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Author

Deakin, Elizabeth

Publication Date

2001-09-01

Working Paper 2001-03

**Sustainable Development and Sustainable Transportation:
*Strategies for Economic Prosperity,
Environmental Quality, and Equity***

Elizabeth Deakin

This paper was prepared with partial support of the
California Futures Network.

University of California at Berkeley
Institute of Urban and Regional Development

Table of Contents

Abstract.....	5
Introduction and Overview	6
Transportation Strategies for Sustainable Development	7
Economic Considerations	13
Key Issues for Sustainable Transportation Planning.....	14
Sustainable Transportation: An Emerging Strategy	16
An Emerging Role for Regional Agencies	19
Next Steps: Directions for Research.....	20
References and Bibliography	21
Sustainable Economic & Urban Development.....	21
Livable Communities.....	23
State Policy Works on Growth	27
Low Density Development/Sprawl.....	28
Regional Coordination and Planning	29
Increasing Density/Compact Development.....	29
Reversing Inner City Decline and Protecting Aging Inner Ring Suburbs.....	30
Affordable Housing.....	31
Changing Household Structure/Needs	32
Racial and Economic Segregation	33
Job Access/Dispersal.....	34
LULUs.....	35
Third World and Developing Countries.....	37
Rural Economic Sustainability	38
Global Sustainability.....	38
Sustainable Development and Public Policy	39
Planning Methods: Organizational Design.....	40
Values/Ideology	41

List of Tables

Table 1: Strategies for Transportation Management: A Partial List	8
Table 2: Strategies for Sustainable Development	17

Sustainable Development and Sustainable Transportation: Strategies for Economic Prosperity, Environmental Quality, and Equity

Elizabeth Deakin

Abstract

Concerns about environmental quality, social equity, economic vitality, and the threat of climate change have converged to produce a growing interest in the concept of sustainable development. Efforts are being made all over the world to increase the sustainability of development patterns. In nations with more advanced economies, particular attention is being paid to the critical roles played by transportation, land use, and activity systems. This paper reviews current thinking about sustainable transportation as part of a broader strategy of transportation and land use planning for sustainability.

Strategies for increasing transportation sustainability include demand management, operations management, pricing policies, vehicle technology improvements, clean fuels, and integrated land use and transportation planning. In the past, planning and implementation of such strategies has been slow and spotty, deterred by the complexities of the underlying issues along with uncertainties about the magnitude and timing of impacts, the efficacy of available courses of action, and the consequences of action or inaction. Recently, however, a new interest in actively pursuing these strategies has emerged. Regional planners are increasingly being asked to take a leadership role in these planning efforts, applying their expertise to analysis of the issues and creating forums for discussion, conflict resolution, and joint undertakings.

The paper concludes with an identification of topics deserving additional research, as well as a detailed bibliography on sustainable development topics.

Introduction and Overview

Concerns about environmental quality, social equity, economic vitality, and the threat of climate change have converged to produce a growing interest in the concept of sustainable development. One definition of sustainable development was put forth in 1992 by the Brundtland Commission: “Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs.” CO₂ reduction, as called for in the Kyoto Protocol and other agreements, is an important objective; however, sustainability has quickly been transformed into a much broader concept having economic, social, and environmental dimensions. Today, sustainable development is widely viewed as development that improves the standard of living and quality of life, while at the same time protecting and enhancing the natural environment and honoring local culture and history. Efforts are being made all over the world to increase the sustainability of development patterns.

