Transportation's Technology Future

Prospects for Energy and Air Quality Benefits

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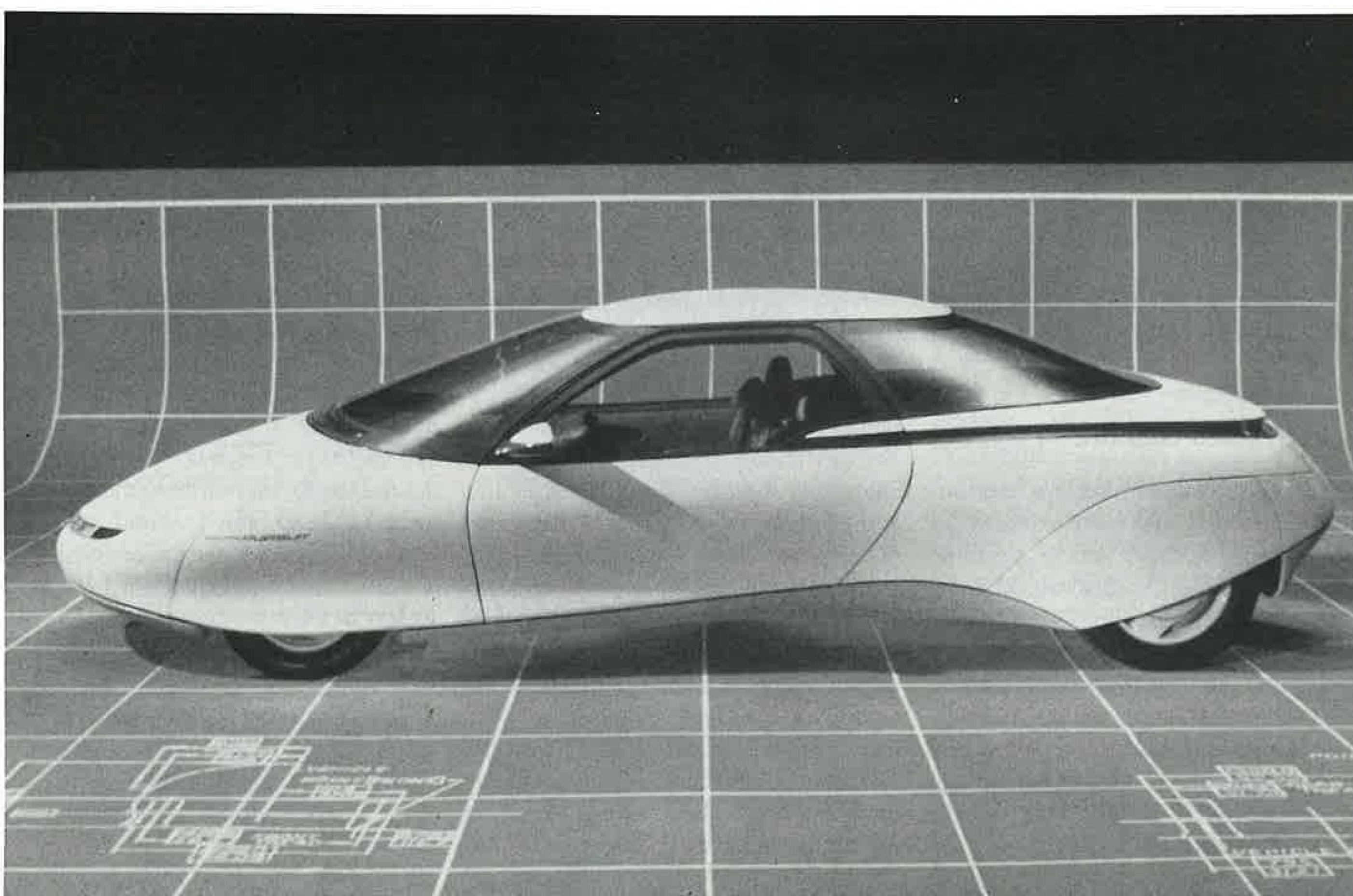
The costs of construction, operation, and maintenance of transportation systems are escalating, and concerns about safety, the environment, and the urban community are increasing. Many transportation decision makers are seeking new approaches for resolving traffic congestion and deteriorating infrastructure problems. Given recent advances in electronics and communications, it is no surprise that transportation professionals are looking to these technologies to help supply solutions to their problems. Such technologies can lead to safer and more efficient roadway operations and maintenance, higher productivity in public transit, more effective travel demand management, and eventually, greatly increased highway capacities.

