
Beyond Greening: Strategies for a Sustainable World

by Stuart L. Hart



Harvard Business Review

Vestas[®]
No. 1 in Modern Energy

Reprint 97105

The image is a grayscale composite. In the upper left, a globe shows the outlines of continents. In the center, a magnifying glass is held over a landscape of rolling hills. In the lower right, there is a pattern of binary code (0s and 1s) that appears to be on a screen or document. A black horizontal bar is positioned across the middle of the image, containing the text 'Beyond Greening:'.

Beyond Greening:

The environmental revolution has been almost three decades in the making, and it has changed forever how companies do business. In the 1960s and 1970s, corporations were in a state of denial regarding their impact on the environment. Then a series of highly visible ecological problems created a groundswell of support for strict government regulation. In the United States, Lake Erie was dead. In Europe, the Rhine was on fire. In Japan, people were dying of mercury poisoning.

Today many companies have accepted their responsibility to do no harm to the environment. Products and production processes are becoming cleaner; and where such change is under way, the environment is on the mend. In the industrialized nations, more and more companies are “going green” as they realize that they can reduce pollution and increase profits simultaneously. We have come a long way.

fer to as its carrying capacity. Increasingly, the scourges of the late twentieth century—depleted farmland, fisheries, and forests; choking urban pollution; poverty; infectious disease; and migration—are spilling over geopolitical borders. The simple fact is this: in meeting our needs, we are destroying the ability of future generations to meet theirs.

The roots of the problem—explosive population growth and rapid economic development in the emerging economies—are political and social issues that exceed the mandate and the capabilities of any corporation. At the same time, corporations are the only organizations with the resources, the technology, the global reach, and, ultimately, the motivation to achieve sustainability.

It is easy to state the case in the negative: faced with impoverished customers, degraded environments, failing political systems, and unraveling societies, it will be increasingly difficult for cor-

Strategies for a Sustainable World

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But the distance we’ve traveled will seem small when, in 30 years, we look back at the 1990s. Beyond greening lies an enormous challenge—and an enormous opportunity. The challenge is to develop a *sustainable global economy*: an economy that the planet is capable of supporting indefinitely. Although we may be approaching ecological recovery in the developed world, the planet as a whole remains on an unsustainable course. Those who think that sustainability is only a matter of pollution control are missing the bigger picture. Even if all the companies in the developed world were to achieve zero emissions by the year 2000, the earth would still be stressed beyond what biologists re-

porations to do business. But the positive case is even more powerful. The more we learn about the challenges of sustainability, the clearer it is that we are poised at the threshold of a historic moment in which many of the world’s industries may be transformed.

To date, the business logic for greening has been largely operational or technical: bottom-up pollution-prevention programs have saved companies

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billions of dollars. However, few executives realize that environmental opportunities might actually become a major source of *revenue growth*. Greening has been framed in terms of risk reduction, reengineering, or cost cutting. Rarely is greening linked to strategy or technology development, and as a result, most companies fail to recognize opportunities of potentially staggering proportions.

Worlds in Collision

The achievement of sustainability will mean billions of dollars in products, services, and technologies that barely exist today. Whereas yesterday's businesses were often oblivious to their negative impact on the environment and today's responsible businesses strive for zero impact, tomorrow's businesses must learn to make a positive impact. Increasingly, companies will be selling solutions to the world's environmental problems.

Envisioning tomorrow's businesses, therefore, requires a clear understanding of those problems. To move beyond greening to sustainability, we must first unravel a complex set of global interdependencies. In fact, the global economy is really three different, overlapping economies.

The *market economy* is the familiar world of commerce comprising both the developed nations and the emerging economies.¹ About a billion people—one-sixth of the world's population—live in the developed countries of the market economy. Those affluent societies account for more than 75% of the world's energy and resource consumption and create the bulk of industrial, toxic, and consumer waste. The developed economies thus leave large ecological *footprints*—defined as the amount of land required to meet a typical consumer's needs. (See the exhibit "Ecological Footprints.")

Despite such intense use of energy and materials, however, levels of pollution are relatively low in the developed economies. Three factors account for this seeming paradox: stringent environmental regulations, the greening of industry, and the relocation of the most polluting activities (such as commodity processing and heavy manufacturing) to the emerging market economies. Thus to some extent the greening of the developed world has been at the expense of the environments in emerging economies. Given the much larger population base in those countries, their rapid industrialization could easily offset the environmental gains made in the developed economies. Consider, for example, that the emerging economies in Asia and Latin America

Increasingly, companies

(and now Eastern Europe and the former Soviet Union) have added nearly 2 billion people to the market economy over the past 40 years.

