



ROAD PRICING IN LONDON, STOCKHOLM AND SINGAPORE

A WAY FORWARD FOR NEW YORK CITY

TRI-STATE TRANSPORTATION CAMPAIGN



INTRODUCTION



Image: Matthias Rhomberg/Flickr, 2007

Congestion Relief Pricing: A Key Part of a Comprehensive Urban Transportation Strategy

The debate over congestion pricing in New York City has been decades in the making. Mayor Michael Bloomberg introduced an implementation plan for congestion pricing on Earth Day in 2007, but the concept has been well known for many years, with Tri-State Transportation Campaign (TSTC) analyzing and advocating for congestion pricing as early as 1993 in its Citizens Action Plan. However, despite gaining wide support from leading transportation and environmental groups, Mayor Bloomberg's plan failed in the legislature in 2008. Since then, the MoveNY coalition has developed and fought for a proposal to establish a congestion pricing system, including tolling travel into the Manhattan central business

district (CBD) below 60th Street, tolls on the four East River bridges (the Manhattan, Brooklyn, Williamsburg, and Queensboro bridges), and for-hire-vehicle surcharges. Now with endemic gridlock both at street level and below ground, congestion pricing is back on the political agenda—this time with support from Governor Cuomo, who earlier this year called congestion pricing “an idea whose time has come” and in his 2018 State of the State (SOTs) address referenced “an exclusive zone in Manhattan where additional charges could be paid.” Now, as we await the work of the “Fix NYC” advisory panel, whose mission is to find solutions to public transit funding shortfalls and crippling congestion in Manhattan's CBD, we can look to other cities to assess the success of their congestion pricing schemes.

Currently, some drivers—those traveling over Port Authority and MTA bridges and tunnels—already pay tolls to enter the CBD. Last year, MTA bridges

and tunnels were converted to open road tolling, which would help facilitate congestion pricing. In the SOTs, Cuomo encouraged the Port Authority to convert its bridges and tunnels to open road tolling as well. Nevertheless, nearly three-quarters of drivers entering the Manhattan core—those crossing over the four City-owned bridges on the East River and those crossing 60th Street southbound—enjoy a free ride. Meanwhile, transit users, whether via subway, bus, commuter rail, ferry, or CitiBike, pay fares and fees for the cost of their travel. In total, 96% of people entering the CBD on a daily basis pay some fare or fee (excepting those arriving on foot or personal bicycle); a mere 4%, those using cars or trucks, do not.

The Manhattan CBD south of 60th Street is the most transit-rich area of the city, and most commuters into the CBD do not do so via a motor vehicle. However, those who drive or take for-hire vehicles into this area increase congestion and impose severe delays on other street-level travel. In particular, the failure to toll the East River bridges and auto travel across 60th Street encourages bridge shopping and the resulting excess vehicle miles traveled. This incentivizes congestion and greenhouse gas emissions, especially in gridlocked zones near the entrances and exits to the bridges.

The recent rise in congestion in New York City has multiple causes: repeated subway failures, unregulated app-based for-hire vehicles, population growth, increased freight movement, construction activity, and increased tourism and pedestrian volumes. All of these have put growing demands on the transportation system's capacity, and it is past time to implement solutions. To do so, we should look globally. A number of international cities have successfully implemented congestion pricing as a part of a larger transportation strategy. This report aims to shed

light on those cities' congestion pricing systems, and outline lessons from which state and local decision-makers can learn.

We examine congestion pricing programs in three cities around the world: London, Stockholm, and Singapore. In each, several patterns have emerged that hold lessons for New York City as state and local governments consider congestion pricing. In these cities, pricing has rationalized the cost of entering the tolled area and fairly charged drivers for some of the negative externalities of their decision to travel by car into the zone. This has encouraged more efficient travel decisions, sped up traffic flow, improved journey time reliability, and—of special importance for New York—raised annual revenue streams of over one hundred million dollars. Each city also employed auxiliary improvements complementary to congestion pricing that enabled alternate transit modes to handle the overflow from the roads.

Each city's scheme was established and has evolved based on localized problems, goals, social norms and innovative solutions, and New York would be no different. However, in all three cases, city officials knew road pricing would enable them to avoid the traditional approach of highway widening to increase road capacity, which is significantly more costly and has been shown to be ineffective at reducing congestion.

The matrix on the following pages summarizes each city's population, congestion pricing scheme, operation, payment system, as well as costs and revenues. Case studies of London, Stockholm, and Singapore follow the matrix. This report concludes with a discussion of key lessons for a future New York City congestion relief pricing scheme. While congestion pricing by itself won't solve every transportation challenge our city faces, it is an integral part of a holistic strategy to make urban transportation more efficient, sustainable and equitable.

ROAD PRICING MATRIX

	Metropolitan Population			Pricing Scheme			Payments, Costs and Revenues				
	Year Scheme Launched	In 2016	% Change Since Launch	Description	Primary Goals	Ancillary Transportation & Policy Improvements	Payment	Hours	Initial Investment	Annual Operating Cost	Annual Net Revenue
London Transport for London	7.3 million in 2003	8.7 million	19%	The cordon pricing scheme uses automatic number plate recognition in an 8 mi ² area (21 km ² zone). Vehicles are registered automatically by cameras that photograph the number plates. The system consists of overhead gantries, cameras at all entrance points, pavement markings, and street signage.	<ul style="list-style-type: none"> Reduce congestion Improve air quality and public health Improve journey time reliability for car users Create a long-term funding source for public transit improvements 	<ul style="list-style-type: none"> 300 new buses Updated bus routes Improved frequency of buses 8,500 park-and-ride spaces Bike/pedestrian infrastructure 	Flat daily fee of £11.50 (US \$15.21) Payments can be made by telephone, text message, online, by post, or via registering for auto pay.	7:00am- 6:00pm Monday-Friday There is no charge on weekends, Bank Holidays, or the days between Christmas Day and New Year's Day, nor during nights (6:00pm to 6:59am).	£161.7 million (USD \$214 million)	£130 million (USD \$172 million)	£137 million/year (USD \$182 million)
Stockholm Swedish Transport Administration	1.9 million in 2007	2.1 million	10%	The cordon congestion tax scheme uses automatic number plate recognition, in a 13 mi ² area (35 km ² zone). Vehicles are registered automatically by cameras that photograph the number plates. The system consists of overhead gantries, cameras at all entrance points, pavement markings, and street signage. The scheme was launched in 2007 after a successful trial in 2006.	<ul style="list-style-type: none"> Reduce congestion Improve air quality and public health Improve journey time reliability for car users 	<ul style="list-style-type: none"> 197 new buses 16 new bus routes 2,800 new regional park-and-ride spaces Bike/pedestrian infrastructure Taxis and for-hire Vehicles, such as Uber, also pay the tax 	Variable pricing based on time of day. Highest peak period cost per passage is 35 krona (US \$4.14). The owner of the car is sent a monthly invoice for the total charge incurred. Payments can be made by mail, online or by direct debit from a bank account.	6:30am- 6:30pm Monday-Friday There is no charge on weekends, public holidays or the day before public holidays, nor during nights (6:30pm – 06:29am), nor during the month of July.	2 billion krona (USD \$236.7 million)	100 million krona (USD \$11.8 million)	1.3 billion krona/year (USD \$155 million)
Singapore Land Transport Authority	3.9 million in 1998	5.6 million	44%	The electronic road pricing (ERP) scheme is fully automatic on specific routes, times of day, and directions, with variable pricing designed to respond to congestion in real-time. Vehicles are required to have an in-vehicle unit on the dashboard and a smart card with fare stored on it. Overhead gantries detect the type of vehicle, the congestion of the route at specific times, and deduct the variable fee from the smart card. The ERP scheme was launched in 1998, replacing a cordon pricing scheme that was first implemented in 1975.	<ul style="list-style-type: none"> Reduce congestion Improve journey time reliability for car users 	<ul style="list-style-type: none"> Parking fees inside the restriction zone were doubled Buses and bus frequency increased HOV+4 lanes were established 15,000 park-and-ride spaces were established outside of the restriction zone 	\$0 -\$4.00 (US \$0 - \$3.00) are collected on a per-pass basis at over 50 points within and surrounding the central business district. Rates vary for different roads and time periods depending on local traffic conditions. The in-vehicle unit costs \$150.00 (US \$111.00).	7:00am-8:00pm Monday-Saturday There is no charge on Sundays, public holidays, or after 1pm the day before a public holiday.	S \$200 million (USD \$110 million)	S \$25 million (USD \$18.5 million)	S \$150 million/year (USD \$100 million)

