Forecasting Energy Impacts of TSM Actions: An Overview

JANIS M. GROSS

This report summarizes the findings of a recent extensive study to determine the energy savings of transportation system management (TSM) actions taken or planned in New York State for 1978-1980. For those actions planned for implementation by 1980, both the direct energy savings and the energy costs of construction and maintenance were quantified. The main determinants of an action's savings are its effects on vehicle kilometers of travel and on travel speeds. Energy costs result from the manufacture, construction, installation, operation, and/or maintenance of the facilities and equipment required for each action. The analysis found net energy savings of 86.9, 96.9, and 106.7 million equivalent L (22.9, 25.5, 28.1 million gal) of gasoline for 1978, 1979, and 1980, respectively (approximately 0.5 percent of the total annual gasoline consumption in the state). Actions that conserve the largest overall amounts of energy are traffic operational improvements, ridesharing activities, passenger amenities, computerized traffic control systems, improved transit marketing, reduced off-peak transit fares; and park-and-ride services. Certain other TSM actions, including demand-responsive transit services and express bus services, have a negative net energy impact. On the average, energy costs represent approximately 15 percent of energy savings. Energy savings occur in all urban areas of the state, but 65 percent of the savings occur in the New York City area.

Conservation of transportation energy in New York State is important for several reasons. First, since transportation consumes approximately 25 percent of all energy resources and 50 percent of all petroleum (1), conservation in this area will significantly affect total energy consumption. Second, foreign sources provide New York State with 60-70 percent of its total petroleum, compared with 50 percent for the United States as a whole (2). Thus, New York State is particularly vulnerable to cutbacks in foreign oil supplies. Conservation in the transportation sector will reduce this vulnerability.

Because of the importance of conserving transportation energy, New York State developed its State Energy Conservation Plan. This plan called for an annual transportation energy saving of 1.1 billion L of gasoline (293 million gal) by 1980. The State Energy Office and New York State Department of Transportation (NYSDOT) have entered into an agreement whereby NYSDOT will assist the State Energy Office in implementing, revising, and refining the following elements of the plan: transportation system management (TSM) plans, right turn on red, 88-km/h (55-mile/h) speed limit, and carpool-coordinator demonstration program.

The most recent estimates of savings realized by each of these activities are 106.7 million L of gasoline (28.1 million gal) for TSM plans in 1980, 29.3 million L (7.7 million gal) for right turn on red, 0.8 million L (0.2 million gal) for the carpool-coordinator demonstration project in 1979, and a net loss in 1978 compared with 1977 of 2.7 million L (0.7 million gal) for the enforcement of the speed limit. Savings for the carpool-coordinator demonstration project are small since it was only carried out among a small group of state workers in Albany, New York. The projected annual savings for this project were almost 1100 L/carpooler. The estimated loss for enforcement of the speed limit arose because of recently reduced compliance.

This paper documents findings about TSM plans. It is a summary of an extensive report (3) that describes the findings and methods in greater detail.

TSM elements of long-range transportation plans were first required in the joint Urban Mass Transportation Administration and Federal Highway Administration regulations issued on September 17, 1975. TSM actions are intended to increase the capacity and efficiency of the existing transportation system by improving traffic flow, smoothing out peak-period loads, or diverting automobile drivers to high-occupancy modes. General categories of TSM actions include (a) actions to ensure efficient use of existing road space, (b) actions to reduce vehicle use in congested areas, (c) actions to improve public transit service, and (d) actions to improve internal transit-management efficiency. These general categories of TSM actions can be broken down into 33 specific actions. A list of actions and their occurrence in eight sections of New York State are shown in Table 1.

Because of their potential to reduce travel demand and to increase transportation-system efficiency, TSM actions can conserve energy. Since TSM actions emphasize moving people rather than vehicles, vehicle kilometers of travel (VKT) are reduced and/or travel speeds are increased, which results in a reduction in energy consumption.