With economic growth comes urbanization. Today one of every three people in the world lives in a city. By 2025, it will be two out of three. Demographers predict that by that year there will be well over 30 megacities with populations exceeding 8 million and more than 500 cities with populations exceeding 1 million. Urbanization on this scale presents enormous infrastructural and environmental challenges.

Because industrialization has focused initially on commodities and heavy manufacturing, cities in many emerging economies suffer from oppressive levels of pollution. Acid rain is a growing problem, especially in places where coal combustion is unregulated. The World Bank estimates that by 2010 there will be more than 1 billion motor vehicles in

Ecological Footprints



In the United States, it takes 12.2 acres to supply the average person's basic needs; in the Netherlands, 8 acres; in India, 1 acre. The Dutch ecological footprint covers 15 times the area of the Netherlands, whereas India's footprint exceeds its area by only about 35%. Most strikingly, if the entire world lived like North Americans, it would take three planet Earths to support the present world population.

Source: Donella Meadows, "Our 'Footprints' Are Treading Too Much Earth," *Charleston (S.C.) Gazette*, April 1, 1996.

the world. Concentrated in cities, they will double current levels of energy use, smog precursors, and emissions of greenhouse gas.

The second economy is the *survival economy*: the traditional, village-based way of life found in the rural parts of most developing countries. It is made up of 3 billion people, mainly Africans, Indians, and Chinese who are subsistence oriented and meet their basic needs directly from nature. Demographers generally agree that the world's population, currently growing by about 90 million people per year, will roughly double over the next 40 years. The developing nations will account for 90% of that growth, and most of it will occur in the survival economy.

The third economy is *nature's economy*, which consists of the natural systems and resources that support the market and the survival economies. Nonrenewable resources, such as oil, metals, and other minerals, are finite. Renewable resources, such as soils and forests, will replenish themselves—as long as their use does not exceed critical thresholds.

Technological innovations have created substitutes for many commonly used nonrenewable resources; for example, optical fiber now replaces copper wire. And in the developed economies, demand for some virgin materials may actually diminish in the decades ahead because of reuse and recycling. Ironically, the greatest threat to sustain-

will sell solutions to the world's environmental problems.

Owing in part to the rapid expansion of the market economy, existence in the survival economy is becoming increasingly precarious. Extractive industries and infrastructure development have, in many cases, degraded the ecosystems upon which the survival economy depends. Rural populations are driven further into poverty as they compete for scarce natural resources. Women and children now spend on average four to six hours per day searching for fuelwood and four to six hours per week drawing and carrying water. Ironically, those conditions encourage high fertility rates because, in the short run, children help the family to garner needed resources. But in the long run, population growth in the survival economy only reinforces a vicious cycle of resource depletion and poverty.

Short-term survival pressures often force these rapidly growing rural populations into practices that cause long-term damage to forests, soil, and water. When wood becomes scarce, people burn dung for fuel, one of the greatest—and least well-known—environmental hazards in the world today. Contaminated drinking water is an equally grave problem. The World Health Organization estimates that burning dung and drinking contaminated water together cause 8 million deaths per year.

As it becomes more and more difficult to live off the land, millions of desperate people migrate to already overcrowded cities. In China, for example, an estimated 120 million people now roam from city to city, landless and jobless, driven from their villages by deforestation, soil erosion, floods, or droughts. Worldwide, the number of such “environmental refugees” from the survival economy may be as high as 500 million people, and the figure is growing.

able development today is depletion of the world's *renewable* resources.

Forests, soils, water, and fisheries are all being pushed beyond their limits by human population growth and rapid industrial development. Insufficient fresh water may prove to be the most vexing problem in the developing world over the next decade, as agricultural, commercial, and residential uses increase. Water tables are being drawn down at an alarming rate, especially in the most heavily populated nations, such as China and India.

Soil is another resource at risk. More than 10% of the world's topsoil has been seriously eroded. Available cropland and rangeland are shrinking. Existing crop varieties are no longer responding to increased use of fertilizer. As a consequence, per capita world production of both grain and meat peaked and began to decline during the 1980s. Meanwhile, the world's 18 major oceanic fisheries have now reached or actually exceeded their maximum sustainable yields.

