Plan B 2.0

Rescuing a Planet Under Stress and a Civilization in Trouble

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Entering a New World

Our global economy is outgrowing the capacity of the earth to support it, moving our early twenty-first century civilization ever closer to decline and possible collapse. In our preoccupation with quarterly earnings reports and year-to-year economic growth, we have lost sight of how large the human enterprise has become relative to the earth's resources. A century ago, annual growth in the world economy was measured in billions of dollars. Today it is measured in trillions.

As a result, we are consuming renewable resources faster than they can regenerate. Forests are shrinking, grasslands are deteriorating, water tables are falling, fisheries are collapsing, and soils are eroding. We are using up oil at a pace that leaves little time to plan beyond peak oil. And we are discharging greenhouse gases into the atmosphere faster than nature can absorb them, setting the stage for a rise in the earth's temperature well above any since agriculture began.

Our twenty-first century civilization is not the first to move onto an economic path that was environmentally unsustainable. Many earlier civilizations also found themselves in environmental trouble. As Jared Diamond notes in *Collapse: How Societies*

Choose to Fail or Succeed, some were able to change course and avoid economic decline. Others were not. We study the archeological sites of Sumerians, the Mayans, Easter Islanders, and other early civilizations that were not able to make the needed adjustments in time.[1]

Fortunately, there is a consensus emerging among scientists on the broad outlines of the changes needed. If economic progress is to be sustained, we need to replace the fossil-fuel-based, automobile-centered, throwaway economy with a new economic model. Instead of being based on fossil fuels, the new economy will be powered by abundant sources of renewable energy: wind, solar, geothermal, hydropower, and biofuels.

Instead of being centered around automobiles, future transportation systems will be far more diverse, widely employing light rail, buses, and bicycles as well as cars. The goal will be to maximize mobility, not automobile ownership.

The throwaway economy will be replaced by a comprehensive reuse/recycle economy. Consumer products from cars to computers will be designed so that they can be disassembled into their component parts and completely recycled. Throwaway products such as single-use beverage containers will be phased out.

The good news is that we can already see glimpses here and there of what this new economy looks like. We have the technologies to build it—including, for example, gas-electric hybrid cars, advanced-design wind turbines, highly efficient refrigerators, and water-efficient irrigation systems.

We can see how to build the new economy brick by brick. With each wind farm, rooftop solar panel, paper recycling facility, bicycle path, and reforestation program, we move closer to an economy that can sustain economic progress.

If, instead, we continue on the current economic path, the question is not whether environmental deterioration will lead to economic decline, but when. No economy, however technologically advanced, can survive the collapse of its environmental support systems.

The Nature of the New World

We recently entered a new century, but we are also entering a new world, one where the collisions between our demands and the earth's capacity to satisfy them are becoming daily events. It may be another crop-withering heat wave, another village abandoned because of invading sand dunes, or another aquifer pumped dry. If we do not act quickly to reverse the trends, these seemingly isolated events will come more and more frequently, accumulating and combining to determine our future.

Resources that accumulated over eons of geological time are being consumed in a single human lifespan. We are crossing natural thresholds that we cannot see and violating deadlines that we do not recognize. These deadlines, determined by nature, are not politically negotiable.

Nature has many thresholds that we discover only when it is too late. In our fast-forward world, we learn that we have crossed them only after the fact, leaving little time to adjust. For example, when we exceed the sustainable catch of a fishery, the stocks begin to shrink. Once this threshold is crossed, we have a limited time in which to back off and lighten the catch. If we fail to meet this deadline, breeding populations shrink to where the fishery is no longer viable, and it collapses.

We know from earlier civilizations that the lead indicators of economic decline were environmental, not economic. The trees went first, then the soil, and finally the civilization itself. To archeologists, the sequence is all too familiar.

Our situation today is far more challenging because in addition to shrinking forests and eroding soils, we must deal with falling water tables, more frequent crop-withering heat waves, collapsing fisheries, expanding deserts, deteriorating rangelands, dying coral reefs, melting glaciers, rising seas, more-powerful storms, disappearing species, and, soon, shrinking oil supplies. Although these ecologically destructive trends have been evident for some time, and some have been reversed at the national level, not one has been reversed at the global level.