LITERATURE REVIEW

Several studies have examined the travel impacts of specific low-cost transportation actions. These include a review of recent experience with TSM and TSM-type actions (4-6), an examination of actions that can reduce peak-period traffic congestion (7), an analysis of activities that can improve air quality (8-10), and an analysis of actions that can be taken to reduce energy consumption (8). In general, these studies have based their analyses on a review of actual case studies in which each of the actions has been implemented.

Several of these studies have concluded that the impact of TSM-type projects on VKT and on travel speeds is small (6-8,10); these studies indicate that these actions have other benefits. In addition, several indicate that appropriate packaging of TSM actions can increase their effectiveness.

OVERVIEW OF METHODS

To estimate the energy impact of TSM actions, both the energy savings and energy costs associated with each action were determined. Generally, savings result from the travel impacts of each action in terms of changes in VKT and speeds. Energy costs are incurred in the construction, installation, operation, and maintenance of specific transportation facilities. The difference between the savings and costs is the net energy savings.

These estimates were made on an annual basis by urban area for the years 1978, 1979, and 1980. Only those projects expected to be completed by the end of 1980 were included in the analysis. The calculations can be represented as follows:

Net energy savings = energy savings - energy cost.

Energy savings = [(Δwork VKT - Δnonwork VKT) ÷ L/km] + (areawide VKT x ΔL/km).

Table 1. Status of TSM actions by metropolitan planning organizations in New York State as of 1978.

TSM Action	Tri-State (NYC)	Capital District	Utica-Rome	Syracuse	Rochester	Buffalo	Binghamton	Chemung (Elmira)
Efficient use of road space								
TOPICS, signal improvements	T,I,P,S	T,I,S	T	T,I,S	T,I,S	T,P,S	T,S	T,I,S
Computerized traffic control system	T,P,S	I			S			
Access ramp metering	S							
One-way street conversion								
Preferential lanes for HOVs	T,P,S			T	T,P	T		
Preferential treatment at toll plazas	S							
Preferential access ramps	S							
Traffic improvements for buses				S		S		
Provisions for pedestrians	S			T	T			
Provisions for bicycles	T,I,P,S	T,I,P	T	T,S	T,S	T	T,S	S
Reduced number of parking spaces	T,S	S		S				
Increased parking rates					T			
Differential parking rates	T							
Parking permit system								
Limited parking with new construction								
Transportation corridor parking	T,I,P,S	T		T				
Work-hour policies	T	T		T	T		T	
Car tolls to reduce peak-period travel	S			S				
Reduction in off-peak transit fares	T	T	T	T	T	T	T	T
Reduction of vehicle use in congested areas								
Ridesharing	T			T,S	T,I		I	S
Car-restricted zones	T,S		T	S	S	T,S		
Truck restrictions	T,I,P,S							S
Improved transit service								
Routing, scheduling, and dispatching improvement	T,P,S	T	T,S	I,S	T,S	S	T,I,P,S	T,S
Express bus service	T,S			T				
Park-and-ride service	S			T,P	T,S			
Shuttle transit services to CBD	T,P	T,P		T,S	T			
Passenger amenities	T,I,P,S	T,I	T,I,P,S	T,I,P	T,I	T,I,P	P,S	I,P
Improved fare-collection systems	T,I,P,S			T,I	T		T	T,I
Improved passenger information	T,I,P,S	T,I	T	T	T,P	T	T,P	T
Demand-responsive services	T,I,P,S	T,I,P	T,I,P	T,P,S	T,P,S	T,I,P,S	P,S	T,P
Increased transit management efficiency								
Improved maintenance	T,I,P,S	T	S	T,I,P,S	T	I,S		
Improved monitoring	T,I,P,S	T,I		T,I,S	T,P,S	T,I,S	T,S	
Improved marketing	T,I,P,S	T,I,P	T,I,P	T,I,P,S	T,I,P,S	T,I,P	T,I,P	T,I,P

Note: T = actually taken, I = in implementation, P = planned, and S = study; TOPICS = Traffic Operation Program for Increasing Capacity and Safety.