By some estimates, humankind now uses more than 40% of the planet's net primary productivity. If, as projected, the population doubles over the next 40 years, we may outcompete most other animal species for food, driving many to extinction. In short, human activity now exceeds sustainability on a global scale. (See the exhibit “Major Challenges to Sustainability.”)

As we approach the twenty-first century, the interdependence of the three economic spheres is increasingly evident. In fact, the three economies have become worlds in collision, creating the major social and environmental challenges facing the planet: climate change, pollution, resource depletion, poverty, and inequality.

Major Challenges to Sustainability

| | Pollution | Depletion | Poverty |
|---------------------|--|--|--|
| Developed economies | <ul style="list-style-type: none"> -greenhouse gases -use of toxic materials -contaminated sites | <ul style="list-style-type: none"> -scarcity of materials -insufficient reuse and recycling | <ul style="list-style-type: none"> -urban and minority unemployment |
| Emerging economies | <ul style="list-style-type: none"> -industrial emissions -contaminated water -lack of sewage treatment | <ul style="list-style-type: none"> -overexploitation of renewable resources -overuse of water for irrigation | <ul style="list-style-type: none"> -migration to cities -lack of skilled workers -income inequality |
| Survival economies | <ul style="list-style-type: none"> -dung and wood burning -lack of sanitation -ecosystem destruction due to development | <ul style="list-style-type: none"> -deforestation -overgrazing -soil loss | <ul style="list-style-type: none"> -population growth -low status of women -dislocation |

Consider, for example, that the average American today consumes 17 times more than his or her Mexican counterpart (emerging economy) and hundreds of times more than the average Ethiopian (survival economy). The levels of material and energy consumption in the United States require large quantities of raw materials and commodities, sourced increasingly from the survival economy and produced in emerging economies.

In the survival economy, massive infrastructure development (for example, dams, irrigation projects, highways, mining operations, and power generation projects), often aided by agencies, banks, and corporations in the developed countries, has provided access to raw materials. Unfortunately, such development has often had devastating consequences for nature's economy and has tended to strengthen existing political and economic elites, with little benefit to those in the survival economy.

their terms of trade have become less favorable. Their purchasing power declines while their already substantial debt load becomes even larger. The net effect of this dynamic has been the transfer of vast amounts of wealth (estimated at \$40 billion per year since 1985) from developing to developed countries, producing a vicious cycle of resource exploitation and pollution to service mounting debt. Today developing nations have a combined debt of more than \$1.2 trillion, equal to nearly half of their collective gross national product.

Strategies for a Sustainable World

Nearly three decades ago, environmentalists such as Paul Ehrlich and Barry Commoner made this simple but powerful observation about sustainable development: the total environmental burden (EB) created by human activity is a function

Emerging economies cannot afford to repeat the mistakes

At the same time, infrastructure development projects have contributed to a global glut of raw materials and hence to a long-term fall in commodity prices. And as commodity prices have fallen relative to the prices of manufactured goods, the currencies of developing countries have weakened and

of three factors. They are population (P); affluence (A), which is a proxy for consumption; and technology (T), which is how wealth is created. The product of these three factors determines the total environmental burden. It can be expressed as a formula: $EB = P \times A \times T$.

Achieving sustainability will require stabilizing or reducing the environmental burden. That can be done by decreasing the human population, lowering the level of affluence (consumption), or changing fundamentally the technology used to create wealth. The first option, lowering the human population, does not appear feasible short of draconian political measures or the occurrence of a major public-health crisis that causes mass mortality.

The second option, decreasing the level of affluence, would only make the problem worse, because poverty and population growth go hand in hand: demographers have long known that birth rates are inversely correlated with level of education and standard of living. Thus stabilizing the human population will require improving the education and economic standing of the world's poor, particularly women of childbearing age. That can be accomplished only by creating wealth on a massive scale. Indeed, it may be necessary to grow the world economy as much as tenfold just to provide basic amenities to a population of 8 billion to 10 billion.

That leaves the third option: changing the technology used to create the goods and services that constitute the world's wealth. Although population and consumption may be societal issues, technology is the business of business.

