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FUELING A COMPETITIVE ECONOMY

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Profiting from Energy

AMERICA'S ENERGY and economic policies remain tied to Cold War concepts of national security. For nearly fifty years all of America's vast resources were directed toward one purpose: containing the Soviet threat of global communism. But the need for a military-oriented industrial strategy fell with the Berlin Wall; long subordinated economic, energy and environmental concerns have risen to the top of the national agenda. Integrating those elements with a refocused military strategy can create a coherent American approach to national and global security for the post-Cold War world: one that is not costly but profitable, and not centrally planned but market-oriented.

The most fruitful starting point for boosting America's economy and reordering its priorities is energy. Wise energy policy creates both a healthier economy and healthier environment. But energy policy does not work in isolation. Only in combination with farsighted economic, environmental and military policies can it help secure America's global position for the 21st century. Taken together, those interconnected policies constitute a new and comprehensive approach to U.S. security, defined in the broad sense of sustaining and improving the quality of life of Americans.

America remains an enormously wealthy nation. Reordering priorities and redirecting resources would be enough to ensure that a new national strategy does not require higher taxes for the vast majority of Americans. A coherent national approach combining energy, economic and environmental

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security creates higher-paying jobs and puts more money in the hands of consumers and businesses. Sensible energy policy reduces the civilian and military costs and the risks of importing foreign oil and frees up huge amounts of domestic capital. Sensible economic policy guides more of that capital, as well as some shifted from military restructuring, toward investments that enhance the nation's long-term competitiveness. The two policies together reduce the costs of unsustainable resource depletion and environmental damage. The result, an "industrial ecosystem," would make America a more efficient and competitive manufacturer.

Harnessing the market to promote resource efficiency is the first step. Both energy and economic policy must share a least-cost, resource-efficient emphasis. America's current subsidized supply-side focus exacerbates the causes of energy waste. That energy waste bleeds the economy: oil imports alone have accounted for nearly three-fourths of the U.S. trade deficit since 1970, or $1 trillion transferred to OPEC nations. For decades a persistent and fundamental misunderstanding of energy's role in national security has needlessly distorted energy policies and diminished America's security.

Decouple Supply and Consumption

THE CHEAP AND ABUNDANT resources that underlay America's postwar economic success began to disappear in the 1970s. In the mid-1950s America extracted roughly half the world's oil, twice as much as Middle Eastern and north African states. That surplus vanished by the 1960s, and by 1973 America imported 36 percent of its oil.

After the 1973 oil shock a supply cutoff was seen as a central threat to American security: a cutoff could raise prices and slash living standards; even its threat could give foreign powers leverage over U.S. decision-makers, constricting options in a crisis. Fear of oil-import disruption and foreign dictation led to an unproductive preoccupation with how U.S. military power and the subsidizing of uncompetitive domestic sources might ensure "stable supplies" to feed a national oil addiction.

Pursuing energy *supplies* led the nation astray. It embodied the myth that economic vitality requires steadily increasing energy consumption. But people do not want supplies of raw energy, such as kilowatt-hours or barrels of oil. Rather they

want the services that energy can provide—comfort, illumination, mobility, steel-making. Energy security is better defined as the nation's ability to sustain adequate, reliable energy *services* in ways that maximize economic competitiveness and minimize environmental degradation.

The oil shocks and sharp price hikes of the 1970s led America to pursue two different paths to energy security. The first was nonmilitary and sought to cut oil imports. National and state efforts decontrolled domestic oil prices, created competition in electric generation and promoted energy efficiency and renewable energy sources such as wind and solar energy. That approach, alongside rising world oil prices, worked spectacularly.

"Pursuing energy supplies led the nation astray."