In developed nations, special attention is being given to the sustainability of current and emerging land use and transportation patterns. This focus reflects both the significant impacts that current patterns of transportation have on the environment and the complex interactions between transportation, land use, and activity systems. In this context, sustainable transportation is seen as transportation that meets mobility needs while also preserving and enhancing human and ecosystem health, economic progress, and social justice now and for the future. Planning for sustainable development aims to attain all three objectives simultaneously and in a just manner, considering access as well as mobility in the process.¹

This paper examines strategies for sustainable transportation as a principal component of sustainable development. A variety of strategies have been identified for potentially increasing transportation sustainability, including demand management, operations management, pricing policies, vehicle technology improvements, clean fuels, and integrated land use and transportation planning. In the past, planning and implementation of such strategies have been slow and spotty, deterred by the complexities of the underlying issues along with uncertainties about

¹ Increasingly, the idea of sustainability has come to be understood as a collective process for considered decision-making and action, and not simply a particular end-state or outcome. Also, the concept is broad enough to include a variety of initiatives—ranging from cleanup and redevelopment of brownfields to inner city revitalization to energy-efficient transportation—and planning for sustainable development increasingly involves strategic coordination of efforts along all of these lines.

the magnitude and timing of impacts, the efficacy of available courses of action, and the consequences of action or inaction. Recently, however, a new interest in actively pursuing these strategies has emerged.

Regional planners are increasingly being asked to take a leadership role in these planning efforts. There are several reasons for this. First, the regional level is appropriately scoped to many of the economic, social and environmental phenomena of concern (regional economics, watersheds, airsheds, urban traffic sheds, etc.). Second, regional agencies typically are repositories for much of the data needed to address traffic and urban development issues, and the planners working for these agencies typically are trained in the modeling and forecasting techniques that are used in the analyses.

On the other hand, at least in the US, regional agencies rarely have the same level of political accountability that national, state or local agencies have, and this can be a drawback if the legitimacy of their proposals is challenged. Debate also continues over the range of options that might appropriately be used. Market approaches, changes in technologies, and regulatory approaches are all under discussion. Some favor market approaches as a more cost-effective strategy, especially in the short run. Others believe that a multi-pronged strategy will be necessary both to accomplish the needed reductions and to assure a modicum of equity. Consensus has yet to emerge on the paths to follow toward sustainability, though new insights emerging from ongoing research may eventually provide direction.

The paper discusses key issues raised in pursuing sustainable transportation, drawing largely from the US experience. A summary of the transportation strategies that have been proposed is presented. Key planning and policy issues then are discussed. The paper concludes with some proposals for research and a bibliography.

Transportation Strategies for Sustainable Development

Table 1 presents a partial list of the transportation strategies that have been suggested as supportive of sustainable development. The strategies are grouped into several categories based on the component of the transport system addressed: vehicles, guideways and operations, and demand.

The first category of strategies would reduce adverse environmental impacts of motor vehicle use through technological change in vehicles and fuels. In the short run, this would most likely focus on strategies for improving the efficiency of conventional vehicles in order to reduce emissions of pollutants and greenhouse gases. In the longer run, the

Table 1. Strategies for Transportation Management: A Partial List

Vehicle / Fuel Technological Changes:

- 1. Improved Efficiency of Conventional Vehicles**
 - ◆ Manufacturer Innovations / Supplier Offerings
 - ◆ Responses to Consumer Demand
 - ◆ Responses to Government Regulation and Incentives: CAFE Standards, R&D Partnerships, Taxes, Rebates, Subsidies
- 2. New Vehicle Technologies**
- 3. New Fuels**

Road / Vehicle Operations Improvements:

- 1. Conventional Traffic Flow Improvements**
 - ◆ Traffic Signal Timing
 - ◆ Ramp Metering
 - ◆ Flow Metering
 - ◆ Bottleneck Removal
- 2. Intelligent Transportation System Improvements**
 - ◆ Smart Highways
 - ◆ Smart Vehicles
 - ◆ Accident / Incident Management
 - ◆ Routing and Scheduling Enhancements
- 3. Driver Education**
- 4. Improved Logistics and Fleet Management**

Demand Management:

- 1. Modal Substitution**
 - ◆ Transit, Paratransit, Ridesharing, Walking, Biking Improvements and Incentives
 - ◆ Rail Substitutes for Truck
- 2. Telecommunications Substitutions**
 - ◆ Telecommuting
 - ◆ Teleshopping
 - ◆ Teleconferencing
 - ◆ Distance Learning
 - ◆ Information Technology-Enhanced Routing and Scheduling (Passengers, Freight)
- 3. Pricing Incentives / Disincentives**
 - ◆ Gas Tax Increases
 - ◆ Vehicle Sales Tax Based on Fuel Efficiency and Expected Life
 - ◆ Vehicle Registration / License Fee Based on Fuel Efficiency, Use (Measured or Estimated)
 - ◆ Other Impact Fees Based on Use
 - ◆ Subsidies for Preferred Modes, Telecommunications Substitutes, Etc.
- 4. Land Use –Transportation Strategies**
 - ◆ Compact Development
 - ◆ Mixed Use Development
 - ◆ Higher Development Densities
 - ◆ Transit, Pedestrian, Bike Friendly Development

introduction of new vehicle technologies and new fuels might be an option and could lead to quieter, safer and cleaner vehicles. In either time frame, a variety of specific steps could be considered. For example, changes could be induced through consumer (demand-side) incentives or disincentives, through incentives offered to vehicle producers (e.g., tax credits), or through direct regulation of vehicle manufacturers (e.g., Corporate Average Fleet Efficiency (CAFE) standards, safety standards).

A second category of strategies involves improvements to the roadways and vehicle operations. Conventional traffic flow improvements such as traffic signal timing, ramp metering, flow metering, and bottleneck removal all have the potential to cut energy use, reduce greenhouse gas emissions, and lower noise levels somewhat by smoothing the flow of traffic and reducing stop-and-go driving. Driver education could reduce emissions by training drivers to avoid heavy accelerations and decelerations and to be mindful of the fuel consequences of high speeds. Scheduling trips outside of the peak periods could reduce congestion and thereby cut a major source of economic loss. Improved methods of accident/incident management and improved logistics and fleet management, both relying increasingly on advanced technologies for vehicle location and communication, also have substantial promise for increased efficiency of operations. Information technology-enhanced routing and scheduling can reduce the fuel needed for transport of both passengers and freight. Technological innovations currently under development offer the potential for significantly larger gains. These include the more advanced aspects of intelligent transportation system improvements such as smart highways and smart vehicles.

Demand management is a third category of strategies for managing the transportation system. Several subcategories of demand management are in use. Modal substitution, telecommunications substitution, pricing, and land use strategies all can be thought of as forms of demand management.

Modal substitution means, for example, replacing car trips with transit, paratransit, ridesharing, biking and walking for personal travel and substituting rail for truck and air freight. This can be accomplished by providing better modal options (offering services and improving their quality in order to attract travel to alternative modes) or through incentives for the use of the alternative modes (e.g., subsidies for users of preferred modes). Regulatory requirements (trip reduction ordinances requiring employers to obtain commute mode shares of no more than 50% by drive-alone, for example) are also a possible way to induce modal substitution.

Telecommunications substitutions for travel also can be considered a form of demand management. Telecommuting, teleshopping, teleconferencing, and distance learning are varieties of telecommunications substitutes for travel.

Pricing incentives and disincentives could be used in the short run to reduce demand and encourage the use of alternative modes or the substitution of telecommunications for travel. In the longer run, vehicle technology improvements would likely be induced by the higher prices. Gas tax increases are the pricing strategy most commonly used in the US and abroad. Fees and taxes that affect vehicle ownership, such as sales taxes and registration fees, also are common. Variations that base taxes and fees on fuel efficiency, emissions, and expected vehicle life could specifically target the reduction of greenhouse gases as could “fee-bate” variations offering tax reductions for efficient, low emissions vehicles along with surcharges for high emitters. Or pricing strategies could base emissions or fuel surcharges on measured or estimated use (VMT/VKT). Finally, rather than use pricing to restrain emissions directly, pricing could take the form of subsidies for preferred modes or for telecommunications substitutes.