Energy costs = [capital energy cost per unit x number of units x (1/service life of project)] + (annual maintenance cost per unit x number of units).

The second term in the formula for energy savings arises from changes in consumption resulting from speed changes. For the most part, projects were analyzed individually rather than as part of packages of several projects. This was done because generally TSM actions in New York State are not implemented in a coordinated manner.

Energy Savings

No generalizations can be made concerning the methods used to estimate the VKT and speed changes required before energy savings can be calculated. These procedures included assignment-based techniques, traffic-flow approaches, and transit fare and service elasticities. The following briefly identifies the approach used for different types of TSM actions.

1. Standard approaches for measuring changes in traffic flow were used for those TSM actions that are intended to reduce travel-time delay and/or to increase travel speeds. Actions included here were traffic-operations improvements, computerized traffic-control projects, access-ramp metering, and truck restrictions.
2. Assignment-based techniques were employed for those actions whose effect on the highway network could be readily simulated. TSM actions in this category are work-hour policies and automobile-restricted zones. The analysis of automobile-restricted zones was supplemented by specific project-level data, when available.
3. Travel-time elasticities between automobile and transit were used in those instances in which the action's impact was on travel times. TSM actions evaluated in this manner were preferential lanes for high-occupancy vehicles (HOVs), preferential treatment at toll plazas for HOVs, preferential access ramps for HOVs, traffic operational improvements for buses, and bus-rerouting projects involving schedule changes. In all but the last two cases, traffic-flow techniques were then employed to determine the effects of the HOV and non-HOV lanes on speed changes.
4. Travel-cost elasticities between transit and automobiles were employed for these TSM actions that include a price change. This includes automobile tolls to reduce peak-period travel, reductions in off-peak transit fares, increased parking rates, and differential parking rates.
5. Transit-service elasticities were used for those rerouting projects that increased service to areas that already had transit, provided service to new areas, or rerouted existing bus kilometers of travel.
6. Case study approaches that applied the experiences of areas that have projects similar to

New York State's were used where other techniques were not appropriate, did not exist, or were too costly or time consuming. This includes one-way-street conversion, ridesharing, park-and-ride service, corridor parking projects, transit passenger amenities, improved transit passenger information, transit monitoring, shuttle transit services, and express bus service. For the last two actions, this technique was used only when specific project-level data were not available.

7. A review of the trip characteristics of potential users was employed for those actions for which it was felt that this was an important factor in possible diversion from driving an automobile. The specific actions studied in this manner were pedestrian facilities and bicycle facilities.

8. Project-level data were used to analyze those projects for which information was readily available. Included here are improved fare-collection projects, demand-responsive transit services, shuttle transit services, and express bus services. Data collected during the planning for similar projects in other areas were employed to analyze the effect of reductions in the number of parking spaces.

For certain types of actions, the analysis procedure cannot be generalized. This applies to improved transit maintenance, limiting parking with new construction, and parking permit systems.

In addition to the procedures identified above, it was also necessary to quantify certain factors (prior mode and use of a car left at home) when a mode change or increase in use resulted from a TSM action. Prior mode was estimated based on case studies of similar projects.

The reason for introducing a term associated with the use of a car left at home is that failure to do so would result in an overestimate of savings. Suppose a person in a one-car family that has two automobile drivers does not use a car for the work trip but instead (as a result of the implementation of a TSM action) uses bus as a mode. In this case, the actual energy saving will be less than the gasoline that the driver formerly used for the work trip. The savings are less because the car left at home is available for use by the other driver in the household for nonwork purposes. Use of a car left at home (the nonwork VKT shown in the savings formula) was estimated by comparing household VKT for households for which the mode to work is driving with that for households for which it is not. It was found that use of the car left at home resulted in a net household VKT saving of 60 percent of the VKT saved during the work trip.

