INTERNATIONAL SCAN:
REDUCING CONGESTION & FUNDING TRANSPORTATION USING ROAD PRICING

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SUMMARY

The purpose of the International Scan was to identify new ideas and practical, workable models for integrating road pricing approaches into state, local, and regional policies, programs, and practices. The findings are intended to inform the U.S. road pricing research agenda and identify best practices from international experience that will assist U.S. practitioners.

The scan team visited with representatives from Sweden, the United Kingdom, Singapore, Germany, the Czech Republic, and the Netherlands in December 2009. The team was composed of representatives from the Federal Highway Administration (FHWA) and Federal Transit Administration (FTA); the Georgia, Minnesota, Virginia, and Washington State Departments of Transportation; the Port Authority of New Jersey and New York; and SRF Consulting Group, Inc. A list of scan team members is presented on the back cover.

INTRODUCTION

Road Pricing

Road pricing has a long history in the form of tolled bridges, tunnels and turnpikes, designed to generate revenue to pay for the construction, operations and maintenance of these facilities. In the last half century, road pricing has been viewed as an opportunity to leverage the principles of supply and demand to manage traffic in the form of congestion pricing. This is achieved by charging drivers a user fee (i.e., a toll or other charge) that may vary by traffic demand, time of day, vehicle classification, and/or other factors. In practice, road pricing provides a tool for road operators to manage limited roadway capacity to reduce congestion and maintain free–flow traffic conditions on highways as well as to generate revenues that help to pay for the capital, operating, and maintenance costs.

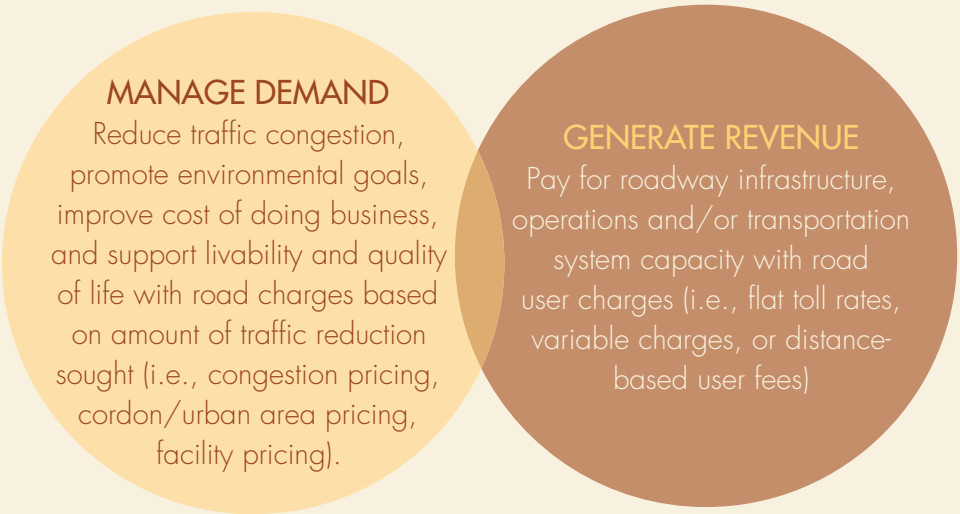
The broad application of congestion pricing in the U.S. has been limited due to political, institutional and public acceptance concerns. However, variable charges have been used successfully by many U.S. industries, including hospitality, air travel, utilities, and telecommunications. Both the U.S. Department of Transportation (USDOT) and the American Association of State Highway Transportation Officials (AASHTO) have made the issues of economic and environmental sustainability and community livability top priorities.

While there are a number of basic objectives that may underlie a road pricing program, the scan team focused on two primary purposes of road pricing: (1) to manage demand and (2) to generate revenue. The graphic below illustrates the fact that there are some programs that emphasize one objective or another, and others that seek to blend the two objectives in one harmonious program.

International Scan Overview

The scan included visits to meet with representatives from urban and nation-wide road pricing efforts in Stockholm, London, Singapore, Germany, the Czech Republic, and the Netherlands. Over a 12-day period, the scan team interacted with host country experts to develop an understanding of the political, institutional, and technical factors that contributed to the successful implementation of road pricing and, in some cases, to their rejection. Findings from this scan are intended to focus attention on the potential for road pricing as an effective part of a sustainable 21st century transportation system.