Land use and urban development strategies alter demand by reducing trip length (by providing a choice of close-by destinations) or by making alternatives to the auto more competitive and cost-effective. (These strategies also may reduce emissions associated with building heating and cooling, service provision, etc.) For example, compact development, mixed use development, and higher development densities can reduce trip lengths and make transit, pedestrian, and bike use practical and affordable. In some cases, compact development also may facilitate better management of urban freight transport (shipment consolidation, delivery scheduling, etc.).

This list of strategies will sound familiar to most transportation professionals. The same list has been used for many years in the search for strategies to reduce air pollution emissions and to manage traffic congestion. Indeed, many of the strategies on the list have been in use for decades. Fuel taxes are in place and are periodically increased. Highway departments and local traffic engineering offices routinely use traffic operations strategies to increase capacity and reduce environmental impact. Transit services and (in the US) ridesharing programs are offered throughout most metropolitan areas and in rural ones as well. Land use strategies promoting infill, compact development, and mixed use are promoted in numerous cities and suburbs.

The widespread use of many of the listed strategies is both an advantage and a drawback. It is an advantage because it means that established programs are in place to offer evidence of efficacy and potentially to serve as a base for further expansion or innovation. It is a drawback because it means that many of the strategies will already be fully deployed where they are cost-effective, with their benefits already captured. Further deployment in these circumstances could produce limited results and in some circumstances could even produce disbenefits. (As an example, consider the impacts of deploying fixed route bus service in low density areas where the service is little utilized; emissions and fuel use per passenger carried can be higher than would occur by using autos or taxis to serve the trips.) Hence, the issue is whether market niches for which these strategies might effectively be applied still exist or whether new markets can be “built” by, for example, increasing densities in suburban locations to make them more transit-friendly.

For some of the strategies, many would respond that there are indeed more markets to be served. For example, traffic signal timing and other operations improvements are in common use, but many localities have lacked the resources to upgrade equipment or to retime their signals on a regular basis. They could benefit from a funded traffic signal management program. Similarly, few localities have had the resources to fully implement bicycle networks, pedestrian improvements, and traffic calming programs, and ISTEA and TEA-21 funds for such strategies are oversubscribed. Transit operators and ridesharing service providers often have lists of unfunded improvements, and few have even begun to explore the possibilities for shuttle services, subscription buses, and other innovations. Not all of these strategies would necessarily be cost-effective from a greenhouse gas reduction perspective, but some surely would be.

Other strategies remain in the early stages of deployment and a strategic effort to implement them might produce meaningful results. This is the case, for example, for many of the strategies involving advanced technologies for highway and transit operations. It also may be the case for certain vehicle and fuel technology strategies, where the wider implementation of experiments and demonstration projects could be useful.

Land use strategies have recently begun to capture the attention of many interest groups, and studies and small programs to test these strategies’ transportation effectiveness are underway. Here, too, wider experimentation and systematic evaluation could be useful.

Pricing strategies are often controversial, particularly when applied to items that formerly have been available “free” (as have been most roads

in the US, for example). Nevertheless, some local governments and private operators are successfully managing parking pricing, and variable tolls and “value pricing” have been implemented on a handful of US highway facilities. In the US, where fuel taxes remain far lower than in other developed countries, proposed gas tax increases, “fee-bates,” emissions fees, and the like have been evaluated in several major studies, but so far implementation has not occurred due to concerns about equity and opposition to any strategy that looks like a tax hike. Nevertheless, there is enough interest in these strategies to consider a larger effort toward their implementation than has occurred to date.

How effective would the various transportation strategies be in reducing congestion, lowering pollutant and greenhouse gas emissions, cutting fuel use, and otherwise reducing the adverse impacts of current transportation systems? The Transportation Research Board investigated this topic in a 1997 report focused on greenhouse gas emissions. Scenarios were developed which represented different approaches to the problem. One scenario emphasized demand management and land use planning. A second scenario targeted improvements in vehicle efficiency. A third emphasized fuel price increases. A fourth strategy assumed the introduction of new vehicle technologies.