The bottom line is that the world is in what ecologists call an "overshoot-and-collapse" mode. Demand has exceeded the sustainable yield of natural systems at the local level countless times in the past. Now, for the first time, it is doing so at the global level. Forests are shrinking for the world as a whole. Fishery collapses are widespread. Grasslands are deteriorating on every continent. Water tables are falling in many countries. Carbon dioxide (CO_2) emissions exceed CO_2 fixation everywhere.

In 2002, a team of scientists led by Mathis Wackernagel, who now heads the Global Footprint Network, concluded that humanity's collective demands first surpassed the earth's regenerative capacity around 1980. Their study, published by the U.S. National Academy of Sciences, estimated that global demands in 1999 exceeded that capacity by 20 percent. The gap, growing by 1 percent or so a year, is now much wider. We are meeting current demands by consuming the earth's natural assets, setting the stage for decline and collapse.[2]

In a rather ingenious approach to calculating the human physical presence on the planet, Paul MacCready, the founder and Chairman of AeroVironment and designer of the first solar-powered aircraft, has calculated the weight of all vertebrates on the land and in the air. He notes that when agriculture began, humans, their livestock, and pets together accounted for less than 0.1 percent of the total. Today, he estimates, this group accounts for 98 percent of the earth's total vertebrate biomass, leaving only 2 percent for the wild portion, the latter including all the deer, wildebeests, elephants, great cats, birds, small mammals, and so forth.[3]

Ecologists are intimately familiar with the overshoot-and-collapse phenomenon. One of their favorite examples began in 1944, when the Coast Guard introduced 29 reindeer on remote St. Matthew Island in the Bering Sea to serve as the backup food source for the 19 men operating a station there. After World War II ended a year later, the base was closed and the men left the island. When U.S. Fish and Wildlife Service biologist David Kline visited St. Matthew in 1957, he discovered a thriving population of 1,350 reindeer feeding on the four-inch-thick mat of lichen that covered the 332-square-kilometer (128-square-mile) island. In the absence of any predators, the population was exploding. By 1963, it had reached 6,000. He returned to St. Matthew in 1966 and discovered an island strewn with reindeer skeletons and not much lichen. Only 42 of the reindeer survived: 41 females and 1 not entirely healthy male. There were no fawns. By 1980 or so, the remaining reindeer had died off.[4]

Like the deer on St. Matthew Island, we too are overconsuming our natural resources. Overshoot leads sometimes to decline and sometimes to a complete collapse. It is not always clear which it will be. In the former, a remnant of the population or economic activity survives in a resource-depleted environment. For example, as the environmental resource base of Easter Island in the South Pacific deteriorated, its population declined from a peak of 20,000 several centuries ago to today's population of fewer than 4,000. In contrast, the 500-year-old Norse settlement in Greenland collapsed during the 1400s, disappearing entirely in the face of environmental adversity.[5]

As of 2005, some 42 countries have populations that are stable or declining slightly in size as a result of falling birth rates. But now for the first time ever, demographers are projecting population declines in some countries because of rising death rates, among them Botswana, Lesotho, Namibia, and Swaziland. In the absence of an accelerated shift to smaller families, this list of countries is likely to grow much longer in the years immediately ahead.[6]

The most recent mid-level U.N. demographic projections show world population increasing from 6.1 billion in 2000 to 9.1 billion in 2050. But such an increase seems highly unlikely, considering the deterioration in life-support systems now under way in much of the world. Will we not reach 9.1 billion because we quickly eradicate global poverty and lower birth rates? Or because we fail to do so and death rates begin to rise, as they are already doing in many African countries? We thus face two urgent major challenges: restructuring the global economy and stabilizing world population.[7]

Even as the economy's environmental support systems are deteriorating, the world is pumping oil with reckless abandon. Leading geologists now think oil production may soon peak and turn downward. This collision between the ever-growing demand for oil and the earth's finite resources is but the latest in a long series of collisions. Although no one knows exactly when oil production will peak, supply is already lagging behind demand, driving prices upward.[8]

In this new world, the price of oil begins to set the price of food, not so much because of rising fuel costs for farmers and food processors but more because almost everything we eat can be converted into fuel for cars. In this new world of high oil prices, supermarkets and service stations will compete in commodity markets for basic food commodities such as wheat, corn, soybeans, and sugarcane. Wheat going into the market can be converted into bread for supermarkets or ethanol for service stations. Soybean oil can go onto supermarket shelves or it can go to service stations to be used as diesel fuel. In effect, owners of the world's 800 million cars will be competing for food resources with the 1.2 billion people living on less than $1 a day.[9]

Faced with a seemingly insatiable demand for automotive fuel, farmers will want to clear more and more of the remaining tropical forests to produce sugarcane, oil palms, and other high-yielding fuel crops. Already, billions of dollars of private capital are moving into this effort. In effect, the rising price of oil is generating a massive new threat to the earth's biological diversity.

