Abridgment

Lessons for Transportation Demand Management from Utility Industry Demand-Side Management

RUTH L. STEINER

Electric utility industry demand-side management (DSM) is compared with transportation demand management (TDM) to make recommendations about the implementation of TDM. The regulatory environment of these two sectors and the types of demand-side measures are described. Finally, lessons for TDM are identified. The following conclusions are reached about TDM based on DSM. (*a*) Congestion pricing gives proper price signals to move people out of automobiles. Political barriers and equity considerations will make implementation difficult. (*b*) Many people hope for a technological fix for poor air quality and transportation congestion. The use of technology may be more successful in the long-term. (*c*) For TDM efforts to be meaningful, they need to be implemented in all communities in a region and simultaneously address the multiple reasons for their implementation: air quality, congestion, energy, and land use. This is not easy, because of different agendas and organizational cultures of agencies, political alignments, competing interests, and parochial concerns of local communities. TDM needs to be implemented uniformly throughout a region, balance the short-term and long-term implementation goals and constraints, and address congestion outside the commute periods.

In response to increases in energy prices and to infrastructure and environmental concerns in the 1970s, environmentalists and other activists recommended that decisions about new infrastructure be based on a least-cost planning process. The traditional method of creating additional supply to meet increased demand would be replaced by a process whereby the cost of new supplies would be compared with the cost of freeing up existing capacity through more efficient management of demand. During the past decade, least-cost planning, with a focus on demand-side management (DSM), has come to be accepted in the utility industry (*1*). In contrast, transportation demand measures have been implemented for a small number of employers or along a single corridor in a region (*2*). The Clean Air Act Amendments of 1990 and a variety of other state and federal legislation have once again focused attention on transportation demand management (TDM).

The purpose of this paper is to identify lessons from the implementation of utility industry DSM for TDM. The types of demand-side management measures are outlined and compared. The organization of these two regulated sectors is compared. Finally, lessons for TDM based on the implementation of DSM are identified.

Department of City and Regional Planning, Institute for Transportation Studies, University of California at Berkeley, 228 Wurster Hall, Berkeley, Calif. 94720.

TYPES OF DEMAND-SIDE MEASURE

The nature of the demand-side measures differs between the two sectors because of the nature of demand. The utility industry uses a mix of generators to meet their needs. The most efficient generators are used for the base load, less efficient generating capacity is used for the intermediate load, and peaking generators start quickly and are the most expensive to operate. In contrast, there is a limit to the capacity of major roadways. If a driver enters the freeway when it is at capacity, he or she encounters congestion and delays in getting to his or her destination. Transportation agencies cannot expand capacity in the same way that utility companies can dispatch additional peaking capacity.

Gellings (*3*) identifies five methods of managing the demand for utility generation: peak clipping, valley filling, load shifting, strategic conservation, and flexible load shape. Peak clipping is designed to reduce demand for the more expensive peaking capacity. Valley filling entails building demand during off-peak periods to make use of generating facilities for longer periods of time. Load shifting is a combination of peak clipping and valley filling that shifts loads from peak to off-peak periods. Strategic measures, such as conservation, appliance efficiency, and improvements in industrial processes, reduce end-use consumption and demand for electricity. Other characteristics of electricity, mostly reliability, are traded for discounted electric rates when demand is reduced through a flexible load shape.

Ferguson (*4*) outlines five methods of controlling the demand for transportation facilities: trip generation, trip distribution, mode choice, spatial route selection, and temporal route selection. Demand management through trip generation focuses on the elimination (e.g., through the use of telecommunications) of specific activities associated with trip making and trip making associated with specific activities. TDM through trip distribution focuses on shifting trips from more congested to less congested areas. When planners focus TDM efforts on mode choice, they attempt to shift trips from lower-occupancy modes of travel (usually solo driving) to a higher-occupancy mode. Spatial route selection shifts trips from a more to a less congested route. Demand management through temporal route selection shifts trips from a more to a less congested time period.

The demand management strategies can be summarized in three categories based on how they reduce demand: load management, trade-off in quality of service, and strategic demand reduction (see Table 1).

TABLE 1 DEMAND MANAGEMENT MEASURES CATEGORIZED BY GOAL AND TYPE

Demand Side Management (DSM)	Transportation Demand Management (TDM)
Load Management: Decrease the Variation in the Level of Activity	
Peak Clipping Valley Filling Load Shifting	Temporal Route Selection
Tradeoff in Quality of Service: reduce reliability of service in exchange for other benefits	
Flexible Load Shape	Trip Distribution Spatial Route Selection Mode Choice
Strategic Demand Reduction: reduce end use energy consumption or level of activity	
Strategic Conservation	Trip Generation Mode Choice

Load management strategies attempt to decrease the variation in the level of activity and do not attempt to prevent the use of the infrastructure; they merely attempt to change the time during which it occurs.