Drawing upon evidence in the literature from modeling studies and field experiments, estimates of greenhouse gas reductions were produced for each scenario. The results, which are for the US, were as follows (TRB Special Report 251, 1997):

- From aggressive demand management and land use planning strategies: 6% reduction by 2020, 15% by 2040
- From a 1.5% annual increase in average new vehicle fuel efficiency: 15–20% reduction by 2020, 35% by 2040
- From higher fuel prices amounting to a 3% increase per year: 20% reduction by 2020, 40% by 2040
- From the introduction of new low-emissions vehicles (5% of fleet by 2020, 35% by 2040): no significant change by 2020, 30% reduction by 2040.

The TRB study concluded that, assuming that these scenario testing results are approximately correct, meeting Kyoto Protocol reductions would require either aggressive changes in vehicles (fuel efficiency levels, technologies) or their fuels, or a combination of vehicle, fuel, and demand management strategies. No one strategy was seen as offering a “silver bullet” for the greenhouse gas emission problem, nor

was any strategy seen as having significantly fewer costs, economic or otherwise, than the others.

Economic Considerations

One issue that has been raised in the past about the various strategies for sustainable transportation is: What will their economic consequences be? Transportation investments, particularly in highways, have been seen (in the US at least) as engines of economic growth and development. Because environmental considerations have been viewed as constraints on the expansion of the transportation system, they also have been seen as potential brakes on economic growth. Widespread concerns are that environmental protection is costly and that economic losses could result from interference with market preferences for auto mobility and suburban living. The implication that we therefore must trade off our desire for environmental protection with our desire for economic development has permeated many policy discussions.

Recently, however, a broader view of these issues has emerged. Work documenting the social and environmental consequences of transport (e.g., DeLucchi, 1996–1998) has made it clear that consumers are typically paying only a portion of the full costs of their transportation choices, particularly in the US. At the same time, there has been growing recognition that many transportation projects have not been subjected to rigorous economic analysis, and hence may not themselves be cost-effective. Models are currently being developed by the National Cooperative Highway Research Program (MicroBen-Cost) and the Federal Highway Administration (The HERS model) in hopes of improving the economic analysis of transport projects.

The courts also have stepped in, requiring that the land development consequences of new transport investments be clearly and explicitly evaluated and reported (Illinois Tollway, 1998). The Illinois Tollway court case, and several others currently pending, is part of a trend in the US to insist on formal analysis of a wider-ranging set of impacts of transportation projects than had been done in the past. Recognizing the need for such analyses, the FHWA Travel Model Improvement Program intends to produce models ready for deployment in the next few years; these models should be capable of providing details on emissions, vehicle usage, incidence of impact, and many other topics of concern. In the meantime, both FHWA and the Environmental Protection Agency have developed simplified methods and guidance for analyzing a variety of transportation, land use, and environmental measures.

The emerging view, then, is that economic development and environmental protection are both desired objectives along with social justice (equity); that transportation planners should be pursuing strategies that deliver on all counts, not just on the economic front; and that analyses should reflect the full range of concerns about projects—economic, social, and environmental.

Key Issues for Sustainable Transportation Planning

We turn next to some of the issues that would have to be addressed in designing and carrying out an invigorated search for transportation strategies which can simultaneously support economic development, protect the environment, and improve social justice. The issues range from uncertainties about the nature and severity of environmental problems, to questions about the extent to which transportation strategies should be used in attacking these problems, to debates over which transportation strategies are most pragmatic and efficacious.