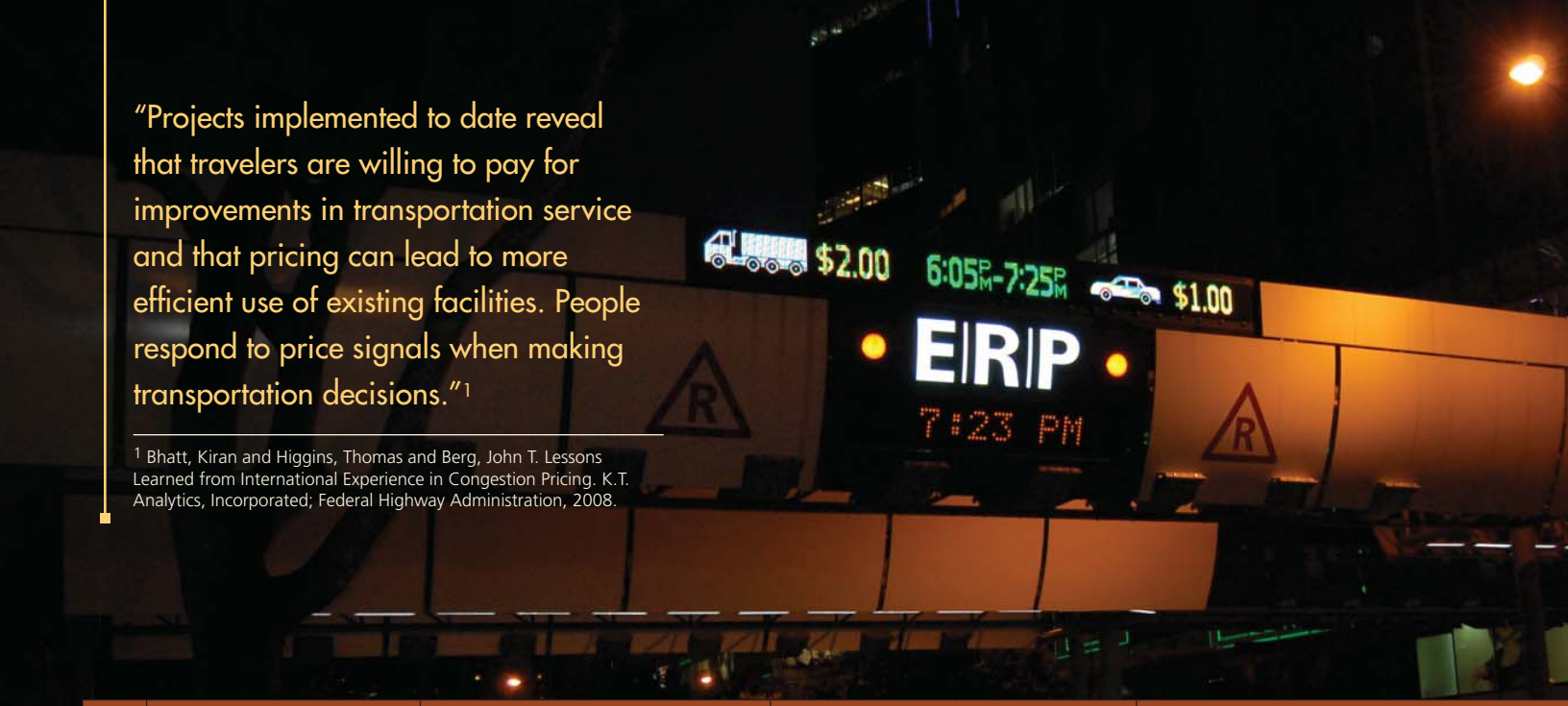
Purposes of Road Pricing



"The evidence in the countries visited in this scan shows that road pricing can play a vital role in creating new funding for transportation, encouraging improved quality of life in the urban environment, advancing economic productivity for goods movement and business, increasing the use of public transit, and reducing congestion and emissions."

"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 facilities. People respond to price signals when making transportation decisions."[1]

[1] Bhatt, Kiran and Higgins, Thomas and Berg, John T. Lessons Learned from International Experience in Congestion Pricing. K.T. Analytics, Incorporated; Federal Highway Administration, 2008.



	COUNTRIES VISITED	PURPOSE/OBJECTIVE	TYPE OF PRICING	MILESTONE DATES
Demand Management	**Stockholm, Sweden:** Congestion Tax	Manage congestion (primary) Promote transit and protect environment (secondary)	Cordon pricing in city center by time of day 10 SEK to 20 SEK (about US $1.50 to $3) per crossing of cordon line into and out of city center	Trial: January - July 2006 Referendum: September 2006 Permanently reinstated: August 2007
	London, United Kingdom: Congestion Charge	Manage congestion (primary) Promote transit and protect environment (secondary)	Area pricing in central London and its western extension Flat daily rate of £8 (US $13)	Started in Central London: February 2003 Price increased from £5 to £8 (60% increase) in July 2005 Western extension: February 2007 Repeal of western extension: Planned in 2010
	Singapore: Electronic Road Pricing (ERP)	Manage congestion (primary) Promote transit (secondary)	Cordon and expressway pricing by time of day and vehicle class	Cordon pricing via manually enforced paper permit system in 1975. Transition to ERP in 1998, followed by expressway pricing
Generation	**Germany:** Heavy Goods Vehicle (HGV) Charging on Highways	Generate revenue and promote "user pays" principle (primary) Protect environment; encourage mode shift to rail and water (secondary)	Truck tolls for heavy goods vehicles (> 12,000 Kg) on the autobahn and limited portions of other national highways based on distance traveled, number of axles, and emissions class	Opened in January 2005
	Czech Republic: Truck Charging on Highways	Generate revenue and promote "user pays" principle (primary) Advance environmental objectives (secondary).	Truck charges on selected national highways based on distance traveled, number of axles, and emissions class	Opened: January 2007 Originally for heavy goods vehicles > 12,000 kg; Expansion to include trucks > 3,500 kg in January 2010
Planned	**Netherlands:** National Distance Based Tax	Planned to manage congestion, replace vehicle tax revenue, and promote "user pays" principle (primary) Promote transit and protect environment (secondary)	National distance-based road pricing of all vehicles (commercial trucks and private cars) on all roadways	Phased implementation originally planned to commence in 2011, with all trucks covered by 2012 and all vehicles by 2018

COUNTRY OVERVIEWS

Road pricing has received considerable attention outside of the U.S. since the inception of Singapore's cordon congestion pricing system in 1975. Many countries in Europe, Asia, and the Pacific region have explored, experimented, and, in some cases, successfully implemented road pricing to address congestion, environmental, and transportation funding issues. Large-scale operational pricing projects have been implemented in the U.K., Norway, Sweden, Germany, Austria, the Czech Republic, Switzerland, Chile, South Korea, Singapore, and Australia over the past three decades.

The table below summarizes the characteristics of the road pricing projects that were visited during the scan. Based on similar purposes and characteristics, Stockholm, London and Singapore are grouped as cordon pricing concepts that aim to reduce urban congestion. Germany and the Czech Republic are paired, as both are national truck tolling systems with the primary goal of revenue generation. The Netherlands is unique among the sites visited, as it is in the planning and implementation stages for a national road pricing system that will likely charge all vehicles based on distance traveled, time of day, and vehicle type.