Trade-off in quality of service includes demand management activities that reduce reliability in exchange for other benefits such as lower costs for electricity and possibly less congestion for drivers. In transportation, these trade-offs involve changes in trip distribution and spatial route selection. For some people, mode shifts involve trade-offs in quality of service.

Strategic demand reduction occurs through reducing end-use consumption in the electricity sector and through measures affecting trip generation and mode choice for transportation services. In other words, the overall level of activity is reduced while the same activities continue.

The predominant demand-side strategy is different between industries. Electric utilities encourage customers to use electricity at different times of the day by offering price incentives and thus manage the load. TDM efforts have emphasized changes in mode or time of travel, or both (*4*). Most efforts have focused on work trips because they are characterized by the lowest automobile occupancy and the most significant congestion (*2*).

COMPARISON OF TDM AND DSM

A comparison of the nature of regulation, pricing, the use of technology, and nature of the demand-side management presents a sharp contrast (see Table 2). Utility industry DSM is regulated in a formal quasi-judicial proceeding with few participants. TDM is implemented largely at the local and regional levels. Decisions about transportation expenditures are made at the federal, state, and regional levels; decisions about the location of various land uses are made locally. DSM measures have a broad focus; they address the energy use by all classes of customers at all times of the day and year. TDM efforts have focused on work trips concentrated in space and time. There has been a less explicit comparison of transportation demand to supply. Utility customers pay through their utility rates for investments in both DSM measures and gen-

TABLE 2 COMPARISON OF TRANSPORTATION AND UTILITY REGULATION AND IMPLEMENTATION OF DEMAND-SIDE MEASURES

Utility Regulation and Demand-Side Management (DSM)	Transportation Regulation and Transportation Demand Management (TDM)
Regulatory Environment	
Formal quasi-judicial proceedings before state and federal regulatory commissions; relatively few participants in decision-making	Decisions are made at the federal, state and local level; large number of participants in uncoordinated decision-making processes
Use of Pricing as a Part of Regulation	
Coordinated demand related pricing (e.g., time of day, seasonal and interruptible rates); facilities financed directly through rates paid by customers; beginning to internalize the cost of externalities associated with electricity production	Fractured pricing structure (e.g. gas taxed at federal and state level, tolls collected on a few highways without obvious relationship to demand, inconsistent parking prices); facilities financed indirectly through gas taxes
Focus of Demand-Side Management Activities	
Broad, considers demand patterns of all categories of customers; compares supply-side and demand-side measures	narrow, responding to shortage of capacity in area and focussing on periods of highest usage (usually commute trips); demand-side not explicitly compared to supply-side measures
Use of Technology	
wide range of end-uses (e.g., light bulbs, sensor switches, appliance efficiency)	focussed on supply-side (e.g. automatic vehicle identification, integrated vehicle highway system) and automobile (e.g., improved catalytic converters, fuel injection)

erating facilities. Transportation infrastructure has been funded from a wide variety of taxes. Pricing as a part of TDM measures has been less pervasive, less consistently imposed, and less sensitive to the level of demand. Finally, utilities used technology in a variety of applications (e.g., industrial motors, appliances, and light bulbs) to improve energy efficiency, whereas the use of technology for TDM has been limited.

LESSONS FOR TDM

This comparison suggests some lessons for the implementation of TDM based on the implementation of DSM measures. Many have suggested that improvement in technology may provide solutions to transportation problems. Clearly, technological solutions have decreased energy consumption and automobile emissions and have improved the flow of traffic. Further reductions in automobile pollution will require changes in catalytic converters, engines, or fuels. Additional technological changes may make highway systems operate more efficiently, but these will not reduce the congestion from too many vehicles on the highway.

Pricing Strategies

Many transportation planners and policy analysts suggest that TDM, especially mode shifts and trip generation, would be more effectively implemented if the cost of driving were higher. Lessons from DSM suggest that pricing is important in reducing demand. However, increases in price are more complicated, but not impossible, in the context of TDM. There has been great political resistance to increases in the price of gasoline. The use of congestion pricing has received a more favorable response because it is seen as a fair way of allocating a scarce resource, the highway capacity.

Although congestion pricing can be easily implemented technically, it may not lead to the desired reductions because commuter traffic demand appears to be highly price inelastic. Studies indicate that commuters are willing to pay tolls as high as 25 cents/mi to save time (*5*).

The use of congestion pricing assumes that the occurrences of congestion are predictable. Although congestion associated with commute trips can be predicted, all occurrences of congestion cannot be predicted. It seems clear that congestion prices should be charged for predictably timed commute trips; it is less clear whether a charge should be made for other trips when the highways are congested. If there is no charge during noncommute periods of congestion, what is the message being sent to drivers about the meaning of congestion pricing?