Europe and Japan have already begun sizable transportation technology programs, including PROMETHEUS (Program for European Traffic with Highest Efficiency and Unprecedented Safety),



GENERAL MOTORS CORPORATION

DRIVE (Dedicated Road Infrastructure for Vehicle Safety in Europe), and AMTICS (Advanced Mobile Traffic Information and Communication System). In the United States, a number of states have undertaken similar efforts. The American Association of State Highway and Transportation Officials, the Highway Users Federation, and other organizations have cited the need for research into advanced technologies *(1,2)*. The ad hoc Mobility 2000 group, composed of representatives from federal and state transportation agencies, professional organizations, and private industry, is helping to define a national transportation technology program *(3)*, as is the Transportation Research Board *(4)*. The proposed Surface Transportation Act of 1991, the first federal funding legislation for the "post-Interstate" era, is the likely vehicle for establishing such a program.

A technology-oriented transportation future should create opportunities for enhancing energy security and air quality. If the United States and other countries are to pursue these opportunities, however, effective organization is crucial. Those involved must overcome long-standing biases and address the issues that will help shape the overall effects of new technology. Although many technical issues must be resolved, it is not too early to outline the basic opportunities, obstacles, and issues that will affect new transportation technologies and their application to energy and air quality problems.

Technology: An Overview

New applications of existing technologies now being considered for transportation include intelligent vehicle-highway systems (IVHS), urban commute vehicles, advanced travel demand management, and new mass transit concepts.

IVHS

IVHS technology considers drivers, roadways, and vehicles to be a single efficient, responsive, high-capacity system. IVHS

Small vehicle roadway.

incorporates three distinct but related areas:

- Advanced traveler information systems (ATIS) transmit real-time traffic condition information or routing advice directly to drivers in their vehicles by audio or visual means. ATIS also provides information to public and commercial groups for fleet management and to the public by radio, television, computer network, or other media.
- Advanced traffic management systems (ATMS) incorporate vehicle detection and surveillance technology, including automated vehicle identification and location, allowing the collection of accurate, timely traffic data. In addition, ATMS provides real-time, responsive traffic control (which is coordinated with route guidance under ATIS) and the integration of freeway and surface street operations so that corridor and area traffic management becomes possible.
- Advanced vehicle control (AVC) involves automatic vehicle steering and headway control so that lane width can be reduced. In the longer term, this subsystem could lead to automated highway operation.

IVHS is generally seen as a "building block" approach for highway automation that generates useful products and other benefits along the way. For example, in the 1990s, ATIS and ATMS are expected to ease traffic congestion by balancing the demand between overused and underused road network segments and by handling traffic diversions around accidents and other obstructions. Elements of ATIS and ATMS will also be used to support automated highway functions when these advanced systems become operational in the 21st century. Interim AVC products, such as collision warning devices, could be available during the 1990s.