LONDON

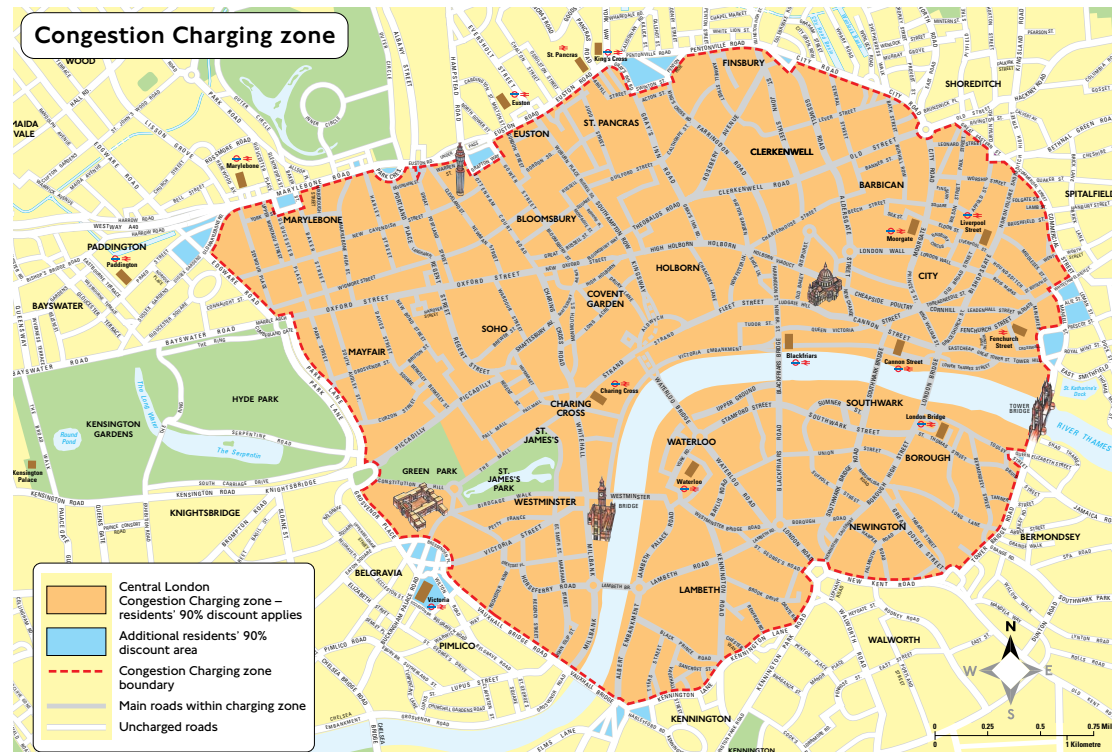


Image: Transport for London, 2011

The capital city of England, and a major global city across economic sectors, entertainment and tourism, London is comparable to New York City in population size and cultural diversity, with a population of 8.8 million as of 2016. Like New York, London has a robust transportation network, including the Underground and Overground rail, commuter rail, an extensive bus network, ferries along the Thames River, a large bicycle and pedestrian network, and a sprawling road network. However, London's streets are characterized by an organic, disconnected layout that twists and turns in various directions, in contrast to New York City's famous planned grid.

Partly as a result of the complexity of its streets, London has been suffering from its own success for decades, with traffic worsening over the decades prior to congestion pricing's implementation. In 1964, a feasibility study of area-wide congestion pricing, known as the Smeed Report, concluded that congestion

pricing in central London would improve traffic and the environment while raising revenues.¹ A more detailed study followed with the same conclusion in 1973, but at that time politics favored a greater investment in public transit and rejected the concept of congestion pricing.² In 1995, yet another study concluded that city's economy would benefit from congestion pricing.³ In addition to increasing gridlock, London endured its own cycle of subway disinvestment in the 1980s and 1990s which contributed to public and political acceptance of congestion charging.

In 1999, national legislation enabled the charges to be introduced, and in 2000, the newly elected Mayor Ken Livingstone made implementing congestion pricing one of his primary objectives.

1 Smeed, R.J. Road Pricing: the economic and technical possibilities. Her Majesty's Stationery Office. 1964.
2 Federal Highway Administration. Lessons Learned From International Experience in Congestion Pricing. Publication #FHWA-HOP-08-047. 2008. Accessed 11 November 2017. <https://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm>
3 [Ibid.](#)

The goals of London's congestion pricing scheme include reducing gridlock, improving bus service, improving journey time reliability for car trips, and making the distribution of goods and services more efficient.⁴ According to Transport for London, in 2002 average traffic speeds in the inner city were slower than 12 km per hour (7.5 mph), and it was estimated that the economic impact was between £2 million and £4 million (USD \$3 million- \$6 million) every week in terms of time lost due to congestion.⁵

London's Congestion Pricing Cordon Scheme

Mayor Livingstone led the initiative and was successful at gaining public support for the cordon pricing scheme that was launched in February 2003. Two primary reasons for London's achievement of public acceptability include the fact that 90% of London residents believed there was too much traffic and were concerned about travel times and air pollution, and, importantly, the decision to implement congestion pricing was up to the Mayor, who had a strong commitment to the campaign and no sustained opposition.⁶ Formal and informal public consultations were conducted throughout the development of the scheme, with feedback reports subsequently made public. Media campaigns explained the operation and implications of the scheme. When the system was launched, the population in London was at 7.3 million residents, and by 2016 the population has grown 19% to 8.7 million residents.