Congestion pricing will not be effective if it is not coordinated with other transportation and pricing policies. If congestion pricing is implemented and transit alternatives to various locations are not improved, workers will only see increased costs without improvements in transportation service. In addition, the effect of congestion pricing could be neutralized by employer-provided transportation or parking allowances (*5*).

Finally, congestion pricing should be implemented throughout a region, or it may induce employers to move to parts of the region in which it is not being implemented. Participating communities may be at a disadvantage relative to nonparticipating neighboring communities, because congestion pricing may raise the cost of doing business in parts of a region.

Coordination of Regional Land Use, Transportation, and Air Quality

Difficulty in the use of congestion pricing is a symptom of the larger problem of implementing TDM: the fragmented regulation of regional transportation and the multiple reasons for the implementation of TDM. This fragmentation has led some to conclude that land use and transportation should be coordinated at the regional level to reduce associated environmental problems. These proposals assume that regional control over land use and transportation could lead to a better balance of jobs and housing, with a resulting decrease in travel, congestion, energy use, and air pollution. Some form of regional tax sharing to eliminate the need for communities to attract business to increase their tax base is often included.

Regulation of land use and transportation at the regional level can be difficult because of different institutional backgrounds, political origins, and sources of funding of existing agencies. Each agency has its own organizational mission, its own governing body, and its own means of communicating and coordinating its activities with communities, the state, and the region. Any attempt to merge these activities will require major organizational change, separate funding, and the means to bring together the diverse concerns of communities that have competed with each other for the same development projects.

Balancing Short-Term and Long-Term Goals

The final lesson for DSM is the need to consider the broader perspective in implementing demand-side measures. It is unclear whether TDM is being implemented as a short-term solution to a short-term problem or as a long-term solution to a long-term problem.

In the past load management and changes in mode choice have been the focus to reduce congestion during commute periods. The number of trips that can be switched to carpools and vanpools is about one-fourth the commute trips (*6*). In the long-term, temporal route selection can only occur where a less congested period exists.

In the short term the number of trips must be reduced and the timing of trips changed. Noncommute trips must be the focus, because congestion already exists during nonpeak periods and on trips to major nonwork destinations (e.g., sports and entertainment centers, airports, and regional shopping centers).

In the long term new technology can be applied, activities redistributed, and the distribution of trips changed so people can combine or eliminate trips. In both the short and the long term, change is needed in the way both cities and daily activities are organized. The short-term solutions must be implemented without compromising long-term goals.

Finally, a comprehensive strategy to evaluate the future of supply and demand throughout a region must be developed. This broader view would compare the supply of transportation with the demand and consider the costs of congestion, air pollution, depletion of oil resources, expansion of the highway system, and decrease in quality of life versus better planning, taxation, and other behavioral responses that would reduce reliance on the automobile. Such an approach should be an integrated process leading to a least-cost planning of the transportation system.

ACKNOWLEDGMENTS

This research was supported by the University of California Universitywide Energy Research Group, the Energy Foundation, AB Volvo, Exxon Company International, Exxon USA, Nissan North America, Shell International Petroleum Company, Shell Oil Company, and General Motors.

REFERENCES

1. M. Hanson, S. Kidwell, D. Ray, and R. Stevenson. Electric Utility Least-Cost Planning: Making It Work within a Multiattribute Decision-Making Framework. *Journal of the American Planning Association*, Vol. 57, No. 1, Winter 1991, pp. 34–43.
2. J. R. Kuzmyak and E. N. Schreffler. *Evaluation of Travel Demand Management Measures to Relieve Congestion*. Report FHWA-SA-90-005. FHWA, U.S. Department of Transportation, 1990.
3. C. W. Gellings, J. H. Chamberlin, and J. M. Clinton. *Moving Toward Integrated Resource Planning: Understanding the Theory and Practice of Least-Cost Planning and Demand-Side Management*. Report EM5065. Electric Power Research Institute, Palo Alto, Calif., 1987.
4. E. Ferguson. Transportation Demand Management: Planning, Development, and Implementation. *Journal of the American Planning Association*, Vol. 56, No. 4, Autumn 1990, pp. 442–56.
5. C. K. Orski. Can Management of Transportation Demand Help Solve Our Growing Traffic Congestion and Air Pollution Problems? *Transportation Quarterly*, Vol. 44, No. 4, Oct. 1990, pp. 283–98.
6. R. Cervero. Unlocking Suburban Gridlock. *Journal of the American Planning Association*. Vol. 52, No. 4, Autumn 1986, pp. 389–406.

Publication of this paper sponsored by Task Force on Transportation Demand Management.