# REPORT ON
# THE VALUE PRICING PILOT PROGRAM
# THROUGH MAY 2009

**September 17, 2009**

U.S. Department of Transportation
Federal Highway Administration

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# EXECUTIVE SUMMARY

The Value Pricing Pilot Program (VPPP) was established by the U.S. Congress as the Congestion Pricing Pilot Program in 1991. It was subsequently renamed the VPPP under Section 1216 (a) of the Transportation Equity Act for the 21st Century (TEA-21) in 1998, and continued through the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU).

A more commonly used term for "value pricing" is "congestion pricing." Congestion pricing can reduce peak period congestion by charging motorists new or higher fees for use of roads during peak times in order to encourage drivers to shift to other travel modes, routes or destinations; to travel at other times of the day; or to forgo making the trip altogether.

The purpose of the VPPP is to demonstrate whether and to what extent roadway congestion may be reduced through application of congestion pricing strategies, and the magnitude of the impact of such strategies on driver behavior, traffic volumes, transit ridership, air quality and availability of funds for transportation programs. The program provides tolling authority and discretionary grants to State or local governments to facilitate the demonstration of congestion pricing applications and report on their effects.

## Lessons Learned from the Value Pricing Pilot Program

Projects implemented under the VPPP have been valuable in demonstrating congestion pricing to the public, and in the case of High-Occupancy Toll (HOT) and Express Lanes have provided valuable options in the form of reliable trips for travelers. The technical feasibility of pricing and its potential to change travel behavior have showed promise. They have also proven that some travelers are happy to have the option of buying a reliable trip. However, due to their limited scale and scope, implemented projects have had positive, but limited impacts on driver behavior, traffic volumes, congestion reduction, transit ridership, air quality, and funding for transportation.

The types of projects that have been implemented in the U.S. have involved "partial" pricing on one or more lanes of an existing free facility (e.g., the conversion of High-Occupancy Vehicle (HOV) lanes to HOT lanes); relatively small increases in peak period toll rates on existing toll facilities; and pricing not involving tolls, such as parking. None of the projects implemented in the U.S. has, as of yet, involved introducing a new charge on an existing toll-free facility, and only one such project is planned on the State Route 520 (SR 520) floating bridge in Seattle, Washington. Moreover, the primary purpose of Seattle's SR 520 pricing project is not congestion reduction but raising new revenue for reconstruction of the floating bridge. These limited projects suggest that the American public is not yet ready for the more aggressive scale of area-wide pricing deployed in London, Stockholm, and Singapore to reduce congestion and improve the urban environment.

## Lessons Learned from the Urban Partnerships Program

In 2006, the VPPP partnered with the Department's Urban Partnership Agreements (UPA) program in order to encourage broader applications of congestion pricing. However, despite the over three-quarters of a billion dollars in grants offered by the Department through the competitive UPA program and its successor Congestion Reduction Demonstration (CRD) program, only one project, the SR 520 project noted above, will implement performance-based pricing on all lanes of a highway facility. The rest are "partial" pricing projects involving priced lanes and one pricing project not involving tolls. While these approaches will be helpful in demonstrating innovative technical and policy approaches to facilitate and accelerate HOV to HOT conversions, they are not the more comprehensive pricing strategies initially contemplated either by the UPA/CRD programs or the VPPP. The Department is conducting a major evaluation effort involving all funded UPA and CRD projects, and early results of this effort will be available in 2010.

The UPA program did provide important lessons from one UPA proposal that did not move forward to implementation – the proposal from New York City to introduce cordon pricing in Manhattan. On March 31, 2008, history was made in the U.S. when the New York City Council, an elected body, voted to charge new fees for use of existing free roads that are for general use. While the project did not go forward as scheduled due to failure to obtain approval from the State legislature, this vote broke new ground in the U.S. Up to this time, elected bodies in the U.S. had supported new road use charges on motorists *only* on new roads, new lanes, or existing lanes previously restricted to high-occupancy vehicles.

New York's historic accomplishment was made possible in part by incentives offered by the U.S. Department of Transportation in the form of discretionary funding support. The possibility of hundreds of millions of dollars being awarded to New York City allowed significant political hurdles to be partly overcome. While there was much that was done right in New York, factors that could have contributed to its failure to gain State legislative approval were: time pressures that did not allow for targeted outreach to explain benefits to key elected officials and their constituents; perceived disproportional burdens relative to benefits to boroughs surrounding Manhattan; and lack of trust by suburban residents that promised transit improvements would actually be put in place.

## Moving Forward

As indicated above, the purpose of the VPPP is to demonstrate what extent roadway congestion may be reduced through application of congestion pricing strategies, and to quantify the impact of pricing on driver behavior, traffic volumes, transit ridership, air quality, and availability of funds for transportation.

However, the projects implemented so far have not had significant impacts on congestion or the other objectives of the VPPP because they typically only involve "partial" pricing of a highway facility. Nonetheless, partial pricing projects have had measurable benefits

– providing a choice for a reliable trip for those who need to be somewhere on time, reducing their frustration. They have also made the concept of congestion pricing more familiar to the public, an important factor if congestion pricing is going to be implemented on a broader scope and scale. Partial pricing projects have gained acceptance from the public because they provide an *additional* choice, leaving in place prior choices such as the choice to drive alone in congested traffic.

To further VPPP's objectives, the VPPP portfolio of implemented projects should include pilot implementations of broad congestion pricing projects involving tolls on all lanes of a highway facility, all roads in a congested area, or all roads of an entire roadway network. Such approaches tend to *take away* the choice to drive alone for free in congested traffic. To make further progress in gaining public acceptance for such congestion pricing strategies far more aggressive than partial facility pricing, the VPPP should include projects that demonstrate the far-reaching benefits only achievable with a broad-scale project, and show new convenient multimodal choices available with a comprehensive transportation investment package in exchange for the loss of the ability to drive for free on congested roads.

Broader applications of congestion pricing involving performance-based tolling of all lanes of entire highway facilities, entire zones, or entire networks could have more significant impacts on congestion and other VPPP objectives. However, moving to implementation of such "truer" applications of congestion pricing is difficult because of significant public concerns. The chief concerns are fairness to those who perceive they have already paid for use of roads through taxes, equity for low-income individuals, traffic diversion from priced highway facilities to toll-free surface streets, administrative costs for toll collection, loss of privacy due to the technology that might be used for toll collection, and the lack of convenient alternative modes of transportation. All of these issues can be mitigated to some extent through a well-designed package of actions, including multimodal transportation investments and supporting travel demand management strategies.

A key issue for public acceptance of a broad congestion pricing approach is equity for low-income individuals. A well-designed congestion pricing plan can be less burdensome to low-income citizens with appropriate use of revenues from congestion pricing. For example, low-income transit riders can benefit significantly from toll-financed transit improvements. Additionally, pricing schemes can include protections for low-income individuals, such as discounted tolls or "life-line" credits. New York City's cordon pricing proposal included tax rebates for low-income individuals for any fees paid in excess of the fare for a transit trip.

Despite the challenges, transportation policymakers are showing increasing interest in broad congestion pricing as a policy tool, because of the potential to achieve public goals more effectively than with other conventional means. The benefits derived from well-designed congestion pricing strategies include more efficient use of resources, generation of revenue for transportation investment, particularly for non-driving alternatives, and support of economic productivity, environmental sustainability, and livable communities.

To make a broad pricing approach more feasible and increase public acceptability, robust outreach and educational efforts are critical. There will need to be extensive outreach and public involvement; a well-crafted plan for use of revenues to benefit all geographic areas in proportion to the burdens placed on them; and advance implementation of transit improvements to assure citizens that improvements are guaranteed. As with the Stockholm project, it may also be helpful to propose the project as a "trial" with an opportunity for an up or down vote at a referendum after the trial period.

While the public typically has a negative view of pricing initiatives early on, careful outreach and educational activities could change this perception, as was demonstrated in New York City, where public approval rose to 60 percent over a relatively short period of time. It is also important to find a local champion who can be called upon to support the program and marshal it through to implementation. Mayor Bloomberg played this role in New York City.

However, even with effective public outreach and strategies to mitigate public concerns, a broad-scale implementation project is not likely to move forward without significant Federal funding support on the scale that moved Mayor Bloomberg to champion the New York City proposal. Many believe that a HOT lane network is the only long-term future scenario that can get the support of the public and political leaders. Also, HOT lane networks can show the public how pricing works on a much broader scale. This familiarity could perhaps lead to public acceptance of more aggressive forms of pricing with higher levels of impact.

# I. INTRODUCTION

The Value Pricing Pilot Program (VPPP) was established by the U.S. Congress as the Congestion Pricing Pilot Program in 1991. It was subsequently renamed the VPPP under Section 1216 (a) of the Transportation Equity Act for the 21st Century (TEA-21) in 1998, and continued through the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU).

A more commonly used term for "value pricing" is "congestion pricing." Congestion pricing involves attempting to reduce peak period congestion by charging motorists new or higher fees for use of roads during peak times in order to encourage drivers to shift to other travel modes, routes or destinations; to travel at other times of the day; or to forgo making the trip altogether.

The VPPP serves as a laboratory for exploring and implementing innovative pricing solutions to address highway congestion and related environmental, energy use and economic productivity impacts. The program assists State and local governments in evaluating alternative pricing strategies, designing related public participation programs, identifying appropriate administrative, technological, and project design concepts, and implementing pilot projects. The program provides Federal funding support and tolling authority as well as technical assistance to State and local project partners.

As prescribed by Congress, the Secretary of Transportation is to monitor the effects of pilot projects implemented under the VPPP for at least 10 years and report to the Senate Committee on Environment and Public Works and the House Committee on Transportation and Infrastructure every 2 years "on the effects such programs are having on driver behavior, traffic volume, transit ridership, air quality, and availability of funds for transportation programs."

Congestion pricing involving tolls has raised several issues. The chief concerns are fairness, equity for low-income individuals, traffic diversion, administrative costs, privacy, and availability of viable alternative modes of transportation. However, each of these concerns can be addressed at least in part with a well-designed program. Benefits such as more efficient use of resources, generation of revenues for transportation, improvements in alternatives to driving, and support of economic productivity, environmental sustainability and livable communities can help address resistance.

On March 31, 2008, the New York City Council, an elected body, voted to charge new fees for use of existing free roads for general use. This vote broke new ground in the U.S. Until this time, elected bodies had *only* supported new road use charges on motorists on new roads, new lanes, or lanes of existing roads previously restricted to high-occupancy vehicles.

Congestion pricing projects already implemented in the U.S. have broken new ground and provided important lessons for those interested in exploring the use of market-based approaches in responding to traffic congestion problems, improving air quality, and reducing energy use and greenhouse gas emissions. Observations from projects implemented to date reveal that travelers are willing to pay for improvements in

transportation service and that pricing can lead to more efficient use of existing highway facilities. People respond to price signals when making transportation decisions, just as they do in other aspects of their economic lives. These responses can serve as important guides for transportation planners and policy makers in future transportation investments.

Pilot projects implemented to date have been relatively limited in scope and scale, involving primarily pricing of lanes on existing highway facilities. They have, therefore, had limited impacts on driver behavior, traffic volumes, congestion reduction, transit ridership, the environment, and availability of revenues for transportation. Because free driving alternatives have continued to exist adjacent to priced lanes, they have also not had any significant negative impacts on equity for low-income drivers. Partial pricing projects have had measurable benefits – providing a choice for a reliable trip for those who need to be somewhere on time, reducing their frustration. They have also made the concept of congestion pricing more familiar to the public, an important factor if congestion pricing is going to be applied with broader scope and scale. Partial pricing projects have gained acceptance from the public because they provide an *additional* choice, leaving in place prior choices such as the choice to drive alone in congested traffic.

On the other hand, broader congestion pricing approaches such as those implemented in London, Stockholm, and Singapore have had significant impacts on traffic volumes, congestion delay, transit ridership, air quality, and the availability of funds for transportation – the key impacts sought through the VPPP. To achieve its stated objectives, the VPPP portfolio of implemented projects must include pilot implementations of broad congestion pricing projects – projects involving tolls on all lanes of a highway facility, all roads in a congested area, or all roads of an entire roadway network. Such approaches tend to *take away* the choice to drive alone for free in congested traffic. To gain public acceptance for such aggressive congestion pricing strategies, the U.S must demonstrate to its citizens the far-reaching nature of benefits of pricing only achievable with a broad-scale project, and new convenient multimodal choices available with a comprehensive transportation investment package. However, such a broad scale pilot implementation project is not likely to move forward without significant Federal funding support, on the scale that moved Mayor Bloomberg to champion the New York proposal. As with the Stockholm project, it may also be helpful to propose the pilot project as a "trial" with an opportunity for an up or down vote at a referendum after the trial period is completed.

This report updates VPPP activities described previously in the U.S. Department of Transportation's "Report to Congress on the Value Pricing Pilot Program through April 2006." It is the second Program report to Congress subsequent to passage of SAFETEA-LU, following a series of reports submitted to Congress under prior pricing legislation. This report presents a description of the concept of congestion pricing and the latest information available on the extent and nature of the VPPP. The report highlights some important lessons that have been learned since the inception of the Federal pricing program in 1991 about the effects of congestion pricing and the process of implementing congestion pricing projects. The report also discusses issues that have been raised with regard to broad congestion pricing approaches, and potential benefits. The final section of the report looks at potential future directions.