Uncertainties About the Problems

Important uncertainties persist about the nature and severity of many environmental problems, including transportation-related air pollutants, greenhouse gas emissions, and even noise. (For example, what are the health effects of long term low-dose exposures?) Uncertainties also persist concerning the economic benefits of transportation infrastructure investments. (See, e.g., Boarnet, 1997). Such uncertainties make it difficult to have a clear story about the need for change or the likely results of intervention and, coupled with the high stakes involved, make it hard to muster the political support needed for action.

Scope and Timing of Technology Change

Technological advances in the automotive industry and other sectors of the economy have considerable potential to reduce air pollution, greenhouse gas emissions, congestion, and a variety of other negative externalities of the automobile. For example, aggressive technology deployments, whether in the form of changes in conventional vehicles or through the introduction of radically different vehicle and fuel technologies, could produce most of the needed reductions in greenhouse gas emissions for the next several decades. And to many, the prospect of “invisible” technological change is far more inviting than the prospect of higher prices or other demand reduction strategies.

However, such technology deployments are by no means assured or may emerge far later than their advocates are predicting. In addition,

price, availability, and performance characteristics are all uncertain, but are important considerations in comparing the technology option to other alternatives.

Another issue is that in the absence of public policy direction the technological changes that do emerge may or may not be directed to environmental improvements or other socially beneficial ends. For example, in the US at present many advances in automotive technology are being applied to increase acceleration and performance or strengthen vehicle bodies, not to boost efficiency or cut greenhouse gas emissions. A variety of interventions could change this directly or indirectly—higher CAFE standards and higher gas taxes are but two of many possibilities. Thus both market studies and studies of potential supplier and consumer incentives or disincentives for technological change would be valuable.

Public Opinion and Support for Action

Consumer preferences are a key driver of transportation and urban development trends. In the US, while polls generally find widespread support for environmental protection and enhancement, they also suggest that many consumers are not yet ready to alter their travel behavior or consumer purchases because of congestion, air pollution, or the threat of global warming. (See, e.g., Stoffer, 12/22/97.) For example, suburban utility vehicles and trucks continue to grow in popularity despite their comparatively low fuel economy, and drive-alone mode shares are increasing.

Many analysts believe that changes in pricing policy, such as higher fuel taxes or full-cost pricing for parking, could substantially change consumer choice. However, public opposition to such measures continues to make their implementation doubtful. Changes in public attitudes might be forthcoming as public understanding of greenhouse gas issues increases, but so far there is little evidence that this is occurring in the US. Indeed, polls, focus groups, and other measures of public knowledge and attitudes suggest that the greenhouse issue is barely on the radar screen for most citizens, and pricing strategies are commonly thought of as new taxes rather than cost recovery or impact mitigation.

Changes in travel behavior resulting from changes in land use and location, modes offered and chosen, and overall activity patterns also would depend on public support for policy changes, along with individual, household, and business decisions consonant with those changes. Here, the increasing interest in “livable communities” and “sustainable development” suggests a growing movement favoring broad policy reform. It remains to be seen, however, whether these new initiatives can

develop enough support to significantly change the patterns of settlement and transportation consumption. Here, the long time frame of greenhouse gas reduction efforts is an advantage, since there is enough time that land use policies could take hold.

Because public opinion and public support for action are so important to implementation, it would be highly worthwhile to devote more attention to the topic as a research element. In particular, it would be valuable to study how, and the extent to which, citizens make connections between their concern for the environment, the transportation policies they and their elected officials espouse, and their own behavior.

Sustainable Transportation: An Emerging Strategy

In the last several years, sustainability initiatives have been undertaken in a number of cities and regions. Among the recent undertakings in North America, for instance, are the Maryland Smart Growth Initiatives, the Portland OR 2040 Plan, Sustainable San Francisco, Sustainable Toronto, Sustainable Seattle, and The Bay Area Alliance for Sustainable Development. These efforts follow upon the 1987 report of the World Commission on Environment and Development (commonly called the Brundtland Commission report) and, in the US, on the President's Council for Sustainable Development (PCSD) report, "Sustainable America: A New Consensus," which argued that sustainable development can only be achieved by building sustainable communities.