Although official experts said energy consumption (and hence energy supply) must rise in lockstep with economic growth, one of us foresaw long ago in these pages that they could be decoupled.[1] That controversial 1976 prediction underestimated by one-fourth the actual fall in energy use per dollar of GNP. The nation's real GNP grew an average of 2.5 percent a year from 1973 to 1986, but energy use did not grow at all, avoiding an additional $150 billion a year in higher energy bills. From 1979 to 1986 the United States got seven times as much new energy from savings as it did from net expansions of supply, and it received more new supply from renewable energy sources than from nonrenewables, such as oil and gas. By 1982 oil imports accounted for only 28 percent of all U.S. energy consumed, down from 46 percent only five years earlier. By 1985 Persian Gulf imports were one-tenth their 1977 peak.

Yet by degrees America abandoned this successful nonmilitary energy policy. In response to the 1979 Soviet invasion of Afghanistan, President Carter established the Rapid Deployment Force for the Middle East, and subsequently the Reagan administration shifted energy policy almost entirely toward a military orientation. Light-vehicle efficiency standards were rolled back, appliance standards were stalled and programs to inform U.S. citizens about energy savings were stifled. Federal

[1]A. B. Lovins, "Energy Strategy: The Road Not Taken?" *Foreign Affairs*, Fall 1976, pp. 65–96.

research and development for energy efficiency was cut 70 percent, for renewables nearly 90 percent. Most federal subsidies to fossil and nuclear fuels, totaling tens of billions of dollars per year, were maintained. Smaller subsidies for efficiency and renewables were eliminated.

These reversals stalled America's once-steady gains in energy efficiency, which by 1986 were saving far more energy each year than the domestic oil industry provided. Those huge savings helped drive an oil price collapse, further discouraging efficiency. America's energy use and oil imports again started climbing. Imports of Persian Gulf oil surged more than sixfold from 1985 to 1989. Yet had the nation simply kept saving oil as fast as in the previous nine years, the United States would not have needed any Persian Gulf oil after 1985. Instead Americans drove 0.56 mile-per-gallon tanks because they did not drive 32 mile-per-gallon cars—which by themselves would have been enough to eliminate gulf imports.

Even before Iraq invaded Kuwait, U.S. forces earmarked for gulf deployment were costing taxpayers around $50 billion a year—nearly $100 per barrel of oil imported from the Persian Gulf. Moreover, since Germany and Japan depend heavily on Persian Gulf oil (without suffering these tremendous annual military costs), America in effect subsidizes the economies of its two major trading competitors.

In the wake of the Gulf War the Bush administration proposed a National Energy Strategy that, by its own projection, would further increase dependence on Middle Eastern oil. Such a policy would diminishe U.S. security in other ways. Emissions of carbon dioxide, the main threat to the earth's climate, would rise 25 percent over the next 25 years. Economically the U.S. annual trade deficit in oil alone would rise to $80 billion (in 1992 dollars) by the year 2000.

That strategy also substituted the Bush administration's favorite technologies for market choices, expanding already lavish subsidies to uneconomic options such as nuclear power and "clean" coal that would squander capital and perpetuate laggard U.S. competitiveness. The response to domestic oil depletion would be to subsidize even faster depletion. The energy sources and links most vulnerable to disruption (such as the trans-Alaska pipeline) were to be expanded and dependence on them prolonged, but Congress demurred on Alaska drilling. The earlier, successful, nonmilitary focus on energy efficiency would continue to languish. Energy use, costs and

pollution would spiral upwards together, further imperiling national security, the economy and the environment.

Technologies that Transform

THE MISSING LINK is efficiency. Sensible energy policy achieves both greater economic and environmental health at lower costs by wringing far more work from each dollar of energy—as do America's major economic competitors. Germany and Japan use half as much energy per dollar of GNP as does America, mostly because of smarter technologies. Becoming equally efficient could cut almost $200 billion a year from America's energy bills. Even larger savings, perhaps $300 billion a year, are cost-effective. The energy bill passed by Congress in October 1992 does little to capture those savings and almost nothing to save oil. Rather than this continuing lopsided emphasis on bailing out failed supply-side ventures, America must harness market forces to give more efficient, cleaner and cheaper energy options a fair chance to compete, especially in transportation and electricity.