If economic activity must increase tenfold over what it is today just to provide the bare essentials to a population double its current size, then technology will have to improve twentyfold merely to keep the planet at its current levels of environmental burden. Those who believe that ecological disaster will somehow be averted must also appreciate the commercial implications of such a belief: over the next decade or so, sustainable development will constitute one of the biggest opportunities in the history of commerce.

Nevertheless, as of today few companies have incorporated sustainability into their strategic thinking. Instead, environmental strategy consists largely of piecemeal projects aimed at controlling or preventing pollution. Focusing on sustainability requires putting business strategies to a new test. Taking the entire planet as the context in which

of Western development.

they do business, companies must ask whether they are part of the solution to social and environmental problems or part of the problem. Only when a company thinks in those terms can it begin to develop a vision of sustainability—a shaping logic that goes beyond today's internal, operational focus

on greening to a more external, strategic focus on sustainable development. Such a vision is needed to guide companies through three stages of environmental strategy.

Stage One: Pollution Prevention. The first step for most companies is to make the shift from pollution control to pollution prevention. Pollution control means cleaning up waste after it has been created. Pollution prevention focuses on minimizing or eliminating waste before it is created. Much like total quality management, pollution prevention strategies depend on continuous improvement efforts to reduce waste and energy use. This transformation is driven by a compelling logic: pollution prevention pays. Emerging global standards for environmental management systems (ISO 14,000, for example) also have created strong incentives for companies to develop such capabilities.

Over the past decade, companies have sought to avoid colliding with nature's economy (and incurring the associated added costs) through greening and prevention strategies. Aeroquip Corporation, a \$2.5 billion manufacturer of hoses, fittings, and couplings, saw an opportunity here. Like most industrial suppliers, Aeroquip never thought of itself as a provider of environmental solutions. But in 1990, its executives realized that the company's products might be especially valuable in meeting the need to reduce waste and prevent pollution. Aeroquip has generated a \$250 million business by focusing its attention on developing products that reduce emissions. As companies in emerging economies realize the competitive benefits of using raw materials and resources more productively, businesses like Aeroquip's will continue to grow.

The emerging economies cannot afford to repeat all the environmental mistakes of Western development. With the sustainability imperative in mind, BASF, the German chemical giant, is helping to design and build chemical industries in China, India, Indonesia, and Malaysia that are less polluting than in the past. By colocating facilities that in the West have been geographically dispersed, BASF is able to create industrial ecosystems in which the waste from one process becomes the raw material for another. Colocation solves a problem common in the West, where recycling waste is often infeasible because transporting it from one site to another is dangerous and costly.

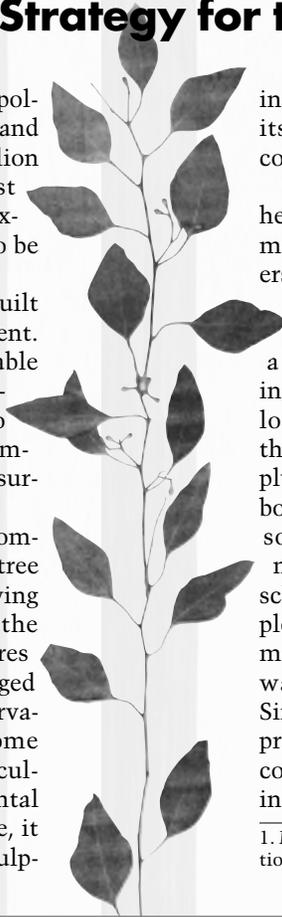
Stage Two: Product Stewardship. Product stewardship focuses on minimizing not only pollution from manufacturing but also all environmental impacts associated with the full life cycle of a product. As companies in stage one move closer to zero emissions, reducing the use of materials and pro-

Aracruz Celulose: A Strategy for the Survival Economy

"Poverty is one of the world's leading polluters," notes Erling Lorentzen, founder and chairman of Aracruz Celulose. The \$2 billion Brazilian company is the world's largest producer of eucalyptus pulp. "You can't expect people who don't eat a proper meal to be concerned about the environment."¹

From the very start, Aracruz has been built around a vision of sustainable development. Lorentzen understood that building a viable forest-products business in Brazil's impoverished and deforested state of Espírito Santo would require the simultaneous improvement of nature's economy and the survival economy.