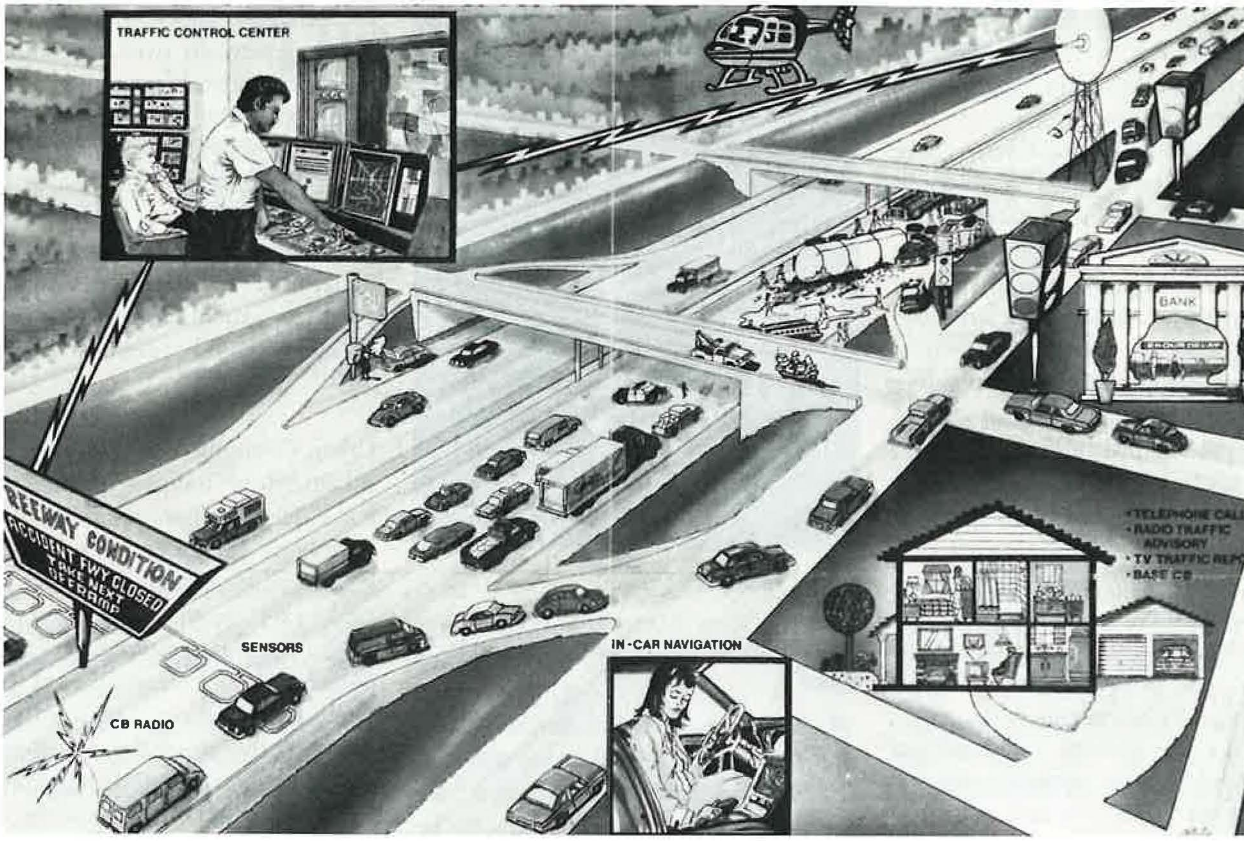
Urban Commute Vehicles

Advanced prototypes of small, highly fuel-efficient urban commute vehicles have been developed recently, and marketing and development of these specialized cars may begin quite soon. California and a few other states are investigating the feasibility of on-road demonstrations by the mid-1990s. Although the prototypes for these demonstrations have yet to be specified, they are expected to be half the width of conventional automobiles, effectively doubling conventional lane capacities. Pollutant emission levels, which are dependent on fuel and engine types, will be estimated in the feasibility studies. For gasoline-powered vehicles, fuel economies should be in the range of 100 to 200 miles per gallon.

Advanced Travel Demand Management

"High-tech" travel demand management can take a number of forms:

- Telecommuting, made possible by advances in telecommunications, refers to working away from the traditional office. The employee, electronically linked to the main office, can work either at home or in a neighborhood office close to home. The objective is to reduce commuting trips or at least to shift these trips out of rush hours and heavily traveled corridors. Recent evidence that telecommuters are more productive supports the development of the concept *(5)*.
- Videotex is an easy-to-use, interactive visual medium that connects users with transportation, shopping, banking, and other services through the telephone



LEVAN COOKSEY, COOKSEY DESIGN ASSOCIATES

Concept of "smart corridor" with advanced driving information systems.

network. France has pioneered this technology in its Teletel system *(6)*, and similar systems are now being set up elsewhere. Videotex customers can use special terminals or computers with modems to make transportation reservations, obtain transit schedule and route information, and request demand-responsive transportation. The system can also inform truckers about freight shipments, reducing empty backhauls. Videotex has the potential to reduce travel demand, improve the overall efficiency of the transportation system, provide mass transit with a powerful new public information tool, and create a high-occupancy transportation mode—"real-time ridesharing."

• ATIS technology allows access to timely traffic information in the home or office for trip planning. This application can also support and enhance both telecommuting and videotex services.

