Commission Briefing Paper 6B-02

Observations on Scenario 2: Travel Demand and Energy Efficiency

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Date: August 6, 2007

Introduction

This paper is part of a series of briefing papers to be prepared for the National Surface Transportation Policy and Revenue Study Commission authorized in Section 1909 of SAFETEA-LU.

Section 1909 requires the final report of the Commission to include an assessment of future needs over 15-, 30-, and 50-year time horizons. A number of alternative scenarios are being developed that make different assumptions about future transportation system emphasis. This paper describes selected observations pertaining to Scenario 2, the "Travel Demand and Energy Efficiency" scenario.

Background

Scenario 2 builds on Scenario 1 (Maximum Operations), but also incorporates widespread deployment of strategies to modify or reduce transportation demand. The purpose of this scenario is to estimate the extent to which transportation congestion, energy consumption, and emissions can be reduced through programs targeted at modifying highway demand (including shifting highway traffic to transit, rail, and waterways) and improving fuel efficiency. While this scenario is ultimately envisioned to cover highways, transit, freight rail, passenger rail and waterways, the results available at this time pertain to highways and transit only.

This scenario includes elements such as:

- Economically efficient highway pricing on all congested facilities
- Land use changes (denser development)
- Aggressive transportation demand management
- Expanded use of
  - Alternative work schedules
  - Flextime
  - Teleworking
- Expanded transit service
- Modified permissible truck configurations

These scenario elements constitute a set of mutually reinforcing policies. The inclusion of a highway pricing element suggests a market-driven approach to implementing many of the other scenario elements. Raising the price of highways relative to transit will lead individuals to modify their commuting patterns in areas in which transit is a competitive alternative. If economically efficient highway tolls were imposed on all congested facilities, prospective employees would tend to seek out employers offering alternative work schedules and other flexible work arrangements in order to minimize their commuting costs. Many employers would be influenced by this demand to modify their procedures if practical to facilitate employee recruitment and retention. The imposition of congestion pricing would also increase the incentive for individuals to modify their residential location choices in favor of dense developments with better transit access; this demand would in turn encourage developers to build such projects, and encourage governments to adopt zoning policies to facilitate these sorts of changes in land use. While these types of market responses would not be immediate if economically efficient highway pricing were to be imposed overnight, given an extended phase-in period, individuals and businesses would be expected to adapt their behavior to accommodate this change. This scenario assumes that these strategies would all be implemented starting after 2020, except that the expansion of transit systems would begin sooner, in order to accommodate additional transit demand after 2020. In practice this would be a very aggressive implementation of congestion pricing that probably could not be entirely achieved within this time frame. However, it is instructive to examine the potential for such a policy to reduce congestion, improve the operation of highway and transit systems, and reduce transportation-related energy consumption and greenhouse gas emissions.

In the absence of a pricing element, the market-driven impetus to adopting the remaining elements of this scenario would be reduced. However, it would be possible to substitute a combination of government incentives and regulatory requirements to attempt to achieve some of the same ends. For example, governments could offer transit subsidies to encourage greater use of this mode, or could put forward a combination of incentives and regulations to encourage and/or require employers to offer more flexible work arrangements. However, each of these government actions would also impose a cost to society in terms of the opportunity cost of alternative uses of funding or regulatory burden, and the magnitude of some of these subsidies and/or regulations may need to be considerable to have a similar effect on peak period highway travel as what congestion pricing is expected to accomplish.

The assumptions underlying the safety component of this scenario are identical to those in Scenario 1, though the actual number of fatalities would be different, based on the lower exposure rates (due to lower highway VMT) assumed as part of this scenario. These assumptions are based on estimates of the potential impacts of devoting alternative levels of funding into the aggressive enforcement of safety laws and regulations. Since the safety analyses were conducted independently of the remainder of this scenario, these findings are discussed separately in another paper.

Economically Efficient Highway Pricing

There are many alternative methods in which full or partial congestion pricing could be implemented in different locations. One approach is the imposition of cordon charges, in which a fee is paid when a vehicle enters a congested downtown area. Another is the application of variable tolls to a specific lane or lanes, either as completely dedicated toll lanes or as Highway Occupancy Toll (HOT) lanes (combination lanes in which tolls are applied only to low occupancy vehicles and high occupancy vehicles are not charged). Congestion charges can also be applied to entire facilities rather than to particular lanes. This scenario includes a concept of universal congestion pricing, in which all highway users are charged an economically efficient price for using highway facilities at times during which they are congested.

Economic theory suggests that when a particular good or service is priced below the marginal cost of providing that good or service, it will tend to lead to inefficient levels of consumption of that item. In the case of the transportation system, the need for additional capacity is generally driven by the use of the system during the peak travel period; to the extent that the pricing structure can be modified to encourage the use of less congested routes, or of the facility itself during less congested hours, this will tend to improve the efficiency of the system.

