PART TWO: New National Initiatives: Energy-Efficient Transportation

Introduction to Part Two

In retrospect, the fight against communism in the Cold War provided a widely agreed, largely nonpartisan national purpose, and a coherence to our foreign policy. The defense effort of the Cold War years also had important economic and social benefits. It advanced technology, admittedly largely military, but with some important civilian spillover; created a large number of high-quality jobs in the research establishment and the defense industry; and provided education, training, and equal opportunities for advancement in the military. Now that the defense imperative has lessened, the question arises of how to reestablish our sense of national purpose, and to redirect resources from military goals into building a strong civilian economy, including improved competitiveness and the creation of high-level, productive jobs.

A broad range of nondefense needs is vying for national attention: health, education, jobs, infrastructure, the environment, and assistance to the new democracies of the former Soviet empire. The list swells and every cause has merits and vocal support. Setting priorities among them is a matter of public discussion and political decision at the highest levels. There is little difficulty in naming good initiatives; the task is to choose among them, and this is the job of the President, Congress, and ultimately American citizens.

Most of the candidates do have certain elements in common. They usually involve technology in some important way, and many of them also include the idea of sustainable uses of that technology. Historically, the use of technology to transform natural resources into products or the provision of services was viewed as limited only by the efficacy of the technology.

Conservation of the resources transformed was not much in question, nor were the side effects of the technology-products or results other than the ones directly sought. This picture is, of course, incomplete. Resources become depleted, and although in many cases good substitutes may be found (usually thanks to technology), in others the economic or political cost of substitution is high; foreign oil to replace the depleted U.S. resource is a case in point. Moreover, indirect effects associated with new technologies have often damaged the environment and diminished the quality of life. Consequently, there is widening agreement that economic growth and the technologies that support it must be sustainable, taking into account resource conservation and protection of the environment.

Energy production and use are central issues for sustainable growth, and the United States is a central player. This country, with 5 percent of world population, is the world's single largest consumer of commercial energy, accounting for one-quarter of the total; per capita, our energy consumption is more than twice as high as Europe's and 25 times higher than Africa's. Our oil consumption per capita is the highest in the world, and two-thirds of this oil is used in the transportation sector. Social and technological changes that reduce the demand for oil in transport can cut pollution, lessen the political tension generated by the oil trade and, by diversifying the range of energy sources on which a large sector of the economy draws, contribute significantly to a more sustainable energy regime. As the largest single contributor to global environmental problems related to energy-global warming in particular-the United States can have a disproportionately large effect in improving matters. Moreover, our relatively high standard of living and technological strength offer an opportunity for leadership. We have the financial and human resources to develop clean energy technologies.

The range of activities possible for a clean energy initiative is broad. Electricity generation and transmission and the use of energy in industry and buildings are all important aspects of a full discussion of efficient, sustainable energy use. Transportation is worth particular attention. It is a principal source of the greenhouse gases that cause global warming (globally, 22 percent of carbon dioxide emissions from fossil fuels is traceable to transport) as well as taking two-thirds of U.S. oil consumption. For this report, we have chosen to examine two transportation initiatives that have the potential to conserve energy, reduce pollution, and lessen the Nation's dependence on foreign oil. These examples are illustrative; many others might have been selected.

The analysis here does not consider transportation policy per se but concentrates instead on how certain options might generate some of the economic and technological benefits formerly provided by defense. Other OTA studies have analyzed many of the issues involved in developing and maintaining a first-class transportation system, including adequate capacity; connections between highway, air, rail, and water transport; energy efficiency; environmental quality; and reduced dependence on foreign sources of oil.[1] This report draws on those studies but its focus is on how certain transportation systems that are appealing on other grounds might promote advanced technologies, foster the growth of knowledge-intensive, wealth-creating industries, create productive jobs, and contribute to America's competitiveness. It also considers the possible overlap of these systems with technologies and skills

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[1] See U.S. Congress, Office of Technology Assessment, U.S. *Passenger Rail Technologies, OTA-STI-222* (Springfield, VA: National Technical Information Service, 1983); *Replacing Gasoline: Alternative Fuels for Light-Duty Vehicles* OTA-E-364 (Washington, DC: U.S. Government Printing Office, September 1990); *Moving Ahead: 1991 Surface Transportation Legislation,* OTA-SET-496 (Washington, DC: U.S. Government Printing Office, June 1991); *New Ways: Tiltrotor Aircraft and Magnetically Levitated Vehicles,* OTA-SET-507 (Washington, DC: U.S. Government Printing Office, October 1991).

available in sectors of the economy hardest hit by the end of the Cold Wm.

The next two chapters examine two sets of options: personal transportation, primarily cleaner cars; and public transportation systems, including high-speed intercity ground transportation systems and intracity mass transit. Both can be considered in the light of the conversion and redirection of resources once expended for strategic military reasons. Mass transit vehicles were prominent among conversion attempts by defense companies in the post-Vietnam drop in military orders,[2] and high-speed intercity systems currently have a good deal of political and popular support as conversion initiatives. Development of less polluting cars and smart vehicles and highways could draw on a number of technologies developed for military purposes.

Rail systems—both urban mass transit and high-speed intercity systems-employ technologies that already work or, in the case of magnetic levitation, seem close to working. However, while they may fit the bill for many transportation policy objectives, their potential to support a large, competitive industry that creates many good jobs or uses many high-tech devices—some adapted from the military-appears moderate at best. The challenges to those entering the business are less in technology than in the chancy economics of a business in which the market is limited, and where orders can fluctuate widely from one year to the next. Even magnetically levitated trains, long the favorite technology of the future for engineering optimists, are not held back by technological problems that the ingenuity of the aerospace and defense industries could solve so much as by the tremendous expense of the systems, the difficulty of acquiring rights of way, and the tough competition of air and auto travel. In any case, rail system industries in other countries, most of them generously subsidized by their governments, are far ahead of America's in experience and the capture of markets. Even if U.S. industries were to challenge them successfully, the markets and manufacturing employment are of moderate size. Japan is a premier producer, consumer, and exporter of passenger train cars, but the rolling stock industry there (finished cars—freight and passenger--and parts) employs only 14,000 people.