As the demand for farm commodities climbs, it is shifting the focus of international trade concerns from the traditional goal of assured access to markets to one of assured access to supplies. Countries heavily dependent on imported grain for food are beginning to worry that buyers for fuel distilleries may outbid them for supplies. As oil security deteriorates, so, too, will food security.

As the role of oil recedes, the process of globalization will be reversed in fundamental ways. As the world turned to oil during the last century, the energy economy became increasingly globalized, with the world depending heavily on a handful of countries in the Middle East for energy supplies. Now as the world turns to wind, solar cells, and geothermal energy in this century, we are witnessing the localization of the world energy economy.

The globalization of the world food economy will also be reversed, as the higher price of oil raises the cost of transporting food internationally. In response, food production and consumption will become much more localized, leading to diets based more on locally produced food and seasonal availability.

The world is facing the emergence of a geopolitics of scarcity, which is already highly visible in the efforts by China, India, and other developing countries to ensure their access to oil supplies. In the future, the issue will be who gets access to not only Middle Eastern oil but also Brazilian ethanol and North American grain. Pressures on land and water resources, already excessive in most of the world, will intensify further as the demand for biofuels climbs. This geopolitics of scarcity is an early manifestation of civilization in an overshoot-and-collapse mode, much like the one that emerged among the Mayan cities competing for food in that civilization's waning years.[10]

You do not need to be an ecologist to see that if recent environmental trends continue, the global economy eventually will come crashing down. It is not knowledge that we lack. At issue is whether national governments can stabilize population and restructure the economy before time runs out. Looking at what is happening in China helps us to see the urgency of acting quickly.

Learning from China

For many years environmentalists have pointed to the United States as the world's leading consumer, noting that 5 percent of the world's people were consuming nearly a third of the earth's resources. Although that was true for some time, it no longer is. China has replaced the United States as the leading consumer of basic commodities.[11]

Among the five basic food, energy, and industrial commodities—grain and meat, oil and coal, and steel—consumption in China has eclipsed that of the United States in all but oil. China has opened a wide lead with grain, consuming 380 million tons in 2005 versus 260 million tons in the United States. Among the big three grains, China leads in the consumption of both wheat and rice and trails the United States only in corn.[12]

Although eating hamburgers is a defining element of the U.S. lifestyle, China's 2005 meat consumption of 67 million tons is far above the 38 million tons eaten in the United States. While U.S. meat intake is rather evenly distributed between beef, pork, and poultry, in China pork totally dominates. Indeed, half the world's pigs are now found in China.[13]

With oil, the United States was still solidly in the lead in 2004, using more than three times as much as China—20.4 million barrels per day versus 6.5 million barrels. But U.S. oil use expanded by only 15 percent between 1994 and 2004, while use in China more than doubled. Having recently eclipsed Japan as an oil consumer, China now trails only the United States.[14]

Energy use in China also obviously includes coal, which supplies nearly two thirds of the country's energy. China's annual burning of 960 million tons easily exceeds the 560 million tons used in the United States. With this level of coal use and with oil and natural gas use also climbing fast, it is only a matter of time before China's carbon emissions match those of the United States. Then the world will have two major countries driving climate change.[15]

China's consumption of steel, a basic indicator of industrial development, is now nearly two and a half times that of the United States: 258 million tons to 104 million tons in 2003. As China has moved into the construction phase of development, building hundreds of thousands of factories and high-rise apartment and office buildings, steel consumption has climbed to levels never seen in any country.[16]

With consumer goods, China leads in the number of cell phones, television sets, and refrigerators. The United States still leads in the number of personal computers, though likely not for much longer, and in automobiles.[17]