Transportation: This burns nearly two-thirds of U.S. oil; hence efficient transportation technologies and systems are the keys to cutting America's oil dependence. Straightforward technological improvements already in widespread commercial use could make light vehicles 50 percent more efficient by the year 2005, saving about two million barrels of oil per day. That is more oil than America imports from the Persian Gulf, and more than five times the optimistically projected rate of extraction from Alaska's Arctic National Wildlife Refuge.

The impending "supercar" revolution could do far more. GM's 1991 prototype of its carbon-fiber "Ultralite" car can carry four adults coast to coast on 29 gallons of gasoline. Remarkable recent advances—in aerodynamics, ultralightweight materials, new motor and energy-storage technologies, micro- and power-electronics, computer-aided design and manufacturing, and software—could even bring a 120 to 150 mile-per-gallon, safe, comfortable and affordable station wagon to market early in the next decade.[2]

The United States remains competitive in these advanced technologies. Superefficient cars hold the promise of restoring

[2]A. B. Lovins, "Advanced Light-Vehicle Concepts," National Academy of Sciences Briefing, July 1991, Rocky Mountain Institute Publication no. T91–20.

America's auto-making preeminence, especially if coupled with comprehensive policies to boost U.S. economic competitiveness. Doubled efficiency is also available for heavy vehicles from big trucks to jetliners.

Emerging policy innovations could speed the introduction of superefficient cars, even if gasoline stays so cheap that new car buyers are almost indifferent to fuel efficiency. With revenue-neutral "feebates," for example, the buyer of a new car pays a fee or gets a rebate; which and how big depends on how efficient the new car is. The fees pay for the rebates until inefficient cars are no longer made, when feebates themselves become unnecessary. Rebates could also be based on the difference in efficiency between the new car bought and the old car scrapped, helping to get efficient clean cars on the road and inefficient dirty cars off the road faster.

"Emerging policy innovations could speed the introduction of superefficient cars. . . "

Electricity: Full use of new technologies, many of the best less than a year old, could save money and fuel in electric generation (saving mainly coal as well as some oil and natural gas). The utilities' think-tank, the Electric Power Research Institute (EPRI), estimates that "electricity use in the United States could be reduced as much as 55 percent through cost-effective means," at an average cost of three cents per kilowatt-hour (kWh).[3]

The Department of Energy (DOE) and the Environmental Protection Agency (EPA) believe that technical improvements could save as much as four-fifths of all electricity now used for lighting. EPRI concurs with Rocky Mountain Institute's finding that there exists the potential to save half of all energy used to run motors. Thus better lighting and motor systems could save half of all U.S. electric generation—and adding other improvements, we believe, would raise that potential to more than three-fourths at an average cost below one cent per kWh.

Such savings are far cheaper than simply *running* existing coal or nuclear stations. Greater efficiency therefore could also prevent most of the pollution emitted by those plants, not at a

[3]D. F. Spencer, "A Preliminary Assessment of Carbon Dioxide Mitigation Options," *Annual Review of Energy and Environment*, vol. 16, 1991, p. 264; A. P. Fickett, C. W. Gellings and A. B. Lovins, "Efficient Use of Electricity," *Scientific American*, September 1990, pp. 65-74.

cost but at a profit—cutting customers' energy bills while raising utilities' dividends.

Policymakers can harness market forces to spur electric efficiency: let utilities keep as extra profit part of the savings created for their customers, rather than letting them profit only by selling more energy. Keeping 15 percent of the savings has spurred the nation's largest investor-owned utility, Pacific Gas & Electric Company, to stop building or planning conventional power plants. Instead it plans to get at least three-fourths of its new power needs in the 1990s from increased efficiency and the remainder from renewable energy sources, the next best buy. Three other utilities now plan to get almost all their new power from efficiency in the 1990s. Last year alone U.S. utilities invested $2 billion to save electricity, and customers matched that amount.