First, to restore nature's economy, the company took advantage of a tax incentive for tree planting in the late 1960s and began buying and reforesting cut-over land. By 1992, the company had acquired over 200,000 hectares and planted 130,000 hectares with managed eucalyptus; the rest was restored as conservation land. By reforesting what had become highly degraded land, unsuitable for agriculture, the company addressed a fundamental environmental problem. At the same time, it created a first-rate source of fiber for its pulp-



ing operations. Aracruz's forest practices and its ability to clone seedlings have given the company advantages in both cost and quality.

Aracruz has tackled the problem of poverty head-on. Every year, the company gives away millions of eucalyptus seedlings to local farmers. It is a preemptive strategy, aimed at reducing the farmers' need to deplete the natural forests for fuel or lumber. Aracruz also has a long-term commitment to capability building. In the early years, Aracruz was able to hire local people for very low wages because of their desperate situation. But instead of simply exploiting the abundant supply of cheap labor, the company embarked on an aggressive social-investment strategy, spending \$125 million to support the creation of hospitals, schools, housing, and a training center for employees. In fact, until recently, Aracruz spent more on its social investments than it did on wages (about \$1.20 for every \$1 in wages). Since that time, the standard of living has improved dramatically, as has productivity. The company no longer needs to invest so heavily in social infrastructure.

1. Marguerite Rigoglioso, "Stewards of the Seventh Generation," *Harvard Business School Bulletin*, April 1996, p. 55.

duction of waste requires fundamental changes in underlying product and process design.

Design for environment (DFE), a tool for creating products that are easier to recover, reuse, or recycle, is becoming increasingly important. With DFE, all the effects that a product could have on the environment are examined during its design phase. Cradle-to-grave analysis begins and ends outside the boundaries of a company's operations—it includes a full assessment of all inputs to the product and examines how customers use and dispose of it. DFE thus captures a broad range of external perspectives by including technical staff, environmental experts, end customers, and even community representatives in the process. Dow Chemical Company has pioneered the use of a board-level advisory panel of environmental experts and external representatives to aid its product-stewardship efforts.

By reducing materials and energy consumption, DFE can be highly profitable. Consider Xerox Corporation's Asset Recycle Management (ARM) program, which uses leased Xerox copiers as sources of high-quality, low-cost parts and components for

new machines. A well-developed infrastructure for taking back leased copiers combined with a sophisticated remanufacturing process allows parts and components to be reconditioned, tested, and then reassembled into "new" machines. Xerox estimates that ARM savings in raw materials, labor, and waste disposal in 1995 alone were in the \$300-

Without a framework for

million to \$400-million range. In taking recycling to this level, Xerox has reconceptualized its business. By redefining the product-in-use as part of the company's asset base, Xerox has discovered a way to add value and lower costs. It can continually provide its lease customers with the latest product upgrades, giving them state-of-the-art functionality with minimal environmental impact.

Product stewardship is thus one way to reduce consumption in the developed economies. It may also aid the quest for sustainability because developing nations often try to emulate what they see

happening in the developed nations. Properly executed, product stewardship also offers the potential for revenue growth through product differentiation. For example, Dunlop Tire Corporation and Akzo Nobel recently announced a new radial tire that makes use of an aramid fiber belt rather than the conventional steel belt. The new design makes recycling easier because it eliminates the expensive cryogenic crushing required to separate the steel belts from the tire's other materials. Because the new fiber-belt tire is 30% lighter, it dramatically improves gas mileage. Moreover, it is a safer tire because it improves the traction control of antilock braking systems.

The evolution from pollution prevention to product stewardship is now happening in multinational companies such as Dow, DuPont, Monsanto, Xerox, ABB, Philips, and Sony. For example, as part of a larger sustainability strategy dubbed A Growing Partnership with Nature, DuPont's agricultural-products business developed a new type of herbicide that has helped farmers around the world reduce their annual use of chemicals by more than 45 million pounds. The new Sulfonylurea herbicides have also led to a 1-billion-pound reduction in the amount of chemical waste produced in the manufacture of agricultural chemicals. These herbicides are effective at 1% to 5% of the application rates of traditional chemicals, are nontoxic to animals and nontarget species, and biodegrade in the soil, leaving virtually no residue on crops. Because they require so much less material in their manufacture, they are also highly profitable.

Stage Three: Clean Technology. Companies with their eye on the future can begin to plan for and invest in tomorrow's technologies. The simple fact is that the existing technology base in many industries is not environmentally sustainable. The chemical industry, for example, while having made

bioengineering of crops rather than the application of chemical pesticides or fertilizers represents a sustainable path to increased agricultural yields. (See "Growth Through Global Sustainability: An Interview with Monsanto's CEO, Robert B. Shapiro," by Joan Magretta, in this issue of HBR.)