## II. WHAT IS CONGESTION PRICING?

Each year, congestion costs Americans billions of dollars in terms of lost time and productivity, air pollution and wasted energy. The Texas Transportation Institute's latest survey of urban mobility in America's 439 urban areas shows that, in 2007, traffic congestion resulted in 2.8 billion gallons of wasted fuel and 4.2 billion hours of lost time stuck in traffic. The cost of delays and wasted fuel totaled $87.2 billion in 2007, more than quadruple the comparable cost figure in 1982. These estimates do not include environmental degradation and economic productivity losses.

Given the magnitude of these costs, it is little wonder that local, State and Federal agencies have been seeking better ways of dealing with congestion problems. In some cases, capacity additions can be made to better serve peak-period travel, but capacity additions are not always possible and are often prohibitively expensive. Further, added capacity is often quickly overwhelmed by increasing traffic demand. The use of technological and operational approaches to improving system performance also shows great promise for reducing congestion, as do strategies that promote telework and the use of more flexible work schedules. Strategies that promote more efficient and responsive public transit systems that tailor services to meeting rush-hour demand also have an important role to play.

Yet these strategies, alone or in combination, would be more effective in reducing congestion if there is a link between the decision to travel on a congested road and full costs associated with that travel. Congestion pricing provides such a link, involving road use fees that vary with the level of demand. Fees are normally assessed electronically to eliminate delay associated with manual toll collection. It is similar to the pricing approach used in other sectors of the economy where demand varies by time of day, or season, or location (e.g., airlines, telephones, hotels, electric or gas utilities).

Congestion pricing recognizes that trips have different values at different times and places and for different individuals. Faced with premium charges during periods of peak demand, road users are encouraged to eliminate lower-valued trips, take them at a different time, or choose alternative routes or transport modes where available. In cases where congestion pricing is applied to specific traffic lanes rather than to an entire highway facility, users have the option of choosing to pay to use congestion-free priced lanes or continue to travel on general purpose lanes without paying a toll.

**Types of Congestion Pricing**

Congestion pricing projects can be grouped into two broad categories: (1) projects involving tolls; and (2) projects not involving tolls.

Projects involving tolls are of five types, the first two which involve "partial" pricing of one or more lanes on existing toll-free facilities.

- *HOT Lanes (Partial Facility Pricing).* This project category involves converting existing high-occupancy vehicle (HOV) lanes into priced lanes called high-occupancy toll (HOT) lanes, or building new HOT lanes. These projects allow vehicles not meeting established occupancy requirements for an HOV lane to "buy-into" the lane by paying a toll. Electronic tolling provides for toll collection at highway speeds and tolls are set at levels necessary to maintain the lane's speed advantage. HOT lanes provide a reliable, uncongested, time saving alternative for travelers wanting to bypass congested lanes and they can improve the use of capacity on previously underutilized HOV lanes. A HOT lane may also draw enough traffic off the congested lanes to reduce congestion on the regular lanes. One of the earliest concepts tested in the VPPP, HOT lanes have now become part of the mainstream of highway projects and such projects may obtain Federal authority to toll under Section 166 of Title 23 United States Code (U.S.C.), i.e., laws pertaining to HOV lanes.
- *Express Toll Lanes (Partial Facility Pricing).* The key characteristic of this project category is the provision of new highway capacity along with the initiation of highway pricing. The new capacity may be in the form of a new through lane or lanes, a bypass lane(s) around a congested point, or a new bridge or tunnel. Users must pay a toll to gain access to the new capacity, but preference (e.g., free or reduced-toll access) may be provided for high-occupancy vehicles. As with other pricing projects, electronic tolling is needed to ensure the effectiveness of time-of-day tolling. Through September 30, 2009, express lane projects may obtain Federal authority to toll under the Express Lanes Demonstration Program authorized by SAFETEA-LU section 1604(b)[1].
- *Pricing on Entire Roadway Facilities.* This category of pricing introduces variable tolls on highway facilities (e.g., roads, bridges, tunnels) that are currently free, or already have fixed tolls. If flat tolls are already in place, the introduction of variable tolling is the key element of interest to the VPPP. As with other congestion pricing categories, the goal of the differential pricing is to reduce congestion, but toll authorities have also used the availability of off-peak toll discounts to encourage the use of electronic tolling. Projects on existing toll roads generally do not need tolling authority under the VPPP, since they are toll facilities and already have tolling authority.
- *Zone-based Pricing, including Cordon and Area Pricing.* This project category involves either variable or fixed charges to drive within or into a congested area

[1] P.L. 111-118 extended SAFETEA-LU, including the Express Lanes Demonstration Project, through February 28, 2010. Continuation of the Express Lanes Demonstration Program is dependent upon future congressional action.

within a city. Since this type of project involves placing new tolls on multiple existing free roads, it is politically more challenging to implement than the other types of projects discussed above. Although this type of project has been implemented abroad in London, Stockholm, and Singapore, there are currently no operating examples in the U.S. A proposal for cordon pricing in New York City was approved by its City Council, but failed to get approval from the State legislature. A feasibility study is underway in San Francisco.

- *Regionwide Pricing.* This project category encompasses pricing at several locations within a region, including new and existing lanes or entire facilities. Due to geographic scale and involvement of new tolls on existing free roads, all projects in this category are feasibility studies. The only regionwide pricing program operating in an urban area is in Singapore.

Projects not involving tolls may be categorized as follows:

- *Making Vehicle Use Costs Variable.* Fixed costs of vehicle ownership, such as insurance costs or registration fees, do not currently depend directly on the amount the vehicle is driven. Projects in this category are designed to convert those fixed costs into costs that vary according to the miles the vehicle is driven, thus giving the driver the incentive to recognize these costs when making the decision to drive. Strategies in this category are unique in providing drivers direct financial savings for reducing their driving. Advanced projects relying on Global Positioning System (GPS) may be able to make an even finer distinction for pricing of auto use according to time and location of travel.
- *Parking Pricing and Other Market-Based Strategies.* This project category encompasses projects that do not fit easily into the previous category, but which also rely on market forces to influence the decision to drive, including various forms of parking pricing and car sharing programs.

## III. OVERVIEW OF THE VALUE PRICING PILOT PROGRAM

The VPPP is a Federal discretionary grant program under which the Secretary of Transportation is authorized to enter into cooperative agreements with up to 15 State or local governments, or other public authorities, to establish, maintain, and monitor local value pricing programs and to report on their effects. The Federal matching share for these programs is 80 percent. Notwithstanding any other provision of the law, any pricing project included under these programs may involve the use of tolls on the Interstate Highway System. Funds available for the VPPP can be used to pay for pre-implementation and implementation costs.

SAFETEA-LU provides a total of $59 million for fiscal years (FY) 2005-2009 for the VPPP. Eleven million dollars was authorized for FY 2005 and $12 million was authorized for each FY 2006 through 2009. Of the amounts made available to carry out the program, $3 million must be set-aside in each of the FY 2006 through 2009 for value pricing projects that do not involve highway tolls.

As of the end of May 2009, 14 States and one city (New York City) were participating in the program. The 14 States are: *California, Colorado, Florida, Georgia, Illinois, Maryland, Minnesota, New Jersey, New York, North Carolina, Oregon, Texas, Virginia, and Washington*. Appendix 1 shows the number of value pricing projects that have been funded by State since 1998. Note that the Commonwealth of Pennsylvania, awarded funds in 2001 and 2002, is no longer participating in the program. Projects that have been granted funds or tolling authority since the last report to Congress, dated April 2006, are listed in Appendix 2. Appendix 3 shows the value pricing projects that have been implemented through May 31, 2009. Appendix 4 provides a comprehensive list of all pricing projects granted funding and/or tolling authority since 1998, including pricing projects that received tolling authority under HOV legislation (23 U.S.C. 166) and under the Express Lanes Demonstration Program authorized under SAFETEA-LU. Appendix 5 describes the projects that have been implemented since April 2006. Additional details on projects implemented prior to April 2006 have been provided in previous reports to Congress.

During the initial years of Federal support for congestion pricing, State and local government interest in the concepts promoted under the VPPP was quite limited, and the prospects for implementing pilot tests of these concepts seemed remote. Today, after 18 years of studies, discussions, public outreach efforts, feasibility investigations, and pilot testing, congestion pricing projects have become operational in some States and interest in further exploration of pricing is evident in virtually every part of the country. However, most projects implemented or under consideration involve “partial” pricing of highways, i.e., HOT lanes or express toll lanes.

### Program Accomplishments

Projects and studies accomplished under the VPPP relative to each type of congestion pricing strategies are listed in the table below.

## Projects and Studies Accomplished Under the Value Pricing Pilot Program

| Project Type | Projects Implemented | Studies |
|---|---|---|
| **Pricing Involving Tolls** | | |
| **HOT Lanes (Partial Facility Pricing)** | Seven HOT lane projects have been implemented under the VPPP since 1995 and are operating successfully in six States. They include on I-15 in San Diego, on I-25 in Denver, on I-95 in Miami, on I-394 in Minnesota, on I-10 and US 290 in Houston, and on SR 167 in Seattle. (Note: Only one other HOT lane project is operational, on I-15 in Salt Lake City.) | The VPPP has funded over two dozen studies involving HOT lanes or express toll lanes, including pre-implementation and outreach efforts. |
| **Express Toll Lanes (Partial Facility Pricing)** | One project, on SR 91, is operating successfully in Orange County, California. Denver/ 2006 | The VPPP has funded an evaluation study of the SR 91 express lanes and over two dozen studies involving HOT lanes or express toll lanes, including pre-implementation and outreach efforts. |
| **Pricing on Entire Roadway Facilities** | Four projects are operating in three States. These include higher peak period tolls on the San Joaquin Hills Toll Road in Orange County, California; on two bridges in Lee County, Florida; on the New Jersey Turnpike in New Jersey; and on the Interstate toll crossings between New York and New Jersey operated by the Port Authority of New York and New Jersey. | A dozen studies have been funded by the VPPP, including pre-implementation studies and evaluation studies of operating facilities**.** |
| **Zone-Based Pricing** | None | Only one study has been funded. |
| **Regionwide Pricing** | None | The VPPP has funded a dozen studies by States and metropolitan planning organizations. |
| **Pricing Not Involving Tolls** | | |
| **Making Vehicle Use Costs Variable** | One carsharing project is operating in San Francisco. | Half a dozen studies have been funded. |
| **Parking Pricing and Other Market-Based Strategies** | Two projects have been implemented in Seattle: a parking cash-out project and a "cash-out of cars" project. | Half a dozen studies have been funded. |

**Related Activities**

In order to encourage broader and bolder applications of value pricing, in December 2006, the Department solicited applications for the VPPP under a joint solicitation with the ITS Program and a new "Urban Partnership Agreements" (UPA) program established by the Department. The solicitation encouraged applications with a short-term time frame for implementation of broad-scale congestion pricing. The grants included VPPP grants as well as other discretionary grants, and were awarded under the Department's UPA program and its successor Congestion Reduction Demonstration (CRD) program. Appendix 6 provides a brief description of the UPA/CRD projects underway in six cities. By far, the largest research effort underway in support of the VPPP is a comprehensive evaluation of the impacts of congestion pricing projects in the six cities awarded discretionary grants for the purpose of demonstrating synergistic combinations of congestion pricing with supporting strategies involving transit, technology and travel demand management.

A second solicitation was issued for the VPPP in September 2008 for grants using FY 2009 funds. The solicitation focused on studies of regionwide congestion pricing and implementation of projects not involving tolls.

In March and April 2007, the Department conducted a national Webcast and regional workshops in Washington, DC, Denver, and Atlanta to promote congestion pricing and encourage applications through the UPA solicitation. Additional outreach activities were conducted through participation in Road Pricing Workshops sponsored by the Transportation Research Board; through congestion pricing webinars sponsored by the Federal Highway Administration (FHWA); and through DOT participation in workshops and meetings sponsored by other stakeholder organizations.

A series of Congestion Pricing Primers and one-page briefs have been developed and widely disseminated, including posting on FHWA's and DOT's Web sites. The FHWA web site additionally provides links to publications on congestion pricing produced by the Department, VPPP grant recipients, the Congressional Budget Office, the General Accountability Office, the Transportation Research Board, universities, and other research organizations. A suite of analytical tools is also available on FHWA's web site to assist in estimating the impacts and assessing costs and benefits of pricing strategies. Several research projects on congestion pricing have been completed or are underway by the Office of the Secretary, FHWA and the Research and Innovative Technology Administration, and are listed in Appendix 7.

## IV. IMPACTS OF CONGESTION PRICING PROJECTS IMPLEMENTED UNDER THE VALUE PRICING PILOT PROGRAM

In this section we summarize the impacts from a sampling of the various types of pricing projects that have become operational in the U.S. Appendix 8 presents similar information for international projects. This section draws on findings from an FHWA research report prepared to support the program, "Value Pricing Pilot Program: Lessons Learned" (K.T. Analytics and Cambridge Systematics Inc. 2008). Appendix 8 draws from a companion FHWA report, "Lessons Learned from International Experience in Congestion Pricing" (K.T. Analytics. 2008).

### Effects on Driver Behavior, Traffic Volumes and Travel Speeds

*HOT Lanes:* On San Diego's I-15 reversible HOT lanes, the total number of vehicles using the previously underutilized lanes increased by 54 percent over the first 3 years of the HOT lane program. The time advantage of the express lanes has been maintained, in keeping with the requirement that free-flowing traffic conditions (i.e., Level of Service C) be maintained.

*Express Lanes:* The SR-91 Express Lanes provide congestion free, high speed travel at 60-65 mph to paying customers during peak periods, while the traffic on adjacent free lanes crawls under heavily congested stop-and-go conditions averaging no more than 15-20 mph. The use of the Express Lanes has continued to grow over time, without reducing traffic speeds.