That China has overtaken the United States in consumption of basic resources gives us license to ask the next question. What if China catches up with the United States in consumption per person? If the Chinese economy continues to grow at 8 percent a year, by 2031 income per person will equal that in the United States in 2004. If we further assume that consumption patterns of China's affluent population in 2031, by then 1.45 billion, will be roughly similar to those of Americans in 2004, we have a startling answer to our question.[18]

At the current annual U.S. grain consumption of 900 kilograms per person, including industrial use, China's grain consumption in 2031 would equal roughly two thirds of the current world grain harvest. If paper use per person in China in 2031 reaches the current U.S. level, this translates into 305 million tons of paper—double existing world production of 161 million tons. There go the world's forests. And if oil consumption per person reaches the U.S. level by 2031, China will use 99 million barrels of oil a day. The world is currently producing 84 million barrels a day and may never produce much more. This helps explain why China's fast-expanding use of oil is already helping to create a politics of scarcity.[19]

Or consider cars. If China one day should have three cars for every four people, as the United States now does, its fleet would total 1.1 billion vehicles, well beyond the current world fleet of 800 million. Providing the roads, highways, and parking lots for such a fleet would require paving an area roughly equal to China's land in rice, its principal food staple.[20]

The inevitable conclusion to be drawn from these projections is that there are not enough resources for China to reach U.S.

consumption levels. The western economic model—the fossil-fuel-based, automobile-centered, throwaway economy—will not work for China's 1.45 billion in 2031. If it does not work for China, it will not work for India either, which by 2031 is projected to have even more people than China. Nor will it work for the other 3 billion people in developing countries who are also dreaming the "American dream." And in an increasingly integrated world economy, where countries everywhere are competing for the same resources—the same oil, grain, and iron ore—the existing economic model will not work for industrial countries either.[21]

Learning from the Past

Our twenty-first century global civilization is not the first to face the prospect of environmentally induced economic decline. The question is how we will respond. We do have one unique asset at our command—an archeological record that shows us what happened to earlier civilizations that got into environmental trouble and failed to respond.

As Jared Diamond points out in *Collapse*, some of the early societies that were in environmental trouble were able to change their ways in time to avoid decline and collapse. Six centuries ago, for example, Icelanders realized that overgrazing on their grass-covered highlands was leading to extensive soil loss from the inherently thin soils of the region. Rather than lose the grasslands and face economic decline, farmers joined together to determine how many sheep the highlands could sustain and then allocated quotas among themselves, thus preserving their grasslands and avoiding what Garrett Hardin later termed the "tragedy of the commons."[22]

The Icelanders understood the consequences of overgrazing and reduced their sheep numbers to a level that could be sustained. We understand the consequences of burning fossil fuels and the resulting CO_2 buildup in the atmosphere. Unlike the Icelanders who were able to restrict their livestock numbers, we have not been able to restrict our CO_2 emissions.

Not all societies have fared as well as the Icelanders, whose economy continues to produce wool and to thrive. The early Sumerian civilization of the fourth millennium BC was an extraordinary one, advancing far beyond any that had existed before. Its carefully engineered irrigation system gave rise to a highly productive agriculture, one that enabled farmers to produce a food surplus, supporting formation of the first cities. Managing the irrigation system required a sophisticated social organization. The Sumerians had the first cities and the first written language, the cuneiform script.[23]

By any measure it was an extraordinary civilization, but there was an environmental flaw in the design of its irrigation system, one that would eventually undermine its food supply. The water that backed up behind dams built across the Euphrates was diverted onto the land through a network of gravity-fed canals. Some water was used by the crops, some evaporated, and some percolated downward. In this region, where underground drainage was weak, percolation slowly raised the water table. As the water climbed to within inches of the surface, it began to evaporate into the atmosphere, leaving behind salt. Over time, the accumulation of salt on the soil surface lowered its productivity.[24]

As salt accumulated and wheat yields declined, the Sumerians shifted to barley, a more salt-tolerant plant. This postponed Sumer's decline, but it was treating the symptoms, not the cause, of falling crop yields. As salt concentrations continued to build, the yields of barley eventually declined also. The resultant shrinkage of the food supply undermined the economic foundation of this once-great civilization. As land productivity declined, so did the civilization.[25]