TECHNOLOGY	MEASURED IMPACTS	ANNUAL REVENUES AND COST	DISTRIBUTION OF NET REVENUES
Automated number plate recognition (ANPR) to assess tax to vehicle owner	20% reduction in traffic congestion in the city center 10-14% decrease of emissions	Gross revenues (2009): 850 million SEK (US $118.5 million) Net revenues: (2009): 530 million SEK (US $74 million) Overhead costs: 320 million SEK (US $44.5 million) about 37% of revenues	Collected by national government and transferred to City of Stockholm. Net revenues used to invest in transit and new roads
Automated number plate recognition (ANPR) to track compulsory payment compliance and identify violators	Initial traffic reductions of 25% and 19% (central London and western extension respectively)	Gross revenues (2008): £268 million (US $435 million) Net revenues: £137 million (US $222 million) Overhead costs: £131 million (US $212 million) about 50% of revenues Capital costs for Central London zone: £130 million (US $211 million)	Net revenues used for transit (80%) and other transport (20%) improvements within greater London.
Dedicated short-range communications (DSRC) in-vehicle units with removable stored-value smart card for payment. ANPR for enforcement	Achieves free-flow road speed targets of 45-65 kph on expressways, and 20-30 kph on arterials.	Gross revenues (2008): SGD $125 million (US $90 million) Net revenues: SGD $100 million (US $72 million) Overhead costs: SGD $25 million (US $18 million) 20% of gross revenues	Net revenues returned to vehicle owners through tax rebates - heavy investment from general fund in transit and highway systems
Global positioning system (GPS) for vehicle location; Global system for mobile communications (GSM) for data transmission; DSRC and ANPR for enforcement. Manual booking system via kiosk terminals and internet for those without on-board units.	Violations < 2%; Empty truck trips declined by 7%; 58% shift from dirtier truck models (Euro class 1,2,3) to cleaner trucks (Euro class 4,5)	Gross revenue (2008): €3.5 billion (US $5 billion) Overhead costs: 15% -20% of gross revenues Average toll rate: €0.163 per kilometer (US $0.378 per mile)	Net revenues for Roads (50%), Rail (38%), and Waterways (12%). €560 million (US $815 million) per year for trucker "harmonization" program
Transponder based DSRC system with gantries on mainline highways. ANPR for enforcement	Average toll rate of US $0.35 per mile on freeways	Gross revenue (2008): CZK 6 billion (US $340 million) Overhead costs: 30% of gross revenues Average toll rate: CZK 4.05 per kilometer ($0.36 per mile) for highways; CZK 1.90 per kilometer ($0.17 per mile) for first class roads	Net revenues for roads and highways, railway lines, and inland transport routes
Under development, likely GPS for vehicle location, GSM-based data communication, and DSRC interrogation with ANPR for enforcement	2020 forecasted results: 10%-15% reduction in vehicle miles traveled; 40-60% reduction in delays; 10% reduction in CO2; 6% increase in public transit usage	Gross revenues (2019 forecasted): €9 billion (US $13.1 billion) Overhead costs: TBD (capped in law at 5% of gross revenues) Capital costs (estimated): €5.7 billion (US $8.3 billion)	Revenues intended to replace existing vehicle ownership taxes

• Monetary units converted using prevailing currency exchange rate in January 2010

DEMAND MANAGEMENT: LONDON CONGESTION CHARGE

In 2003, under the leadership of Mayor Livingstone, London launched a bold initiative to designate a cordon around central London and charge vehicles to travel within the eight-square-mile area. In 2007, the charging area was doubled in size with a western extension. Due to changes in leadership and public consultation, the western extension will be repealed in 2010.

With London roads congested most of the day prior to the congestion charges, it was estimated that delays were costing people and businesses £4 million (US $7 million) to £6 million (US $10 million) per week in time and money. Thus, the objective of the congestion charge was to reduce traffic, improve travel times for buses, generate new revenues for public transit, and enhance the quality of life in Central London. The mayor's vision included a 40 percent increase in public transit service by 2011, with the immediate expansion of bus services prior to congestion charging began in 2003.

The flat weekday charge was initially set at about £5 (US $12) and was then raised to £8 (US $16) in 2005. The charging is effective between 7:00 a.m. - 6:00 p.m. Various exemptions and discounts are allowed, including a 90 percent discount for residents living in the pricing zone. Buses, taxis, emergency vehicles, hybrid cars, and motorcycles are exempt as well.

Central and western London congestion charging zone

Enforcement is conducted using more than 650 closed-circuit cameras set up along the cordon and within the zone with roving vans policing the zone. Live video images of the license plates of all vehicles are captured.

Results of the Congestion Charge

The number of vehicles entering the charging zone decreased by 25 percent and the amount of circulating traffic fell by 15 percent after the first year of implementation. Travel speeds increased by 30 percent, trip times decreased by 14 percent, and traffic delays plummeted by 25 percent in the charging zone. **Transport for London (TfL) reported an average of 70,000 fewer vehicle trips than in the year prior to the congestion charge.** Of those reduced trips, they estimate that 50 to 60 percent shifted to transit, 20 to 30 percent of the trips were eliminated, and 15 to 25 percent are carpooling.

Congestion in Central London has steadily returned, so that in 2009 congestion levels are equal to those before 2003. This is, in part, due to the conversion of various streets into pedestrian malls, implementation of bus lanes, and reconstruction of water and sewer lines in preparation for the 2012 Olympics.

Revenues from the congestion charge were £268 million (US $437 million) in 2008. When accounting for expenses (approximately 50 percent), the congestion charge generated about £137 million (US $222 million) in 2008, which, by law, must be spent on transportation in London.

While the objectives of the congestion pricing in London were achieved, critics point to the high operating costs of the system as a drawback. Much of the success of the system rests with its relative simplicity, with only one price (£8 per day) when the system is in operation. Based on TfL's 2006 and 2007 reports, the business and economic impacts of congestion pricing have largely been neutral.

Note: The Federal Reserve certified currency exchange rate for December 12, 2009 was used (US $1.62 per £1.00)

DEMAND MANAGEMENT: STOCKHOLM CONGESTION TAX



The purpose of the Stockholm road pricing project is to reduce traffic congestion and vehicle emissions in the inner city area (CBD). It was initially introduced by the Green Party and Social Democrats as part of a larger, full-scale trial with the objectives of reducing congestion, improving access and mobility, promoting transit, and promoting environmental sustainability.