The congestion pricing cordon zone includes the area inside London's Inner Ring Road, which is a 19 kilometers (12 mi) route comprising main roads encircling the inner city. The cordon

4 Transport for London. Central London Congestion Pricing Impacts Monitoring. Sixth Annual Report. 2008. <https://tfl.gov.uk/modes/driving/congestion-charge/discounts-and-exemptions?intcmp=2133>
5 Transport for London website, "Congestion Charging" (2007). Available from www.cclondon.com/whatis.shtml (accessed 16 November 2011).
6 Federal Highway Administration. Lessons Learned From International Experience in Congestion Pricing. Publication #FHWA-HOP-08-047. 2008. Accessed 11 November 2017. <https://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm>

pricing scheme is a fully automatic fee payment system, through automatic number plate recognition, in an area of 21 square kilometers (8 square miles). Vehicles are registered automatically by cameras that photograph the number plates. The system consists of overhead gan-

tries, cameras at all entrance points, pavement markings, and street signage. Transport for London (TfL) operates the system, which is an agency that holds similar authority to our MTA and New York City Department of Transportation.

Payments can be made by telephone, text message, online, and by post, or drivers can register for auto-pay. If payment is not received by Transport for London by midnight on the day after travel, drivers will be fined £130. There is a flat daily fee of £11.50 (USD \$15.21) from 7:00am- 6:00pm from Monday to Friday. There is no charge on weekends, bank holidays, the days between Christmas Day and New Year's Day, nor during nights (6:00pm to 6:59am).

Impacts of Congestion Pricing

The goals of London's congestion pricing scheme include reducing congestion, improving bus service, improving journey time reliability for car trips, and to make the distribution of goods and services more efficient.⁷ An important part of London's comprehensive transportation strategy is that by law, all revenue raised must be reinvested into London's transport infrastructure.

Congestion pricing was planned as part of a more comprehensive transportation strategy, including public transit improvements and increased enforcement of parking and traffic regulations.⁸ On the launch date of the original

7 Transport for London. Central London Congestion Pricing Impacts Monitoring. Second Annual Report. 2004. <http://content.tfl.gov.uk/impacts-monitoring-report-2.pdf>
8 "Report to the Mayor of London" (PDF). The Greater London (Central Zone): Congestion Charging Order 2001. Transport for London. February 2002. Archived from the original (PDF) on 28 February 2008. Retrieved 24 January 2008.

zone, 300 new buses were introduced. New bus routes were introduced and existing routes increased frequency or were extended through the zone. Over 8,500 park-and-ride spaces have been established. In anticipation of increased bicycle and pedestrian travel, additional infrastructure was put in place for improved safety.

The initial investment in infrastructure and operations for congestion pricing was £161.7 million (USD \$214 million). The annual operating costs are roughly £130 million (USD \$172 million), and the annual net revenue is roughly £137 million (USD \$182.1 million). Since the launch of the program, the rate has increased over time from £5 in 2003 to £8 in 2005, £10 in 2011 and £11.50 in 2014. The annual operating costs in London soak up almost half of the annual gross revenue, which is not the case in Stockholm or Singapore, which use 7% and 16% of their gross revenue respectively on operating costs. According to the Move NY Fair Plan, New York City's annual operating costs would be roughly \$760 million, with total net revenue of \$1.5 billion; thus, expected operating costs would be 34%.⁹

Since implementation, London has reduced congestion, improved air quality and public health, and created a long-term funding source for future transportation improvements. During the first ten years since the introduction of the scheme, gross revenue reached about £2.6 billion (USD \$3.9 billion) up to the end of December 2013. From 2003 to 2013, about 46% or £1.2 billion (USD \$1.8 billion) of net revenue has been invested in public transport, road and bridge improvement, and walking and cycling schemes. Of this, a total of £960 million (USD \$ 1.44 billion) was invested on improvements to the bus network. To reiterate, all revenues must be reinvested into London's transportation infrastructure by law.

⁹ Move NY Campaign. The Move NY Fair Plan. 2015. Pages 20-22. <http://iheartmove.org/wp-content/uploads/2015/02/Move-NY-Fair-Plan-150217v1.pdf>



Image: Mariordo59/Flickr, 2013

Compared to pre-congestion pricing congestion levels, Transport for London reported a 30% reduction in traffic congestion, an increase in average speed by 30%, and significant increases in travel time reliability in 2004.¹⁰ Traffic entering the zone during charging hours has declined by 18%, and traffic circulating within the zone has declined by 15%.¹¹ Bus service increased by 23%, and reliability and journey time improved as well. As a result, bus ridership has increased by 38%.¹² The shift in mode from car to bus was significantly more than the shift to cars outside the inner city onto the ring road. Of the thousands of car trips no longer made to the cordon zone, 50% shifted to public transit, roughly 25% were diverted outside the cordon area, and the rest can be attributed to carpooling, walking or biking, or traveling outside the hours of congestion pricing operation.¹³ Further, these mobility benefits have been largely maintained over time, despite population growth. By 2011, bus ridership had reached a 50-year high, and bike trips had increased 79% since 2001.¹⁴

¹⁰ Transport for London. Central London Congestion Pricing Impacts Monitoring. Second Annual Report. 2004. <http://content.tfl.gov.uk/impacts-monitoring-report-2.pdf>

¹¹ Ibid.

¹² Ibid.

¹³ Ibid.

¹⁴ Federal Highway Administration. Lessons Learned From International Experience in Congestion Pricing. Publication #FHWA-HOP-08-047. 2008. Accessed 11 November 2017. <https://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm>

Traffic volume reductions have been sustained over time as a result of congestion pricing, with 9.9% less volume in 2015 compared with 2000, despite nearly 20% population growth in London. However, traffic congestion has begun to increase in recent years. Transport for London cites its focus on managing road capacity for growing transit ridership as well as growing pedestrian and bicycle levels for the moderate increases in congestion: according to TfL's most recent Travel in London report, the diverging trends of congestion increasing despite traffic volumes falling reflects the removal of road capacity for general vehicle traffic as a result of new policies of safety improvement; pedestrian, bus and cycle priority; and traffic calming measures.¹⁵

London has also experienced environmental and public health benefits as a result of less traffic in the inner city. From 2002-2003, carbon dioxide (CO₂) emissions declined by 16%, nitrogen oxide (NO_x) emissions declined by 13.5%, and particulate matter (PM10) declined by 15.5%.¹⁶ As a result of these reduced vehicle emissions, there is a reduced risk of serious illnesses such as asthma, bronchitis, and heart attacks. According to a recent study, 1,888 extra years of life have been saved among London's more than eight million residents who are now breathing cleaner air.¹⁷ Protecting the environment and improving public health continues to be a major priority for Transport for London. The congestion pricing scheme has included discounts for low emissions and electric vehicles, which has evolved into a recent toxicity charge for older cars and those with higher emissions.