*Pricing on Toll Facilities:* In 2001, the Port Authority of New York and New Jersey (PANYNJ) initiated a variable toll program at the two tunnels and four bridges connecting New York City and New Jersey. Surveys of auto users and truck dispatchers indicate that 7.4 percent of passenger trips and 20.2 percent of truck trips changed in some way in response to time-of-day pricing. About 20 percent of auto users who changed their travel behavior in some way shifted to transit.

*Making Vehicle Use Costs Variable*: Pilot field tests of this approach have been carried out and evaluated in Minneapolis-St. Paul, Atlanta, Oregon, and Seattle. These experimental projects have shown that driver behavior changes significantly when drivers are made fully aware of the real costs of driving and given an opportunity to avoid some of these costs by changing their travel behavior.

*Parking Pricing and Other Market-Based Strategies:* King County, Washington, implemented a small parking cash-out demonstration project in downtown Seattle under the VPPP, where participating employers that offered their employees free parking also offered the option to receive cash in lieu of the parking space. Slightly over 10 percent of the employees offered cash-out, who previously drove to work, opted to accept the cash and leave their cars at home. A large-scale, on-street parking pricing project is being implemented in San Francisco involving on-street parking meter rates that vary to ensure some availability at all times, and early results will be available in 2010.

### Effects on Transit Ridership

Most experience with priced lanes in the U.S. has been with underutilized HOV facilities being converted to HOT lanes. Such conversions allow some vehicles to shift from congested lanes, using the toll price to limit the degree of shifting and preserving the incentives for carpool and transit use. However, this form of pricing does not encourage increased transit use in and of itself through increasing the costs of auto use or improving transit operating conditions. One exception, on San Diego's I-15, transit ridership increased by 9 percent during the evaluation period, likely due to new bus service that was introduced in the corridor at the same time.

Experimental "making vehicle use costs variable" projects have shown some increases in transit use. In Portland, Oregon, 14 percent of households in a pilot test of rush-hour fees reported that a household member began using public transit to save money. In Seattle, findings from a pilot test of regionwide pricing using a sample of households indicated that nearly 80 percent of households drove less and/or shifted travel modes.

### Effects on Air Quality

None of the projects implemented have measured any significant impact on air quality to date.

### Effects on Equity for Low-Income Individuals

Since implemented variable toll projects have involved partial facility pricing or relatively small increases in peak period tolls, there have not been significant equity impacts. With an eye toward addressing equity issues that arise with broader pricing approaches, studies funded under the VPPP have explored innovative approaches to address equity issues:

- ***A "Fast and Intertwined Regular (FAIR)" lanes*** approach studied in Alameda County, California, involved providing toll credits to qualified low-income users based on their monitored usage of free regular lanes located adjacent to priced lanes. Accumulated credits would allow periodic free use of the priced lanes by these motorists (DeCorla-Souza 2005).

- ***A "FAST Miles" regionwide pricing approach*** being studied in Minneapolis, Minnesota would allocate a fixed amount of toll credits to all area motorists. Total credits allocated to motorists would be limited by the peak period capacity available on the roadway system. This would ensure that demand would not exceed supply of road space (i.e., roadway capacity) and guarantee congestion-free travel for all motorists in exchange for use of their free credits to "pay" for roadway use (DeCorla-Souza 2006). Interim findings from the study suggest that a simple credit-based approach, such as providing a monetary rebate on annual vehicle registration fees or taxes, is more likely to gain public acceptance.

**Effects on Transportation Revenues**

Since most implemented U.S. projects to date have focused on partial facility pricing (primarily HOV to HOT conversions), they have generated limited revenues, sufficient only to cover costs for operation of the pricing program on existing lanes. However, the objective has been to manage demand on the priced lanes; generation of revenue has not been a goal. In San Diego, the FasTrak program on I-15 HOT lanes is fully funded with toll revenues, including operating and enforcement costs. Since 1998, the FasTrak program has generated over $7 million in surplus revenue, which has been used to fund express bus service in the I-15 corridor.

In Orange County, California, the 10-mile express toll facility in the median of SR 91 generates gross annual toll revenues of over $40 million. This amounts to about $1 million per lane mile annually. Revenues are used to pay for operations and maintenance, and for debt service for the facility. Excess revenues are proposed to be used for highway improvements in the corridor extending into Riverside County.

## V. LESSONS LEARNED FROM THE URBAN PARTNERSHIP AGREEMENTS PROGRAM

In 2006, the VPPP partnered with the Department's UPA program in order to encourage broader applications of congestion pricing. However, despite the over three-quarters of a billion dollars in grants offered by the Department through the competitive UPA program and its successor CRD program, only one project will implement performance-based pricing on all lanes of a highway facility. The rest are "partial" pricing projects involving priced lanes and one pricing project not involving tolls. While these approaches will be helpful in demonstrating innovative technical and policy approaches to facilitate and accelerate HOV to HOT conversions, they are not the more comprehensive pricing strategies initially contemplated either by the UPA/CRD programs or the VPPP. The Department is conducting a major evaluation effort involving all funded UPA and CRD projects. Early results from this effort will be available in 2010.

### HOV to HOT Conversion: Lessons Learned from Miami, Minneapolis, Los Angeles, and Atlanta

Underutilized HOV lanes are prime candidates for conversion to HOT lanes. However, there are limits to the number of underutilized HOV facilities, and some of these present operational challenges. The UPA competitive process demonstrated that there are ways to expand the opportunities for HOT lane implementation even when there might be physical capacity constraints. In Miami, new physical capacity has been created by re-striping the lanes on I-95. By making the lanes narrower and taking a portion of the shoulders, an additional lane has been created, to be priced along with the existing HOV lane which had been overutilized. Minneapolis will create a new HOT lane on a segment of I-35W by using a shoulder as a travel lane during peak hours. Los Angeles is creating an additional lane on I-10 by re-striping it and using a portion of the wide buffer between the existing HOV lane and the regular lanes. Both the new lane and the HOV lane will serve as HOT lanes. In Atlanta and Miami, additional capacity for use by priced single-occupant and HOV-2 vehicles is being "created" by increasing occupancy requirements for free service from 2+ persons per vehicle to 3+ persons per vehicle.

### Full Facility Pricing: Lessons Learned from Seattle

The only project proposing to toll all lanes on an existing toll-free facility is the SR 520 floating bridge in Seattle. This project has gained acceptance not because of its performance-based congestion pricing feature, but rather because the public and elected officials saw tolling as the only way to obtain the revenue needed to reconstruct the bridge. The variable tolling feature of the project resulted from Seattle's interest in securing a UPA award.

It is noted that Seattle's public and elected officials are far ahead of the rest of the country when it comes to understanding the benefits of variable tolls. Surveys have shown significant understanding and strong public support for variable tolls. To a large measure, this is due to a long history of public outreach and public involvement in the planning process, supported in part by VPPP grants to the Puget Sound Regional Council (PSRC) as well as the Washington State DOT.

Like Seattle, many jurisdictions see congestion pricing first and foremost as a way to generate significant revenues. However, this support can be short-lived if congestion reduction is not part of the rationale for implementation of a pricing strategy.

**Zone-Based Pricing: Lessons Learned from New York City**

The UPA program did learn important lessons from one UPA proposal that did not move forward to implementation – the proposal from New York City to introduce cordon pricing in Manhattan.

Mayor Bloomberg recognized that if New York City wanted to seriously address congestion, a major contributor to air pollution, congestion pricing was the only strategy that would have a significant impact. Prior to his announcement to move forward with congestion pricing on Earth Day in April 2007, *Partnership for New York City*, a business-led organization, had taken up the cause of congestion pricing and joined with a coalition of interest groups to build support for an UPA program proposal. An important aspect of Mayor Bloomberg's proposal was to dedicate net revenues from the congestion pricing program to fund capital improvements to the Metropolitan Transportation Authority's transit system. A strong firewall was proposed in State legislation to ensure that net revenues were protected from diversions to other uses.

On March 31, 2008, the New York City Council, an elected body, voted to charge new fees for use of existing free roads for general use. While the project did not go forward as scheduled due to failure to obtain approval from the State's legislature, this vote broke new ground in the U.S. Up to this time, elected bodies in the U.S. had *only* supported new road use charges on motorists on new roads, new lanes, or existing lanes previously restricted to high-occupancy vehicles.

The proposal's success in the City Council was bolstered by the combination of a strong political champion (Mayor Bloomberg), significant congestion, support by a coalition of diverse interest groups, and an appealing plan for use of net revenues. A key factor was also the DOT funding incentive.

While there was much done right in New York, factors that could have contributed to its failure were:

- *Time pressures*: The simplest explanation for the failure may be the tight time schedule for securing UPA funding that was imposed by DOT. The tight time frame did not allow time for targeted outreach to key elected officials in order to explain to them the benefits of the proposal to their constituents, and to make modifications to the proposal needed to address their concerns;

- *Distribution of benefits*: Elected officials from boroughs surrounding Manhattan perceived that insufficient benefits would accrue to their constituents while bearing most of the cost burden;

- *Lack of trust by suburban residents*: Based on past experience, suburban residents promised transit improvements doubted that those improvements would actually be put in place; and

- *Political factors not directly related to the pricing proposal.*

The proposal from New York City demonstrated that bold and broad pricing approaches can be spurred by collaboration among multiple local agencies when the Department uses an integrated funding approach involving different modal administrations.

## VI. MOVING FORWARD WITH CONGESTION PRICING

The purpose of the VPPP is to demonstrate to what extent roadway congestion may be reduced through application of congestion pricing strategies. However, as discussed previously, the projects implemented so far have not had significant impacts on congestion due to their limited scope, involving "partial" pricing of highway facilities.

There is no doubt broad congestion pricing could have more significant impacts on congestion with performance-based tolling of all lanes of entire highway facilities, entire zones or entire networks (see "Types of Congestion Pricing" in section II). However, such broad applications raise several issues, chiefly: fairness, equity for low-income individuals, traffic diversion, administrative costs and privacy.

### Concerns About Congestion Pricing

***Fairness:*** A primary reason for the success of partial facility pricing is that motorists want the choice of whether or not they pay for their use of roads. With a full facility or comprehensive congestion pricing scenario, some feel they would not have such a choice and would be forced off the roads they have always used for free. When congestion-free service is promised in exchange for the extra costs, many simply cannot conceive that highways could be free of congestion, despite admission by many that they would consider changing their schedule, mode, or route if this type of pricing were implemented.

When proposals are made to increase peak period toll rates on tollways, motorists worry that the system could be a financial burden that they can ill afford on top of current taxes. For example, a new peak period toll or toll increase of just 15 cents per mile amounts to an extra $3.00 for a 20-mile trip to work, $6.00 per day, and $1,500 per year.

There is some indication that the public might accept pricing on existing toll-free facilities if there is a credible and concurrent reduction in other taxes, or if the revenues will be dedicated to pay for transportation improvements that they are convinced are needed, as in the case of the New York City proposal and SR 520 in Seattle.

Focus group studies conducted under the VPPP have shown that the public does not understand how transportation is funded today. To gain public acceptance for pricing on existing roads, it will be important to explain to the public how transportation is currently funded, how any new system will affect households, how much more (or less) they will pay as a result, and what benefits will accrue to them in return.

***Equity:*** With broad congestion pricing proposals, concerns about equity for low-income individuals relate to the ability of low-income motorists to pay the new charges.

Before use of revenues is considered, the benefits of broad-scale congestion pricing are not distributed equally among all users. High income users are more likely to remain on priced highways, paying the congestion fee and benefiting from a faster trip. Low-income users are worse off if they choose other less expensive times, routes or modes. If they stay on the priced highway, the value that they place on the faster trip may be less

than the out-of-pocket cost to them. Some note that pricing is particularly unfair to commuters with less flexible work schedules, since they are unable to shift their time of travel. Low-income workers tend to have jobs with fixed schedules.

Another equity concern is that congestion pricing may make it too difficult or too expensive for low-skilled workers to get to their jobs. Entry-level and unskilled jobs are often not well-served by public transit. Even if transit routes provide service to jobs of this type, the work hours for such jobs often require travel during off-peak service times, when public transit is less frequent and less appealing as an option. Thus many low-skilled workers need to drive to hold on to their jobs. Note, however, that tolls would normally not be charged during off-peak periods with a congestion pricing approach that sets toll rates based on demand.

Despite the above concerns, a well-designed broad congestion pricing strategy can be less burdensome to low-income citizens with appropriate use of toll revenue. For example, when a portion of the toll revenue is dedicated to transit, low-income transit riders can benefit significantly from toll-financed transit improvements. Additionally, pricing schemes can include protections for low-income individuals, such as "life-line" credits or toll discounts with the amount of discount scaled based on income. In the case of the New York City cordon pricing proposal, the State legislature included tax rebates for low-income individuals for any fees paid that exceed the fare for a transit trip.

***Traffic Diversion:*** With full facility pricing, if new or higher charges are established on only some roads (e.g., limited-access highways), some traffic is likely to divert to free routes, increasing congestion in neighborhoods.

The key to reducing diversion to alternative free routes is making improvements to quality, convenience and price of alternative modes. For example, bus service can be made more attractive through improvements in travel time, frequency of service (which reduces wait time), reductions in fares, improved parking availability at park-and-ride lots, and more comfortable rides. However, while this will increase the proportion of "tolled off" drivers who opt for transit, it will not completely eliminate diversion to alternative toll-free routes. Net diversion to free routes can only be avoided if the total cost of travel on the priced highway, comprising out-of-pocket cost as well as travel time and other non-monetary cost, is no higher than the total cost on the highway prior to introduction of pricing[2].