• Supported by the automated vehicle identification/location elements of ATIS, time-of-day pricing for roadway use becomes feasible. Electronic toll-collection could augment or even replace fuel taxes and might provide a better and more equitable technique for supporting the "pay-as-you-go" method of highway funding. Potentially, the environmental costs of vehicle use and desired traffic demand levels could be factored into rate structures.

All of these demand-related applications are currently being used or demonstrated. The state of California and other jurisdictions have undertaken successful telecommuting programs. Videotex, well established elsewhere, is now making inroads in the United States. ATIS technology has been installed on selected roads in Berlin and London and is being tested this year in Los Angeles through the "Pathfinder" project *(7)*. Electronic toll collection is in place on San Diego's Coronado Bridge and is being installed on the Dulles Toll Road in Virginia *(8)*. An extensive system is expected to be incorporated into new toll roads to be built with private funds in Orange County, California.

New Mass Transit Concepts

Many of the new technologies described above will also be useful for mass transit improvements. The information and communication infrastructure likely to develop in a technology-oriented future would give mass transit operators improved methods for fleet management and marketing. Transit vehicle supply could be optimally balanced with demand, and flexible, personalized services could be efficiently provided. In addition, advanced hardware systems, such as magnetic levitation (maglev) in which a magnetic field is used for both vehicle suspension and propulsion, are promising possibilities for more environmentally compatible mass transportation in both urban and high-speed intercity operations.

Energy and Air Quality: Links and Issues

Energy security and air quality goals can be supported by a number of transportation-related approaches. For vehicles, these strategies include

- Improving vehicle fuel economy;
- Maintaining more effective vehicle emissions controls; and
- Providing flexibility beyond the single (gasoline) fuel transportation system, including cleaner, renewable fuels and compatible propulsion systems.

System-level strategies generally involve

- Reducing overall travel demand;
- Shifting trips from lower- to higher-occupancy vehicles; and
- Shifting travel to nonpeak periods and smoothing traffic flow, thereby reducing fuel wastage and the polluting effects of vehicle stops and delays.

These links between energy and air quality are encompassed by the four technologies described previously. On the proposed automated highways, for example, vehicle cruise speeds could be set at the optimum for fuel economy. But even before such control is possible, it is reasonable to expect that vehicles with degraded emissions control systems could be identified by using the vehicle-highway communications capabilities that will be developed under IVHS. To ensure compatibility, vehicle fuels and propulsion systems will both need to be considered in designing future transportation systems. Development of clean vehicle fuels and propulsion systems could even be accelerated under the transportation technology agenda. For example, although automated vehicle control is possible with current internal combustion engines, electrified propulsion might offer much more precise control over vehicle functions.

In the early 1990s, implementation of advanced technologies should start producing energy and air quality benefits at the systemwide level. Travel demand mitigation and improved mass transit services can be obtained with current technology; the early phases of IVHS deployment support these concepts and should also begin to help smooth traffic flow.

Questions and Issues

The development of the new National Transportation Policy, the drafting of the impending Surface Transportation Act of 1991, and the worldwide attention being given to advanced technologies together represent the most significant rethinking of transportation programs in more than three decades. The challenge is to structure technology advances so that they mutually support transportation and environmental efforts, or at the least so that the two kinds of efforts do not compete. The opportunity to structure an approach that effectively supports mobility, energy, and air quality has never been greater. However, some difficult issues will need to be addressed before such an approach can be identified and agreed on.

A basic question related to IVHS is how household travel and land use will be affected by large increases in highway capacity. If increased capacity leads only to increased trips in single-occupant, gasoline-powered vehicles, then the impact of IVHS might actually be negative. If IVHS technology is applied widely enough to demand management (for example, roadway pricing) and to transit, and if the best fuel and propulsion systems determined are used, the effect could be positive. A much better understanding of the relationship between travel time/cost and trip making is also needed, and transportation and land use relationships in general must be better defined. If all of these issues are effectively addressed, a technology program "package" could be designed to promote the desired overall impact on energy, air quality, and transportation.

Many other issues need to be resolved as well, all of which are intimately intertwined with energy and air quality considerations. For example, automated vehicle identification/location applications cannot be allowed to compromise privacy. Roadway pricing (tolls) must be made equitable. Legal ramifications, including tort and product liability, from automated highway operations will need to be resolved. Worker's compensation coverage will need to be specified for telecommuters.