Freed from outmoded regulations utilities start taking economics seriously, buying the cheapest options first. They offer rebates for energy-efficient products and designs, giveaways of products like compact fluorescent lamps and even "negawatt" markets in which saved electricity is traded and bid at auction. The prize: about $100 billion a year of scarce domestic capital freed for reinvestment, new export opportunities, superior services, cleaner air and greater comfort, productivity and competitiveness. Increased investment in efficiency could net 1.1 million new jobs by 2010.[4]

Alternative Sources: Many states are beginning to factor in the substantial social costs of electric generation such as acid rain, climatic change and urban smog.[5] Such calculations further shift utility investments toward efficiency and cleaner renewable sources like wind and solar energy. But many renewable energy options are already competitive—passive solar heating, solar heat for industry, certain biofuels, small-scale hydropower, windpower and solar-thermal-electric generation.

Five U.S. national laboratories recently concluded that increasing research and development by a mere $160 million a

[4]Howard Geller, et al., *Energy Efficiency and Job Creation*, American Council for an Energy-Efficient Economy, Washington (DC), October 1992.

[5]Material in this section is drawn from R. Ottinger, et al., *Environmental Costs of Electricity*, Pace University Law School Report to NYSERDA and USDOE, New York: Oceana Publications, 1990; Idaho National Engineering Laboratory, et al., *The Potential of Renewable Energy*, Interlaboratory White Paper, SERI/TP–260–3674, National Renewable Energy Laboratory, Golden (CO), March 1990; USDOE, *National Energy Strategy*, Washington (DC): U.S. Government Printing Office, February 1991, p. 109; H. Richard Heede, et al., "The Hidden Costs of Energy," Washington (DC): Center for Renewable Resources, October 1985.

year for 20 years could by 2030 enable these renewable energy sources to provide cost-effectively about half the total energy and all the electricity used in the United States in 1989. That includes the equivalent of nine million barrels of oil per day, directly replacing oil and natural gas.

By contrast nuclear power remains uncompetitive when compared to both efficiency and renewables. According to the DOE, the average cost of electricity from nuclear power plants brought into service since 1980 is 9.9 cents per kWh. That price neglects decommissioning and environmental costs estimated at 2.9 cents per kWh. It also ignores federal subsidies, which in 1984 alone exceeded $15 billion—nearly the value of the nuclear power generated. Yet even 9.9 cents per kWh is twice the latest windpower bids and about 10 times the cost many utilities report for saving electricity. Reorienting the DOE budget away from its emphasis on nuclear weapons, nuclear power and fossil fuels would more than pay for restoring previously vibrant research and development in energy efficiency and renewables. Such options displace far more carbon dioxide per dollar spent and thus help fight a key environmental threat: global warming.

"... nuclear power remains uncompetitive when compared to both efficiency and renewables."

Offset Global Warming

THE SUPPLY-SIDE emphasis of U.S. energy policy has subsidized the overuse of fossil fuels, creating grave environmental risks, particularly climatic change. By the middle of the next century heat-trapping "greenhouse" gases are expected to be twice pre-industrial levels, raising the Earth's average temperature by one to five Celsius degrees over the next 100 years with potentially grave consequences. This view is shared by both the U.N. Intergovernmental Panel on Climate Change and the U.S. National Academy of Sciences.

A separate global environmental problem, stratospheric ozone depletion, has already exceeded worst-case fears: the scientific community failed to anticipate an ozone hole developing over the South Pole. That surprise forced nations to adopt belated emergency protocols eliminating the production

of ozone-depleting chlorofluorocarbons. Yet ozone depletion will persist for decades even after CFC production ceases, contributing to worldwide increases in skin cancer and possibly serious ecological disruption. In the case of global warming it would be equally risky to delay action until intolerable harm is apparent—and unnecessary, especially since the solution is profitable, whether or not the problem becomes real.