¹⁵ Transport for London. Travel in London, Report 9. 2016. Pages 155-167. <http://content.tfl.gov.uk/travel-in-london-report-9.pdf>

¹⁶ Transport for London. Central London Congestion Pricing Impacts Monitoring. Fourth Annual Report. 2006. <http://content.tfl.gov.uk/fourthannualreportfinal.pdf>

¹⁷ Tonne et al. Air pollution and mortality benefits of the London Congestion Charge: spatial and socioeconomic inequalities. Occupational and Environmental Medicine. 2008. <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.1032.2321&rep=rep1&type=pdf>

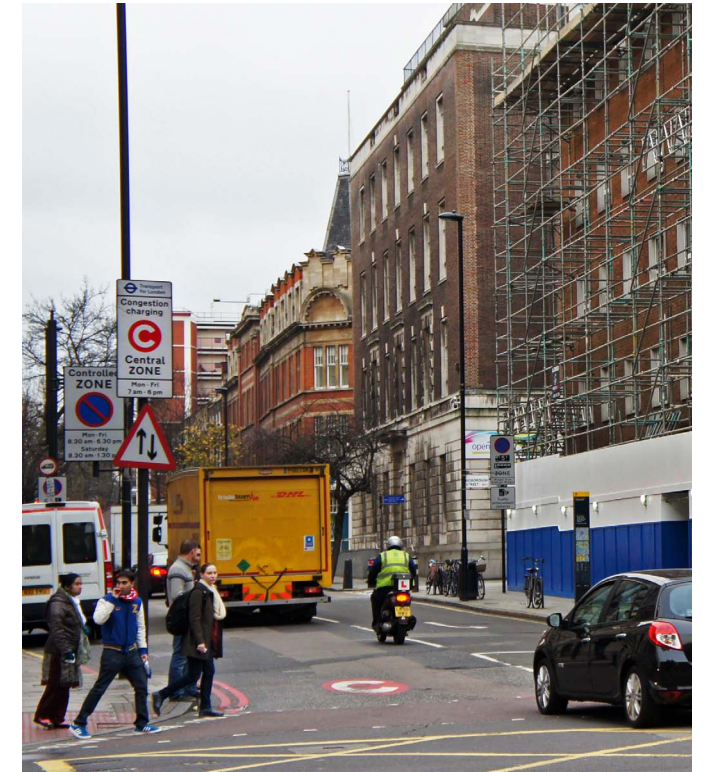


Image: Mariordo59/Flickr, 2013

STOCKHOLM

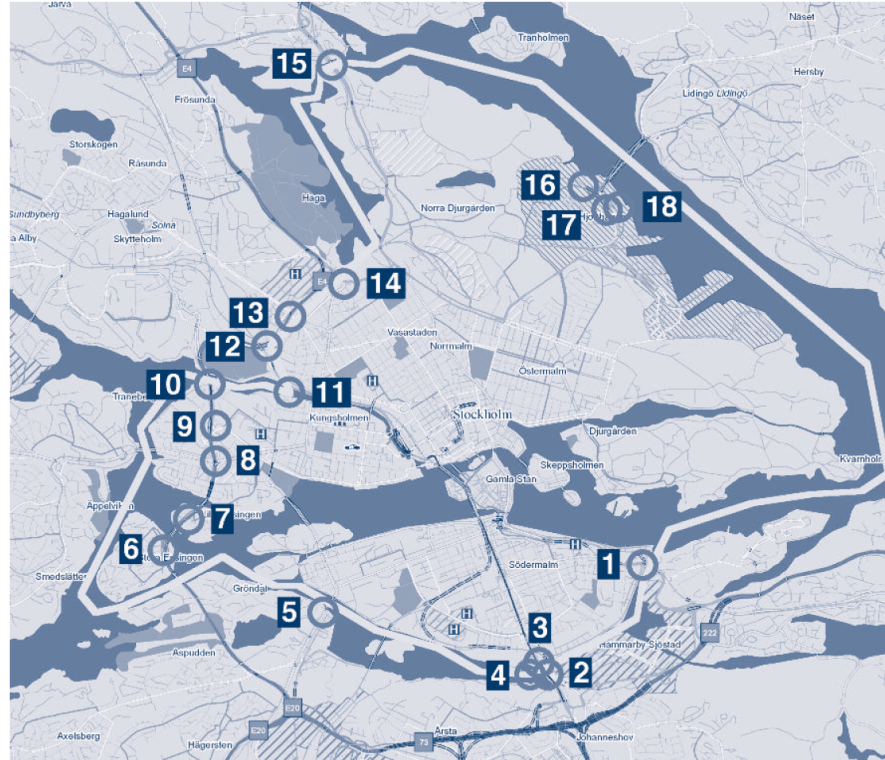


Image: Access Magazine, 2011

The capital city of Sweden is made up of fourteen islands and fifty-seven bridges on the country's largest archipelago. It is also Sweden's most populous city and its cultural, economic, and political center.

The County of Stockholm's population was 1.8 million in 2006. By 2016, the population had grown to 2.1 million, a 10% change in population over ten years. Around 66% of the city's inhabitants live within the toll cordon in the inner city. The zone has close to 23,000 workplaces employing approximately 318,000 persons, of which more than two-thirds are commuting from outside the zone.¹

Stockholm's Congestion Pricing Pilot

In 2003, Stockholm's City Council adopted a proposal to conduct congestion charge trials due

¹ Eliasson, Jonas. The Stockholm Congestion Charges: An Overview. Centre for Transport Studies Stockholm. 2014. <http://www.transportportal.se/swopec/cts2014-7.pdf>

to growing traffic congestion that was choking the bridges and roadways into the inner city.² In 2004, the Swedish Parliament passed a congestion pricing pilot program, despite the pilot being a politically divisive issue in Stockholm with low public support.³ Newspapers published doomsday headlines about the concept and predicted its failure before a congestion pricing trial was established for Stockholm in 2006.⁴ By this time, the congestion pricing cordon system had been running successfully in London for three years.

The trials consisted of three parts, including expanding public transport, constructing additional park-and-ride facilities, and the

² Dr Muriel Beser Hugosson and Dr Jonas Eliasson. The Stockholm Congestion Charging System –An Overview of the Effects After Six Months. Association for European Transport and Contributors. 2006. http://web.mit.edu/11.951/oldstuff/albacete/Other_Documents/Europe%20Transport%20Conference/traffic_engineering_an/the_stockholm_cong1720.pdf

³ Ibid.