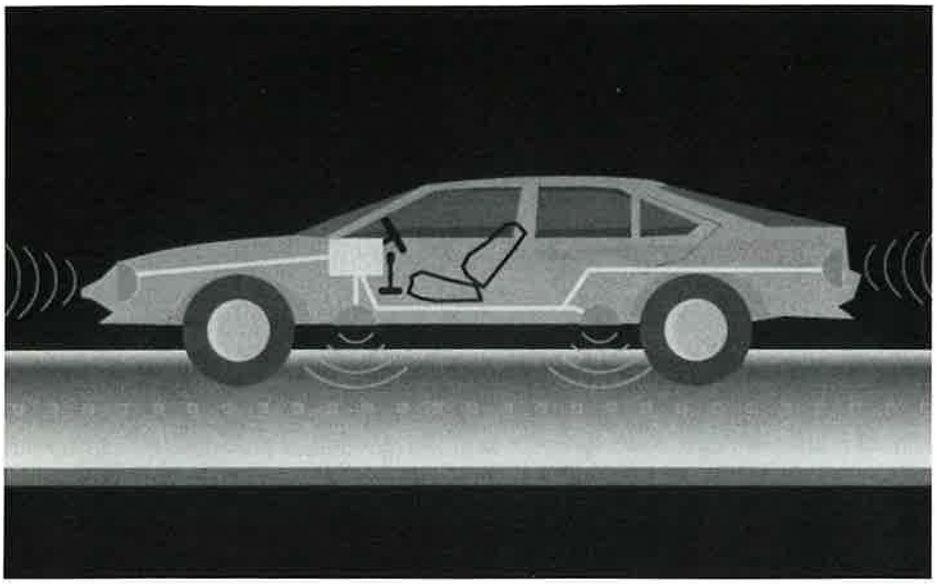
Research, development, and demonstration of transportation technologies will go forward while the appropriate technology package for meeting energy, air quality, and mobility goals is being defined. The technical requirements and performance characteristics of IVHS and other advanced systems need to be identified, and only research can do this. Likewise, rigorous testing and evaluation is needed to assess technology options. Such a program requires the participation of government, academia, and private industry, including vehicle manufacturers. New technology opportunities extend well beyond the publicly owned infrastructure.

Joint Action for Meeting Mobility, Energy, and Air Quality Goals

Barriers to Joint Action

Capturing the potential energy and air quality benefits that exist in transportation's technology future will depend on forging new, effective partnerships. This is true both within the transportation sector and across the interest areas for pursuing joint action. Transportation's technology partnership is only now in the formative stage, as represented by the Mobility 2000 group. Coordination with energy and air quality groups at the national level is not yet even in the exploratory stage.

Assuming that transportation's technology partnership comes together, some barriers to joint action will still exist. Organizational inertia can be a formidable obstacle to progress. One mitigating element, however, is the growing



Vehicle control concept.

momentum from the building of the technology partnership within the transportation community. If joint action with energy and air quality interests is put on the agenda, the momentum may carry into these areas as well. The innovative environment created by transportation technology initiatives could bring about the discussion of fresh, common approaches to energy, air quality, and transportation problems.

Progress on this front may still be difficult, because transportation, energy, and environmental interests have differing mandates and constituencies to satisfy. In the past, these factors have often conflicted. The new private/public partnership being formed under the transportation technology banner brings new opportunities for conflict as well as for consensus. Public interest and private market forces are not always compatible. Also, the automotive industry, already cautious in committing resources to a federally sponsored IVHS program, may be even more cautious if the project also includes cooperating with industry regulators, such as the Environmental Protection Agency and the National Highway Traffic Safety Administration. For their part, environmental groups have often been suspicious of both the automobile industry and government highway agencies. Some claim that these adversarial relationships are necessary to protect environmental interests by maintaining a "checks and balances" system among forces that are inherently antagonistic.

Arguments for Joint Action

Assuming that barriers and suspicions can be overcome, why pursue a joint action strategy? There are a number of convincing answers to this question.

First, transportation and environmental groups find themselves in a curious predicament. Expansion of highway capacity cannot be seriously pursued if it means putting additional pollution-producing vehicles onto urban systems. Capacity expansion can only take place in concert with the development of clean propulsion energy. At the same time, urban growth means that vehicular travel will continue to increase, putting greater demands on a relatively fixed capacity. The resulting congestion represents a major barrier to cleaning the air and improving national energy efficiency. At least on this level, reciprocal policy mandates appear to exist.

