over the last half-century is an aberration, now itself headed for the junk heap of history.

The potential for reducing materials use has been examined over the last decade in three specific studies. The first—*Factor Four*, by Ernst von Weizsäcker, an environmentalist and leader in the German Bundestag—argued that modern industrial economies could function very effectively with a level of virgin raw material use only one fourth that of today. This was followed a few years later by the Factor Ten Institute organized in France under the leadership of Friedrich Schmidt-Bleek. Its research concludes that resource productivity can be raised by a factor of 10, which is well within the reach of existing technology and management given the appropriate policy incentives.⁴¹

In 2002, American architect William McDonough and German chemist Michael Braungart teamed up to coauthor a book entitled *Cradle to Cradle: Remaking the Way We Make Things*. Waste and pollution are to be avoided at any cost. “Pollution,” says McDonough, “is a symbol of design failure.”⁴²

One of the keys to reducing materials use is recycling steel, the use of which dwarfs that of all other metals combined. Steel use is dominated by the automobile, household appliance, and construction industries. Among steel-based products in the United States, automobiles are the most highly recycled. Cars today are simply too valuable to be left to rust in out-of-the-way junkyards.⁴³

The recycling rate for household appliances is estimated at 90 percent. For steel cans, the U.S. recycling rate in 2003 of 60 percent can be traced in part to municipal recycling campaigns launched in the late 1980s.⁴⁴

In the United States, roughly 71 percent of all steel produced in 2003 was from scrap, leaving 29 percent to be produced from virgin ore. Steel recycling started climbing more than a generation ago with the advent of the electric arc furnace, a method of producing steel from scrap that uses only one third the energy of that produced from virgin ore. And since it does not require any mining, it completely eliminates one source of environmental disruption. In the United States, Italy, and Spain, electric arc furnaces used for recycling now account for half or more of all steel production.⁴⁵

It is easier for mature industrial economies with stable populations to get most of their steel from recycled scrap, simply because the amount of steel embedded in the economy is essentially fixed. The number of household appliances, the fleet of automobiles, and the stock of buildings is increasing little or not at all. For countries in the early stages of industrialization, however, the creation of infrastructure—whether factories, bridges, high-rise buildings, or transportation, including automobiles, buses, and rail cars—leaves little steel for recycling.

In the new economy, electric arc steel minimills that efficiently convert scrap steel into finished steel will largely replace iron mines. Advanced industrial economies will come to rely primarily on the stock of materials already in the economy rather than on virgin raw materials. For metals such as steel and aluminum, the losses through use will be minimal. With the appropriate policies, metal can be used and reused indefinitely.

In recent years, the construction industry has begun deconstructing old buildings, breaking them down into their component parts so they can be recycled and reused. For example, when PNC Financial Services in Pittsburgh took down a seven-story downtown building, the principal products were 2,500 tons of concrete, 350 tons of steel, 9 tons of aluminum, and foam ceiling tiles. The concrete was pulverized and used to fill in the site, which is to become a park. The steel and aluminum were recycled. And the ceiling tiles went back to the manufacturer to be recycled. This recycling saved some \$200,000 in dump fees. By deconstructing a building instead of simply demolishing it, most of the material in it can be recycled.⁴⁶

Germany and, more recently, Japan are requiring that products such as automobiles, household appliances, and office equipment be designed so that they can be easily disassembled and their component parts recycled. In May 2001, the Japanese Diet enacted a tough appliance recycling law, one that prohibits discarding household appliances, such as washing machines, televisions, or air conditioners. With consumers bearing the cost of disassembling appliances in the form of a disposal fee to recycling firms, which can come to \$60 for a refrigerator or \$35 for a washing machine, the pressure to design appliances so they can be more easily and cheaply disassembled is strong.⁴⁷

With computers becoming obsolete every few years as technol-

ogy advances, the need to be able to quickly disassemble and recycle them is a paramount challenge in building an eco-economy.

In addition to measures that encourage the recycling of materials are those that encourage the reuse of products such as beverage containers. Finland, for example, has banned the use of one-way soft drink containers. Canada's Prince Edward Island has adopted a similar ban on all nonrefillable beverage containers. The result in both cases is a sharply reduced flow of garbage to landfills.⁴⁸

A refillable glass bottle used over and over requires about 10 percent as much energy per use as an aluminum can that is recycled. Cleaning, sterilizing, and relabeling a used bottle requires little energy, but recycling cans made from aluminum, which has a melting point of 660 degrees Celsius (1,220 degrees Fahrenheit), is an energy-intensive process. Banning nonrefillables is a win-win-win option—cutting material and energy use, garbage flow, and air and water pollution.⁴⁹

There are also transport fuel savings, since the containers are simply back-hauled to the original bottling plants or breweries. If nonrefillable containers are used, whether glass or aluminum, and they are recycled, then they must be transported to a manufacturing facility where they can be melted down, refashioned into containers, and transported back to the bottling plant or brewery.