Archeologist Robert McC. Adams has studied the site of ancient Sumer on the central floodplain of the Euphrates River, an empty, desolate area now outside the frontiers of cultivation. He describes how the "tangled dunes, long disused canal levees, and the rubble-strewn mounds of former settlement contribute only low, featureless relief. Vegetation is sparse, and in many areas it is almost wholly absent....Yet at one time, here lay the core, the heartland, the oldest urban, literate civilization in the world."[26]

The New World counterpart to Sumer is the Mayan civilization that developed in the lowlands of what is now Guatemala. It flourished from AD 250 until its collapse around AD 900. Like the Sumerians, the Mayans had developed a sophisticated, highly productive agriculture, this one based on raised plots of earth surrounded by canals that supplied water.[27]

As with Sumer, the Mayan demise was apparently linked to a failing food supply. For this New World civilization, it was deforestation and soil erosion that undermined agriculture. Changes in climate may also have played a role. Food shortages apparently triggered civil conflict among the various Mayan cities as they competed for food. Today this region is covered by jungle, reclaimed by nature.[28]

During the later centuries of the Mayan civilization, a new society was evolving on faraway Easter Island, some 166 square kilometers of land in the South Pacific roughly 3,200 kilometers west of South America and 2,200 kilometers from Pitcairn Island, the nearest habitation. Settled around AD 400, this civilization flourished on a volcanic island with rich soils and lush vegetation, including trees that grew 25 meters tall with trunks 2 meters in diameter. Archeological records indicate that the islanders ate mainly seafood, principally dolphins—a mammal that could only be caught by harpoon from large sea-going canoes.[29]

The Easter Island society flourished for several centuries, reaching an estimated population of 20,000. As its human numbers gradually increased, tree cutting exceeded the sustainable yield of forests. Eventually the large trees that were needed to build the sturdy canoes disappeared, depriving islanders of access to the dolphins and dramatically shrinking their food supply. The archeological record shows that at some point human bones became intermingled with the dolphin bones, suggesting a desperate society that had resorted to cannibalism. Today the island has some 2,000 residents.[30]

One unanswerable question about these earlier civilizations was whether they knew what was causing their decline. Did the Sumerians understand that the rising salt content in the soil from water evaporation was reducing their wheat yields? If they knew, were they simply unable to muster the political support needed to lower water tables, just as the world today is struggling unsuccessfully to lower carbon emissions?

These are just three of the many early civilizations that moved onto an economic path that nature could not sustain. We, too, are on such a path. Any one of several trends of environmental degradation could undermine civilization as we know it. Just as the irrigation system that defined the early Sumerian economy had a flaw, so too does the fossil fuel energy system that defines our modern economy. For them it was a rising water table that undermined the economy; for us it is rising CO_2 levels that threaten to disrupt economic progress. In both cases, the trend is invisible.

Whether it resulted from the salting of Sumer's cropland, the deforestation and soil erosion of the Mayans, or the depleted forests and loss of the distant-water fishing capacity of the Easter Islanders, collapse of these early civilizations appears to have been associated with a decline in food supply. Today the annual addition of more than 70 million people to a world population of over 6 billion at a time when water tables are falling, temperatures are rising, and oil supplies will soon be shrinking suggests that the food supply again may be the vulnerable link between the environment and the economy.[31]

The Emerging Politics of Scarcity

The first big test of the international community's capacity to manage scarcity may come with oil or it could come with grain. If the latter is the case, this could occur when China—whose grain harvest fell by 34 million tons, or 9 percent, between 1998 and 2005—turns to the world market for massive imports of 30 million, 50 million, or possibly even 100 million tons of grain per year. Demand on this scale could quickly overwhelm world grain markets. When this happens, China will have to look to the United States, which controls the world's grain exports of over 40 percent of some 200 million tons.[32]

This will pose a fascinating geopolitical situation. More than 1.3 billion Chinese consumers, who had an estimated $160-billion trade surplus with the United States in 2004—enough to buy the entire U.S. grain harvest twice—will be competing with Americans for U.S. grain, driving up U.S. food prices. In such a situation 30 years ago, the United States simply restricted exports. But China is now banker to the United States, underwriting much of the massive U.S. fiscal deficit with monthly purchases of U.S. Treasury bonds.[33]

Within the next few years, the United States may be loading one or two ships a day with grain for China. This long line of ships stretching across the Pacific, like an umbilical cord providing nourishment, will intimately link the two economies. Managing this flow of grain so as to simultaneously satisfy the food needs of consumers in both countries, at a time when ethanol fuel distilleries are taking a growing share of the U.S. grain harvest, may become one of the leading foreign policy challenges of this new century.