Global warming is not a normal and inevitable result of optimal economic activity. Rather it is largely an artifact of the uneconomic and inefficient use of resources, particularly energy, and of the government subsidies that distort resource allocation and use. Renewable energy sources and efficiency together can cost-effectively cut carbon dioxide emissions by half or more while providing most of the nation's and world's energy in the next century.

For example, the Swedish State Power Board found that doubling electric efficiency, switching generators to natural gas and biomass fuels and relying most upon the cleanest power plants would support a 54 percent increase in real GNP from 1987 to 2010—while phasing out all nuclear power. Additionally the heat and power sector's carbon dioxide output would fall by one-third, and the costs of electrical services by nearly $1 billion per year. Sweden is already among the world's most energy-efficient countries, even though it is cold, clould and heavily industrialized. Other countries should be able to do better.[6]

Germany has promised a 25 percent reduction in carbon dioxide emissions by 2005, and two southern California utilities have pledged a 20 percent cut over 20 years. The United States is the only major industrialized country without a carbon dioxide target. Yet simply relying more on efficiency and renewable energy sources could cut America's carbon dioxide emissions more than 50 percent *and* reduce its total energy bill, improving the environment while boosting the domestic economy.

[6]Birgit Bodlund, et al., "The Challenge of Choices: Technology Options for the Swedish Electricity Sector," *Electricity*, Lund, Sweden: Lund University Press, 1989, pp. 883–947. For a comprehensive review see A. B. and L. H. Lovins, "Least-Cost Climatic Stabilization," *Annual Review of Energy and Environment*, vol. 16, 1991, pp. 433–531.

Restoring Economic Security

AMERICA'S ECONOMIC security has slowly eroded. Median family income is now lower than in 1973. Only the richest fifth of Americans experienced significant growth in income or wealth since the late 1970s; the remainder suffered stagnating or declining living standards. Wages have dropped to 1960s levels for most workers, and half the full-time jobs created in the 1980s paid wages below the poverty level for a family of four. The United States is the only major industrialized nation whose manufacturing workers earn less per hour than a decade ago.[7]

These economic problems stem in part from a decline in the speed, quality and innovation of U.S. manufacturing compared to other countries. Thus the nation has been left to compete for production through low wages and a weak dollar or to import high value-added products. Both options erode economic security.

In the immediate postwar era Europe and Asia were busy rebuilding basic industries such as steel and textiles, while America was moving into sophisticated products such as aerospace and computers. But today those competitors rival America in the same markets, and all major industrial nations vie to develop the same critical technologies: microelectronics, computers, telecommunications, aerospace, transportation systems, biotechnology, advanced materials and sustainable energy technologies.

"Japan has long had a national security doctrine that encompasses economic security."

Japan has long had a national security doctrine that encompasses economic security. That integrated approach has helped a small, resource-poor country enjoy remarkable economic success. The Japanese doctrine of comprehensive security includes energy security: Japan spends 22 percent of government research and development on energy; the United States spends 4 percent (though both countries misspend most of it). The Japanese

[7]See Arthur Kennickell and Janice Shack-Marquez, "Changes in Family Finances from 1983 to 1989," *Federal Reserve Bulletin*, January 1992; *Money Income and Poverty Status in the United States*, U.S. Census Bureau, September 1990; "Families on a Treadmill," staff study for the Congressional Joint Economic Committee, Jan. 17, 1992; and "Household Wealth and Asset Ownership: 1988," U.S. Census Bureau, December 1990.

invest in new factories, machinery and other capital goods at twice the rate of Americans. Japan's strategy targets key industries needed to maintain high value-added jobs, such as those in research and development and advanced manufacturing.

Adopting a coherent economic strategy for America would be nothing new; the nation's Cold War military-industrial policy contained many of the same elements. Military contracts and federal funding bought more than 80 percent of all research and development in the U.S. aircraft industry between 1945 and 1984, helping to create America's leading export industry. Investments throughout the 1960s by the Defense Department's Advanced Research Projects Agency (DARPA) almost singlehandedly created America's leadership in computer science.