Currently, the user fees imposed on highway users are typically assessed on a per-gallon (i.e., fuel taxes) or a per mile (i.e., fixed rate tolls) basis. As a result, highway users are typically charged the same amount, regardless of where or at what time of day they travel; users of congested roads pay the same rate as those on uncongested routes. When highway users make decisions about whether, when, and where to travel, they consider both the implicit costs (such as travel time and safety risk) and explicit, out-of-pocket costs (such as fuel costs and tolls) of the trip. Under normal operating conditions, their use of the road will not have an appreciable effect on the costs faced by other users. However, as traffic volumes begin to approach the carrying capacity of the road, traffic congestion and delays begin to set in and travel times for all users begin to rise, with each additional vehicle making the situation progressively worse. However, individual travelers do not take into account the delays and additional costs that their use of the facility imposes on other travelers, focusing instead only on the costs that they bear themselves. Under an efficient pricing concept, in order to maximize net societal benefits, users of congested facilities would be levied charges precisely corresponding to the economic cost of the delay and other costs that they impose on one another.

By varying the price that highway users would pay for a facility by time of day, an economically efficient pricing mechanism would tend to spread peak traffic volumes more efficiently, and increase net benefits to users. By increasing the price of peak period highway travel relative to other alternatives, a pricing mechanism is likely to reduce total highway travel as drivers shift to other transportation modes and/or non-transportation alternatives (i.e., teleworking) for some trips. This approach would not necessarily eliminate all congestion delay, as many drivers will continue driving at peak periods, as long as the value that they place on their trip exceeds the amount of the congestion charge and other costs they will experience. Drivers would also continue to experience delay due to incidents (accidents, weather, special events), work zone delay, signals (even if they are optimally timed), and other traffic control devices.

This particular type of pricing mechanism was included as part of this scenario based primarily on the availability of tools to analyze it. The Highway Economic Requirements System (HERS) bases its decisions in part on changes in estimated highway user costs, and thus has the ability to compute the incremental cost that adding an additional driver to a particular congested facility would be expected to have on all other users of that facility. The amount of VMT diverted as a result of the application of efficient highway prices was estimated using the same procedures utilized to estimate the impacts of other changes in highway user costs, based on travel demand elasticity research that suggests that a 1% change in total highway user costs (including travel time costs, vehicle operating costs, and crash costs) leads on average to a 0.4% change in driver response in terms of VMT over the short term and an 0.8% change over the long term. The analysis assumed that 50% of the VMT diverted off of congested routes at peak periods would shift to transit, while the remaining 50% would shift to other time periods or would not occur at all due to changes such as expansions in telework, denser land use, and the elimination of low value trips.

This particular analysis makes no direct assumptions about the disposition of revenues generated from congestion pricing. Such revenues could be used to finance the transit expansions identified as part of this scenario (as suggested in the initial scenario description), fully or partially offset the motor-fuel tax, finance the highway expansions identified as part of this scenario (this was not assumed as part of the analysis), or for some other transportation or non-transportation purpose.

While not directly modeled as part of this analysis, a true efficient pricing mechanism could also incorporate the negative impacts of individual vehicles on non-congested routes as well. For example, while adding passenger vehicles to an uncongested facility may not have a major impact on other users of the facility, significant shifts of traffic (particularly truck traffic) from congested higher order facilities to uncongested lower order facilities may have negative safety implications. The implicit societal costs of such safety impacts could be computed and charged to these vehicles, which would tend to discourage these types of traffic shifts to some degree.

Findings and Observations - 2020

The highway findings for the first 15 years are identical to those in Scenario 1, as the analysis assumes the implementation of the strategies included in this scenario would not be implemented until after 2020.

For transit, this scenario does not include a current sustainable funding level analysis, as the investment required to expand transit systems to accommodate higher transit PMT would exceed that which could be accommodated at current funding levels. The "medium funding level" and "high funding levels" would both increase by $4 billion under this scenario (from $14 to $18 billion for the medium funding level and from $21 to $25 billion for the high funding level), as transit systems are expanded to accommodate increases in transit travel demand. In response to these transit system expansions, transit ridership would be expected to grow by approximately 2 billion PMT relative to the base case, independent of the highway strategies that would be implemented later.

Findings and Observations - 2035

The analysis indicates that at current sustainable funding levels for highways, the adoption of a package of aggressive travel demand management strategies would result in a significant reduction in average delay on urban principal arterials in 2035 (from 8.7 to 7.6 hours per 1000 VMT, a 13 percent reduction) relative to the base case (note, however, in either case average delay would be higher than in 2005). This relative improvement in operational performance would be achieved despite a small reduction in the number of new lane miles added over the 30-year period.

The “medium funding level” for highways (defined as the minimum amount required to at least maintain major performance indicators at 2005 levels over a 30-year period) would be significantly lower under Scenario 2 than the base case, with an average annual cost of $133 billion (in $2006) over 30-years compared to an average annual cost of $159 billion (in $2006) in the base case. This difference is even more dramatic that it appears, since the travel demand strategies (and the resulting cost savings) did not begin until halfway through the 30-year period. By definition, the medium funding level results in a similar level of performance in terms of average delay on urban principal arterials and the percentage of VMT on roads with acceptable ride quality. However, this level of performance was achieved at a lower cost and with the addition of approximately 35,000 fewer lane miles over the 30-year period than in the base case.