The way the world accommodates the vast projected needs of China, India, and other developing countries for grain, oil, and other resources will help determine how the world addresses the stresses associated with outgrowing the earth. How low-income, importing countries fare in this competition for grain will also tell us something about future political stability. And, finally, the U.S. response to China's growing demands for grain even as they drive up food prices for U.S. consumers will tell us much about the capacity of countries to manage the emerging politics of scarcity.

The most imminent risk is that China's entry into the world market, combined with the growing diversion of farm commodities to biofuels, will drive grain prices so high that many low-income developing countries will not be able to import enough grain. This in turn could lead to escalating food prices and political instability on a scale that will disrupt global economic progress.

Earlier civilizations that moved onto an economic path that was environmentally unsustainable did so largely in isolation. But in today's increasingly integrated, interdependent world economy, if we are facing civilizational decline, we are facing it together. The fates of all peoples are intertwined. This interdependence can be managed to our mutual benefit only if we recognize that the term "in the national interest" is in many ways obsolete.

Getting the Price Right

The question facing governments is whether they can respond quickly enough to prevent threats from becoming catastrophes. The world has precious little experience in responding to aquifer depletion, rising temperatures, expanding deserts, melting polar ice caps, and a shrinking oil supply. These new trends will fully challenge the capacity of our political institutions and leadership. In times of crisis, societies sometimes have a Nero as a leader and sometimes a Churchill.

The central challenge, the key to building the new economy, is getting the market to tell the ecological truth. The dysfunctional global economy of today has been shaped by distorted market prices that do not incorporate environmental costs. Many of our environmental travails are the result of severe market distortions.

One of these distortions became abundantly clear in the summer of 1998 when China's Yangtze River valley, home to 400 million people, was wracked by some of the worst flooding in history. The resulting damages of $30 billion exceeded the value of the country's annual rice harvest.[34]

After several weeks of flooding, the government in Beijing announced in mid-August a ban on tree cutting in the Yangtze River basin. It justified the ban by noting that trees standing are worth three times as much as trees cut. The flood control services provided by forests were three times as valuable as the lumber in the trees. In effect, the market price was off by a factor of three! With this analysis, no one could economically justify cutting trees in the basin.[35]

A similar situation exists with gasoline. In the United States, the gasoline pump price was over $2 per gallon in mid-2005. But this reflects only the cost of pumping the oil, refining it into gasoline, and delivering the gas to service stations. It does not include the costs of tax subsidies to the oil industry, such as the oil depletion allowance; the subsidies for the extraction, production, and use of petroleum; the burgeoning military costs of protecting access to oil supplies; the health care costs for treating respiratory illnesses ranging from asthma to emphysema; and, most important, the costs of climate change.[36]

If these costs, which in 1998 the International Center for Technology Assessment calculated at roughly $9 per gallon of gasoline burned in the United States, were added to the $2 cost of the gasoline itself, motorists would pay about $11 a gallon for gas at the pump. Filling a 20-gallon tank would cost $220. In reality, burning gasoline is very costly, but the market tells us it is cheap, leading to gross distortions in the structure of the economy. The challenge facing governments is to incorporate such costs into market prices by systematically calculating them and incorporating them as a tax on the product to make sure its price reflects the full costs to society.[37]

If we have learned anything over the last few years, it is that 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, costing millions of people their lifetime savings, retirement incomes, and jobs. Distorted world market prices that do not incorporate major costs in the production of various products and the provision of services could be even costlier. They could lead to global bankruptcy and economic decline.

Plan B—A Plan of Hope

Even given the extraordinarily challenging situation we face, there is much to be upbeat about. First, virtually all the destructive environmental trends are of our own making. All the problems we face can be dealt with using existing technologies. And almost everything we need to do to move the world economy onto an environmentally sustainable path has been done in one or more countries.