The concept involves a cordon around the Stockholm city center and charge a variable fee for crossing the cordon. Vehicles registered in Sweden are charged when they pass one of 18 "control points" entering or exiting the CBD on weekdays between 6:30 a.m. and 6:30 p.m. The rates vary from 10 SEK (US $1.50) to 15 SEK (US $2.25) depending on the time of day for crossing a control point, up to a maximum of 60 SEK (US $9) per day. Since the congestion charge is managed as a tax by the national government, any change in the fee schedule requires parliamentary action.

The road pricing project in Stockholm was unique in that it was initially introduced by a seven-month demonstration period, after which the system was turned off. Prior to the demonstration, public support was at 25 percent. After the demonstration a public referendum was held, and public support from Stockholm voters grew to 50 percent in favor of reinstating congestion pricing. **Stockholm residents realized the tangible benefits of congestion pricing coupled with significant investments in transit service.**

The overall implementation included a 1.3 billion SEK (US $180 million) investment for the tolling system plus 2 billion SEK (US $280 million) in related public transit improvements. The transit investment funded a 10 percent expansion of the Stockholm public transport system, which included 200 articulated buses (equivalent of 10,000 new seats), 2,400 new park-and-ride spaces, bus-priority at traffic signals, improved rail service, new dedicated bus lanes, and 12 new express bus routes.

The transit and tolling systems were to be launched in tandem. However, the transit service enhancements went into operation six months before the congestion charging system due to tolling system procurement delays. It is noteworthy that transit usage and congestion levels did not change with the introduction of the new transit service. It was only after the congestion charging system went live that travel behaviors changed and a 20% reduction in traffic was realized, along with concurrent increases in transit usage.

Vehicles exempt from paying fees include public buses, taxis, certain alternative fuel vehicles (ECO-cars, LPG, and electric), emergency vehicles, motorcycles, vehicles with handicap plates, and foreign-registered vehicles. An exemption is also provided to the residents of the Island of Lidingö, who can only access the rest of Sweden by traversing the CBD. Vehicles driving between the Island and the bridge control points have 30 minutes to make a through trip without being charged. However, if they remain in the CBD for more than 30 minutes, charges are applied. The capital cost to institute the "Lidingö Rule" was estimated at more than 200 million SEK (US $28 million) plus ongoing exemption costs due to system downtimes. Another exception is through-traffic on the E4/E20 Essingeleden Highway going past Stockholm. In total, about 30 percent of total vehicles are exempt.

The toll collection system was installed to include three overhead gantries at each control point, which include digital imaging cameras that capture front and rear license plate images of all vehicles, and dedicated short range communications (DSRC) antennas that were used in conjunction with in-vehicle transponders that were available to travelers during the trial. With the adoption of the permanent system, officials decided that the automated number plate number recognition (ANPR) system performed so well that the transponder-based option was not necessary and eliminating it offered an opportunity to reduce overall system operating costs.

Demonstration Results

Overall, the congestion tax reduced traffic volumes by 10 to 15 percent and congestion fell by 20 percent in the CBD. Transit ridership grew by 6 to 9 percent during the demonstration. This resulted in a 14 percent reduction in vehicle miles traveled and a 10 to 14 percent decrease in emissions. After the system was taken offline at the end of the demonstration, traffic volumes returned to approximately the same level as before the trial. After its permanent reintroduction in August 2007, data shows that access to the CBD has improved, travel times were lower, and a 15 percent reduction in traffic was realized.

Note: The Federal Reserve certified currency exchange rate for December 12, 2009 was used (US $0.14 per 1.00 SEK)

DEMAND MANAGEMENT: SINGAPORE ELECTRONIC ROAD PRICING

In 1975, Singapore undertook a bold new approach to manage traffic and improve air quality by introducing a fee for vehicles entering the CBD during the morning peak period between 7:30 and 9:30 a.m. Since its inception as a non-electronic, pre-paid windshield permit, **Singapore's road pricing system has expanded and modernized to become the most extensive cordon-based demonstration of congestion pricing in the world.** Known as Electronic Road Pricing (ERP), the system is fully automated, with more than 60 charging points covering the center city and some primary high-volume expressways.

The ERP system uses dedicated short-range communications (DSRC) and Automatic Number Plate Reader (ANPR) technology for enforcement. Vehicles are charged while traveling at full highway speeds. All vehicles registered in Singapore are required to have a transponder with a pre-paid "stored value smart card" inserted. The smart cards are available through various banks and can be replenished online, by telephone, at kiosks, and at ATMs. A new generation smart card was introduced in 2006 and can be used to pay transit fare, parking, and at various retail stores, with the intent of increasing the card's utility to the holders. Vehicles without an active transponder detected face a SGD $70 (US $50) fine, while those with insufficient smart card funds are charged an administrative fee of SGD $8 (US $6). **This automated enforcement keeps violations at less than one percent. The introduction of ERP was accompanied with new park-and-ride lots, expanded transit service into the CBD, and a 30 percent decrease in CBD parking rates.**

The price varies by time of day, location, and vehicle classification. Adjustments to the pricing schedule are considered every three months to ensure free flow speeds. Speed targets are 45 to 65 kph on expressways and 20 to 30 kph on other streets. The rates vary from zero to approximately US $2 per cordon crossing and are in effect from 7 a.m. to 7 p.m. every weekday. On expressways, the price varies from zero to about US $4 and is in effect weekdays from 7 a.m. to 9:11 a.m. and 5:30 p.m. to 10:30 p.m.

Revenues

In 2008, annual gross revenues were SGD $125 million (US $90 million) with net revenues of SGD $100 million (US $72 million). While all of the net revenues are directed to the general fund, vehicle owners receive periodic rebates on their vehicle taxes that are funded by the ERP net revenues. Investments from the general fund are provided to appropriately address the needs of Singapore's multimodal transportation system.