⁴ Eliasson, Jonas. The Stockholm Congestion Charges: An Overview. Centre for Transport Studies Stockholm. 2014. <http://www.transportportal.se/swopec/cts2014-7.pdf>

congestion charge. The trial began in late 2005 with extended public transit, including 197 new

buses and 16 new bus routes.⁵ Where possible, existing bus, underground, and commuter train lines were augmented with additional departures. In addition, 2,800 new park-and-ride facilities were also built in the region to provide transportation options for those who chose to drive to the edge of the cordon and take transit from there.⁶ In addition to these transportation improvements, Sweden also has a history of investing in bicycle and pedestrian safety improvements, with the world's first Vision Zero policy adopted by the Swedish Parliament in 1997, which set a goal of achieving zero annual pedestrian and bicycle and fatalities by 2020. The congestion charge trial began in January 2006, and required vehicle owners to pay 20 krona per passage (USD \$3.00) into or out of the Stockholm inner city on weekdays between 6:30 a.m.-6:29 p.m.

The initial investment in the system, including the trial and first year operations, was 2 billion krona (USD \$236 million).⁷ The management of the congestion tax pilot program was shared between the Transport Administration, which managed the design of the system, and the Transportation Board, which handled the system payments. Those two agencies continue to administer Stockholm's current congestion pricing program. It is a fully automatic fee payment system through automatic number plate recognition by cameras that photograph the number plates. The owner of the car is then sent a monthly invoice for the total tax incurred during a month, which they can then pay by mail, electronically, or via direct debit from a bank account. The cordon area is 35 square kilometers (13 square miles) and consists of

⁵ Dr Muriel Beser Hugosson and Dr Jonas Eliasson. The Stockholm Congestion Charging System –An Overview of the Effects After Six Months. Association for European Transport and Contributors. 2006. http://web.mit.edu/11.951/oldstuff/albacete/Other_Documents/Europe%20Transport%20Conference/traffic_engineering_an/the_stockholm_cong1720.pdf

⁶ Ibid.

⁷ Eliasson, Jonas. Personal Interview. 5 December 2017.

overhead gantries, cameras at all entrance points, pavement markings, and street signage.

For six months in January 2006, the congestion pricing trial operated with automatic tolling at eighteen points located at the main bottlenecks leading into the inner city, forming a cordon. The concept of congestion pricing had very low public support before the trial, with polls showing roughly 80% resident opposition.⁸ However, traffic across the cordon dropped immediately after the trial launched, which resulted in reduced travel delay and congestion throughout the city. After a few weeks, the decrease in traffic volumes across the cordon during the trial period stabilized around 22% compared to 2005 levels, resulting in congestion reductions around 30-50%.⁹ The reduced congestion also meant that travel time reliability increased.¹⁰ Drivers switching from car to public transport meant that the number of passengers in the transit system increased by around 4-5%.¹¹ Public attitudes changed toward congestion pricing and media publications celebrated its success.

After the trial significantly reduced traffic, Stockholm residents voted to make the system permanent in a referendum that determined that the majority of Stockholm voters were in favor of keeping the charges.¹² The media interest for the charges faded after having been in the headlines almost daily for four years. Rather than discussing the existence of the charges, Sweden's political parties and other

⁸ Eliasson, Jonas. Every Fourth Car Disappeared: Stockholm's Congestion Pricing Success Story. Transit Center. 27 November 2017.

⁹ Eliasson, J., Hultkrantz, L., Nerhagen, L., & Rosqvist, L. S. (2009). The Stockholm congestion-charging trial 2006: Overview of effects. Transportation Research Part A: Policy and Practice, 43(3), 240-250.

¹⁰ Eliasson, Jonas. The Stockholm Congestion Charges: An Overview. Centre for Transport Studies Stockholm. 2014. <http://www.transportportal.se/swopec/cts2014-7.pdf>

¹¹ Dr Muriel Beser Hugosson and Dr Jonas Eliasson. The Stockholm Congestion Charging System –An Overview of the Effects After Six Months. Association for European Transport and Contributors. 2006. http://web.mit.edu/11.951/oldstuff/albacete/Other_Documents/Europe%20Transport%20Conference/traffic_engineering_an/the_stockholm_cong1720.pdf

¹² Eliasson, Jonas. The Stockholm Congestion Charges: An Overview. Centre for Transport Studies Stockholm. 2014. <http://www.transportportal.se/swopec/cts2014-7.pdf>

stakeholders gradually moved on to discussing how the charges could be redesigned and how the revenues should be used. The permanent congestion pricing system officially launched in January 2007, after the Parliament decided that the fees would be levied as a tax. This new infrastructure tax would help to finance the maintenance of the bridges as well as public transit improvements.

Expansion of Congestion Pricing

As a result of permanently establishing the congestion tax, traffic reduction has remained remarkably stable over time within the cordon area.¹³ The Essingeleden highway, which carries regional through-traffic in Stockholm, was not originally included in the cordon area. In response to increased traffic congestion, the congestion tax system was expanded to include the Essingeleden highway in 2016. At the same time, the pricing scheme was updated to a graduated pricing system by time of day to further mitigate congestion during the main morning and evening peak periods. Under the new graduated pricing system, the highest peak period cost per passage cost is 35 krona (USD \$4.14), from 7:30 a.m. - 8:29 a.m. and from 4:00 p.m. - 5:30 p.m. Outside of those periods between 6:30 a.m. and 6:29 p.m., the charge is based on time periods, with tolls between 11-25 krona (USD \$1.30-2.95). There is no charge on weekends, public holidays or the day before public holidays, nor during nights, nor during the month of July.

The Impacts of Congestion Pricing in Stockholm

Stockholm's congestion pricing scheme was established to reduce traffic congestion, improve journey time reliability for drivers, and improve air quality and public health. Voters in Stockholm are concerned with environmental

¹³ Börjesson, M., Eliasson, J., Hugosson, M. B., & Brundell Freij, K. (2012). The Stockholm congestion charges—5 years on. Effects, acceptability and lessons learnt. *Transport Policy*, 20, 1–12.



Image: Susanne Nilsson/Flickr, 2017

protection, so marketing the tax in part as an environmental charge to reduce vehicle-associated carbon emissions was important to gaining public acceptability. In terms of cost-benefit of the system, the upfront cost was recouped after four years.¹⁴ It was also estimated that more conventional measures to reduce traffic (e.g., ring roads to divert traffic away from the center) would require far greater investments to achieve comparable traffic reduction goals.¹⁵

The annual operating costs have decreased over ten years of operation from around 250 million krona/year (USD \$29.7 million) to 100 million krona/year (USD \$11.8 million), and the net revenues have increased since the variable fare updates in 2016.¹⁶ Before 2016, the highest peak charge per passage was 20 krona, while after 2016 the highest peak charge is now 35 krona per passage. The net revenue from the system used to be around 500 million krona before the charge was increased; after January 2016, the net revenue is now around 1.3 billion krona/year (USD \$155 million/year).¹⁷

¹⁴ Eliasson, Jonas. The Stockholm Congestion Charges: An Overview. Centre for Transport Studies Stockholm. 2014. <http://www.transportportal.se/swopec/cts2014-7.pdf>

¹⁵ Federal Highway Administration. Lessons Learned From International Experience in Congestion Pricing. Publication #FHWA-HOP-08-047. 2008. Accessed 11 November 2017. <https://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm>

¹⁶ Eliasson, Jonas. Personal Interview. 5 December 2017.