Reflecting the recommendations and action items in those precedent documents, the local and regional efforts typically focus on the interrelationships among transportation, housing and employment trends and policies, and the resulting consequences for the environment (especially air quality), energy use, economic prosperity, and social equity. They often are developed through a process involving a wide range of interests (business leaders, environmentalists, social justice advocates, etc., as well as public officials and agency staff members). Often, they involve the negotiation of procedural agreements as well as the development of performance indicators and specific actions to be undertaken.

Table 2 lists some of the strategies that are proposed in sustainable development plans. As the table shows, the strategies range from land use planning to transportation, housing, and economic development, and linkages and overlaps are strong.

Transit-oriented development is often an important element of sustainable development plans. The intent is that by clustering high density mixed use development in a pedestrian-oriented layout around

Table 2. Strategies for Sustainable Development

Land Use and Community Development

- ◆ Preservation, Rehabilitation, and Redevelopment of Central Cities and High Density Inner Suburbs
- ◆ Infill in Cities and Suburbs — Increased Density, Mixed Use
- ◆ Reusing Brownfields, Recycling Buildings
- ◆ TODs and PODs as the Paradigm for New Developments
- ◆ Quality of Life: Attention to Crime / Schools / Services / Amenities
- ◆ Recycling / Precycling / Composting Programs

Transportation

- ◆ Access vs. Mobility — Basic Concepts
- ◆ Bike- and Pedestrian-Friendly Cities
- ◆ Transit, Paratransit, Ridesharing
- ◆ Telecommuting / Teleconferencing
- ◆ New Technologies for Improved Efficiency: evs, Traffic Control Systems, Transportation Information Systems
- ◆ Prices and Subsidies Aligned with Sustainability

Housing and Other Building Designs

- ◆ A Range of Choices
- ◆ Energy Efficient Buildings
- ◆ Edible Landscaping
- ◆ Natural / Indigenous Plants

Business/Job Creation

- ◆ Business Leadership
- ◆ Community Economic Development
- ◆ Clean / Safe Technologies

Social Equity

- ◆ Aligning Taxes and Subsidies with Sustainable Development
- ◆ Equitable Distribution of Resources

major transit nodes, residents and users of the resulting district will be able to reduce auto use while maintaining high levels of accessibility and mobility. Accomplishing these objectives is a major challenge, however. Finding appropriate sites for development near transit is not always an easy task. When sites are available, there still may be difficulty in interesting developers in the sites, especially if they are also being asked to deal with the added complexities of mixed use development. Markets for such living and working arrangements are clearly present in some regions, but are less apparent in others. Lenders may be disinterested in such projects and often charge premium rates because they believe the risk to be higher than for a single use or greenfield site project.

Redevelopment of brownfields is an even more challenging element of many sustainable development plans. Brownfields are abandoned or underutilized parcels of land that contain, or are suspected to contain, some level of contamination. Most brownfields are located in urban areas, especially central cities and older suburbs. A National Conference of Mayors report surveyed 149 US cities and found more than 47,000 acres of brownfields in the 122 cities reporting them. In addition to the contamination itself, lost opportunities for economic development and the jobs and tax revenues it brings are a major concern.

Traditionally, brownfield sites have been thought of as suitable only for light commercial or industrial redevelopment, but increasingly re-evaluations are being done which suggest that many sites could be appropriate for a multitude of uses, including housing and office space, wildlife habitat, parks, open space and recreation. Many brownfield sites are in areas already served by transit and therefore have some potential for higher density infill. But on top of the usual concerns about costs, marketability, and risks, brownfield sites pose additional challenges: the cost and uncertainties of site clean-up, potential long-term liability, and concern about economically viable end uses. The US Environmental Protection Agency and some states have active programs to encourage redevelopment of brownfields, but the funds available to support these efforts are modest.