Note: The Federal Reserve certified currency exchange rate for December 12, 2009 was used (US $0.72 per SGD $1.00)

REVENUE GENERATION: GERMANY HEAVY GOODS VEHICLE TOLLING

The German Heavy Goods Vehicle (HGV) tolling program began commercial operations in January 2005. **It is the world's first satellite-based, country-wide electronic tolling system** and applies only to trucks weighing more than 12 tons. All trucks, irrespective of national registry, are tolled based on the number of axles, vehicle emissions rating, and distance traveled.

The key policy objectives were to raise revenue by imposing a national mileage-based, "user-pays" infrastructure fee for trucks. The pricing is based on distance traveled, emission levels, and number of axles. In addition to revenue generation, the objectives of the system were to create incentives to shift freight truck traffic to rail and waterways, promote the use of cleaner truck technologies, encourage more efficient routing and scheduling of trucks, and provide funding for maintenance and expansion of transportation infrastructure.

Using an innovative combination of satellite-based (GPS), mobile communications (GSM), on-board computers (OBUs), dedicated short-range communications (DSRC), and automated number plate readers (ANPR), toll rates range from 14.1 to 28.8 euro cents per kilometer (22.6 to 35.1 US cents per mile). The average toll rate is 16.3 euro cents per kilometer (34 US cents per mile). Annual gross revenues have grown steadily from €2.86 billion (US $4.4 billion) in 2005 to €3.5 billion (US $5 billion) in 2008. With about 90 percent of toll transactions automated, the annual operating cost is estimated between 15 to 20 percent of revenues (about 6 to 8 US cents per mile). While manual bookings are 10 percent of all transactions, they represent more than one third of total operating costs.

Initially predicted to be five percent, the actual violation rate is less than two percent. Fines are €400 (US $624) for intentional violations and €200 (US $312) for unintentional violations. The maximum fine is €20,000 (US $31,200), and the responsibility for fines is split equally between the driver and shipper.

Revenues are allocated by Parliament using the framework of 50 percent to roads, 38 percent to rail, and 12 percent to waterways. Initially, to gain support from the German trucking community, these additional revenues were added to the general fund allocation for roads, rail and waterways.

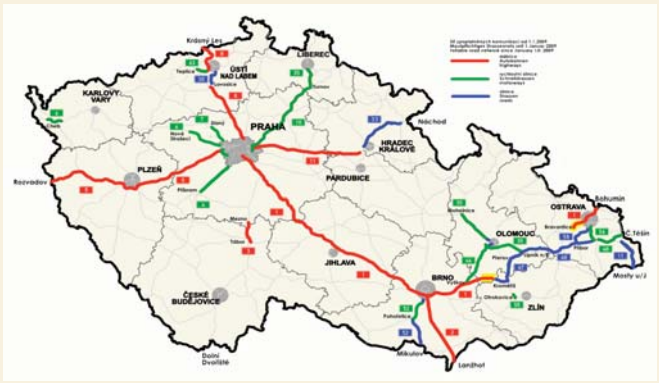
"The idea of a distance-based charge was conceived in 1989. Studies were conducted subsequently, and, in 1995, based on the recommendations of the German High Commission (Paellman Commission) on Financing of Federal Transport Infrastructure, the federal government decided to introduce distance-based tolls. Initial opposition turned into acceptance because tolling of all heavy goods vehicles was considered fairer for German trucks vis-à-vis foreign trucks, which accounts for about 35 percent of all of the country's truck traffic."[2]

[2] Robinson, Ferrol. Heavy Vehicle Tolling in Germany: Performance, Outcomes and Lessons Learned for Future Pricing Efforts in Minnesota and the United States. Humphrey Institute of Public Affairs, University of Minnesota, October 2008.

Note: The Federal Reserve certified currency exchange rate for December 12, 2009 was used (US $1.45 per €1.00)

REVENUE GENERATION: CZECH REPUBLIC NATIONAL TRUCK TOLLING

Situated at the center of the EU, 40 percent of the trucks using the Czech highway system are foreign-based. Thus, the primary goal of the Czech Truck Tolling program is to generate revenue from foreign trucks that were perceived to not be paying their fair share of system costs. The tolling program began operations in January 2007 and uses DSRC-based tolling points on the highways mainline with automated number plate readers for enforcement. At the outset, the toll applied only to trucks weighing more than 12 tons. As of January 2010, the truck toll was being applied to all commercial trucks weighing more than 3.5 metric tons.



This implementation of truck tolling on freeways and expressways is considered to be the first phase of a more comprehensive road pricing system. Future plans (phase 2) are to extend to 800 km of additional roadways by 2017, by including some arterial and local roads. The capital costs for the initial implementation (phase 1) and future expansion (phase 2) of the system is estimated at approximately CZK 18 billion (US $1 billion). When complete, Phases 1 and 2 will include 1,120 miles of expressways and freeways as well as 43 miles of connecting main roads. This expansion of the existing system will seek to employ microwave technology and GPS-based on-board units, because the cost associated with installing additional gantries on arterials and local roads is seen as excessive.

Revenues from the program generated about Czech Koruna (CZK) 6 billion (US $340 million) in 2008, with an average toll rate of CZK 4.05 per kilometer (US $0.36 per mile) for motorways and highways and CZK 1.90 per kilometer (US $0.17 per mile) for first class (i.e., principal arterials) roadways. Certain types of vehicles, including first responders and law enforcement, are exempt from the toll, but are still required to register and install an on-board unit.

Note: The Federal Reserve certified currency exchange rate for December 12, 2009 was used (US $0.06 per CZK $1.00)

REVENUE GENERATION & DEMAND MANAGEMENT: NETHERLANDS

The Netherlands, a small, densely populated country with highly congested roads, is in the process of implementing an ambitious national road pricing program. They plan to roll out a country-wide distance-based road user fee for trucks by 2012 and to expand the toll to all vehicles (about 8 million) by 2018.