¹⁷ Ibid.

Overall, the congestion pricing system in Stockholm provides several mobility benefits. Traffic to and from the inner city cordon was reduced by 20%, and traffic delays decreased by 30-50%. Vehicle miles traveled decreased by 14% in the cordon and decreased by 1% outside the cordon. After the variable pricing system was introduced in 2016, traffic congestion dropped an additional 5% during that period.

The reduction in traffic in the inner city meant the Parliament's environmental goals were met, with post-pricing reductions of 14% in carbon dioxide (CO₂), 7% in nitrogen oxide (NO_x) and 9% in particulate matter (PM10). Outside of the cordon, greenhouse gases were reduced by roughly 2.5%.¹⁸ The use of air pollution modelling shows estimates that there will be 20-25 fewer premature deaths per year in Stockholm's inner city and a total of 25-30 fewer premature deaths annually in the Stockholm metropolitan area.¹⁹

¹⁸ Eliasson, Jonas. The Stockholm Congestion Charges: An Overview. Centre for Transport Studies Stockholm. 2014. Pages 12-13. <http://www.transportportal.se/swopec/cts2014-7.pdf>

¹⁹ Forsberg, B., Burman, L., & Johansson, C. Stockholmsförsköket har folkhälsopotential. 2006. *Läkartidningen*, 50, 4043–5.



Image: Tommie Hansen/Flickr, 2013

SINGAPORE

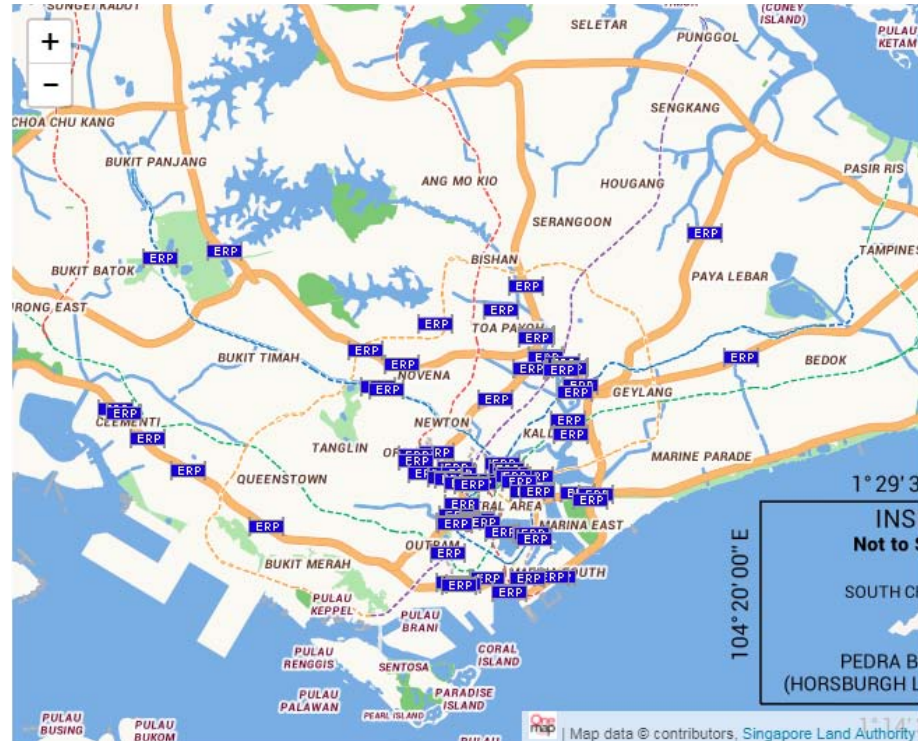


Image: Land Transport Authority, 2017

The island nation-state of Singapore has a vibrant economy, high income levels and high car ownership. The island has two bridges connecting it to Malaysia. There is a distinctly pragmatic political culture, and the power structure is centralized. This may have made it easier for Singapore to be the first-ever country to successfully establish road pricing. In 1974, before it was launched, the government carried out a year-long assessment and education program, and the system was modified based on public feedback. The government has continued to expand and update the program since its beginning to enhance public acceptability.¹

Singapore pioneered road pricing with the first cordon scheme established in 1975, the Area License Scheme (ALS), which was launched as one part of a comprehensive congestion mitigation initiative.² From the start, their

¹ Federal Highway Administration. Lessons Learned From International Experience in Congestion Pricing. Publication #FHWA-HOP-08-047. 2008. Accessed 11 November 2017. <https://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm>

² Prof. Gopinath Menon Dr. Sarath Guttikunda. Electronic Road

approach has been scientific and systematic, and the system has evolved to be variable and responsive to real-time traffic congestion. Singapore's congestion pricing schemes have been entirely focused on reducing traffic and improving trip reliability.

With the ALS, drivers entering the cordon were required to purchase a license in advance and display it on the windshield, which cost \$3 per day or \$60 per month (USD \$1 or \$20).³ In 1975, Singapore's population was 2.2 million and the number of vehicles entering the inner city was 100,000 vehicles per day, with an annual growth rate of 6%. After the ALS, the rate slowed to 4% annually.⁴ The initiative also included doubling the parking fees in the downtown area and increased parking and

Pricing: Experience & Lessons from Singapore. 2010. SIM-air Working Paper Series: 33-2010. <http://www.environmentportal.in/files/ERP-Singapore-Lessons.pdf>

³ Phang, Sock-Yong and Rex S. Toh. Road Congestion Pricing in Singapore: 1975 to 2003. *Transportation Journal*, vol. 43, no. 2, 2004, pp. 16-25. JSTOR, JSTOR, www.jstor.org/stable/20713563.

⁴ Cervero, Robert. *The Transit Metropolis*. 1998. Island Press, Washington, D.C., ISBN 1-55963-591-6.

cordon license enforcement.⁵ It resulted in a reduction of almost 20% in congestion levels, its revenues were nine times the costs, and most importantly, citizens of Singapore supported the scheme.⁶ The ALS lasted until 1998, when Singapore replaced it with the first Electronic Road Pricing (ERP) scheme.