Programs sponsored by the US Department of Housing and Urban Development also are supportive of sustainable development efforts; Community Development Block Grant funds and Enhanced Enterprise Zone designations are two examples of programs that have sometimes supported sustainable transportation and land use strategies. CDBG funds have been used for bicycle and pedestrian improvements, traffic calming and transit village planning, for example. Again, however, the demand far outstrips available funding.

Coordinating the programs to produce an overall impact greater than could be produced by any one program is a major thrust of sustainable development plans. This itself poses challenges, since the programs traditionally have been handled by different organizations whose operating styles and expectations can be quite different. Still, the potential for important synergies seems real and, at least on paper, many of the plans appear to be quite impressive. Documenting and evaluating these sustainability initiatives—both their institutional framework and the substance of their accomplishments—could provide valuable models for other areas wishing to follow suit.

An Emerging Role for Regional Agencies

In the US, states and some cities and towns have developed important strategies for sustainable transportation. Only a few plans for sustainable transportation have been developed at the regional level. Increasingly, however, regional agencies are being called upon to carry out a role in sustainable development planning. Their involvement is sought because the regional agencies have the data, the expertise, and the scope needed to address sustainability issues at a metropolitan level.

On the other hand, most regional agencies in the US are voluntary associations of local government (as well as the designated recipients of federal and state funds for planning). As voluntary associations, the regional agencies typically lack the strong political base, the visibility, the accountability and, as a result, the legitimacy that would be needed to implement their plans. Indeed, many regional agencies' planning efforts are largely ignored as transportation programs are assembled by state departments of transportation and local governments make individual, often uncoordinated, land use decisions.

As the interest in sustainable development has grown, however, people have realized that regional agencies can serve two important functions. One is a technical support function, with regional agency staff carrying out the forecasting exercises, simulations, and empirical studies needed to effectively analyze each strategy's social, economic, and environmental effects as well as any synergies or conflicts that may result from simultaneous implementation of multiple strategies. In this regard, those agencies with strong technical skills and an ability to do fast turn-around analyses have a decided advantage.

A second function for regional agencies is as a forum for discussion and negotiation among local governments. If regional agencies can serve as the place to network, trade information, develop cooperative agreements for joint action, and resolve conflicts if necessary, they can

begin to build the links between localities' individual plans and to suggest strategic ways to develop a regional approach. This, together with stronger analytical support, offers strong hope for an improved regional process and, ultimately, for a stronger alignment of economic objectives with social and environmental goals in urban development planning.

Next Steps: Directions for Research

This review of the opportunities and problems in fashioning a more sustainable transportation system suggests several areas for research. In particular, the following kinds of research programs are needed:

Evaluation Research on the Effectiveness of Sustainability Strategies: As experience accumulates with measures being proposed as sustainable development/sustainable transportation strategies, it will be important to document the range of experiences and evaluate their effectiveness.

Consumer Responses to Sustainability Strategies: Concerns about potential public opposition to such strategies as higher density development and full cost pricing frequently have blocked their serious consideration, even though analyses suggest that these strategies would be highly effective. Very little hard research has been done to document actual public opinion on these topics, however. Even less research has been done to understand the underlying reasons for the concerns that may exist. Research into consumer responses to sustainability strategies could help policy makers and planners develop ways to alleviate concerns and increase public acceptance, or could point to other strategies worth trying.

Research on Effective Planning Processes and Institutional Arrangements: Evaluation research is needed to document effective planning practices and institutional arrangements for sustainable development planning, as well as to identify practices and arrangements that are problematic and in need of reform. Research is also needed to develop better methods and procedures for planning and better institutional arrangements, recognizing that sustainable development planning is likely to be multi-objective, multi-subject, and multi-participant.

Comparative Research: Since efforts on sustainability are occurring in many countries, comparative research looking to the experiences of other countries would likely be highly instructive for US planners and policy makers.

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