American primacy in technology, however, began to wane as the nation reduced its rate of public investment in infrastructure and in civilian research and development. Military-industrial policy, which provided a slow spinoff of research and development to civilian technologies, became increasingly ineffective in a world of newly reconstructed and vibrant economic competitors. Today both Germany and Japan spend a considerably higher fraction of GNP on civilian research and development than does the United States.

Correcting America's underfunding of research and development would take a civilian DARPA with a multibillion-dollar budget. A candidate agency already exists. In 1988 Congress gave the National Bureau of Standards a new name, the National Institute of Standards and Technology (NIST), and a new mission: to coordinate government policy on industrial technology and stimulate new ideas in the private sector. NIST could provide start-up support for private companies and universities working on critical technologies. An added government incentive would be to make permanent the federal tax credit for research and development.

Yet funding research and development in civilian technologies without improving America's manufacturing capability might only create more potential products and jobs for the Japanese, as it has in the past with consumer electronics. Failure to keep abreast of overseas competitors has cost the U.S. manufacturing sector three million jobs since 1979. The vast majority of those jobs were lost in the high-paying, durable goods sector, which includes automobiles. Employment in

durable goods manufacturing has reverted to 1965 levels. Manufacturing workers made up more than 25 percent of the U.S. labor force in the late 1960s; today they are 15 percent. Investments already made are projected to propel Japan's manufacturing base past America's by the end of the decade.[8]

Match U.S. Competitors

THE UNITED STATES needs to adopt the same kind of comprehensive long-term strategy for creating high-paying jobs as its major trading partners. The aim of such a strategy is not for the government to pick economic winners and losers but rather to create a climate benefiting all industries. A combination of increased research and development in new technologies, improved manufacturing processes and creative use of market forces would generate those high-paying jobs, while giving the nation a healthier environment.

The first step has already been discussed: a new energy policy to promote greater efficiency among U.S. businesses. Such a policy would free hundreds of billions of dollars' worth of private capital in the coming decade to be reinvested in the U.S. economy. An effective economic strategy would help this capital to be used as efficiently as possible to revitalize American competitiveness, particularly in manufacturing.

"... assist the diffusion of these new technologies to small businesses."

The second step is thus to expand the list of civilian technologies funded by NIST to include the kinds of "flexible" manufacturing technologies currently employed by the Japanese, which allow for rapid production and product innovation.[9] That list should also include programmable machine tools, computer-aided design and computer-assisted manufacturing.

The third step is to assist the diffusion of these new technologies to small businesses. A 1987 survey of 1,000 American metal-working manufacturing plants found that

[8]Kenneth Courtis, Deutsche Bank Asia, testimony before the Congressional Joint Economic Committee, May 8, 1992.

[9]Joseph Romm, "The Gospel According to Sun Tzu," *Forbes*, Dec. 9, 1991, pp. 154–162.

most lacked even one computerized machine.[10] Those outmoded suppliers, accounting for one million U.S. manufacturing jobs, are clearly at risk, and for no good reason.

The federal government already has a proven model for diffusion of new technologies: the U.S. Agricultural Extension Service, with a budget of more than $1.2 billion, offices in almost every county and a staff of nearly 5,000 scientists and technical experts. Studies have found a high rate of return on investment in agricultural research, extension and farmers' schooling. The extension service is a key reason why American farmers are the world's most successful exporters. Yet agriculture contributes just two percent to U.S. GNP; manufacturing contributes 19 percent.

Better-funded, nonprofit regional Manufacturing Technology Centers and Technology Extension Centers could make new manufacturing technologies available to small- and medium-sized companies. The centers provide management and technical information to companies, demonstrate new production technologies and make short-term loans of sophisticated equipment. Currently the states and NIST together spend less than $100 million a year to fund 27 such centers. Yet even five times that number would serve only seven percent of America's small manufacturers. The Japanese, by comparison, spend $500 million a year for 185 comparable testing and research centers.