Other second-order travel impacts were not considered at this time. These include switching to car travel because of reduced congestion, the impacts certain TSM actions might have on location and land use decisions, and decisions about car purchasing. These impacts are more long term in nature and would probably not manifest themselves until after 1980.

Once changes in VKT were determined, changes in fuel consumption were calculated by using the following overall average over-the-road New York State efficiencies (11): 1978 = 4.9 km/L (11.6 miles/gal), 1979 = 5.0 km/L (11.9 miles/gal), and 1980 = 5.2 km/L (12.3 miles/gal).

The data from 1971 (12), updated to the specific years analyzed, were used to determine changes in fuel consumption resulting from speed changes.

Energy Costs

The values for energy costs given in this paper refer to energy costs that arise from the manufacture and installation of equipment, the operation and maintenance of the facilities, and the energy costs arising from the construction of structures, roads, etc. Other sources of cost such as the use of the car left at home are reflected in the savings figures. Energy costs as well as savings must be determined so that a fair assessment of TSM energy impacts can be made.

The methodology used in estimating costs is very simple. There are four key steps in the process: (a) consider aspects of the action or project that result in the consumption of energy, (b) estimate the life of the project, (c) determine the appropriate energy factors, and (d) apply the basic formula. The basic formula is

Annual energy construction cost = energy cost per unit (e.g., per dollar) x number of units (e.g., dollar cost) x (1/service life of project, e.g., 10 years).

In many cases an additional annual maintenance or operating cost should be added to the result of the above calculation in order to obtain the total annual energy cost.

Published values for energy cost per unit generally reflect total energy cost. If it is deemed appropriate to amortize these costs annually, it is necessary to know the life of the project. Table 2, taken from a New York State source (13) gives service-life estimates for a range of actions. Our study simply assumed that if the life of the project is, for example, 25 years the annual energy cost associated with construction would be one-twenty-fifth of the total energy figure. Given the uncertainty in energy estimates, an amortized estimate based on interest rates would not be appropriate. The energy costs contained in this report represent annual cost.

The first step in the process to determine sources of energy consumption requires research by the analyst and, ideally, extensive knowledge of the project or action. A reasonably good estimate suitable for an environmental impact statement (EIS) can be made by using information from similar projects. It is easy to overlook certain sources of energy consumption, but such omissions made by a careful analyst should be minor ones.

Estimates of project life for this study were made by using the numbers given in Table 2 that were deemed most appropriate. The values for energy cost per unit needed for the use of the basic formula were obtained for most projects from the literature.

The most complete source of data on the energy costs of transportation actions is Energy and Transportation Systems (14). Although many numbers in that document are based on California's experience, sources that contain information for all states (15) generally show the energy costs to be similar. Thus, the use of California numbers should give acceptable results for planning purposes elsewhere.

It should be noted that numbers that reflect manufacturing energy costs will yield energy costs that truly reflect energy for New York State only when all manufacturing is done in New York. Normally, some equipment, asphalt, and so on will be manufactured outside the state. In that event the energy cost is a cost to the nation generally, though not necessarily to New York. Such possibilities, however, are not considered here.

The information provided in terms of energy cost per dollar does not generally use 1979 dollars but those of some other given year. Therefore, they were converted by using the formula

Energy per $ (1979) = energy per $ (given year) x (consumer price index for given year/consumer price index for 1979).

Table 2. Improvement service life (maximum).