In late 2007, the Dutch Cabinet decided to implement a national road payment based on the following four policy goals:

- Improve mobility and accessibility to benefit the economy.
- Develop a more fair system that focuses on use of the road system rather than on vehicle ownership (replace current license fees and vehicle taxes).
- Enhance the environment.
- Improve road safety.

While the precise price per kilometer is still in planning, the program's current expectation calls for tariffs for autos at the start of implementation to be 0.030/km (US $0.07 per mile), with the rate expected to reach 0.067/km (US $0.155 per mile) at full implementation. The lower rates at the program's start reflect the fact that the vehicle ownership taxes will be phased out over time, with the user fees ramp up in parallel. The per-kilometer tariffs for other vehicles upon implementation are planned to be 0.017/km (US $0.039 per mile) for commercial vans; 0.028/km (US $0.065 per mile) for buses; and 0.024/km (US $0.056 per mile) for trucks. The relatively low rate for trucks corresponds to the fact that trucks pay relatively lower rates for the vehicle taxes that will be replaced by the road charging system. In addition to pricing by vehicle type, the system is planned to take into account the vehicle emission class, and time of day pricing for peak and off-peak travel. All revenues will be dedicated back to the road system to offset existing license and registration fees.

Although the method of toll collection and vendors have not been selected, it has been determined that satellite-based (GPS) technology combined with in-vehicle equipment and mobile communications is the preferred method. Key next steps include extensive consultation, the amendment of legislation, and development of a more detailed migration plan from vehicle taxes to the distance-based tax.

Note: The Federal Reserve certified currency exchange rate for December 12, 2009 was used (US $1.45 per €1.00)

MAJOR FINDINGS

The host EU countries and Singapore are ahead of the U.S. in broad-scale road pricing implementation. They each provide valuable case studies for learning for U.S. transportation professionals and decisions makers. Overall, the experience in each host country has proven that road pricing is an effective tool to manage demand and raise revenue.

Based on discussions and observations made during and after the scan, the team developed the following nine major findings:

1. **Host countries and regions with clearly defined and well-understood policy goals were able to achieve their targeted outcomes most effectively.**

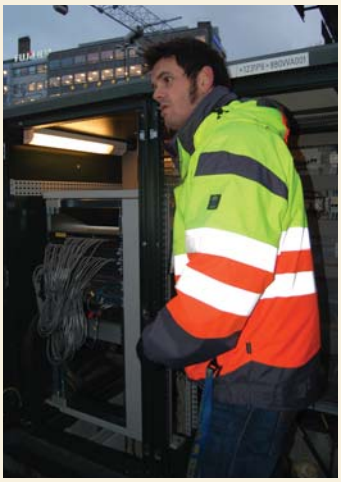
   The city-center urban road pricing programs visited all targeted congestion mitigation as a central goal. Generally, road pricing was one element of a larger program of initiatives working collectively to address traffic congestion and its impacts.

   - Singapore identified clear transportation goals as a critical foundation for urban development and economic growth plans, and has maintained this focus for many years. Congestion management objectives include road pricing tied directly to targeted minimum speed thresholds for urban streets and arterials. In addition to the Electronic Road Pricing (ERP) system, congestion management is also addressed through multimodal transportation investments as alternatives to driving, parking management systems to facilitate identification of available parking, and national quotas that cap increases in vehicle ownership. Highly integrated land-use and transportation planning also support congestion management objectives.

   - Stockholm's congestion tax was designed to reduce congestion in the city center in a manner that promoted public acceptability and fairness through setting reasonable toll prices, daily maximum charges, expanded transit and park-and-ride services as alternatives to driving, and exemptions for traffic from the Island of Lidingö that are unable to avoid traversing the city center. The congestion pricing program improves the quality of life in the city center for residents and travel options for drivers. Revenues from the congestion tax In Germany and the Czech Republic, the distance-based charging of commercial vehicles is designed to capture revenues aligned with the infrastructure life-cycle costs required to maintain roadways for heavy vehicle use. Political decisions in Germany to divert existing general funds from transportation in order to address other budget shortfalls contradicted commitments to use road-pricing revenues to augment existing infrastructure investment, fueling resentment and skepticism from trucking interests.

   - The Germans and Czechs viewed their pricing programs as an opportunity to capture road revenues from foreign through truck traffic but found manual booking systems for those without in-vehicle units are expensive to operate.

   - The Netherlands is planning a "tax consolidation" approach to develop aggressive and comprehensive replacement for fragmented transportation taxes



into a single distance-based charge for all vehicles and roadways. . The Dutch government believes a true user tax would be more effective than the current ownership taxes. The ownership taxes "overcharges" car owners who don't drive much. For example, owners of classic cars pay an ownership tax even if they don't drive the cars. The universal "user pays" principle in the Netherlands is expected to generate strong environmental benefits from trip consolidation and alternative mode choices. The environmental benefits achieved by the Germans and Czechs are evident through price incentives for cleaner vehicles and a reduction in empty truck movements.

2. A large-scale demonstration project is a powerful tool for public acceptance, allowing people to experience the benefits of congestion pricing.

Stockholm's trial of the congestion tax system from January to July 2006 demonstrated the benefits of congestion pricing first-hand. Sequencing a referendum vote after the trial concluded was instrumental to garnering public support. The pilot demonstration also provided technical and administrative staff the opportunities to refine the system and its performance, streamline business processes, and reduce operating cost.

3. Thorough planning and performance measurement pays benefits in ensuring achievement of overall goals, managing the pricing program as an element of overall transportation system performance, and directing implementation and operations effectively.

Comprehensive network planning was integral to the pre-implementation efforts for the road pricing systems examined on this scan. The best in class road pricing programs have integrated public transport options into their planning and pre-implementation actions.

- Stockholm, London and Singapore made significant advanced investments in transit equipment, facilities and services.
- In planning the Stockholm system, internationally recognized traffic experts were retained to measure network effects of various configurations of the charging zone to ensure that there were no unintended effects outside of the congestion charging zone.
- The Netherlands has undertaken comprehensive planning exercises to look at network effects of proposed tariffs across several modes, as well as the operating performance of the network when travel demand is redistributed by time of day.
- Singapore is using advanced analytics and traffic models to better understand the network impacts of pricing on parking and transit.