Clean technologies are desperately needed in the emerging economies of Asia. Urban pollution there has reached oppressive levels. But precisely because manufacturing growth is so high—capital stock doubles every six years—there is an unprecedented opportunity to replace current product and process technologies with new, cleaner ones.

Japan's Research Institute for Innovative Technology for the Earth is one of several new research and technology consortia focusing on the development and commercialization of clean technologies for the developing world. Having been provided with funding and staff by the Japanese government and more than 40 corporations, RITE has set forth an ambitious 100-year plan to create the next generation of power technology, which will eliminate or neutralize greenhouse gas emissions.

Sustainability Vision

Pollution prevention, product stewardship, and clean technology all move a company toward sustainability. But without a framework to give direction to those activities, their impact will dissipate. A vision of sustainability for an industry or a company is like a road map to the future, showing the way products and services must evolve and what new competencies will be needed to get there. Few companies today have such a road map. Ironically, chemical companies, regarded only a decade ago as the worst environmental villains, are among the few large corporations to have engaged the challenge of sustainable development seriously.

environmental activities, their impact will dissipate.

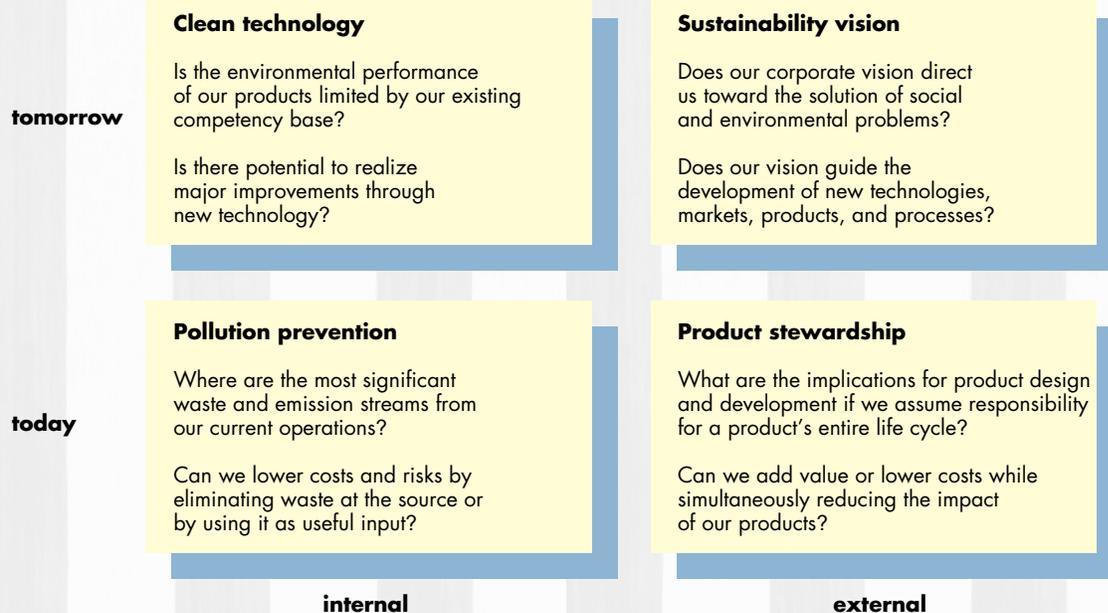
substantial headway over the past decade in pollution prevention and product stewardship, is still limited by its dependence on the chlorine molecule. (Many organochlorides are toxic or persistent or bioaccumulative.) As long as the industry relies on its historical competencies in chlorine chemistry, it will have trouble making major progress toward sustainability.

Monsanto is one company that is consciously developing new competencies. It is shifting the technology base for its agriculture business from bulk chemicals to biotechnology. It is betting that the

Companies can begin by taking stock of each component of what I call their *sustainability portfolio*. (See the exhibit "The Sustainability Portfolio.") Is there an overarching vision of sustainability that gives direction to the company's activities? To what extent has the company progressed through the three stages of environmental strategy—from pollution prevention to product stewardship to clean technology?