The “high funding level” for highways (an amount sufficient to support all cost-beneficial investments) would be significantly lower under Scenario 2 than the base case, with an average annual cost of $182 billion (in $2006) over 30-years compared to an average annual cost of $218 billion (in $2006) in the base case. This reduced level of investment would achieve a reduction in delay relative to the base case, but would require the addition of approximately 45,000 fewer new lane miles over the 30-year period.

For transit, this scenario does not include a current sustainable funding level analysis, as the investment required to expand transit systems to accommodate higher transit PMT would exceed that which could be accommodated at current funding levels. The “medium funding level” and “high funding levels” would both increase by $8 billion under this scenario (from $17 to $25 billion for the medium funding level and from $23 to $31 billion for the high funding level), as transit systems are expanded to accommodate increases in transit travel demand. Transit ridership was assumed to grow by approximately 10 billion PMT relative to the base case to accommodate shifts from highway to transit in response to the application of an economically efficient pricing mechanism for highways, bringing total transit ridership in 2035 to approximately 3 times year 2005 levels.

The savings on the highway side of this scenario more than offset the increased costs on the transit side.

Findings and Observations - 2055

By 2055, the analysis indicates that at current sustainable funding levels for highways the differences between Scenario 2 and the Base Case would become even more pronounced. Average delay on urban principal arterials in 2055 under Scenario 2 would be 42 percent lower than under the base case (6.8 hours per 1000 VMT compared to 11.6 hours). This relative improvement would occur despite the addition of approximately 14,000 fewer lane miles as part of Scenario 2.

Scenario 2 differs significantly from the base case in terms of the “Medium funding level” for highways in that it is actually possible to maintain performance in a cost-beneficial manner under this scenario. In the base case, beyond 2035 it was no longer possible to maintain average delay at 2005 levels in a cost-beneficial fashion, due to the cumulative impact of rising population and the unavailability of affordable right-of-way on which to add capacity in densely populated areas. These relative gains in operation performance come despite the significantly lower average annual investment level identified ($146 billion per year compared to $178 billion per year in the base case).

The level of cost beneficial investments for highways under Scenario 2 in terms of the “High funding level” would be significantly lower under Scenario 2 than the base case (average annual level of $185 billion in 2006 dollars compared to $259 billion in the base case). However, the effectiveness of this investment would be greater, as average delay on urban principal arterials would be 14 percent lower than under the base case (5.6 hours per 1000 VMT compared to 6.5). The number of new lanes miles added under Scenario 2 would be approximately 131,000 lower than in the base case over 50 years.

For transit, this scenario does not include a current sustainable funding level analysis, as the investment required to expand transit systems to accommodate higher transit PMT would exceed that which could be accommodated at current funding levels. The “medium funding level” and “high funding levels” would both increase by $20 billion (in $2006) under this scenario (from $20 to $40 billion for the medium funding level and from $26 to $46 billion for the high funding level), as transit systems are expanded to accommodate increases in transit travel demand. Transit ridership was assumed to grow by approximately 46 billion relative to the base case to accommodate shifts from highway to transit in response to the application of an economically efficient pricing mechanism for highways, bringing total transit ridership in 2055 to more than 7 times above 2005 levels.

The savings on the highway side of this scenario more than offset the increased costs on the transit side.

General Observations

This demand-side oriented scenario provides a useful contrast to other scenarios that are more supply-side oriented in nature. While the strategies identified here would appear to have some potentially significant positive results, they do not in and of themselves cure all shortcomings. While the medium and high funding levels identified under this scenario are lower than the base case, they remain significantly higher than current levels of investment.

This scenario focuses on the demand aspects of efficient pricing and other strategies, rather than the revenue aspects of these strategies. The imposition of congestion pricing on a widespread basis would produce significant amounts of new revenue. The disposition of such revenues would be an important part of an overall program framework, and could affect other aspects of transportation demand depending on how they were utilized. For example, if these revenues were used to reduce other fees imposed on transportation users (such as fuel taxes or transit fares) this would have an effect on overall travel demand levels.

It should be noted that implementing the type of pricing mechanism incorporated in this scenario would present some technical challenges. The administrative costs of a comprehensive pricing system could be significant, requiring extensive information on the user demand and mechanisms for calculating and imposing charges in real time. Additional infrastructure (whose costs are not accounted for in this scenario) could also be required to implement such a strategy, to the extent that such costs are not already included in the aggressive ITS deployment strategy assumed in both Scenario 1 and Scenario 2.

Under this scenario, average speeds at peak periods would be higher, and the stop and go traffic conditions that currently exist in many locations would be reduced. However, the congestion charges imposed under this scenario would not reduce highway usage to the point at which congestion would be eliminated. Imposing a charge high enough to eliminate congestion at all times would result in some trips whose benefits exceed their cost being priced off the highway; this would represent an inefficient use of resources from an economic perspective.

While the particular flavor of congestion pricing analyzed as part of this scenario may not be what the Commission would ultimately like to consider, the analysis does provide a sense for what such strategies could potentially accomplish, in conjunction with other complementary strategies.