Even more fundamental than the design of products is the redesign of manufacturing processes to eliminate the discharge of pollutants entirely. Many of today's manufacturing processes evolved at a time when the economy was much smaller and when the volume of pollutants was not overwhelming the ecosystem. More and more companies are now realizing that this cannot continue and some, such as Dupont, have adopted zero emissions as a goal.⁵⁰

Another way to reduce waste is to systematically cluster factories so that the waste from one process can be used as the raw material for another. NEC, the large Japanese electronics firm, is one of the first multinationals to adopt this approach for its various production facilities. In effect, industrial parks are being designed, both by corporations and governments, specifically to combine factories that have usable waste products. Now in industry, as in nature, one firm's waste becomes another's sustenance.⁵¹

Government procurement policies can be used to dramatically boost recycling. For example, when the Clinton administration issued an Executive Order in 1993 requiring that all government-purchased paper contain 20 percent or more post-consumer waste by 1995 (increasing to 25 percent by 2000), it created a strong incentive for paper manufacturers to incorporate wastepaper in their manufacturing process. Since the U.S. government is the world's largest paper buyer, this provided a burgeoning market for recycled paper.⁵²

New technologies that are less material-dependent also reduce materials use. Cellular phones, which rely on widely dispersed towers or on satellites for signal transmission, now totally dominate telephone use in developing countries, thus sparing them investment in the millions of miles of copper wires that the industrial countries made.⁵³

One industry whose value to society is being questioned by the environmental community is the bottled water industry. The World Wide Fund for Nature, an organization with 5.2 million members, released a study in 2001 urging consumers in industrial countries to forgo bottled water, observing that it was no safer or healthier than tap water, even though it can cost 1,000 times as much.⁵⁴

WWF notes that in the United States and Europe there are more standards regulating the quality of tap water than of bottled water. Although clever marketing in industrial countries has convinced many consumers that bottled water is healthier, the WWF study could not find any support for this claim. For those living where water is unsafe, as in some Third World cities, it is far cheaper to boil or filter water than to buy it in bottles.⁵⁵

Phasing out the use of bottled water would eliminate the need for billions of plastic bottles and the fleets of trucks that haul and distribute the water. This in turn would eliminate the traffic congestion, air pollution, and rising carbon dioxide levels from operating the trucks.⁵⁶

A brief review of the environmental effects of gold mining raises doubts about whether the industry is a net benefit to society. In addition to the extensive release of mercury and cyanide into the environment, annual gold production of 2,500 tons requires the processing of 750 million tons of ore—second only

to the 2.5 billion tons of ore processed to produce 1 billion tons of raw steel.⁵⁷

Over 80 percent of all the gold mined each year is used to produce jewelry that is often worn as a status symbol, a way of displaying wealth by a tiny affluent minority of the world's people. Birsal Lemke, a widely respected Turkish environmentalist, questions the future of gold mining, wondering whether it is worth turning large areas into what she calls "a lunar landscape." She is not against gold per se, but against the deadly chemicals—cyanide and mercury—that are released in processing the gold ore.⁵⁸

To get an honest market price for gold means imposing a tax on it that would cover the cost of cleaning up the mercury and cyanide pollution from mining plus the costs of landscape restoration in mining regions. Such a tax, which would enable the price of this precious metal to reflect its full cost to society, would likely raise its price severalfold.

Another option for reducing the use of raw materials would be to eliminate subsidies that encourage their use. Nowhere are these greater than in the aluminum industry. For example, a study by the Australia Institute reports that smelters in Australia buy electricity at an astoundingly low subsidized rate of 0.7–1.4¢ per kilowatt-hour, while other industries pay 2.6–3.1¢. Without this huge subsidy, we might not have nonrefillable aluminum beverage containers. This subsidy to aluminum indirectly subsidizes both airlines and automobiles, thus encouraging travel, an energy-intensive activity.⁵⁹

The most pervasive policy initiative to dematerialize the economy is the proposed tax on the burning of fossil fuels, a tax that would reflect the full cost to society of mining coal and pumping oil, of the air pollution associated with their use, and of climate disruption. A carbon tax will lead to a more realistic energy price, one that will permeate the energy-intensive materials economy and reduce materials use.