Consider the auto industry. During the 1970s, government regulation of tailpipe emissions forced the industry to focus on pollution control. In the

The Sustainability Portfolio



This simple diagnostic tool can help any company determine whether its strategy is consistent with sustainability. First, assess your company's capability in each of the four quadrants by answering the questions in each box. Then rate yourself on the following scale for each quadrant: 1—nonexistent; 2—emerging; 3—established; or 4—institutionalized.

Most companies will be heavily skewed toward the lower left-hand quadrant, reflecting investment in pollution prevention. However, without investments in future technologies and markets (the upper half of the portfolio), the company's environmental strategy will not meet evolving needs.

Unbalanced portfolios spell trouble: a bottom-heavy portfolio suggests a good position today but future vulnerability. A top-heavy portfolio indicates a vision of sustainability without the operational or analytical skills needed to implement it. A portfolio skewed to the left side of the chart indicates a preoccupation with handling the environmental challenge through internal process improvements and technology-development initiatives. Finally, a portfolio skewed to the right side, although highly open and public, runs the risk of being labeled a "greenwash" because the underlying plant operations and core technology still cause significant environmental harm.

1980s, the industry began to tackle pollution prevention. Initiatives such as the Corporate Average Fuel Efficiency requirement and the Toxic Release Inventory led auto companies to examine their product designs and manufacturing processes in order to improve fuel economy and lower emissions from their plants.

The 1990s are witnessing the first signs of product stewardship. In Germany, the 1990 "take-back" law required auto manufacturers to take responsibility for their vehicles at the end of their useful lives. Innovators such as BMW have influenced the design of new cars with their *design for disassembly* efforts. Industry-level consortia such as the Partnership for a New Generation of Vehicles are driven largely by the product stewardship logic of lowering the environmental impact of automobiles throughout their life cycle.

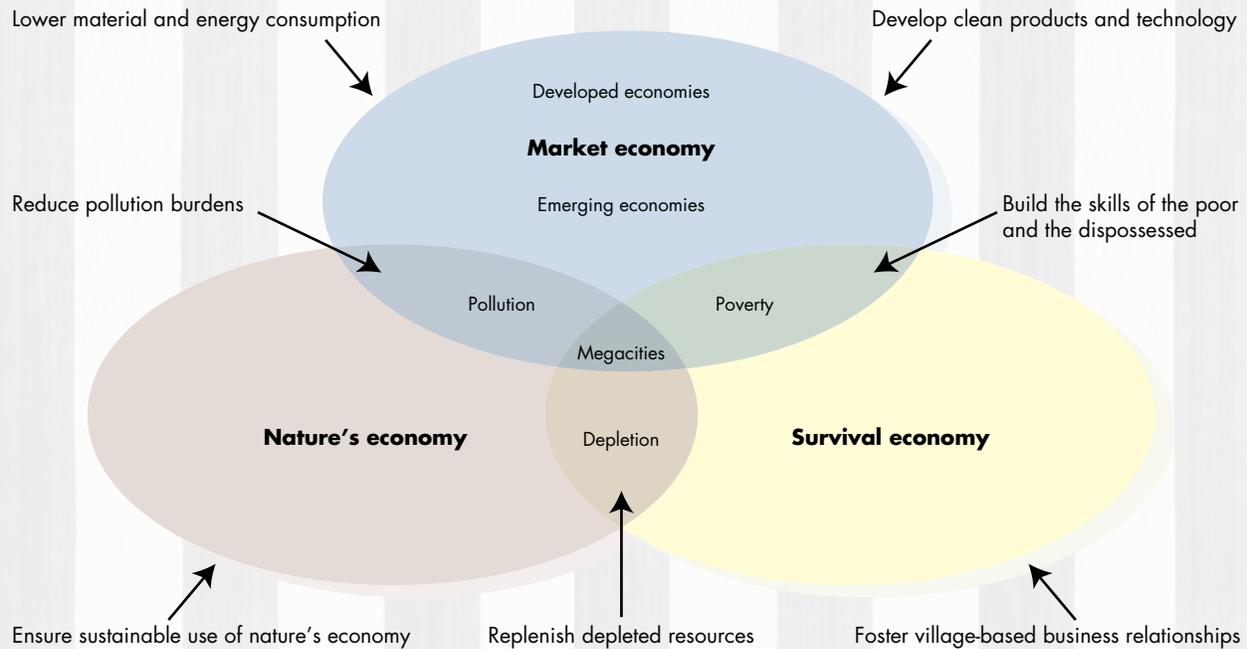
Early attempts to promote clean technology include such initiatives as California's zero-emission vehicle law and the U.N. Climate Change Conven-

tion, which ultimately will limit greenhouse gases on a global scale. But early efforts by industry incumbents have been either incremental—for example, natural-gas vehicles—or defensive in nature. Electric-vehicle programs, for instance, have been used to demonstrate the infeasibility of this technology rather than to lead the industry to a fundamentally cleaner technology.