Nonpolluting personal vehicles, on the other hand, might become a very big market. Americans have historically chosen the automobile as their means of transport and so much in the country favors its use that it is probably unrealistic to imagine a large-scale shift away from some form of individual personal vehicle. The automobile sustains a large slice of the Nation's economic activity-the Department of Labor identified 776,000 jobs in 1992 in the manufacture of motor vehicles and equipment.[3] The U.S. auto industry is thirsty for technological innovation that can enable it to produce cars to increasingly demanding environmental and performance standards. The opportunities for technology transfer and conversion from Federal labs and military contractors to supply this demand are considerable. Key areas in the development of new cars overlap with the expertise of the military industrial research community. They include the handling and use of new fuels such as hydrogen; the application of advanced materials such as ceramics, plastics, alloys, carbon fiber, and composites; the use of computers to model manufacturing processes and performance and so improve design; the development of fuel cells, batteries, and ultracapacitors; and the use of electronic controls

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[2] See U.S. Congress, Office of Technology Assessment, *After the Cold War: Living with Lower Defense Spending,* OTA-ITE-524 (Washington, DC: U.S. Government Printing Office, February 1992), pp. 207-209 for an account of some of the attempts made by defense contractors in the 1970s to move into transport.

[3] Annual average for 1991, U.S. Department of Labor, Bureau of Labor Statistics, Table 12, ''Employment of Workers on nonfarm payrolls by industry, monthly data seasonally adjusted, " *Monthly Labor Review, vol.* 115, No. 6, June 1992, p. 83.

and sensors.[4] The demands of space flight, stealth, undersea operation, strategic defense, and other military and aerospace programs have pushed forward work on these technologies.

In the following chapter we consider principally battery powered electric vehicles (EVs) and electric hybrids that use fuel cells. These are personal vehicle technologies that promise very large reductions in emissions and that offer a bridge to a future of reduced fossil fuel use. They pose technical problems that are far from solved, but if solutions are found they will include innovative technologies that could have wide application. At the same time, alternative fuels for internal combustion engine vehicles (ICEVs), including methanol, ethanol, natural gas, and reformulated gasoline, also offer considerable benefits in lowered pollution. They have the advantage of easy introduction into the familiar ICEV, and they require much less in the way of new infrastructure than EVs. These factors, combined with the technological uncertainties of EVs, could give alternative fuel ICEVs a considerable edge over EVs in the near or medium term. However, if EVs succeed technologically, and if the electricity they require is generated by renewable sources, they could prove to have decisive advantages.

At the moment battery EVs are more advanced than fuel cell vehicles, and will probably meet most of the early demand for ultraclean vehicles in places with strict air quality standards, in particular California. In the longer term, however, the fuel cell vehicle could be the more rewarding technology, better able to serve a broader market that extends beyond specialized niches. Fuel cells seem more easily able to provide the range and quick refueling that battery EVs still struggle to achieve. Both battery EVs and fuel cell vehicles using hydrogen are themselves without emissions, and don't contribute to local pollution where they are driven. However, the generation of electricity for battery EVs or the production of hydrogen for fuel cell vehicles may be polluting; depending on the source, there could be an increase in emissions of sulphur oxides at powerplants and continuing emissions of carbon dioxide. With a renewable or less polluting energy source, emissions of greenhouse gases could be eliminated or reduced, as could pollution at the point of electricity generation.

Federal laboratories have some useful experience with fuel cells and batteries. Industries in other countries do not so far have a clear lead over the United States. New law authorizes more support of EV R&D than it has had in the recent past, and environmental regulation may create a market for these vehicles. However, the Japanese Government's Ministry of International Trade and Industry (MITI) has what looks to be a more integrated plan of support for the development of EV technologies and markets than we do, and car companies in Japan and Europe are vigorously developing prototypes and even marketing early models. And it remains a question whether EVs, even with government support, can overcome their technical problems enough to compete with the ever-improving ICEV.

A different approach to applying new technology to personal vehicles is through the development of intelligent vehicle/highway systems (IVHS). The potential size of the markets, in the United States and abroad, means that the commercial opportunities are promising, perhaps highly so. Many of the systems incorporate technology with which defense firms have experience; not only defense contractors and their suppliers but also the national laboratories could probably play a considerable part. To achieve the greatest long-term benefits for the Nation from IVHS will require coordination between different levels of government, research institutions, and the private sector. A successful IVHS effort might contribute public benefits by reducing the time wasted in

[4] GM Advanced Engineering Staff, memo to Deputy Assistant Secretary, U.S. Department of Energy Defense Programs, on "Cooperative R&D Programs Between the Domestic Automobile Industry and the DOE Defense Program Laboratories," Mar. 27, 1992.

congestion and through the creation of a variety of skilled jobs, in the design, production, installation, and management of advanced integrated systems. In the near term, domestic and foreign consumer electronics firms are likely to continue to develop and sell systems that can be independently installed in cars.

Energy-conserving transportation as a new national initiative is one part of a larger shift in national technology goals toward achieving greater energy efficiency and self-sufficiency, this being fundamental to any program of achieving long-term sustainability in the economic and environmental life of the Nation. The chapters on transport technologies that follow identify some specific tasks that lie within the broader context sketched above.