The challenge in building an eco-economy materials sector is to ensure that the market is sending honest signals. In the words of Ernst von Weizsäcker, "The challenge is to get the market to tell the *ecological* truth." To help the market to tell the truth, we need not only a carbon tax, but also a landfill tax so that those generating garbage pay the full cost of getting rid of it.⁶⁰

New Industries, New Jobs

Describing the eco-economy is obviously speculative, but less so than it might seem simply because its broad outlines are defined by the principles of ecology. The specific trends and shifts described here are not projections of what will happen, though the term “will” is often used for the sake of efficiency. No one knows if these shifts “will” in fact occur, but it will take something similar to this if we are to build an eco-economy.

Building a new economy involves phasing out old industries, restructuring existing ones, and creating new ones. For example, coal use is being phased out, replaced by efficiency gains in many countries, but also by natural gas, as in the United Kingdom, and by wind power, as in Denmark and Germany.⁶¹

The world automobile industry faces a modest restructuring as it shifts from the gasoline-powered internal combustion engine to the gas-electric hybrid, the diesel-electric hybrid, or the high-efficiency diesel that is so popular in Europe. This will require both a retooling of engine plants and the retraining of automotive engineers and automobile mechanics.

The new economy will also bring major new industries, ones that either do not yet exist or are just beginning. Wind electricity generation is one such industry, incorporating three subsidiary industries: turbine manufacturing, installation, and maintenance. Now in its embryonic stage, this promises to become the foundation of the new energy economy. Millions of turbines soon will be converting wind into cheap electricity, becoming part of the landscape, generating income and jobs in rural communities throughout the world.

As wind power emerges as a mainstream low-cost source of electricity, it will spawn another industry—hydrogen production. Once wind turbines are in wide use, there will be a large, unused capacity during the night when electricity use drops. With this essentially free electricity, turbine owners can turn on the hydrogen generators, converting the wind power into hydrogen. This can then be used to run power plants now fueled with natural gas, as gas becomes too costly or is no longer available. The wind turbine will replace the coal mine, the oil well, and the gas field.

Among the many changes in the world food economy will be the continuing shift to fish farming. Aquaculture, the fastest

growing subsector of the world food economy, has expanded at 9 percent a year since 1990. The farming of fish, particularly omnivorous species such as carp, catfish, and tilapia, is likely to continue expanding rapidly simply because these fish convert grain into animal protein so efficiently. With this aquacultural growth comes the need for a rapidly expanding aquafeed industry, one where feeds are formulated by fish nutritionists, much as they are for the poultry industry today.⁶²

Bicycle manufacturing and servicing is a growth industry. As recently as 1965, world production of cars and bikes was essentially the same, with each at nearly 20 million, but as of 2003 bike production had climbed to over 100 million per year compared with 42 million cars. This growth in bicycle sales reflects growth in the ranks of those reaching the bicycle level of affluence, principally in Asia. Among industrial countries, the urban transport model being pioneered in the Netherlands and Denmark, where bikes are featured prominently, gives a sense of the bicycle's future role worldwide.⁶³

As bicycle use expands, interest in battery-assisted bikes is also growing. Similar to existing bicycles, except for a tiny battery-powered electric motor that can either power the bicycle entirely or assist elderly riders or those living in hilly terrain, its soaring sales are expected to continue climbing.⁶⁴

Yet another growth industry is raising water productivity. Just as the last half-century was devoted to raising land productivity, this half-century will be focused on raising water productivity. Irrigation technologies will become more efficient. The continuous recycling of urban water supplies, already started in some cities, will become common, replacing the "flush and forget" system.

As oil prices rise, teleconferencing gains appeal. To save fuel and time, individuals will be "attending" conferences electronically with both audio and visual connections. One day there will likely be literally thousands of firms organizing electronic conferences.

Other promising growth industries are solar cell manufacturing, light rail construction, and tree planting. For the 1.7 billion people living in developing countries and villages that lack electricity, the mass production of solar cells is the best bet for electrification. As people tire of traffic congestion and pollu-

tion, cities throughout the world are restricting car use and turning to light rail to provide mobility. As efforts to reforest the earth gain momentum, and as tree plantations expand, tree planting will emerge as a leading economic activity.⁶⁵

Restructuring the global economy will create not only new industries, but also new jobs—indeed, whole new professions and new specialties within professions. Turning to wind in a big way will require thousands of wind meteorologists to analyze potential wind sites, identifying the best sites for wind farms. The role of wind meteorologists in the new economy will be comparable to that of petroleum geologists in the old economy.