Studies completed for FHWA (The Louis Berger Group 2009, Noblis Inc. 2008) as well as the United Kingdom's Department for Transport (Department for Transport 2004) suggest that a relatively small reduction in existing traffic (of about 10 percent) can restore free-flowing traffic conditions on the highway system. This may be observed on

[2] This means that, for every driver who continues to use the priced highway, the value of time savings on the priced highway would be equal to or higher than the out-of-pocket cost for tolls. This is theoretically possible if the demand for highway use were to be reduced significantly simply due to the increased attractiveness of alternative modes. In the parlance of economists, the demand curve for highway use would need to shift significantly to the left.

Columbus Day, when a relatively small percentage of commuters are off work, or in August in Washington, DC, when Congress is not in session. This suggests that about 10 percent of solo-drivers on a newly priced highway would need to be "tolled off" a priced highway in conjunction with a congestion pricing strategy designed to significantly reduce highway congestion.

Handling a significant portion of former highway drivers may be possible on downtown-oriented transit systems, but is more difficult in corridors oriented to suburban employment centers. Paratransit could perhaps play a larger role. For example, private shuttle services operate successfully without public subsidy for travel to airport destinations not served by transit, because of the high costs to park at airports. High costs to drive on suburban highways during peak periods could potentially spur development of such private services oriented to employment centers. Vanpool services are also likely to increase ridership. Government support and encouragement of telework arrangements and flexible work schedules could provide additional options to commuters to avoid peak period travel altogether. Of the 10 percent of solo-drivers that would be tolled off a priced suburban highway, perhaps as much as 2 to 4 percent might opt for transit, paratransit, vanpooling, carpooling, telework, or flexible work schedules in order to avoid peak period charges. The remaining 6 to 8 percent (calculated by subtracting the 2 to 4 percent who might opt for alternatives from the 10 percent that would be tolled off) might choose to drive on alternative free routes.

Some increase in the capacity of the priced highway will be needed to accommodate these 6 to 8 percent of drivers (and keep congestion toll rates relatively low) if traffic diversion to free routes is to be avoided. Small increases in peak period highway capacity could potentially be achieved at relatively low cost by converting highway shoulders into "dynamic" travel lanes that could be used during peak periods in combination with active traffic management strategies (DeCorla-Souza 2009). Induced demand would be curbed using congestion pricing on all lanes of the actively managed facility. Pricing projects that incorporate active traffic management will begin operating in 2010 in Minneapolis and Seattle. They will provide valuable lessons about the feasibility and desirability of such approaches.

***Administrative and Other Costs:*** Implementing and operating a congestion pricing scheme is expensive relative to other ways of generating revenue from highway users. Operating costs for congestion pricing are estimated to range from 10 to 20 cents per electronic transaction. If the average toll is 15 cents per mile, and the average length of tolled highway used per trip is 5 miles, the toll operator must spend about 20 percent of the revenue (i.e., 10 to 20 cents out of 75 cents) to collect the toll. By comparison, collection of fuel taxes costs about 1 percent of revenue.

Moreover, the above costs do not include enforcement costs. Revenues from penalties are generally sufficient to pay for these costs, but enforcement costs are an economic cost to society, paid by toll violators.

Congestion pricing is justified only if the value of benefits, such as those discussed in the next section, exceed the incremental costs for implementation and operation. Before a decision to proceed is made, synergistic combinations of congestion pricing and

supporting strategies should be subjected to a comparative benefit-cost or cost-effectiveness evaluation along with other alternatives. The long-range transportation planning process could be used to educate the public about costs and benefits of alternative pricing approaches, and to begin the discussion about the trade-offs between conventional transportation investment approaches and approaches involving congestion pricing. For example, the five alternatives analyzed and presented for consideration by the public for the Year 2040 regional transportation plan for the Seattle area all involve substantial increases in road user fees beyond present practice (Puget Sound Regional Council 2009). The alternatives are compared to a base case that does not include pricing. One alternative essentially implements full pricing for all vehicles on all expressways and arterials, similar to PSRC's GPS-based charging trial funded under the VPPP.

Note that administrative costs will not be the only additional public costs for implementation of a comprehensive congestion pricing approach. In addition to making improvements to quality of transit service, its physical capacity will also need to be enhanced. Handling 10 percent of former highway drivers may be possible on downtown-oriented transit systems, and may not require a level of expansion of transit capacity that is impossible over a short time-frame. Yet, there would be high public cost burdens, both for new capital equipment as well as for operations. For example, a transit system that currently serves 20 percent of downtown workers may need to serve an additional 8 percent, requiring a 40 percent increase in transit service. A transit system that currently serves one percent of suburban workers may need to serve an additional 2 percent, requiring a 200 percent increase in transit service. Fortunately, future streams of congestion pricing revenues could be leveraged to pay up-front costs for new capital needs for transit rolling stock and park-and-ride facilities. Also, some of the transit operating cost burdens could be funded from the continuing stream of toll revenues.

***Privacy:*** Some members of the public are concerned about the privacy impacts of the technology used to monitor road use and collect toll payments. With partial facility pricing, this has not been a major concern. Toll facility operators have reported that even when anonymous accounts have been offered to the public, there have been very few who have signed up. Singapore has alleviated privacy concerns by collecting tolls using smart cards with stored value that may be inserted into the in-vehicle equipment supporting the transponder. These “electronic purses” are replenishable at Automated Teller Machines (ATMs), and may also be used for other purchases unrelated to tolling.

Privacy does not appear to be a major concern with full pricing of *only* the limited access highway network using transponder-based toll collection technology. In a focus group study on such a strategy conducted by DOT (Volpe 2008), privacy was not an issue that resonated strongly or generated much discussion with most participants, perhaps because vehicle identification technology would be restricted to limited access highways only, and information on trip origins and destinations off the tolled system would not be collected.

However, privacy has been consistently raised as a concern when pricing has been proposed for implementation with use of in-vehicle units that would collect information on travel using GPS technology. Even when it has been made clear that information on

the location of travel will never leave the vehicle, and only the total amount of toll charges will be sent to a "back-office" for billing and payment, some motorists have expressed concerns. They are uncomfortable with such information being available in their vehicles, and worry that it may be accessible to others at any time. Research currently underway through the National Cooperative Highway Research Program is exploring non-GPS technology that could potentially be used to collect ubiquitous user charges. These technologies may have fewer privacy concerns since specific location data would not be collected.

**Potential Benefits of Congestion Pricing**

Despite the issues noted above, transportation policymakers are showing increasing interest in broad congestion pricing as a policy tool, because of the potential to achieve public goals more effectively than other conventional means. The benefits derived from congestion pricing include more efficient use of resources, generation of revenue for transportation investment, and support of economic productivity, environmental sustainability and livable communities.

***Using Resources More Efficiently and Generating Revenue for Transportation Investment:*** The benefits that accrue to transportation system users and to society as a whole from the adoption of congestion pricing ultimately stem from the fact that it encourages people to use available resources more efficiently. In the absence of such mechanisms, the "market" for the use of the transportation system becomes distorted, leading to overuse of some portions of that system and underutilization of other elements. This inefficiency of use can in turn send distorted signals about where investment in transportation system capacity is particularly needed.

By its very nature, congestion pricing is also a means of generating revenue from highway users. The decision to implement congestion pricing is thus also a decision about the mix of funding sources (from both users and non-users) that are used to support the development and operation of the transportation system. By raising the out-of-pocket costs of highway travel to users, highway user charges tend to reduce the demand for use of the system. While user charges levied on a fixed rate per-mile or per-gallon basis do have an impact on traveler behavior, variable rate user charges with rates tied to the time of day or real-time congestion levels have the potential to have much larger impacts on peak-period travel.

Different forms of congestion pricing affect the efficiency of the transportation system in different ways. Implementing tolls on highways that vary by time of day or by the level of congestion on the facility encourage people to shift their time, route, or mode of travel to one that is less congested (or to forgo particularly low-valued trips altogether), thereby reducing congestion on the system as a whole. Pricing can also be used on new, express facilities to ensure that such facilities operate at maximum efficiency, providing a premium service for especially high-valued road trips (such as urgent travel or transit vehicles carrying large numbers of patrons).

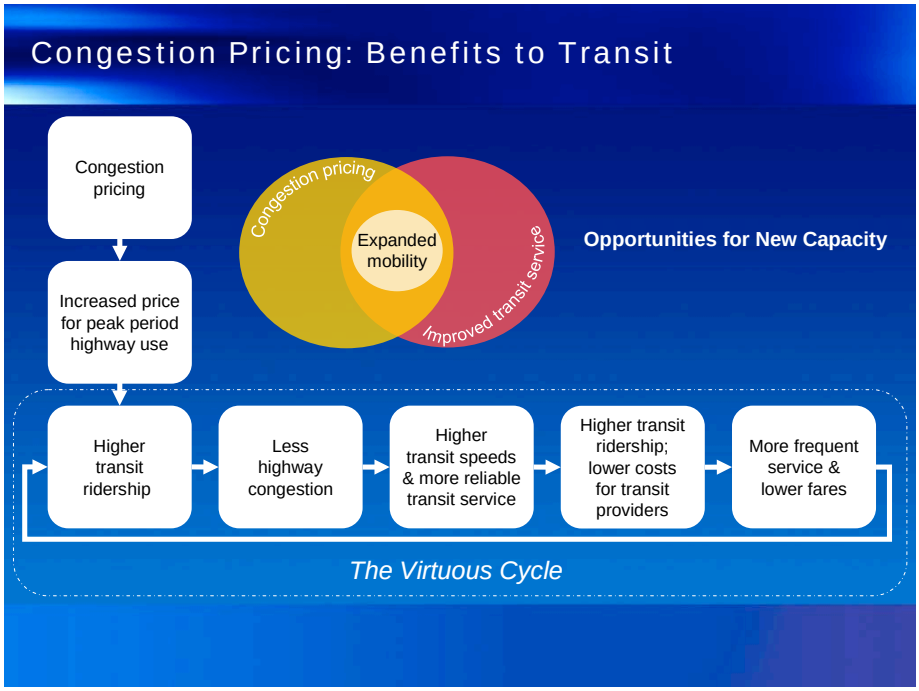
Road pricing can also reduce congestion, significantly reducing the level of capital investment required to achieve a given level of operational performance on the highway system in a growing economy. Reduced traffic levels can also reduce the amount of wear and tear on our roads and thus the investment required to keep them in a state of good repair. This effect is particularly strong in large, heavily congested urban areas, where efficient pricing may obviate the need for some extremely expensive highway capacity improvements. For example, the average cost of construction to add a lane to an urban freeway is estimated at almost $15 million per lane mile. Weekday peak period use of this lane addition amounts to about 10,000 vehicles per weekday, translating to a cost of about 40 cents per mile driven by each peak period vehicle using the lane, or $8.00 for a 20-mile trip made on an added urban freeway lane during peak periods.

On the other hand, fuel taxes generated from a 20-mile trip amount to a total of only about 32 cents, assuming a vehicle fuel efficiency rating of 25 mpg. The reduced need for such expensive highway improvements can reduce the demand on scarce tax-based resources and free up resources to be used for investing in other forms of transportation or in other sectors of the economy. Under the investment scenarios analyzed in DOT's 2006 *Status of the Nation's Highways, Bridges, and Transit: Investment and Performance* report to Congress, the universal adoption of congestion pricing was projected to reduce annual highway investment requirements by 16 to 27 percent.

Congestion pricing also assists in keeping pace with growing travel demand over time, something that has been a constant challenge in recent decades. As congestion tolls increase in corridors with growing demand, this can provide a clear signal that transportation investment is needed in such locations. It can also provide a source of revenues to support such investment that is closely tied to the system users who will benefit from that investment. By pricing road use properly, the amount of additional travel that may be induced by capacity improvements can also be limited.

Congestion pricing and public transportation in particular can convey mutual benefits, with each supporting and reinforcing the effectiveness of the other. Congestion pricing reduces travel times for buses that currently operate on congested roadways. It can also provide a potential source of revenue to support transit. By supporting the development and operation of premium express transit facilities and services, pricing can also help improve the operating frequency, quality and reliability of public transportation, leading to increased public transportation ridership.

A high-quality public transportation system enhances congestion pricing by providing a viable alternative for serving commuters who decide to shift their mode of travel in light of higher charges for highway use in peak periods. This is particularly beneficial for commuters or others who may find it difficult to shift the timing of their trips, and can help limit the extent to which newly priced travelers may simply decide to divert their trips to other toll-free routes. A high-quality transit alternative can also address equity concerns by providing mobility to low-income travelers and by reducing the toll levels that would be necessary to reduce highway use by a certain amount. This relationship between road pricing and transit is sometimes referred to as "the virtuous cycle" (see the graphic below).




***Economic Productivity:*** By addressing congestion through pricing, the overall productivity of the economy can be improved. Growing congestion and unreliability of travel times affects truck transportation productivity and ultimately the ability of sellers to deliver products to market. Additionally, when deliveries cannot be relied on to arrive on time, firms must keep additional "buffer stock" inventory on hand, increasing their cost of doing business and potentially affecting their competitiveness in international markets. While the business community would see some increased monetary costs as a result of a pricing scheme, there would be net savings in the total cost of doing business because the value of time and vehicle operating cost savings, and savings in costs for maintaining buffer stock would be significantly greater than the out-of-pocket cost for tolls.