We see the components of Plan B—the alternative to business as usual—in new technologies already on the market. On the energy front, for example, an advanced-design wind turbine can produce as much energy as an oil well. Japanese engineers have designed a vacuum-sealed refrigerator that uses only one eighth as much electricity as those marketed a decade ago. Gas-electric hybrid automobiles, getting 55 miles per gallon, are easily twice as efficient as the average vehicle on the road.[38]

Numerous countries are providing models of the different components of Plan B. Denmark, for example, today gets 20 percent of its electricity from wind and has plans to push this to 50 percent by 2030. Similarly, Brazil is on its way to automotive fuel self-sufficiency. With highly efficient sugarcane-based ethanol supplying 40 percent of its automotive fuel in 2005, it could phase out gasoline within a matter of years.[39]

With food, India—using a small-scale dairy production model that relies almost entirely on crop residues as a feed source—has more than quadrupled its milk production since 1970, overtaking the United States to become the world's leading milk producer. The value of India's dairy production in 2002 exceeded that of the rice crop.[40]

On another front, fish farming advances in China, centered on the use of an ecologically sophisticated carp polyculture, have made China the first country where fish farm output exceeds oceanic catch. Indeed, the 29 million tons of farmed fish produced in China in 2003 was equal to roughly 30 percent of the world's oceanic fish catch.[41]

We see what a Plan B world could look like in the reforested mountains of South Korea. Once a barren, almost treeless country, the 65 percent of South Korea now covered by forests has checked flooding and soil erosion, returning a high degree of environmental stability to the Korean countryside.[42]

The United States—which retired one tenth of its cropland, most of it highly erodible, and shifted to conservation tillage practices—has reduced soil erosion by 40 percent over the last 20 years. At the same time, the nation's farmers expanded the grain harvest by more than one fifth.[43]

Some of the most innovative leadership has come at the urban level. Amsterdam has developed a diverse urban transport system; today 35 percent of all trips within the city are taken by bicycle. This bicycle-friendly transport system has greatly reduced air pollution and traffic congestion while providing daily exercise for the city's residents.[44]

Not only are new technologies becoming available, but some of these technologies can be combined to create entirely new outcomes. Gas-electric hybrid cars with a second storage battery and a plug-in capacity, combined with investment in wind farms feeding cheap electricity into the grid, could mean that much of our daily driving could be done with electricity, with the cost of off-peak wind-generated electricity at the equivalent of 50¢-a-gallon gasoline. Domestic wind energy can be substituted for imported oil.[45]

The challenge is to build a new economy and to do it at wartime speed before we miss so many of nature's deadlines that the economic system begins to unravel. This introductory chapter leads into five chapters outlining the leading environmental challenges facing our global civilization. Following these are seven chapters that outline Plan B, both describing where we want to go and offering a roadmap of how to get there.

Participating in the construction of this enduring new economy is exhilarating. So is the quality of life it will bring. We will be able to breathe clean air. Our cities will be less congested, less noisy, and less polluted. The prospect of living in a world where population has stabilized, forests are expanding, and carbon emissions are falling is an exciting one.

Additional Resources

More information on the topics covered in Plan B 2.0 *can be found in the references listed here. Additional data and an expanded list of resources are available on the Earth Policy Institute Web site at www.earthpolicy.org/books/PB2/resources.htm.*

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4. Ned Rozell and Dan Chay, "St. Matthew Island: Overshoot & Collapse," *Energy Bulletin*, 23 November 2003.
5. Diamond, op. cit. note 1, pp. 90, 248–76; "Población Total, Por Sexo E Indice de Masculinidad, Según División Político Administrativa y Area Urbana-Rural," table in Chile Instituto Nacional de Estadísticas, *Resultados Generales Censo 2002* (Santiago, Chile: 2003).
6. United Nations, *World Population Prospects: The 2004 Revision* (New York: 2005); Population Reference Bureau, *2005 World Population Data Sheet*, wall chart (Washington, DC: August 2005); Population Reference Bureau, *2004 World Population Data Sheet*, wall chart (Washington, DC: August 2004).
7. United Nations, op. cit. note 6.
8. See Chapter 2 for further discussion of peak oil.
9. Car fleet includes passenger cars and commercial vehicles, many of which are light trucks and sport utility vehicles used for personal use, from Ward's Communications, *Ward's World Motor Vehicle Data 2004* (Southfield, MI: 2004), p. 238; population living on less than $1 a day in World Bank, *World Development Report 2005* (New York: Oxford University Press, 2004).
10. Diamond, op. cit. note 1, pp. 90, 248–76.