Improvement	Service Life (years)
Right-of-way, obstacle removal	100
Major structures	30
Major geometrics (change of intersection configuration, curve flattening, etc.)	20
Concrete barrier (median or half section)	20
Minor geometrics (left-turn lanes, channelization)	15
Lighting	15
Major sign structures	15
Metal median barrier	15
Signals and flashing beacons	10
Resurfacing (2.5 in)	10
Minor signing	10
Metal guide rail	10
Armor coat (1 in)	7
Concrete pavement grooving	
<10 000 AADT/lane	7
>10 000 AADT/lane	5
Delineators and guide markers	5
Asphalt pavement grooving	
<10 000 AADT/lane	5
>10 000 AADT/lane	4
Oil and stone	4
Shoulder stabilization	4
Pavement markings	
Thermoplastic	
Minimum	3
Maximum	7
Paint	0.5

Note: AADT = annual average daily traffic.

FINDINGS

The 1978-1980 analysis of TSM actions implemented and planned in New York State found that the following energy savings, costs, and net savings in equivalent liters of gasoline (EqL) will be realized:

Year	EqL (000 000s) Savings	Costs	Net Savings
1978	101	14	87
1979	114	17	97
1980	128	21	107

A summary of these findings by TSM category and year is shown in Table 3. The net savings figures represent aproximately 0.5 percent of the total gasoline consumed annually in the state. Energy savings are distributed among all four general categories (see Table 1) of TSM actions. However, only seven actions account for more than 90 percent of the total savings. These actions that conserve a relatively large amount of energy are traffic operation improvements, ridesharing activities, passenger amenities, computerized traffic control systems, improved transit marketing, reduced off-peak transit fares, and park-and-ride services.

Few generalities can be made about the types of actions that are the most effective. One obvious observation is that they are mostly transit actions. This occurs because the majority of TSM actions taken across New York State are transit oriented. Generally, transit actions and ridesharing induce people to leave their cars without increasing nonautomobile VKT. Thus, no offsetting energy cost occurs.

Several of the actions are very successful because of the large number of projects being under-

Table 3. Estimates of gasoline savings and costs for TSM actions that will be implemented by 1980.

TSM Action	EqL (000 000s) 1978 Savings	1978 Costs	1978 Net Savings	1979 Savings	1979 Costs	1979 Net Savings	1980 Savings	1980 Costs	1980 Net Savings
TOPICS	22 504 033	2 104 885	20 399 148	28 759 882	3 116 441	25 643 441	30 276 488	3 238 546	27 037 942
Computerized traffic control systems	7 106 502	31 054	7 075 448	7 106 502	31 054	7 075 448	9 649 230	163 533	9 485 697
Preferential lanes for HOVs	1 270 408	12 833	1 257 575	1 226 830	12 833	1 213 997	2 249 729	216 072	2 033 657
Provisions for pedestrians	0	8 596	-8 596	0	8 596	-8 596	0	8 596	-8 596
Provisions for bicycles	0	126 103	-126 103	0	188 282	-188 282	0	245 598	-245 598
Reduced parking spaces	3 856 829	703	3 856 126	3 735 864	703	3 735 161	3 606 124	703	3 605 421
Increased parking rates	0	0	0	0	0	0	0	0	0
Differential parking rates	0	0	0	0	0	0	0	0	0
Work-hour policies	2 340 800	0	2 340 800	2 122 680	0	2 122 680	2 049 720	0	2 049 720
Reduced off-peak transit fares	7 531 775	0	7 531 775	7 295 217	0	7 295 217	7 041 305	0	7 041 305
Ridesharing	23 479 535	1 634	23 477 901	26 673 484	114	24 673 370	23 814 786	0	23 814 786
Automobile restricted zones	7 551	29 055	-21 504	7 315	29 055	-21 740	7 060	29 055	-21 995
Truck restrictions	0	0	0	0	0	0	0	0	0
Routing, scheduling, and dispatching improvements	2 296 716	744 933	1 551 783	2 237 961	744 933	1 493 028	2 226 876	869 079	1 357 797
Express bus service	262 679	820 070	-557 391	254 129	820 070	-565 941	246 126	820 070	-573 944
Park-and-ride service	7 007 964	1 573 056	5 434 908	8 203 448	1 609 615	6 593 833	8 929 726	1 637 089	7 292 637
Shuttle transit services	180 181	20 501	159 680	238 598	41 002	197 596	271 920	113 400	158 520
Passenger amenities	12 056 651	1 334 283	10 722 368	12 907 832	2 444 289	10 463 543	17 593 061	3 395 216	14 197 845
Improved fare collection	1 648 611	0	1 648 611	1 594 993	167 922	1 427 071	1 544 757	167 922	1 376 835
Improved passenger information	2 890 755	131 161	2 759 594	3 083 556	130 097	2 953 459	4 387 472	265 529	4 121 943
Demand-responsive services	643 906	5 113 082	-4 469 176	673 672	5 550 284	-4 876 612	891 662	7 860 213	-6 968 551
Improved maintenance	3 128 764	1 954 967	1 173 797	4 008 932	1 603 505	2 405 427	4 210 533	1 330 114	2 880 419
Improved monitoring	328 860	42 457	286 403	328 860	422 796	-93 936	328 860	861 703	-532 843
Improved marketing	2 554 736	131 746	2 422 990	5 473 562	151 027	5 322 535	8 796 529	167 724	8 628 805
Total	101 097 256	14 181 119	86 916 137	113 933 317	17 072 618	96 860 699	128 121 964	21 390 162	106 731 802