Congestion also affects labor markets. Just as improvements in transportation technology over the last two centuries have allowed our urban centers of commerce to grow, increasing congestion has the opposite impact. This effectively reduces the size of the labor pool that firms are able to draw from, limiting their ability to attract employees with the best qualifications or most suitable skills. As a result, congestion can limit the productivity of these firms. By reducing congestion with broad-scale congestion pricing, business productivity can be increased.

***Environmental Sustainability:*** Congestion pricing can reduce energy consumption and greenhouse gas emissions by encouraging use of alternative travel modes and by improving the flow of traffic.

Congestion pricing can also work in concert with other, more targeted measures aimed at reducing fuel consumption. Efficient pricing can help reduce the so-called "rebound effect" that can occur when vehicle owners respond to improved fuel economy by driving more. Congestion pricing can also enhance the effectiveness of pricing mechanisms

aimed directly at reducing greenhouse gas emissions, such as carbon taxes or cap-and-trade systems.

***Livability:*** Congestion pricing can promote more livable communities by reducing traffic, noise and emissions of pollutants, encouraging development and use of transit, biking and walking as alternatives to driving, and reducing the need for additional highway capacity investment. For example, when congestion pricing reduced traffic in Central London, some freed-up roadway space was utilized to create bike lanes and bus-only lanes, further improving transportation alternatives.

Two of the most comprehensive and successful international examples of zone-based pricing have been in London and Stockholm. Their experiences demonstrate that properly structured zone-based charging schemes can reduce urban congestion, improve the environment, and increase public transportation ridership. More importantly, these examples demonstrate the significant relationship between the success of broad-scale congestion pricing and the provision of public transportation. In both cases, the government introduced major increases in transit service *in advance* of implementation of congestion pricing. In London, a significant portion of the revenue is used for continuing support of transit services. However, many States have constitutional or other legal provisions that would prevent money raised from tolling from going to non-road projects. Unless addressed, these prohibitions would limit the effectiveness of congestion pricing.

**Key Lessons Learned with Regard to Public Acceptance**

Based on project experience and three comprehensive reviews of public opinion studies on congestion pricing [Higgins (1997); Berg (2003); Zmud (2007)], some important summary lessons about the role of public opinion in project development emerge. These lessons have been learned from the more limited U.S. pricing projects, as well as from international projects, and are applicable to "partial" pricing as well as broad-scale congestion pricing.

***Congestion Must Be Seen as a Major Problem***. When a congestion pricing proposal is presented to the public, the conversation should begin with review of the problem being addressed—traffic congestion and its economic and social costs. Only when a sufficient number of people view congestion as a major problem that congestion pricing will have a chance of public acceptance. The public is not likely to accept congestion pricing if it appears that the primary purpose of the new charges is simply to generate revenue.

***Other Project Goals are Important***. Congestion relief is the primary rationale for congestion pricing, but other project goals can also garner support. Of particular importance are clear statements about planned use of toll revenues for investments with a high level of public support such as transit improvements that were part of New York City's cordon pricing proposal.

***Familiarity Breeds Support***. Where the opportunity already exists to use tolled facilities, the likelihood of acceptance of variable tolling is higher than where people are unfamiliar

with tolling in general. Further experience with congestion pricing is an important factor in explaining variations in people's views on this approach to dealing with traffic congestion. This has been observed with partial pricing projects in the U.S., where many initial opponents of proposals for priced lanes have been converted to supporters after seeing them in operation. This has been observed as well as with broader pricing approaches abroad. Many initial opponents of broad-scale congestion pricing express the view that pricing will not work because people cannot or will not change their mode or time of travel. What this view ignores is that "most" people do not have to change their travel patterns for congestion pricing to be effective in reducing congestion. If some do on some days, this can be enough to appreciably reduce congestion. Experience has borne this out and has often convinced one-time opponents that congestion pricing can work.

***Presenting Congestion Pricing as Offering New Choices is Important***. The chances for gaining support for congestion pricing are enhanced when pricing is presented as offering new and better travel choices such as improved alternative transportation modes, along with flextime and telework opportunities. People make travel choices every day by choosing a time to travel, a mode of travel, or whether or not to make the trip. A new way of charging for road use can affect all these choices and present travel opportunities with reduced congestion and perhaps a broader array of travel choices.

***Public Involvement is an Essential Part of Project Development.*** One clear lesson emerging from experience with congestion pricing to date is that, if project implementation is to be successful, affected citizens need to be given full information about the proposed pricing project and its goals, and need to be given the opportunity to see and evaluate the trade-offs involved with different ways of dealing with traffic congestion. Local stakeholders need to be given the opportunity to be involved in project design and development and to provide project planners with continuing advice and feedback on project options.

## VII. NEXT STEPS

The VPPP has begun to open the door to public acceptance for pricing. This is a significant accomplishment. However, as noted, the implemented VPPP projects have primarily been HOV to HOT conversions. Clearly, HOT lanes will continue to provide congestion relief and will further public acceptance of pricing as a viable solution for congestion management and reduction. Nevertheless, it appears that there may be a window of opportunity opening to spur implementation of broader, more aggressive pricing strategies such as cordon or expressway system pricing. Many are debating the best course to pursue: the more incremental approach where HOT/Express lanes are seen as necessary precursors to bold congestion pricing versus an approach that encourages bold transformational changes. It may be that these two approaches should be pursued concurrently. Some ideas for consideration along each path are offered below.

***Incremental Progress:*** Congress can choose to continue the VPPP's current defacto focus on an incremental approach whereby HOT lanes provide the path forward to more aggressive pricing strategies. This approach provides a vehicle for demonstrating the value and feasibility of pricing, while providing the option of a reliable trip to travelers willing to pay. In locations where HOT lanes are operational, travelers have valued this choice. However, opportunities for conversions from HOV to HOT are limited because there are not many existing HOV lanes that are underutilized, and others present operational challenges. Creating *newly constructed* HOT lanes is a relatively slow and costly process. And as a "partial" pricing approach, HOT lanes have a modest impact on national goals such as more efficient use of resources, generation of revenue for transportation investment, and support of economic productivity, environmental sustainability and livable communities.

Some areas are increasing HOV occupancy requirements on overutilized HOV lanes to facilitate conversion from HOV to HOT. Spare capacity to be priced is "created" on existing HOV lanes by causing some HOV-2 vehicles to shift to free lanes or form larger carpools to avoid the new tolls. Data from evaluation of such a strategy being implemented in Miami and in Atlanta should provide more information on the overall effects on vehicle volumes and congestion in adjacent free lanes, and the desirability of this approach. Another option might involve simply pricing HOV-2 vehicles to restore free-flowing conditions on HOV-2 lanes, while keeping service on the lanes free for HOV-3 vehicles, and refraining from opening the HOV lanes to priced single-occupant vehicles. This strategy is used with the QuickRide program in Houston on US 290. Such policy options could be explored further, and may facilitate conversions from HOV to HOT lanes. They would have a modest impact on national goals, since they are partial pricing approaches, but they could demonstrate to the public the value and feasibility of pricing, while providing the option of a reliable trip to travelers willing to pay.

Another approach might be to focus on existing toll roads. Toll roads generally do not need Federal authority to employ congestion pricing. Also, since they are already tolled, the public is less likely to oppose pricing them for the purpose of achieving improved performance. A key hurdle in this approach is the limited ability and willingness of most toll authorities to share toll revenue with transit agencies. Further, many State constitutions or other State laws prohibit the use of highway trust fund revenues (which

might include revenue from tolls) for non-road projects. As we discussed in Section VI, a key factor to ensure success of congestion pricing and public acceptance is the concurrent provision of improved transit services, which will need financial support.

Many large metropolitan areas are considering longer-term strategies involving development of networks of HOT or express lanes, and one metropolitan area (the San Francisco Bay Area) has already adopted such an approach for its long-range transportation plan. What this approach can provide is a reliable trip for rush hour travelers willing to pay the price and generation of some surplus revenue (after paying for operating costs) where existing HOV lanes are converted to HOT lanes. These surplus revenues could be used to pay for new transit services, as in the case of San Diego's HOV to HOT conversion on I-15, or in the case of existing HOV lanes that are proposed to be converted to HOT lanes on I-95/395 in Northern Virginia.

However, some studies have concluded that where networks involving *new* HOT lanes are proposed to be constructed, these networks will not be financially self-supporting, because of the high cost of adding new lanes in urban areas, as discussed earlier, as well as high costs of direct connectors between intersecting HOT lanes at freeway interchanges. Tax support will therefore be needed for these networks. What this approach could provide is a reliable trip for rush hour travelers willing to pay the price, and a more complete express network for carpools and buses. Since some congestion remains on the free lanes, freight mobility and business productivity will continue to degrade, albeit more slowly. There would be a very limited impact on long-term issues such as environmental sustainability and creation of livable communities. Nonetheless, HOT lane networks can show the public how pricing works on a much broader scale, and familiarize them with pricing. This familiarity could perhaps lead to public acceptance of more aggressive forms of pricing with higher levels of impact. Congress may therefore want to consider ways to support this strategy.

***Broad-Scale Pilot Approach:*** To date, the VPPP has not spurred pilot implementation of broad congestion pricing projects on the scale of those operating in London, Stockholm, and Singapore. To make significant progress on congestion pricing strategies more aggressive than partial facility pricing, the Federal Government will need to demonstrate to its citizens the far-reaching benefits from broad-scale congestion pricing. Approaches that could be demonstrated are not simply the type of zone-based pricing approaches that have been implemented internationally and considered in New York, but could also involve pricing of entire travel corridors, all roads in a network of limited-access highways to create a high-performance highway system (DeCorla-Souza 2007) or all roads in a network of major roadways including arterials, such as the concept pilot-tested by the PSRC. If Congress chooses this route, it will need to provide for tolling authority for such a pilot or pilots in reauthorization of Federal legislation. However, a broad-scale implementation project is not likely to move forward without significant Federal funding support, on the scale that moved Mayor Bloomberg to champion the New York City proposal. Federal funding would need to be available for a long enough period to allow for effective public and political outreach to gain the needed local and State legislative approvals. As with the Stockholm project, it may also be helpful to propose pilot project(s) as a "trial" with an opportunity for an up or down referendum vote after the trial period.

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# APPENDICES

## Appendix 1 – Value Pricing Pilot Program Projects since 1998

| State | Number of projects funded by the VPP Program* |
|---|---|
| CA | 16 |
| CO | 2 |
| FL | 11 |
| GA | 5 |
| IL | 2 |
| MD | 3 |
| MN | 8 |
| NJ | 4 |
| NY | 2 |
| NC | 1 |
| OR | 2 |
| PA | 1 |
| TX | 10 |
| VA | 3 |
| WA | 9 |

*Includes projects granted no funding but only tolling authority, as well as funded projects that may have been terminated or withdrawn, or are currently under development, have been completed and/or are currently operational

## Appendix 2 – VPPP Funding Awards and Grants of VPPP Tolling Authority since April 2006

| State | Locality | Project |
|---|---|---|
| **California** | Riverside | Assessment of PierPass, Off-Peak Truck Discounts |
| | San Diego | SANDAG Smart Parking-Pricing |
| | San Francisco | Car Sharing Pricing Innovations |
| | Santa Clara | Investigation of Pricing Strategies in Santa Clara |
| | Santa Clara | HOT lane on connector ramp |
| | San Francisco | SF Park Parking Management Program |
| **Florida** | Tampa | Dynamically Priced Car Sharing with Zipcar |
| | Miami | HOT Lanes on I-95 (Toll Authority only) |
| **Illinois** | Chicago | Comprehensive Pricing In Northeast Illinois |
| **Minnesota** | Twin Cities | Parking Pricing Demo in the Twin Cities |
| | Twin Cities | Mileage Based User Fee Regional Outreach |
| | Twin Cities | FAST Miles in the Twin Cities |
| | Twin Cities | Tolling on Dynamically Priced Shoulder Lanes on I-35W |
| | Twin Cities | Tolling on Dynamically Priced Shoulder Lanes on I-94 |
| | Twin Cities | Tolling on Dynamically Priced Reversible Median Lane on Rte 77 |
| **New Jersey** | New York metro area | All Electronic Toll Collection |
| **New York** | New York City | On-Street Parking Pricing |
| | New York State | Pilot test of Truck VMT fees |
| **Washington** | King County | Pay as you Drive Insurance |
| | Seattle | Open Road Tolling on SR-520 |
| | Puget Sound region | Outreach for Puget Sound Tolling Strategies |
| | Seattle | Express lanes system concept study |