The fourth step is to invest in worker training. High-paying jobs are high-skilled jobs such as those in advanced manufacturing, which place heavy responsibility on the production-line worker. Yet U.S. workers in manufacturing and other industries are not trained to compete with the millions of skilled and semi-skilled east Europeans and Asians now entering the global labor force. Private U.S. programs concentrate primarily on training executives and college graduates, ignoring the 75 percent of U.S. high-school graduates who do not go on to complete college. Federal funding for worker training and retraining in the 1980s dropped by more than half, to $5.6 billion from $13.2 billion previously.

Germany spends four times more of its GNP on workers than

[10]Maryellen Kelley and Harvey Brooks, "From Breakthrough to Follow-Through," *Issues in Science and Technology*, Spring 1989, p. 43. One study found that by the late 1980s as much as 40 percent of Japan's stock of machine tools was computer-controlled (or programmable), compared to 11 percent for the United States.

does the United States. Germany's apprentice training system, which receives joint private and public funding, sends teenagers to school one day a week and to work four days a week. The same kind of American system could include community service starting in middle school, school-based apprenticeships combining academic education with practical work experience and traditional work-based apprenticeships extending from the last two years of high school through two years of technical college.[11] Apprenticeships could encompass not only manufacturing but also other segments of the labor market such as computer programming, auto repair and middle management. Oklahoma and Oregon are among the states already leading in the development of such programs.

A fifth step is increased funding for civilian infrastructure. America's spending on infrastructure fell from about four percent of GNP in the 1950s and 1960s to roughly two percent in the 1980s—two to three times lower than America's principal competitors. Investment in roads, bridges, mass transit, airports, school buildings and telecommunications is vital to boosting productivity, training workers and creating a high-performance economy. One study concluded that the decline in public infrastructure spending accounted for the majority of America's productivity decline since 1973.[12] New infrastructure should be held to the highest standards of energy, resource and land-use efficiency and include advanced communications technology, such as fiber optics.

The Goal: Industrial Ecosystem

AN ULTIMATE GOAL for the nation should be an "industrial ecosystem." This means an industrial process that minimizes both inputs of energy and materials and outputs of waste products and pollutants: manufacturing byproducts are designed to be sold or reused. A proper economic strategy would ensure that new manufacturing would only increase America's environmental quality. With its emphasis on resource efficiency the industrial ecosystem

[11]Stephen Hamilton, *Apprenticeship for Adulthood*, New York: The Free Press, 1990, pp. 140–41.

[12]David Alan Aschauer, "Public Investment and Private Sector Growth," Washington (DC): Economic Policy Institute, 1990.

should become the dominant manufacturing approach of the 21st century.

Such an approach is economical because it frees up capital at both ends. So-called clean production processes use fewer toxic inputs and recycle or reuse production chemicals. Products are also designed to be clean to use, recyclable and hence more profitable. Since 1973 the 3M company has eliminated more than 500,000 tons of waste and pollutants, saving $482 million; another $650 million was saved by conserving energy. Highly efficient companies have an obvious competitive advantage over more wasteful companies. Yet American companies produce roughly five times more waste per dollar of goods sold than the Japanese, and more than twice that of Germans.[13]

The federal government can play a role in harnessing market forces to accelerate the transition to clean production techniques and thus create conditions similar to the resource abundance that was so crucial to America's past economic success. Research and development can focus on resource and process efficiency as well as developing new, easily recyclable materials. The Office of Technology Assessment estimates that U.S. manufacturing wastes can be cut in half with existing technologies and that another 25 percent could be eliminated with more research and development. Manufacturing Technology Centers can help smaller businesses design efficient manufacturing processes and help train American workers in clean production techniques.