taken across the state. Individual traffic operational improvement, ridesharing, transit amenity, marketing, park-and-ride, and fare-reduction projects will each result in only small energy savings. However, if these small savings per project are multiplied by a large number of projects, a relatively large saving results.

Computerized traffic control systems are the only action that does not involve a large number of projects. Here, rather, savings occur because each project affects a large number of vehicles.

Certain actions have net energy costs. These include bicycle facilities, pedestrian facilities, automobile-restricted zones, express bus service, demand-responsive transit services, and improved transit monitoring. In part, these energy losses are a result of the special nature of these projects: Demand-responsive services are generally not implemented to conserve resources but to increase the mobility of special groups. Other actions such as bicycle and pedestrian facilities do not result in large energy savings but involve energy costs to construct and maintain the facilities. Though they may be expected to result in energy savings, express bus services actually cost energy because they generate additional buses with additional gasoline consumption but attract many of their riders from other transit services rather than from among automobile drivers.

There are eight actions for which no projects will be implemented in New York State by 1980. The absence of any energy savings associated with these actions (which were excluded from Table 3) is not meant to imply that, if implemented, these actions would not conserve energy. These actions are access-ramp metering, one-way-street conversion, preferential treatment at toll plazas for HOVs, preferential access ramps for HOVs, traffic operational improvements for buses, parking permit systems, limiting parking associated with new construction, and automobile tolls to reduce peak-period travel.

On the average, energy costs represent approximately 15 percent of energy savings. (The actual numbers are 14 percent in 1978, 15 percent in 1979, and 16.7 percent in 1980.) These costs are not evenly divided among the 33 actions. Some projects are implemented at no or relatively small costs, such as reduction in the number of parking spaces, work-hour policies, reduced off-peak transit fares, and ridesharing activities. Actions taken at relatively large energy costs per liter saved are routing, scheduling, and dispatching improvements; park-and-ride service; shuttle transit services; passenger amenities; and improved transit maintenance. This high cost occurs in part because these are actions that are required to generate additional bus kilometers (an energy cost) in order to attract new riders.

The energy saving is not evenly distributed in the eight urban areas of the state: 69.3 million L or 65 percent of the saving in 1980 is conserved in the Tri-State area, with the remainder saved in the seven upstate urban areas. Because of the extensive transit system, large transit ridership, and high VKT in the Tri-State area, the potential for conservation is greater than it is in upstate areas.

The types of projects that save energy are different in the Tri-State area than in the upstate areas. In the Tri-State area the following actions result in relatively large savings: traffic operational improvements, computerized traffic control systems, reduced off-peak transit fares, ridesharing activities, park-and-ride services, passenger amenities, improved passenger information, and improved transit marketing.