Singapore's Electronic Road Pricing System

In 1998 when the ERP system was launched, Singapore had a population of 3.9 million residents and the number of vehicles entering the inner city was 235,000 per day.⁷ By 2016, the population has grown over 44% to 5.6 million, but statistics from the Land Transport Authority show that by 2015, average daily traffic entering the inner city was only 300,400 vehicles.⁸ In the same year, the average daily ridership on public transportation was 2.7 million trips.⁹

Singapore's Land Transport Authority operates the system. The ERP scheme is fully automatic on specific routes, times of day, and directions, with variable pricing designed to respond to congestion in real time. Vehicles are required to have an In-vehicle Unit (IU) on the dashboard and a smart card with fare stored on it. The ERP gateways have been constructed to detect the type of vehicle and the congestion of the route at specific times; they then deduct the variable fee from the smart card. When a vehicle equipped with an IU passes under an ERP gantry, a road usage charge is deducted from the smart card in the IU. Sensors installed

⁵ Federal Highway Administration. Lessons Learned From International Experience in Congestion Pricing. Publication #FHWA-HOP-08-047. 2008. Accessed 11 November 2017. <https://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm>

⁶ Watson, Peter and Edward Holland. Relieving traffic congestion: the Singapore area license scheme. 1978. World Bank Staff Working Paper Number 281. Washington, D.C.: The World Bank. <http://documents.worldbank.org/curated/en/883181468759586286/Relieving-traffic-congestion-the-Singapore-area-license-scheme>

⁷ Land Transport Authority. A World Class Land Transport System, White Paper. 1996. Republic of Singapore. <https://www.lta.gov.sg/content/dam/ltaweb/corp/PublicationsResearch/files/ReportNewsletter/White-Paper.pdf>

⁸ Land Transport Authority. Singapore Land Transport Statistics in Brief 2015. <https://www.lta.gov.sg/content/dam/ltaweb/corp/PublicationsResearch/files/FactsandFigures/Statistics%20in%20Brief%202015%20FINAL.pdf>

⁹ Ibid.



Image: Tomoaki INABA/Flickr, 2011

on the gantries communicate with the IU via a dedicated short-range communication system, and the deducted amount is displayed to the driver on the IU screen.

The ERP system started with 28 gantries, but there are now over 80 ERP gantries throughout the inner city.¹⁰ A vehicle may pass more than one during a trip, and thus pay more than one variable congestion charge. All congestion charge prices vary based on the type of vehicle, the time of day, and level of real-time congestion on each route. The charges vary between \$0-\$4.00 (USD \$0-\$3.00), and are collected on a per-pass basis.¹¹ The IU costs \$150.00 (USD \$111.00). The system runs from 7:00am-8:00pm from Monday-Saturday. There is no charge on Sundays, public holidays, or after 1:00 p.m. the day before a public holiday.

There were many complementary measures put in place to restrain car use in addition to the ERP scheme. Parking fees inside the restriction zone increased, the number of buses and bus frequency were increased, HOV+4 lanes were established, and over 15,000 park-and-ride spaces were established outside of the

¹⁰ Prof. Gopinath Menon Dr. Sarath Guttikunda. Electronic Road Pricing: Experience & Lessons from Singapore. 2010. SIM-air Working Paper Series: 33-2010. <http://www.environmentportal.in/files/ERP-Singapore-Lessons.pdf>

¹¹ Ibid.

restriction zone.¹²

Singapore's goals for the ERP scheme are focused purely on reducing traffic congestion and improving the reliability of journey times. Their scheme has evolved over decades to be automatically responsive to congestion in real time. In this way, the ERP rates are set based on real-time travel speeds and congestion. The initial investment is estimated to be around \$200 million (US \$110 million).¹³ Roughly half of this capital cost was purchase and installation of about 1.1 million IU units.¹⁴ The annual operating costs are roughly \$25 million (USD \$18.5 million), and annual net revenue is \$150 million (USD \$100 million).

The Impacts of Congestion Pricing in Singapore

Singapore's evolving congestion pricing system has been well-designed and systematically monitored over decades to restrain car traffic and improve speeds and journey times. Despite strong population growth, the ERP has reduced traffic in the inner city by 24% and average speeds have increased from 30-35 KPH to 40-45 KPH (18-22 MPH to 24-28 MPH).¹⁵ In addition, there have been extensive public transit improvements, and bus and train ridership has increased by 15%.

There have also been many other public improvements that support congestion mitigation, which have social benefits including better accessibility, connectivity, improved public health, and support for economic development. The Land Transport Authority also reports that as a result of markedly less traffic since congestion pricing, that levels of CO₂ and other greenhouse gas emissions

¹² Land Transport Authority. A World Class Land Transport System, White Paper. 1996. Republic of Singapore. <https://www.lta.gov.sg/content/dam/ltaweb/corp/PublicationsResearch/files/ReportNewsletter/White-Paper.pdf>

¹³ Phang, Sock-Yong, and Rex S. Toh. "Road Congestion Pricing in Singapore: 1975 to 2003." *Transportation Journal*, vol. 43, no. 2, 2004, pp. 16-25. JSTOR, JSTOR, www.jstor.org/stable/20713563.

¹⁴ Ibid.

¹⁵ Federal Highway Administration. Lessons Learned From International Experience in Congestion Pricing. Publication #FHWA-HOP-08-047. 2008. Accessed 11 November 2017. <https://ops.fhwa.dot.gov/publications/fhwahop08047/02summ.htm>



Image: Carlos Felipe Pardo/Flickr, 2008

have been reduced by 10-15% within the inner city.¹⁶ In addition, revenues from ERP have supported public transit, street safety, and transit-oriented development. For example, Singapore has expanded the bus and rail system and constructed new intermodal transit hubs. In addition, a comprehensive bicycle and pedestrian network has been created with a focus on first-and-last mile connectivity projects. The Land Transport Master Plan of 2008 contained strategies to make public transport a choice mode, invest in transit-oriented development, and improve pedestrian access and cycling infrastructure for first- and last-mile trips.¹⁷

Congestion pricing is one piece of a comprehensive traffic reduction strategy in Singapore, with major investments in public transit, bicycling and walking networks, and transit-oriented development. In addition, parking fees have increased over time, as well as the taxes and fees related to car ownership. Beyond that, additional measures taken by Singapore's government are among the most stringent in the world: existing policies require drivers to purchase a certificate that can cost as much as \$50,000 (USD \$37,000), which lasts 10 years. Currently, the government only allows

¹⁶ Sreyus Palliyani and Der-Horng Lee. Sustainable transport policy—An evaluation of Singapore's past, present and future. *Journal of Infrastructure, Policy and Development* (2017) Volume 1 Issue 1, pp.112-128.

¹⁷ Ibid.

car ownership to increase by 0.25% per year, but a new policy starting in February 2018 will not allow any increase. From then on, drivers will have to bid for an existing certificate.¹⁸ Paired with the dynamic ERP system, these comprehensive transportation improvements and policies ensure transportation options, reduced congestion and delay for drivers, and improved reliability of roadway performance.