There is a growing demand for environmental architects who can design buildings that are energy- and materials-efficient and that maximize natural heating, cooling, and lighting. In a future of water scarcity, watershed hydrologists will be needed to study the local hydrological cycle, including the movement of underground water, and to determine the sustainable yield of aquifers. They will be at the center of watershed management regimes.

As the world shifts from a throwaway economy, engineers will be needed to design products that can be recycled—from cars to computers. Once products are designed to be disassembled quickly and easily into component parts and materials, comprehensive recycling is relatively easy. These engineers will be responsible for closing the materials loop, converting the linear flow-through (throwaway) economy into a recycling economy.

In countries with a wealth of geothermal energy, it will be up to geothermal geologists to locate the best sites either for power plants or for tapping this underground energy directly to heat buildings. Retraining petroleum geologists to master geothermal technologies is one way of satisfying the likely surge in demand for geothermal geologists.

Another pressing need, particularly in developing countries, is for sanitary engineers who can design sewage systems using waterless, odorless, composting toilets, a trend that is already under way in some water-scarce communities. Yet another growing demand will be for agronomists who specialize in multiple cropping and intercropping. This requires an expertise both in the breeding and selection of crops that can fit together in a tight rotation in various locales and in agricultural practices that facilitate multiple cropping.

Corporations will obviously be challenged by economic restructuring, but so too will universities. Economic restructuring means a demand for new professions such as wind meteorologists, energy architects, and recycling engineers and thus for courses to train tomorrow's professionals.

The Environmental Revolution

Restructuring the global economy according to the principles of ecology represents the greatest investment opportunity in history. In scale, the Environmental Revolution is comparable to the Agricultural and Industrial Revolutions that preceded it.

The Agricultural Revolution involved restructuring the food economy, shifting from a nomadic life-style based on hunting and gathering to a settled life-style based on tilling the soil. Although agriculture started as a supplement to hunting and gathering, it eventually replaced it almost entirely. The Agricultural Revolution eventually cleared one tenth of the earth's land surface of either grass or trees so it could be plowed and planted to crops. Unlike the hunter-gatherer culture that had little effect on the earth, this new farming culture literally transformed the earth's surface.⁶⁶

The Industrial Revolution has been under way for two centuries, although in some countries it is still in its early stages. At its foundation was a shift from wood to fossil fuels, a shift that set the stage for a massive expansion in economic activity. Indeed, its distinguishing feature is the harnessing of vast amounts of solar energy stored beneath the earth's surface as fossil fuels. While the Agricultural Revolution transformed the earth's surface, the Industrial Revolution is transforming the earth's atmosphere.

The additional productivity that the Industrial Revolution made possible unleashed enormous creative energies. It also gave birth to new life-styles and to the most environmentally destructive era in human history, setting the world firmly on a course of eventual economic decline.

The Environmental Revolution resembles the Industrial Revolution in that each is dependent on the shift to a new energy source. And like both earlier revolutions, the Environmental Revolution will affect the entire world.

There are differences in scale, timing, and origin among the

three revolutions. Unlike the first two, the Environmental Revolution must be compressed into a matter of decades. The other revolutions were driven by new discoveries, by advances in technology, whereas this revolution, while it will be facilitated by new technologies, is being driven by our need to make peace with nature.

As noted earlier, there has not been an investment situation like this before. The \$1.7 trillion that the world spends now each year on oil, the leading source of energy, provides some insight into how much it could spend on energy in the eco-economy. One difference between the investments in fossil fuels and those in wind power, solar cells, and geothermal energy is that the latter are not depletable.⁶⁷

For developing countries dependent on imported oil, the new energy sources promise to free up capital for investment in domestic energy sources. Not many countries have their own oil fields, but all have wind and solar energy waiting to be harnessed. In terms of economic expansion and job generation, these new energy technologies are a godsend. Investments in energy efficiency will grow rapidly simply because they are profitable. In virtually all countries, saved energy is the cheapest source of new energy.

There are also abundant investment opportunities in the food economy. It is likely that the world demand for seafood, for example, will increase at least by half over the next 50 years, and perhaps much more. If so, fish farming output—now 42 million tons a year—will roughly need to double, as will the investments in fish farming. Although aquaculture's growth is likely to slow from the 9 percent a year of the last decade, it nonetheless presents a promising investment opportunity.⁶⁸

A similar situation exists for tree plantations. As of 2000, tree plantations covered some 187 million hectares. An expansion of these by at least half will be needed both to satisfy future demand and to reduce pressures on natural forests.⁶⁹

No sector of the global economy will be untouched by the Environmental Revolution. In this new economy, some companies will be winners and some will be losers. Those who participate in building the new economy will be the winners. Those who cling to the past risk becoming part of it.