## Appendix 3 – Implemented Value Pricing Projects through May 2008

| State | Locality/ Year Implemented | Project |
|---|---|---|
| **HOT Lanes** | | |
| **California** | San Diego/<br>1996 (low tech)<br>1998 (electronic tolls) | HOT lanes on I-15: Toll varies dynamically from depending on traffic demand. In 2008 and 2009, the lanes were extended. |
| **Colorado** | Denver/2006 | HOT lanes on I-25: Tolls vary according to a fixed rate from 50 cents to $3.25 depending upon traffic demand. Buses and 2 person and larger carpools are free. |
| **Florida** | Miami/2008 | HOT lanes on I-95: Tolls vary dynamically from 25 cents up to $6.20 (i.e., $1.00 per mile) depending on traffic demand. Buses and 3-person carpools are free. Tolls in effect 24 hours a day. |
| **Minnesota** | Minneapolis/2005 | HOT lanes on I-394: Tolls vary dynamically from 25 cents to $8.00 depending on traffic demand. Buses and two-person and larger carpools are free. |
| **Texas** | Houston/1998 | HOT lanes on Katy Freeway (I-10): Up to 2008, $2 toll charged to two-person carpools in the peak hour of the peak period; three-person and larger carpools were free. In 2008, facility was expanded. Two-person carpools are now free. Tolls vary from 60 cents to $1.80. |
| **Texas** | Houston/2000 | HOT lanes on US 290: Toll policy same as for I-10, but applies only to morning peak period. |
| **Utah** | Salt Lake City/2006 | HOT lanes on I-15: Offers a limited number of flat rate monthly stickers priced at $50.00 to allow single-occupant vehicle access; value priced electronic tolling planned for implementation by 2009. |
| **Washington** | King County/Seattle 2008 | HOT Lanes on SR 167: Tolls vary dynamically from 50 cents - $9.00 depending upon traffic demand. Buses and two-person and larger carpools are free. Tolls in effect between 5 a.m. and 7 p.m. |
| **Pricing on New Lanes** | | |
| **California** | Orange County/1995 | Express Lanes on SR91: Toll varies from $1.20 to $10.00 depending on traffic demand. |
| **Pricing on Toll Roads** | | |
| **California** | Orange County/2002 | Peak pricing on the San Joaquin Hills mainline: Toll surcharge of 75 cents during the peak period at the mainline toll plaza; tolls are $3.50 in off-peak and to $4.25 in peak. |

| | | |
|---|---|---|
| **Florida** | Lee County/1998 | Variable pricing of two bridges: 50 percent toll discount (amounting to 25 cents) offered in shoulders of the peak periods (westbound direction only). |
| **New Jersey** | New York metropolitan area/ 2001 | Variable tolls on interstate crossings: Off-peak tolls discounted by 25 percent relative to peak period tolls, i.e., $6 vs. $8. |
| **New Jersey** | Statewide/2000 | Variable Tolls on New Jersey Turnpike: Peak period toll exceeds off-peak toll by 24.8 percent for the entire 148 mile (238 km) length, off-peak toll is $4.85 vs. peak toll of $6.45. |

**Projects Not Involving Tolls**

| | | |
|---|---|---|
| **California** | San Francisco/2001 | Car sharing: Charges are $5 per hour (12 p.m. – 8 a.m.) plus 40 cents per mile, and $1 per hour (other times) plus 40 cents per mile. |
| **Washington** | Seattle/2002 | Parking cash-out: Monthly average parking cost in downtown Seattle is about $175. This is the amount those cashing out might expect to receive. |
| **Washington** | Seattle/2000 | Cash out of cars: Weekly average cost for owning a car was estimated at $326.00. This is the amount those "cashing out" their cars might expect to save. |

## Appendix 4 -- Comprehensive List of Pricing Projects Considered Since 1998
## (Including projects that have not received grant awards or tolling authority from the VPPP )

| State | Locality | Project |
|---|---|---|
| **California** | Alameda Co. | I-880/I-680 |
| | Alameda Co. | Highway pricing with dynamic ridesharing |
| | Alameda Co. | I-680 SMART Carpool Lanes |
| | Los Angeles Co. | HOT lanes on I-10 and I-110 (Toll authority planned from Section 166) |
| | Orange County | SR 91 evaluation |
| | Orange County | Implementation of peak pricing on the San Joaquin Hills Toll Road |
| | Orange County | Implementation of Dynamic Pricing on SR 91 |
| | Riverside | Assessment of PierPass, Off-Peak Truck Discounts |
| | Santa Clara | Investigation of Pricing Strategies in Santa Clara |
| | Santa Clara | Implementation of pricing on HOV connector ramp |
| | Santa Cruz | HOT lanes on median of Route 1 |
| | San Diego | Extension of I-15 HOT lanes |
| | San Diego | Violation Enforcement System on I-15 HOT Lanes |
| | San Diego | Smart Parking-Pricing |
| | San Francisco | Car Sharing Pricing Innovations |
| | San Francisco | Area Road Charging and Parking Pricing |
| | San Francisco | Comprehensive Smart Parking |
| **Colorado** | Denver | I-25 HOT Lanes (Toll authority provided from Section 166) |
| | Denver | C-470 New Priced Lanes |
| **Florida** | Broward County | Variable Tolls on the Sawgrass Expressway |
| | Broward County | I-595 Express Lanes (Toll authority planned from VPPP) |
| | Fort Myers Beach | Cordon Pricing Study |
| | Statewide | Sharing of Technology on Pricing |
| | Lee County | Pricing on Bridges |
| | Lee County | Priced Queue Jumps |
| | Lee County | Variable Tolls for Heavy Vehicles |
| | Lee County | Pricing on Sanibel Bridge and Causeway |
| | Miami-Dade | Pricing Options on the Florida Turnpike |
| | Miami-Dade | HOT Lanes on I-95 (Research and Outreach) |
| | Miami | HOT Lanes on I-95 (provided toll authority from VPPP) |
| | Tampa | Dynamically Priced Car Sharing with Zipcar |
| **Georgia** | Atlanta | Simulation of Pricing on Atlanta's Interstate System |
| | Atlanta | Express Toll Lanes on I-75 |
| | Atlanta | I-75 South HOT/Truck Toll Only Study |
| | Atlanta | Variable Pricing Institutional Study for GA-400 |
| | Atlanta | HOT lanes on I-85 (Toll authority planned from Section 166) |
| | Savannah | Northwest Truck Tollway |
| **Illinois** | Chicago | Variable Tolls on the Northwest Tollway |
| | Chicago | Comprehensive Pricing In Northeast Illinois |

| | | |
|---|---|---|
| **Maryland** | Statewide | Feasibility of Pricing at Ten Locations |
| | Baltimore | Express Toll Lanes on Section 100 of I-95/JFK Expressway (Toll authority provided from VPPP) |
| | Baltimore | Express Toll Lanes on Section 200 of I-95/JFK Expressway (Toll authority provided from VPPP) |
| **Minnesota** | Statewide | Variabilization of Fixed Auto Costs |
| | Twin Cities | Project Development Outreach |
| | Twin Cities | Parking Pricing Demo in the Twin Cities |
| | Twin Cities | Mileage Based User Fee Regional Outreach |
| | Twin Cities | FAST Miles in the Twin Cities |
| | Twin Cities | Tolling on Dynamically Priced Shoulder Lanes on I-35W |
| | Twin Cities | Tolling on Dynamically Priced Shoulder Lanes on I-94 |
| | Twin Cities | Tolling on Dynamically Priced Reversible Median Lane on Rte 77 |
| **New Jersey** | New Jersey | Variable Tolls on the New Jersey Turnpike |
| | NY Metro Area | Variable Tolls on Water Crossings |
| | NY Metro Area | Express Bus/HOT Lane for the Lincoln Tunnel |
| | NY Metro Area | All Electronic Toll Collection |
| **New York** | New York City | Parking Pricing in Manhattan |
| | New York State | Pilot test of Truck VMT fees |
| **North Carolina** | Raleigh/Piedmont | HOT Lanes on I-40 |
| **Oregon** | Statewide | Mileage Based User Fee Evaluation |
| | Portland | Express Toll Lanes on Highway 217 |
| **Pennsylvania** | Philadelphia | Variable Tolls on the PA Turnpike |
| **Texas** | Austin | HOT Lane Enforcement and Operations on Loop 1 |
| | Austin | Truck Traffic Diversion Using Variable Tolls |
| | Dallas | Regional Value Pricing Feasibility Study |
| | Dallas | Managed lanes on I-635 (Toll authority provided from Express Lanes Demo Program) |
| | Dallas | Express Toll Lanes on I-30/Tom Landry Freeway |
| | Ft. Worth | North Tarrant Express Lanes (Toll authority from Express Lanes Demo Program) |
| | Houston | HOT Lanes on I-10 and US 290 |
| | Houston | HOT Lanes on Katy Freeway (expansion) |
| | Houston | Houston HOT Network |
| | San Antonio | Value Priced Express Toll Lanes on I-10 |
| | San Antonio | Express Toll Lanes on I-35 |
| **Utah** | Salt Lake City | HOT lanes on I-15 (Toll authority provided from Section 166) |
| **Virginia** | Hampton Roads | Variable Pricing in the Hampton Roads Region |
| | DC Metro Area | HOT lanes on the Capital Beltway (Toll authority planned from Section 166) |
| | DC Metro Area | Regional Network of Value Priced Lanes |

| | | |
|---|---|---|
| **Washington** | King County | Parking Cash Out |
| | King County | Cash Out of Cars |
| | King County | Pay as you Drive Insurance |
| | Seattle area | GPS Based Pricing |
| | Seattle area | Outreach for Puget Sound Tolling Strategies |
| | Seattle area | HOT Lanes on SR 167 |
| | Seattle area | Open Road Tolling on SR-520 |
| | Seattle area | Express lanes system concept study |

## Appendix 5 – VPPP Projects Implemented Since April 2006

Five projects have been implemented since April 2006. More details on projects implemented prior to April 2006 have been provided in previous reports to Congress.

### HOT Lanes on I-25/US 36 in Denver, Colorado

The I-25 Bus/HOV lanes, also known as Downtown Express lanes, are a two-lane barrier-separated reversible facility in the median of I-25 between downtown Denver and 70th Avenue, a distance of 6.6 miles. The facility opened as a HOT facility on June 2, 2006. In March of 2009, 88,114 vehicles paid a toll to travel in the I-25 Express Lanes. A total of $164,007 in toll revenue was collected. More than 1,800 toll-paying vehicles are using the lanes in the morning peak period and more than 1,400 toll-paying vehicles are using the lanes in the afternoon peak period. Carpools, buses and motorcycles continue to use the lanes toll-free as long as they are in the lane marked "HOV" when they pass through the toll collection point near 58th Avenue. That is the only time there is a designated lane for HOVs and for toll paying vehicles. Toll rates for the I-25 Express Lanes vary by time of day to ensure the lanes remain free-flowing. HOT lane traffic consistently flows freely during all hours of the day. Toll collection is electronic only. No cash is accepted. The use of the previously underutilized HOV lanes is now being maximized, giving motorists another option to escape traffic congestion.

### HOT Lanes on SR 167 in the Puget Sound Region, Washington State

On May 3, 2008, HOV lanes on State Route (SR) 167 in King County/Seattle were converted to HOT lanes. The project extends from Southwest 15th Street in Auburn to I-405 in Renton. This 4-year pilot project will evaluate the ability of the HOT lane concept to manage congestion and generate revenue. Preliminary results indicate that the number of daily tolled trips has continued to increase, although the average toll paid by customers has fallen slightly below $1.00 per trip. The revenue generated by the tolls has climbed to just under $30,000 per month in March 2009. HOT lane traffic consistently flows freely during all hours of the day. During the 4-year pilot, the performance, socio-economic impacts, and public acceptance of the facility will be assessed on an annual basis.

### HOT Lanes on I-95 in Miami

The Miami-Ft. Lauderdale region is creating a 21-mile managed-lane facility on I-95, between I-395 and I-595, with a longer term goal of providing a network of managed lanes throughout the congested region. The express facility is being created by converting a single HOV lane in each direction into two HOT lanes in each direction by narrowing the travel lanes from 12 ft. to 11 ft. and narrowing the shoulders. The first segment, the southern half of the northbound I-95 HOT lanes, opened in December 2008. This is the second project in the Nation (after the Houston QuickRide project) to increase the occupancy requirement on HOV lanes, in this case from HOV 2+ to HOV 3+. The new occupancy requirement will ensure that the lanes remain free-flowing as HOV demand increases in the future, and will create some excess capacity for priced vehicles. The Express lanes generated monthly toll revenue of about $386,300 in March 2009

bringing the total revenue to date to approximately $1.01 million. Tolls ranged from $0.25 to the highest toll for the month of $3.00. The average off-peak toll was only $0.50. Approximately 88 percent of the customers were charged $1.75 or less. The facility operates at 15 mph above the adjacent toll-free lanes during the p.m. peak period (4 p.m. to 7 p.m.) and operates above 45 mph 100 percent of the time.

**HOT Lanes Extension on I-15 in San Diego, CA**

The I-15 HOT lanes are being extended to create a 20-mile "Managed Lanes" facility in the median of Interstate 15 (I-15) between State Route 163 and State Route 78. When completed, there will be a 4-lane facility in the median with a moveable barrier, multiple access points from the regular highway lanes, and direct access ramps for buses from five transit centers. A high frequency bus rapid transit system is under development and will replace the existing express buses that serve the corridor. The first 4.5 miles of new HOT lanes opened to traffic on September 22, 2008. Another 3.5 miles were opened to traffic on March 16, 2009. Latter stages will include four additional miles of new Managed Lanes by 2011, and the widening of the original 8-mile reversible section by 2012. When complete, the new State-of-the-art system will collect tolls from over 30 locations covering 84 "tolled lanes."

**HOT Lanes Expansion on the Katy Freeway (I-10) in Houston**

Katy Freeway (I-10), in the western portion of Houston, is a heavily congested urban interstate facility. The existing freeway is 23 miles long and consists of six general-purpose main lanes (three in each direction), with two-lane continuous one-way frontage roads in each direction for most of its length. Additionally, the freeway has a one-lane reversible HOV lane between I-610 and State Highway 6, and one HOV lane in each direction between State Highway 6 and the Grand Parkway (State Highway 99). The freeway is being expanded to eight general-purpose lanes, four in each direction, with continuous three-lane frontage roads in each direction. In addition, in the center of the facility from I-610 west to State Highway 6, four HOT lanes were constructed, two in each direction. From State Highway 6 to the Grand Parkway, two HOT lanes were constructed, one in each direction. The first segments of the HOT lanes opened in April 2009.