Although the auto industry has made progress, it falls far short of sustainability. For the vast majority of auto companies, pollution prevention and product stewardship are the end of the road. Most auto executives assume that if they close the loop in both production and design, they will have accomplished all the necessary environmental objectives.

But step back and try to imagine a sustainable vision for the industry. Growth in the emerging markets will generate massive transportation needs in the coming decades. Already the rush is on to stake out positions in China, India, and Latin America. But what form will this opportunity take?

Building Sustainable Business Strategies



Consider the potential impact of automobiles on China alone. Today there are fewer than 1 million cars on the road in China. However, with a population of more than 1 billion, it would take less than 30% market penetration to equal the current size of the U.S. car market (12 million to 15 million units sold per year). Ultimately, China might demand 50 million or more units annually. Because China's energy and transportation infrastructures are still being defined, there is an opportunity to develop a clean technology yielding important environmental and competitive benefits.

Amory Lovins of the Rocky Mountain Institute has demonstrated the feasibility of building *hypercars*—vehicles that are fully recyclable, 20 times more energy efficient, 100 times cleaner, and cheaper than existing cars. These vehicles retain the safety and performance of conventional cars but achieve radical simplification through the use of lightweight, composite materials, fewer parts, virtual prototyping, regenerative braking, and very small, hybrid engines. Hypercars, which are more akin to computers on wheels than to cars with microchips, may render obsolete most of the competencies associated with today's auto manufacturing—for example, metal stamping, tool and die making, and the internal combustion engine.

Assume for a minute that clean technology like the hypercar or Mazda's soon-to-be-released hydrogen rotary engine can be developed for a market

such as China's. Now try to envision a transportation infrastructure capable of accommodating so many cars. How long will it take before gridlock and traffic jams force the auto industry to a halt? Sustainability will require new transportation solutions for the needs of emerging economies with huge populations. Will the giants in the auto industry be prepared for such radical change, or will they leave the field to new ventures that are not encumbered by the competencies of the past?

A clear and fully integrated environmental strategy should not only guide competency development, it should also shape the company's relationship to customers, suppliers, other companies, policymakers, and all its stakeholders. Companies can and must change the way customers think by creating preferences for products and services consistent with sustainability. Companies must become educators rather than mere marketers of products. (See the exhibit "Building Sustainable Business Strategies.")

For senior executives, embracing the quest for sustainability may well require a leap of faith. Some may feel that the risks associated with investing in unstable and unfamiliar markets outweigh the potential benefits. Others will recognize the power of such a positive mission to galvanize people in their organizations.

Regardless of their opinions on sustainability, executives will not be able to keep their heads in

the sand for long. Since 1980, foreign direct investment by multinational corporations has increased from \$500 billion to nearly \$3 trillion per year. In fact, it now exceeds official development-assistance aid in developing countries. With free trade on the rise, the next decade may see the figure increase by another order of magnitude. The challenges presented by emerging markets in Asia and Latin America demand a new way of conceptualizing business opportunities. The rapid growth in emerging economies cannot be sustained in the face of mounting environmental deterioration, poverty, and resource depletion. In the coming decade, companies will be challenged to develop clean technologies and to implement strategies that drastically reduce the environmental burden in the

developing world while simultaneously increasing its wealth and standard of living.

Like it or not, the responsibility for ensuring a sustainable world falls largely on the shoulders of the world's enterprises, the economic engines of the future. Clearly, public policy innovations (at both the national and international levels) and changes in individual consumption patterns will be needed to move toward sustainability. But corporations can and should lead the way, helping to shape public policy and driving change in consumers' behavior. In the final analysis, it makes good business sense to pursue strategies for a sustainable world.

1. The terms *market economy*, *survival economy*, and *nature's economy* were suggested to me by Vandana Shiva, *Ecology and the Politics of Survival* (New Delhi: United Nations University Press, 1991).

Reprint 97105

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