On the technical level, clean propulsion energy and advanced transportation systems must be compatible. For example, the proposed small urban commuter vehicles may need separate specialized roadways, at least for the line-haul. The energy and air quality benefits expected from such a technology may be realized only if that specialized infrastructure is provided by public highway agencies. The same urban vehicle might become a successful mass transit "feeder" if direct links are built between the specialized roadways and transit station parking lots. Technical matches such as these provide additional potential for reciprocity.

Additional arguments can be made for joint and common action. Transportation is now defining its vision for the future. That vision must, by necessity, take into account the future's energy and air quality realities. Active coordination and cooperation between transportation and environmental interests can help clarify that vision. The technical research and development resources from these diverse fields could then be more closely coordinated or even combined. Such rearrangement would eliminate redundant or competing efforts and result in a more effective way of meeting mobility, energy, and air quality goals.

In addition, each interest area can supply individual strengths that could combine for an effective program. Transportation and energy interests often have access to large sources of funding for pursuing joint initiatives. Air quality and energy interests have regulatory powers that can be enlisted. All three areas have specialized expertise that would prove invaluable in achieving an environmentally benign, energy-secure transportation future.

Finally, beyond the practical and technical considerations, joint action might mean that greater political support would materialize for each group when individual constituencies buy into the common program.

California's Experience

California has sizable, state-mandated energy and air quality agencies, with comprehensive regulatory powers and broad missions that have impacts on transportation. In addition, its Program for Advanced Technology for the Highway is the largest and most comprehensive of its kind in the United States *(9)*. During the past 15 years, the California Department of Transportation (Caltrans), California Energy Commission (CEC), and California Air Resources Board (CARB) have attempted various cooperative efforts. Progress, although not steady, has nonetheless been real. California's experiences may therefore shed some light on what could occur nationally in the coming years.

The attempts to forge a link between transportation and air quality groups in California provide good illustrations of the pitfalls, opportunities, and changing political realities involved in building coalitions. In the 1970s, a proposed arrangement between Caltrans and CARB to allow the environmental agency to review state highway projects for emissions impact mitigation raised considerable concern in the California State Legislature. Some legislators thought that this might be a first step in abridging the authority of transportation officials to make transportation decisions. Yet just recently, this same legislative body gave extraordinary powers to regional air quality boards in California to mandate transportation measures for the purpose of emissions reduction.

Nowhere is this political reality more apparent than in the Los Angeles region, where the South Coast Air Quality Management District has incorporated strict transportation controls into its air quality plan. The severity of the air pollution problem in the Los Angeles area has given rise to new political priorities. One result has been a willingness to try new approaches, including new technologies, in solving both air quality and traffic congestion problems. The advanced technology program staff at Caltrans view this as a clear opportunity for joint action.

Since the 1970s, and despite difficulties along the way, the three state agencies have been able to coordinate efforts in transportation system management (TSM), developing along the way some understanding of a common ground. In the early 1980s, all three agencies collaborated with the California League of Cities on TSM educational forums for local elected officials. These meetings helped broaden local officials' understanding of transportation options and the links between these choices and solutions to energy and air quality problems. The earliest vanpool programs in California were funded equally from transportation and energy sources.

Today, CARB is one of the strongest proponents of high-occupancy vehicle lanes on state highways. A program to improve traffic flow efficiency, the Fuel Efficient Traffic Signal Management Program, was started by CEC and has since become an established local assistance program at Caltrans. Because of such ongoing cooperation, Caltrans was able to obtain more than $100 million in energy (oil overcharge) funds for TSM, transit improvements, and, in the new technology arena, a "smart highway" demonstration project (involving ATIS and ATMS) in Los Angeles.

A Common Future?

The implications for energy security and air quality from transportation's technology-oriented future are still unclear. Much will depend on whether the interested parties perceive common ground, how complex issues are resolved, and what technology packages are finally developed. However, the new attention to technological alternatives, the development of the National Transportation Policy, and the impending landmark federal transportation legislation together offer a special opportunity for joint action on transportation, energy, and air quality problems. California's experiences indicate that forging a common action agenda may be difficult, but it is not impossible. The first step is for transportation, energy, and environmental constituencies to recognize the opportunity that is being presented.

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