If America is to be the leader in clean technology, one pervasive myth must be squelched—that environmental protection hurts the economy. While polluters who are unable to become more efficient may suffer, most U.S. businesses and consumers will benefit greatly—as have their counterparts in countries with higher standards. Regulations and market initiatives that encourage energy efficiency will ultimately enhance the nation's economic performance by putting tens, even hundreds, of billions of saved dollars per year into the hands of private citizens and businesses.

America's most formidable trading competitors prove this daily. Germany and Japan have some of the world's strictest

[13]Michael Porter, "America's Green Strategy," *Scientific American*, April 1991, p. 168; "Some Companies Cut Pollution by Altering Production Methods," *The Wall Street Journal*, Dec. 24, 1990, p. 1.

environmental laws and highest energy prices. Those conditions (and relative resource scarcity) helped drive industrial innovation on a broad front, yielding world-class resource efficiency, low waste, strong economies and trade surpluses. Moreover a booming sector of their economies sells or licenses pollution-control, energy-saving and recycling equipment to the United States.

". . . one pervasive myth must be squelched—that environmental protection hurts the economy."

Well-written environmental rules can benefit the nation. Traditional "end of pipe" controls are flawed; they focus on pollution after it has been created and offer no incentive for beating the standard. In contrast a scaled incentive system gives greater rewards for larger reductions, spurring continuous improvements in technology. Tradeable emission rights can also help entire regions to meet pollution-reduction targets, allowing highly efficient companies (those that surpass the target) to make money from the less efficient.

Environmental taxes can also be a powerful tool to improve market efficiency. One reason America overuses fossil fuels is that prices do not accurately reflect social costs such as pollution. A carbon tax on all fossil fuels could encourage efficiency and fund conversion to benign alternatives. Likewise, the unsustainable cutting of forests, as well as topsoil and groundwater depletion, boosts income only temporarily by liquidating precious capital—yet national accounts do not reflect this loss. Such resource depletion ultimately does not add to a nation's vitality, but steals from future generations. Fairness requires both honest accounting and faithful reinvestment in the nation's future security.

Create Jobs and Make Money

THESE POLICIES would create millions of high-paying jobs in research and development, education and job training, and help rebuild America's infrastructure and manufacturing base, in turn creating even more jobs. They would make the United States a leader in environmentally sound products such as energy-efficient and renewable-energy equipment. Following this strategy America could vigorously compete in the global economy of the 21st century. The income

and corporate taxes generated by these new jobs and industries, as part of revenues from a rejuvenated business sector, will help reduce budget deficits over the long term.

Short-term spending on research and development, job training and infrastructure requires tens of billions of dollars per year. Such investment could readily be funded by ending energy subsidies and reallocating military spending, which remains elevated at Cold War levels and continues to divert scarce capital from more pressing priorities.[14]

Reducing the deficit at the same time could require tax increases for the top ten percent of Americans, those owning 70 percent of the nation's privately held wealth. The 80 percent of Americans whose incomes stagnated through the 1980s should not—and need not—be so burdened. Nor need the deficit be reduced overnight. What matters is that America invest, not merely consume. Energy efficiency alone, bringing lower fuel and power bills, has the same stimulative effect as a tax cut and can increase private wealth over the next generation by trillions of dollars.

Only political leadership can deliver the comprehensive new vision of security America needs in the post-Cold War world. America's ability to sustain a global role and to maintain its own security is predicated on the nation's domestic economic vitality. The truest measure of national security is the ability of succeeding generations to expect and indeed achieve a better quality of life. The end of the Cold War presents ideal starting points: to adopt a market-oriented energy policy, to demilitarize economic policy, to practice sustainable environmental policy, and to integrate all three.

[14]For detailed analyses of possible military restructuring see William W. Kaufmann and John D. Steinbruner, *Decisions for Defense*, Washington (DC): Brookings Institution, September 1991; Earl Ravenal, *Designing Defense for A New World Order*, Washington (DC): Cato Institute, 1991. These multiyear strategies for responding to radically altered international circumstances offer savings, compared with current government plans, in excess of $70 billion per year by 1997.