Performance measurement is key to managing and maintaining goal attainment.

- All new pricing systems adopted direct performance measurements of traffic reductions, travel speed increases, mode shift, and clean vehicle adoption, as well as estimates of business impacts and emissions reductions.

- Singapore's ongoing management of their congestion charge includes quarterly verification of travel speeds and refinement of prices to ensure that 85th percentile travel speed standards are maintained on two different classes of roadways.
- The Netherlands has adopted comprehensive risk analyses to manage program schedules and budgets.

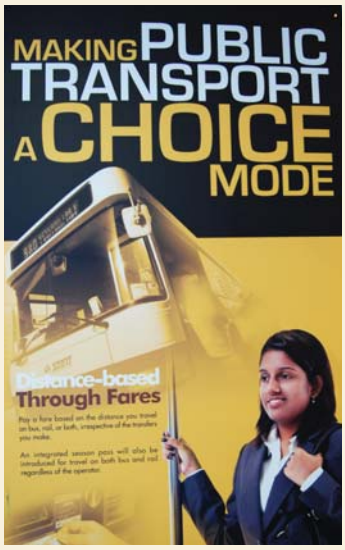
Post-implementation planning and performance assessments focused on the right measures have proven to ensure cost efficiency and operating effectiveness.

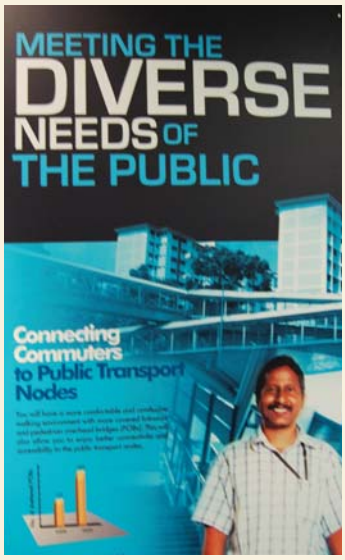
- Stockholm has benefited from ongoing assessments of system redundancies and business practices to reduce operating costs while maintaining system performance. Changes to payment methods, payment processes, and image processing have saved systems and operating costs.
- The Czech Republic is seeking relief from contractually high DSRC OBU costs, by planning system expansion to employ GPS and microwave technologies.
- Germany's truck tolling system suffers from high costs for manual bookings, but the joint venture contract incentivizes system accuracy not cost performance.

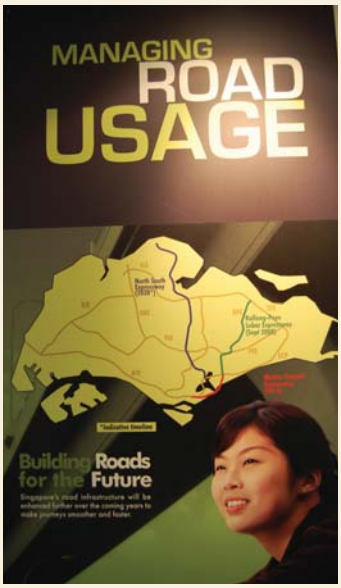
4. Linking the pricing structure to the benefits received by the user contributes to public acceptance and helps to avoid the potential negative impacts from traffic diversion.

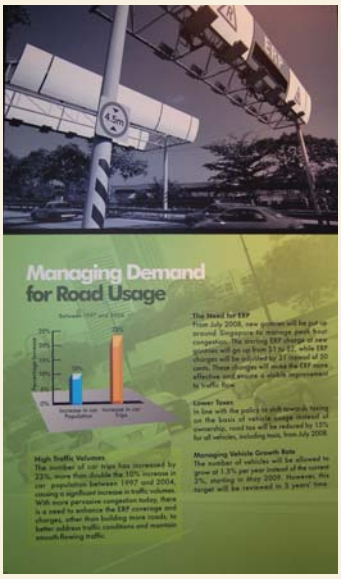
In order to maintain support for road pricing, some of the sites visited attempt to connect the pricing structure to the benefits received by the toll payer.

- In Sweden, toll rates on new roadway infrastructure are set at levels that reflect the value of the reduced travel time and operating costs relative to existing non-priced routes. While this strategy may not fully recover the costs for the new infrastructure (thus requiring public subsidy), it ensures that the new infrastructure will be used optimally, (i.e., traffic will not stay on existing free routes simply to avoid the toll). In Stockholm, the price schedule for the cordon charges was set to reflect the expected benefits to those who would be paying the new charges. There was a concern that if tolls were perceived by the public to be too high, they would be less acceptable. Toll rates were set at the minimum levels needed to manage congestion, and not to achieve any specific revenue target. The congestion tax rates were set to match the value of time saved. Since its introduction, the congestion charging rates have not been changed; while there is a recognition that they will need to be increased in the future to address growing travel demand and inflation, public acceptability of any rate changes is an important consideration. However, since the congestion charge is defined as a national tax, it can only be changed by an act of parliament, which makes it less nimble.
- In Singapore, the price is reviewed and can be adjusted every 3 months to ensure that targeted "optimal" speeds can be maintained for at least 85% of vehicles that pay the toll. There is particular concern that the public obtain value, in terms of free flowing traffic, in return for the tolls paid. In the early days of operation, the Land Transport Authority attempted to set toll rates to









achieve the targeted speeds "on average" but quickly found out that this meant that only about half of the toll-payers received the targeted service levels, and therefore felt that they had not received value for tolls paid. This led the Authority to institute that 85th percentile standard. All net funds collected via ERP are returned to the general fund and redistributed to road users in the form of vehicle ownership tax rebates, which further emphasizes that the purpose of road pricing is not to generate revenue but to improve service levels during peak hours. Singapore's ERP has the most dynamic and flexible pricing structure of the sites visited.