## Appendix 6 – Projects Under the UPA and CRD Programs

***The Urban Partnership Agreement (UPA Program):***

In mid-August 2007, the DOT announced the designation of five metropolitan areas (Miami, Minneapolis-St. Paul, New York City, San Francisco, and Seattle) as "Urban Partners," based on the results of a comprehensive review and competitive selection process. Each Urban Partner agreed to implement a comprehensive policy response to urban congestion that includes what DOT referred to as the "4 Ts": (1) a *tolling* (congestion pricing) demonstration, (b) enhanced *transit* services, (c) increased emphasis on *teleworking* and flex scheduling, and (d) the deployment of advanced *technology*. The approaches taken vary between Partner jurisdictions (e.g., HOV-to-HOT lane conversion in Miami vs. full facility pricing in Seattle), but in each case the projects represent innovative solutions.

*UPA Project Summaries*:

- **Miami.** The Miami Urban Partnership (UP) will convert a single HOV lane in each direction into a dual HOT lane on 21 miles of I-95 from Fort Lauderdale to downtown Miami. Key features include increasing the HOV limit from HOV-2+ to HOV-3+ and expanding the 10-lane highway to 12 lanes by reducing the width of the existing lanes from 12 feet to 11 feet and using a portion of the shoulder. Miami was awarded $62.0 million through the UP program. Phase 1A, the northbound segment of the HOT lane project was opened to traffic in early December 2008. Phase 1B, the southbound segment of the HOT lane is to be completed by December 2009. All work is being conducted under a $117 million design-build contract with built-in incentives for early completion.

- **Minneapolis/ St. Paul.** The Minneapolis/St. Paul Urban Partnership involves the creation of 15 miles of continuously priced lanes on I-35W between downtown Minneapolis and the southern suburbs. Existing HOV lanes will be converted to dynamically-priced HOT lanes, the HOT lanes will be extended and narrow bus-only shoulder lanes will be converted to wider Priced Dynamic Shoulder Lanes. Minneapolis/St. Paul was awarded $133.3 million for this project. The State legislation to authorize tolling on I-35W was signed into law in the spring of 2008. The initial HOT lanes and majority of the transit projects are expected to become operational by the end of 2009.

- **Seattle.** The Seattle Urban Partnership will result in implementation of variable pricing on the State Route 520 floating bridge that currently carries about 160,000 people per day between Seattle and its eastside suburbs. Seattle was conditionally awarded $138.7 million for this project. The variable tolls on the existing bridge are intended to help pay for the new bridge. Legislatively, both the Tolling Policy Bill (HB 1773) and the SR-520 Bridge Replacement Finance Bill (SB 3096) were passed on March 11, 2008. State provided authority to toll SR-520 is expected in the 2009 legislative cycle and must be in place before the full award will be

available for draw-down. The tolling of SR-520 is expected to be implemented by December 2010.

- **San Francisco.** The original terms of the UP Agreement provided for tolling of either Doyle Drive or the Golden Gate Bridge and included (conditional) funding of $158.7 million. Because the type of tolls and level of pricing eventually proposed by the Partners were considered by the Department to not be effective in significantly reducing congestion on Doyle Drive, the project was scaled back to approximately $87 million and now includes funds only for a large-scale downtown parking pricing project (with on-street parking meter rates that vary to ensure some availability) and support for the reconstruction of Doyle Drive. The approximated $72 million that had been provided for the facility-based congestion pricing scheme was redistributed to support the CRD project in Atlanta, Georgia. The project is expected to become operational by April 2010.

- **New York City.** New York City was one of the five initial Urban Partners. Their agreement called for the establishment of cordon/area pricing whereby cars would to be charged $8 and trucks $21 a day to enter Manhattan below 60$^{th}$ Street. Although the City Council approved the scheme, the proposal was not endorsed by the State legislature. As a result, the DOT rescinded the New York City UPA and re-distributed the $354 million of funds that had been provided for NYC to advance projects under the CRD program.

***The Congestion Reduction Demonstration (CRD) Program:***

Chicago, Los Angeles, and Atlanta were selected to partner with DOT on this program

- **Los Angeles, California:** The project in Los Angeles will convert existing HOV Lanes to dynamically-priced HOT Lanes on I-10 and I-110. The LA County Metropolitan Transportation Authority received approximately $210 million in Federal Transit Administration bus money to finance new bus service and park-and-ride facility improvements in exchange for a commitment to have the I-10 and I-110 HOT lanes operational by December 31, 2010.

- **City of Chicago:** The City of Chicago was to receive approximately $153 million in FTA bus money for an Express Bus / Bus Rapid Transit system and an on-street parking pricing program using a private concessionaire. Because the legal authority was not secured by deadline set, the Department withdrew the award for this project.

- **Atlanta, Georgia:** The Georgia Department of Transportation received approximately $110 million to implement the first phase of a HOT Lane network on a 20 mile segment of I-85, northwest of the City of Atlanta. The $39.5 million of the total funding was derived from "prior year" lapsed New Starts Programs earmarks, with the remainder coming from funds forfeited by the San Francisco Urban Partner. Funding will be available for expenditure only after the Partner Agencies obtain approval from the Georgia State Transportation board to increase

the HOV vehicle occupancy designation from HOV-2 to HOV-3. The HOT lanes must be in operation by January 31, 2011.

## Appendix 7 – Research Projects Completed Since April 2006 or Underway

**Office of the Secretary**

*On-going Research:*

- Central Indiana Congestion Pricing Strategies.
- Congestion Pricing: Analyzing Financial and Greenhouse Gas and Fuel Impacts and Development of TRUCE 3.0.
- TRUCE Statewide Model for Congestion Pricing Analysis.
- Alternative Freeway Congestion Pricing Scenarios in Major U.S. Metropolitan Areas.
- Vehicle Choice Model.
- Assessing the Full Costs of Congestion on Surface Transportation Systems and Reducing Them through Pricing.
- Administrative Costs of Tolling and Congestion Pricing.

**Federal Highway Administration**

*Completed Research:*

- K.T. Analytics and Cambridge Systematics Inc. (2008). Lessons Learned from the Value Pricing Pilot Program. Prepared for the Federal Highway Administration. Available at: http://ops.fhwa.dot.gov/publications/fhwahop08023/vppp_lessonslearned.pdf
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    - Congestion Pricing Overview.
    - Non-Toll Pricing.
    - Technologies That Enable Congestion Pricing.
    - Technologies That Complement Congestion Pricing.
    - Transit and Congestion Pricing.

- Economics: Pricing, Demand, and Economic Efficiency.
- Income-Based Equity Impacts of Congestion Pricing.

*On-going Research:*

- Domestic Scan of Congestion Pricing and Managed Lanes in the Planning Process (Office of Planning).
- Synthesis of Congestion Pricing Data (Office of Research and Development).
- Development of Case Studies Examining the Integration of Pricing into the Metropolitan Transportation Planning Process (Office of Operations).
- Performance of HOV Facilities and Development of a Policy Options Evaluation Tool for Managed Lanes (Office of Operations).
- Simulation Analysis to Understand the Traffic Flow Benefits of Pricing Initiatives (Office of Operations).
- Analysis of the Benefits of HOT Lanes (Office of Operations).
- Development of a Highway Capacity Manual Chapter on Congestion Pricing.
- Exploratory Advanced Research into Revealed Preferences with Pricing (Office of Policy and Governmental Affairs).

**Research and Innovative Technology Administration**

*On-going Research:*

- Urban Partnership Agreements (UPA) National Evaluation.

## Appendix 8 – Summary of FHWA Report on "Lessons Learned from International Experience in Congestion Pricing"

Large road pricing projects have been implemented in the U.K., France, Norway, Sweden, Germany, Switzerland, Singapore, and Australia over the past three decades. Additionally, congestion pricing has been analyzed and evaluated through numerous studies in nearly all European Union member countries, in Southeast Asia, Canada, Australia, and New Zealand.

To further understanding of international pricing, the FHWA report "Lessons Learned from International Experience in Congestion Pricing" (K.T. Analytics, Inc. 2008) provides a summary of selected operational area-wide congestion pricing projects outside of the U.S. The report draws lessons from a sample of projects with the richest and most relevant experience, focusing on three comprehensive area wide projects: Singapore, London, and Stockholm.

### Singapore

Congestion pricing has been a major component of traffic management and emissions reduction in Singapore. The Area Licensing Scheme was established in 1975 when a charge of S$3.0 (US$1.30) was introduced for vehicles entering the 2.0 square-mile central business area ("Restricted Zone" - RZ) between 7:30 and 9:30 in the morning. Buses, motorcycles, police vehicles and four-person carpools were excluded from charges. Introduction of congestion pricing was accompanied by provision of new Park-and-Ride lots with shuttle service into the RZ and expanded bus service (33 percent increase).

Since introduction, the Singapore congestion pricing program has gone through several modifications and expansion. Electronic Road Pricing (ERP), with charges varying by time of day, location and type of vehicle was introduced in 1998 for vehicles entering the central priced zone and at three points along three motorways. Subsequently, pricing has been extended to many more points on all motorways. The ERP program has been fully automated and charges are now collected electronically at more than 50 charge points spread across the city, as shown in Figure 1.

### London

The Congestion Charging program commenced in London in February 2003. It covered the 8.0 square mile, heavily congested central business district shown in Figure 2. The eastern zone shown with darker shading was designed as the "charging zone." The charging zone represented less than 1.5 percent of the total area of Greater London. Subsequently, the charging zone was extended to the west to cover an additional 8.0 square miles (shown in lighter shading in Figure 2). The overall program package included 40 percent increases in capacity of buses and trains over an 8-year period, starting immediately with expansion of bus service.

The program entails a flat weekday fee. Initially set at £5, the fee was raised to £8 in 2005. The fee is charged to vehicles crossing into, leaving, or traveling within the charging zone. The charging is effective between 7:00 a.m. and 6:30 p.m. (modified in 2007 to 7:00 a.m.-6:00 p.m.).

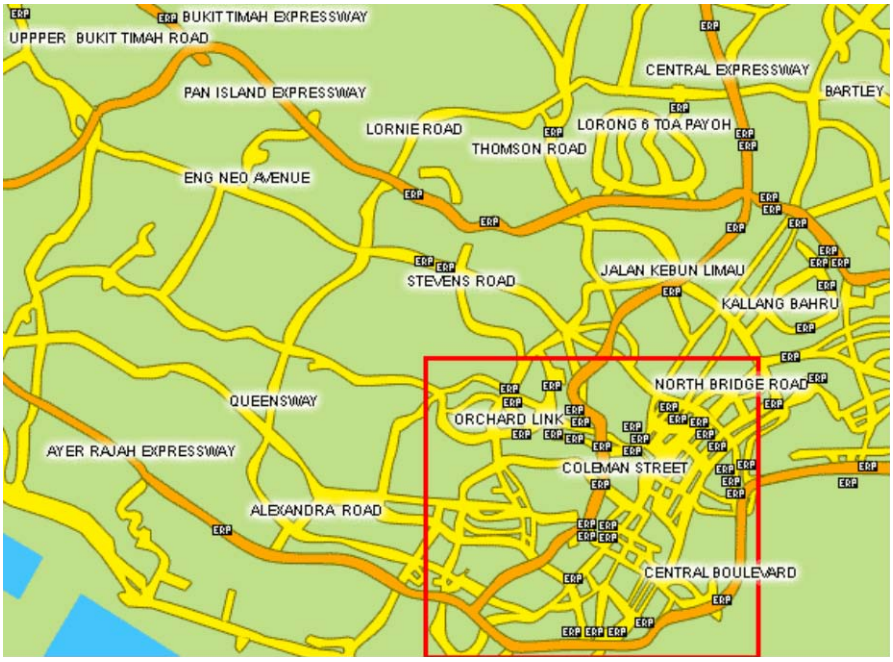


**Figure 1a: Singapore Electronic Road Pricing (2005)**

**[CBD Priced Zone (Inset) and Expressways (Red)]**

ERP


ERP **Figure 1b: Singapore CBD Priced Zone (2005)**

Source: K.T. Analytics, Inc (2008)

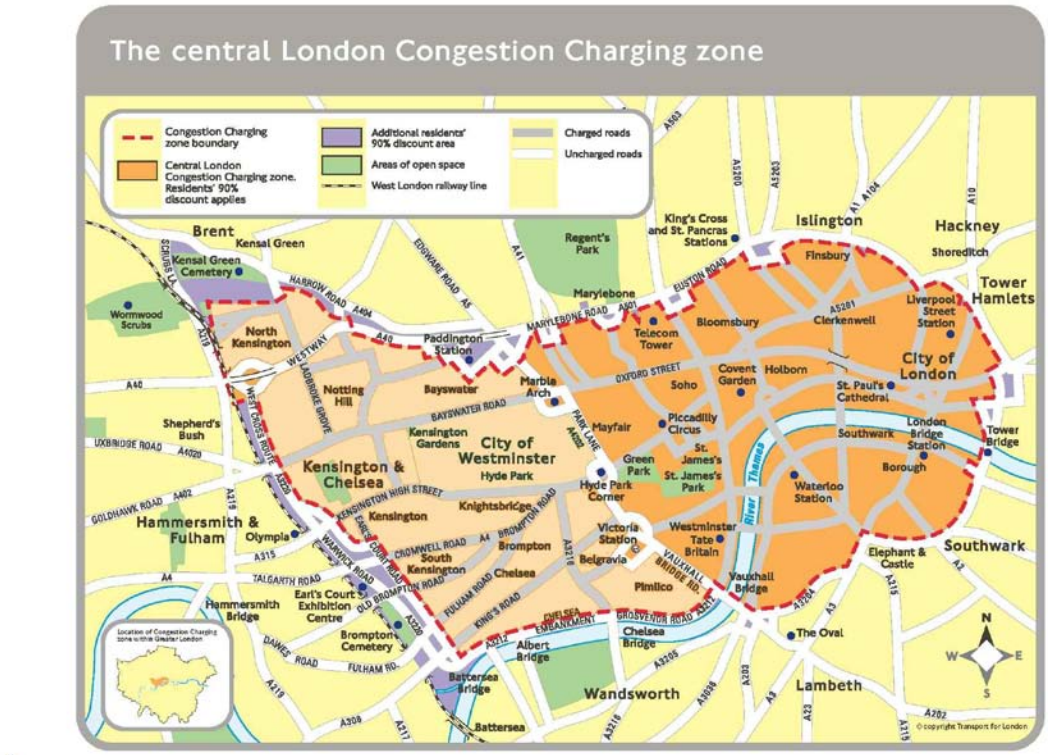


**Figure 2: THE CENTRAL LONDON CONGESTION CHARGING ZONE**

**2003 Original Charging Zone - Eastern Dark Shaded Area**
**2005 Expansion Zone Added - Western Light Shaded Area**
**(Excludes North-South Edgware/Park/Vauxhall Roads)**
**(Inset: Charge Zone Within Greater London Area)**

Source: K.T. Analytics, Inc (2008)

**Stockholm**

The central city area of approximately 20 square miles is designated as the priced zone. It covers the central city and constitutes a small part of the urbanized county area. The three elements of the program are shown in Figure 3 – Charging Cordon, Expanded Transit Routes and New Park-and-Ride Lots.