In the upstate areas, the list is more limited. Two actions--traffic operational improvements and ridesharing activities--account for 90 percent of the saving there. There is much less emphasis on transit-related actions, since transit ridership is low in upstate areas. Those actions intended to produce a systemwide ridership increase (such as amenities and information) have a smaller potential for impact. The large saving attributed to traffic operational improvements is in part the result of the large number of projects being undertaken throughout the state.

CONCLUSIONS

As previously stated, TSM actions implemented and planned by New York State by 1980 will conserve an estimated 106.7 million EqL of gasoline (28.1 million gal). This figure represents 0.5 percent of estimated 1980 gasoline consumption in the state.

These findings indicate that implementation of planned TSM actions will not be a major factor in realizing the goal of the State Energy Conservation Plan, which calls for a saving of 1.1 billion L (293 million gal) in the transportation sector by 1980. The estimated saving attributed to TSM plans is, in fact, only 9.6 percent of this goal. Even if the eight urban areas in New York State could be encouraged to double their effort in the TSM area, less than 20 percent of the needed saving would be achieved. It is unlikely that this doubling of effort could be achieved, especially in the short term.

New York State will obviously have to pursue additional transportation actions if 5 percent of this sector's overall energy is to be conserved. It has been estimated at NYSDOT that full compliance with the 88-km/h (55-mile/h) speed limit could save approximately 1.8 percent of the state's annual gasoline consumption, or about 414 million L (108 million gal). NYSDOT has also made estimates of the potential effect of trip combining or chaining. Studies indicate that this group of actions can potentially save between 1.6 and 13.1 percent of upstate New York's estimated 1980 gasoline consumption (16). Though the upper range may be unrealistic, the lower range is reasonable and would make this an action worth encouraging. Extensive programs to encourage ridesharing can also be effective. A 10 percent increase in automobile occupancy for work and for shopping trips can reduce New York State's estimated 1980 gasoline consumption by 1.7 percent. A 25 percent increase would result in a 3 percent saving (16).

A large potential saving also lies in the purchase of fuel-efficient vehicles. The increase in average automobile efficiencies between 1977 and 1978 resulted in a saving of 545 million L (143.4 million gal) of gasoline (2.4 percent of gasoline used in the state) compared with expected consumption if fleet efficiencies had not increased, according to a 1979 NYSDOT estimate.

The above discussion is not meant to imply that TSM actions should not be pursued. Other reasons exist for implementing such actions, e.g., effect on mobility, air quality, safety, and conservation of resources. It is left to each area to trade off and weigh the attainment of these various goals and objectives (including energy) against each other in order to develop a comprehensive TSM program. As a result of this process, projects that save considerable amounts of energy may be rejected whereas those that have small or no energy savings may be accepted.

The development of coordinated packages of TSM projects may increase the savings that can be realized from TSM actions. This has not been done in the past in New York State. Rather, TSM planning has been an inventory activity. It appears, however, that the urban areas in the state are beginning to view TSM as a planning process and to develop a coordinated and comprehensive TSM element of their transportation plans.

One additional point concerning energy conservation in New York State is important to note. New York State is the most energy-efficient state in the nation; it consumes 33 percent less gasoline per capita than the national average. Much of this is a result of the existing extensive use of transit in the downstate area, where the rate of use of public transportation is considerably higher than the national average rate. Because of the high transit ridership, it becomes difficult to effect additional mode shifts from automobile. That is why the prior mode of many of the new patrons of new services is other transit and not automobile.

In spite of these findings, it is important to consider project impacts on energy use in evaluating TSM actions. This has not always been done in the past. The magnitude of the impact on energy use of this category of projects is probably in the same range as their impact on other things such as air quality, safety, and traffic congestion. When included in the evaluation process, energy savings will generally be another factor in these projects' favor.

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