- The German truck toll rates for use of the freeway system (i.e., Autobahns) are low enough that there is little or no diversion of truck traffic to toll-free alternatives. While there was some diversion immediately after implementation in 2005, truckers quickly realized that time and operating cost savings on the Autobahn system more than compensated for new toll charges for use of the Autobahns. The Germans set the truck toll rates to average 16.3 euro cents per kilometer (37.8 US cents per mile) to capture the impact of heavy goods vehicles on the transportation system. The fairness of the toll rates as charges for services is reinforced by the method by which toll rates are calculated. To determine the average toll rate, the estimated infrastructure costs imposed by HGVs (estimated in 2010 to be 5.2 billion) was divided by the total number of HGV kilometers on the highway system (29.8 billion kilometers). This is calculated to 17.4 euro cents per kilometer, so the 16.3 cents actual average toll rate is perceived to be fair. It captures more than 90 percent of the estimated HGV impacts on the highway network. In addition, the 560 million (US $815 million) annual harmonization fund for truckers is dedicated for use by the trucking community for safety training and equipment purchases, which provides a direct nexus between the funding source and the use of funds.

5. Public outreach and communications was a key component of the program at every stage: prior to making the implementation decision, during the program design process, as well as during the operational phase.

Both London and Stockholm had years of public debate about congestion charging before the political decision to implement was made. London's program benefited from promotion by business groups concerned about congestion, while the Stockholm program was spearheaded by environmental groups. Both programs were designed to address public concerns, and include a number of exemptions and discounts to mitigate negative impacts on particular segments of the public.

After several attempts to implement a distance charge, the Dutch realized that proactive stakeholder outreach during the planning and concept development stage is essential. Over the past two years, staff and leadership at the Dutch Ministry of Transport have invested heavily in public outreach and education. By engaging in a thorough and thoughtful planning and public involvement process, the Dutch developed clear, salient, and timely messages about the purpose and benefits of pricing. A key message is "drive less, pay less."

In Singapore, key messages continue to be conveyed to the public to ensure continued support. These messages include:

- "keep roads free-flowing,"
- "people-centered transportation," and
- "public transit is a viable choice."

As system expansion continues, before a new gantry is installed, there is extensive outreach in the neighborhoods that would be impacted to address concerns. For example, the timings for operation of expressway pricing were modified to respond to public comments.

The Czech and German programs achieved support from local truckers by emphasizing the effect on "leveling the playing field" with foreign haulers and the fairness of "user pays."

6. Open-source system designs offer long-term advantages in leveraging market competition to manage costs of implementation and operations, ensure system flexibility and scalability, and establish a foundation for system interoperability.

The Netherlands plan will establish standards and requirements that will allow multiple vendor solutions to create a competitive environment.

- The Dutch procurement will encourage market engagement in all aspects of the system, driving down costs for system implementation, equipment, and in-vehicle installations.
- Through open-standards and private sector engagement, the Netherlands will encourage private value-added services for on-board devices that help defray operating costs as well as drive consumer adoption and public acceptance of road pricing.
- The Dutch goal is for system operating costs to not exceed 5 percent of gross revenues.

Singapore's second generation smart card for the in-vehicle unit financial purse is designed to be interoperable with the transit fare media and parking payment systems, as well as being accepted for retail purchases and linked to bank accounts.

7. Interoperability among states and countries is recognized as a critical issue that needs to be addressed at high levels.

The EU has adopted Directive 2004/52/EC, which outlines requirements for member countries to adopt interoperable standards (i.e., European Electronic Toll Service [EETS]) for electronic tolling, allowing one vehicle, to pay road user fees anywhere in the EU via one contract and with one on-board unit.

- Technical, administrative and legal hurdles have made advancing interoperability time consuming and challenging. The European Parliament and EU Council approved the directive in 2004 and five years later a decision on the EETS definition was approved in October 2009.
- Existing systems with large sunk costs in proprietary applications and equipment heighten the challenge of transition.

Interoperability addresses technical, business, administrative, financial and legal issues, requiring thorough treatment and multi-disciplinary expertise.

Intergovernmental coordination in sharing national vehicle registry information between agencies is key to today's operations and enforcement, and for interoperable systems of the future.

- All sites visited have procedures in place between agencies within their own country to share vehicle registry data for easy applications of license plate imaging for invoicing and violation processing.
- The use of Automatic Number Plate Recognition (ANPR) technologies for enforcement was ubiquitous, being used in Singapore, London, Stockholm, Germany, and the Czech Republic. More agreements to share information across borders are still needed.
- Clearly defined and well-understood policy goals in Stockholm guided decisions large and small, such as revenue usage, rate schedule, and appropriate technology solutions.
- The Netherlands is using a "tax consolidation" approach to develop aggressive and comprehensive replacement for fragmented transportation taxes into a single distance based tax.

8. Equity and privacy concerns are addressed by host countries through exemptions, revenue use, technology, and business rules.

- Exemptions are used in London and Stockholm to help address issues of equity. In addition, their emphasis on using toll revenues to fund transit sends a strong and clear message about equity and the project purpose.
- Privacy was elegantly handled by Singapore's use of a "smart cash card" that does not contain user data. The primary data on the smart card is the account balance, which can be used to pay for parking or other amenities.

9. The urban area pricing projects integrated public transit investments and land use planning in order to manage congestion.

- Stockholm and London made robust investments in public transit and alternative modes leading up to and following the introduction of road pricing. In Singapore, officials have adopted and committed funding to realize a master transportation plan which integrates road pricing, transit, roadway expansion and land use.
- The coordination of road pricing policy with public transportation investments is best coordinated by a single entity. In London, Transport for London (TfL) is responsible for implementing the Mayor's Transport Strategy for London and for managing transportation services for all modes of transportation and throughout the city. In Singapore, the Land Transport Authority plans the long-term transportation needs of Singapore for those who drive and those who take public transportation. The Swedish Government is in the process of consolidating its transportation agencies to bring all modes under one umbrella.

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