The charges are in effect weekdays from 6:30 a.m. to 6:30 p.m. and the price is set at 10, 15 and 20 SEK (US$1.33, 2.00 and 2.67 at 2006 rates) for off-peak, shoulder and peak period, respectively. The charges are collected when entering or exiting the zone at 18 barrier free "control points" encircling the city center. The daily maximum charge for multiple crossings is set at 60 SEK (US$8.00).

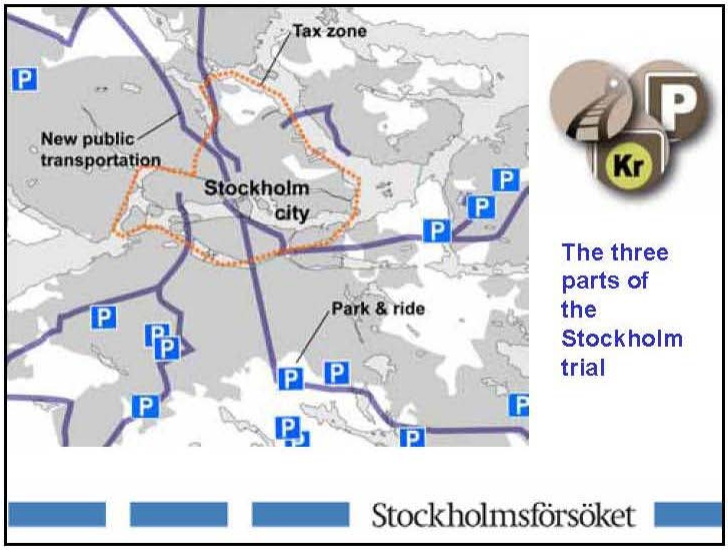


**Figure 3: Stockholm Priced Zone Shown Within The Inner County (Expanded Transit Routes and PAR Facilities Also Shown)**

Source: K.T. Analytics, Inc (2008)

**Findings & Conclusions**

***Mobility:*** Without exception, broad-scale pricing strategies implemented abroad have met their principal objective of reducing congestion and sustaining relief. Broad-scale pricing in Singapore, London, and Stockholm has resulted in 10 to 30 percent or greater reduction in traffic in the priced zone and has sustained the reductions over time. The speeds increased significantly within the zone as well as outside along approach roads. Ten to 30 percent increase in speed has been realized. Buses in Singapore and London have particularly benefited from speed increases. In the three broad-scale pricing programs, up to 50 percent of those foregoing car travel to the priced zone shifted to public transportation. In London and Stockholm, the greatest shift was to public transportation while in Singapore it was to 4+ carpools and to car travel during the shoulder time just before the start of pricing. The traffic reductions in priced zones have been sustained over 30 years in Singapore and 5 years in London.

***Revenues/Costs:*** The significant revenues generated by pricing have been seen as an important source of benefits in all three projects. Project revenues in London and Stockholm (as well as in toll cordon projects in Norwegian cities) have been used to cover operating and enforcement costs first and remaining revenues have funded improvements to bus and rail services. In London and Stockholm, the desire and ability to use pricing program revenues for public transportation was a major objective and "selling" point. In Singapore, while the revenues are not directly dedicated for public transportation, the availability of these funds probably has allowed the government to more easily to pursue ambitious public transportation programs. Also, broad-scale

pricing projects are generating revenues far in excess of costs. In Singapore's Area Licensing Program, revenues were nearly 10 times the operating costs. The revenues under the central area cordon pricing program are nearly 14 times the operating costs. If capital costs are included, the revenues are still 2.5 times the costs. For the London charging program, the revenues have been a little over twice the operating costs. Inclusion of capital costs brings this ratio down only marginally.

***Economy and Business**:* Broad-scale congestion pricing applications appear to have realized societal economic benefits in excess of costs. Singapore's 1975 program is estimated to have achieved a rate of return on investment of at least 15 percent, even without inclusion of realized savings other than the value of time savings. The London scheme is estimated to have generated a B/C ratio of 1.4: 1. Regarding business impacts, in Singapore, surveys suggested that the pricing program did not change business conditions or location patterns. Overall, the business community responded positively to the program. Analysis indicates pricing in London has neutral regional economic impacts, though annual surveys suggest businesses in the priced zone have outperformed those outside. A majority of businesses continue to support the charging scheme, provided investment in public transportation is continued. In Stockholm surveys, albeit over a very short time span of trial, no identifiable impacts on retail business or household purchasing power were identified. The long-term study of overseas congestion pricing conduced by CURACAO, (i.e., Coordination of Urban Road-user Charging Organisational Issues (CURACAO 2007)) finds "generally low level of measured impact" on regional economies. While the result may be partly attributable to the unique economic vitality and strength of the cities in which pricing occurs, there is no evidence of economic damage.

***Environment**:* A better environment has been one of the primary objectives of the Stockholm cordon pricing program, though not a major objective behind the London and Singapore pricing programs. However, all three have made attempts at monitoring and measuring air quality implications of changing operating speeds, number and timing of trips or the mode on which trips are taken. Evaluators in Singapore concluded that tailpipe emissions most likely declined in the priced zone because there was such a large reduction in automobile travel. Regarding smoke and haze, measurements showed declines, but they could not be unambiguously attributed to the pricing program. Analysis in London shows changes in air quality within and alongside the Inner Ring Road boundary of the zone. Levels of NOX fell by 13.4 percent between 2002 & 2003, CO2 by 15 percent and particulates (PM10) by 7 percent. More recent analysis confirms the trend. Some of these reductions are attributed to the effects of reduced levels of traffic flowing more smoothly, but the majority are due to improved vehicle technology. Generally, it appears broad-scale pricing has had a role in reducing pollution. As well, public transportation expansion, made possible by the congestion charge revenues, has the potential to reduce pollutants and sustain reductions over time.

***Equity**:* Equity impacts have received general analytic attention but little project level evaluation. The focus has been on varying concepts of equity, modeling of impacts and pricing designs to address income equity issues. At the level of projects or proposed projects, Singapore has examined equity impacts. Regarding specific cities reviewed for

pricing activity, the perception that congestion pricing is unfair to low income drivers has not been a major concern in Singapore, London or Stockholm after implementation.

Findings from Singapore are most in depth, though experience in the proposed Edinburgh program also is instructive. In Singapore, the results of modeling analysis based on before and after user survey data suggested that gainers outnumbered losers 52 percent to 48 percent. Attitudinal surveys carried out after program implementation show pedestrians, taxi riders and residents outside the priced zone found the impact as neutral or negative while cyclists, bus passengers, and residents within the zone judged pricing as favorable. Car drivers and passengers judged the program as mildly unfavorable. Travel evaluations and stakeholder surveys found increases in transit were fairly uniform for low, medium and high income peak period travelers. The evaluators concluded that, overall, there were only small differences among income groups in modal response. There was also no evidence that trip times increased or decreased more for any particular income group.

A CURACAO publication reviewing equity issues across programs urges attention to the design of pricing programs, including location, time of day and level of charge; the use of exemptions and rebates; provision of travel alternatives and use of surplus revenues to moderate perceived equity issues.

***Acceptability****:* Based on project experience and public opinion studies on pricing, certain key factors emerge as potential determinants of public acceptance:

- *The Problem Addressed Resonates*: Whatever the mix of problems addressed by pricing proposals, whether congestion, pollution or some combination, acceptability is enhanced where the problem is clear and severe to affected parties. Congestion may or may not be the most central candidate problem for pricing; pollution may be more resonant. Pricing plans enhance implementation prospects when they hone in on the most resonant problem or problems.
- *Pricing Is Convincingly Effective:* Acceptability studies suggest the public or decisionmakers may be skeptical about the effectiveness of pricing in reducing congestion or pollution. The implication is proposals will have better prospects where they can demonstrate effectiveness, perhaps by reference to like projects or through well-evaluated test programs or both.
- *Program Design Meets Program Concerns*: Acceptability of pricing is enhanced where pricing program parameters are in line with public and decisionmaker concerns. Top concerns will vary by area, but planners increase the odds of acceptance by determining the concerns and structuring the program accordingly. Some top concerns may be about "free riders" and enforcement; others may be about complexity of technology; others about specific groups facing hardship or adverse boundary effects. Implementation prospects improve with full attention to specific concerns.
- *Revenue Distribution Follows Preferences*: Gearing revenues toward most favored purposes is important to acceptability. Research shows revenues directed toward transit and/or road improvements may garner support in some

locations, but may compete with other preferences elsewhere, including possible tax reductions.

- *Fairness Is Broadly Addressed:* Equity across income groups subject to pricing often leads equity discussions among analysts of road pricing. However, research shows acceptability does not vary greatly across income groups and equity defined more broadly may dominate and deserve more attention. Specifically, these fairness perspectives may be key: fairness of outcomes, i.e. assurance some are not evading the pricing scheme who should be paying; "procedural" fairness, i.e. people feeling full opportunity to participate in developing pricing plans; fairness to special groups, e.g. handicapped or emergency workers; use and spatial fairness where occasional payers reap the same benefit from new roads and transit as frequent users; and ways to moderate different treatment of travelers within or to/from a cordon scheme.
- *Government Planners Are Open, Responsive, Resourceful Solution Partners*: Numerous findings suggest how government planners are perceived may be as important to acceptance as the nature of their pricing proposal(s). It seems if government has at least some favorable image coping with bottlenecks, improving transit and improving traffic management, acceptability of pricing proposals is enhanced. Likewise important is sensitivity to governmental image as a taxing entity with already sufficient resources to deal with congestion. Transparency in pricing planning and decision making also will enhance acceptability, including the degree to which non-pricing options have been examined; and the extent of reference to pricing experience elsewhere. Finally, government partnerships for funding of comprehensive pricing strategies are important to acceptance, suggesting State and national governmental agreements and matching funds may be a necessary step.
- *Pricing Schemes Operate Over Time*: A consistent finding is acceptance tends to grow the longer pricing programs are in existence. The exact reasons for growing acceptance are not well explored. It may have to do with experience demonstrating no harm to business, absence of feared queues at tollgates and the visible, proven link between revenues and transportation improvements.

In terms of implementing pricing programs, a few key points emerge from overseas experience:

- *Broad-scale pricing often requires new policy and institutional arrangements*. Major national level legislative initiatives were enacted before broad-scale pricing could be implemented in London and Stockholm. The experience shows that formal agreements may be needed for: power to impose and collect charges; use of selected technology to administer and enforce charges; to cite violators and collect fines; make modifications to the pricing scheme; and for the use of revenues from the charges. Experience also shows that policy and institutional arrangements and agreements have profound impact on public and political acceptability of broad-scale pricing proposals and operational success.

- *Successful projects depend on effective outreach and sensitivity to public acceptability*. All of the projects overseas have paid considerable attention to measuring public attitudes and reaching out to the public, stakeholders, and elected officials to further understanding of pricing and gain reactions. Outreach efforts as part of initial feasibility studies often find neutral or skeptical opinions, or outright resistance, which is often followed by acceptance as projects get underway. The support of a key stakeholder and/or a senior politician who is able to influence public opinion also seems crucial to furthering implementation prospects. While businesses have not been obstacles to implementation and are generally accepting of operating programs, continued support at least in London appears to hinge on continued investment in public transport.

- *Effective, reliable and acceptable pricing and enforcement technologies are key to implementation*. Technology is important to the success of most pricing concepts, and the technology has been generally up to the task. Various technologies for pricing and enforcement, both low and high end, generally are proving reliable and effective. The Singapore windshield license and manual enforcement system worked well in the early stages and the electronic successor using in-vehicle transponders with stored value "Smart Card" technology is now working well. London's license plate recognition system has been effective, though plans are underway to move to an electronic tolling system which will reduce administrative costs and allow variable pricing schedules.

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