Image: Dickson Phua/Flickr, 2013

¹⁸ Shane, Daniel. CNN Money. Singapore slaps limit on the number of cars on its roads. <http://money.cnn.com/2017/10/24/news/singapore-car-numbers-limit/index.html>

LESSONS LEARNED FOR NYC

Four Lessons From London, Stockholm and Singapore

As Governor Cuomo’s “Fix NYC” panel explores how New York City should tackle its traffic congestion and fund public transit, the clearest solution—and one the governor has expressly raised—is a robust congestion pricing program that charges drivers and for-hire vehicles entering midtown and lower Manhattan. Fortunately for New Yorkers, congestion pricing is not a novel concept, and we can learn lessons from the results of other cities’ congestion pricing programs. In particular, four principles underpin successful pricing programs: significant investment in transit before and during the implementation of congestion pricing; reinvestment of revenues generated directly into public transit; dynamic tolling that changes commuter behavior; and information campaigns that generate broad public support for congestion pricing.

Congestion Pricing Requires Transit Investment

Mobility and access to opportunity, regardless of socioeconomic status, is one of the most fundamental conditions for a successful regional economy. The key lesson of congestion pricing is that in order to get drivers of all socioeconomic groups out of private or for-hire vehicles, affordable, accessible transportation options are necessary. Notably, London, Stockholm, and Singapore all have four key elements that make mode-shift away from cars possible: an efficient public transportation system, compact development, walkability, and limitations on the use of private vehicles. Currently, New York lacks only the limitations on vehicle use that encourage additional mode-shift.

London, Stockholm, and Singapore each deliberately made investments in their transit and transportation infrastructure before and during the implementation of congestion pricing: London purchased 300 new buses, overhauled their bus network, and added significant bicycle infrastructure; Stockholm added almost 200 new

buses and 16 new routes, constructed park-and-ride facilities, and also expanded bicycle infrastructure; and Singapore increased its bus fleet and frequency, raised parking fees in the congestion zone, established HOV+4 lanes, and built park-and-ride stations outside the zone.

For a congestion pricing program in New York to be successful, our city will have to do the same. Metropolitan Transportation Authority Chairman Joe Lhota announced an \$836 million “Subway Action Plan” to make immediate repairs and improvements to New York City’s ailing subway system in June of 2017¹. These improvements should be paired with investments in surface-level transit, including improvements to bus, ferry, and bicycle commuting. In particular, the MTA and the City of New York, which controls the New York City Department of Transportation, must invest in cost-effective improvements to bus service: additional bus lanes into and throughout the congestion zone to speed up bus trips and separate buses from other traffic; procurement of a new fleet of electric buses to ensure frequent service while reducing pollution; ensuring our new fare payment system allows all-door boarding; deploying transit signal priority on key routes throughout the congestion zone; improved bus stop infrastructure, including shelters and countdown clocks; and robust enforcement of bus lanes to ensure lanes remain clear. For congestion pricing to work, New York will have to not only improve the subways; it will have to reverse its alarming year-on-year decline in bus ridership by improving bus service as well.

Fair Tolls Change Commuters’ Preferences

In too many cities, traffic is an assumed fact of life, but the reality is that traffic is merely the accumulated choices of thousands of drivers—and that behavior is subject to change. In the weeks after Stockholm began charging drivers to enter the city center, traffic congestion declined as much as 50%, and when the city switched

¹ The MTA now estimates the Subway Action Plan’s total operating cost at \$1.5 billion over the life of the plan.

its congestion pricing system to incorporate variable tolling depending on time of day in 2006, traffic congestion dropped an additional 5%. Similarly, in Singapore, where traffic has dropped by 24%, its real-time dynamic system shows dramatic results for traffic reduction, speeds, and trip time reliability. The results of congestion pricing programs demonstrate that human behavior changes as a result of imposing a daily fee—and that that behavior is not simply limited to mode shift from cars to transit, but that it also includes eliminated trips, more efficient trips, and changes to travel time of day. However, in order to encourage mode shift, the fee must be significant enough to change behavior, and, given the rapid growth of for-hire vehicles, should also include them as well.

In cities with congestion pricing, the reduction in traffic has been met with a parallel rise in the use of public transit: bus use in London is up 38%, and Transport for London calculates that of the car trips that no longer take place because of congestion pricing, 50% of those commuters shifted to transit. In Singapore, bus and train ridership is up 15%. These behavioral changes not only remove cars from the road, they raise additional revenues at the farebox for public transit and build public support for improvements to transit.

Congestion Pricing Revenues Must Support Public Transit

In looking at the successes of London, Stockholm, and Singapore, a clear pattern emerges: road pricing is most successful when the funds raised through tolling are devoted to public transit. In other cities, this has formed a positive feedback loop that encourages transit use over single-occupancy vehicles: in London, for instance, all revenues raised from congestion pricing must be reinvested in transportation infrastructure by law. The end result is a reliable stream of funding for public transit, and it is no coincidence that London has been at the forefront of transit infrastructure, including

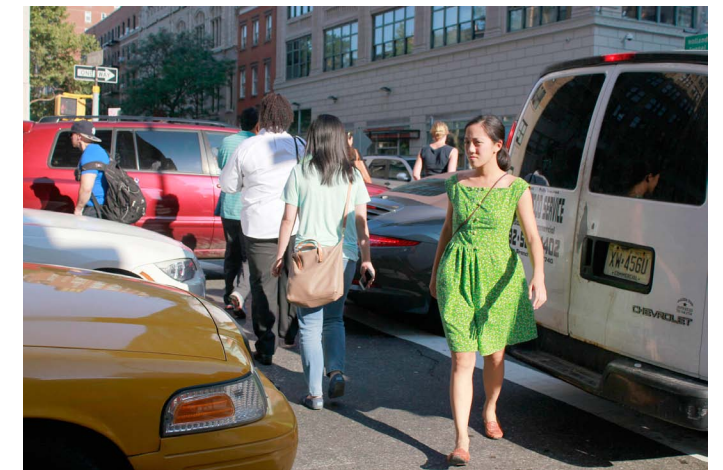


Image: WNYC New York Public Radio/Flickr, 2015

developing new Overground lines and projects like Crossrail and Crossrail 2 over the last several years.

Additionally, research shows that the way revenues are distributed has a significant impact on equity², and that spending revenues on transit increases congestion pricing’s benefits to working-class families³, which is a key concern that has been raised by Mayor Bill de Blasio and other congestion pricing skeptics. In particular, where lower-income users are more likely to use bus service rather than drive, they fare better under congestion pricing⁴. On the other hand, if revenues are not redistributed in any way, road pricing generally results in gains for higher-income groups and losses for lower-income groups.⁵ In New York in particular, research by Community Service Society demonstrates that for every one low-income resident to will have to pay a toll, thirty-eight will benefit from improved transit service.⁶

Lastly, we should ensure that revenues raised

² May, A D and Sumalee, A, 2005. One step forwards, two steps back? An overview of road pricing applications and research outside the US. International perspectives on road pricing. Washington, TRB.

³ Cohen, Y., 1987. Commuter welfare under peak period congestion tolls: Who gains and who loses? International Journal of Transport Economics, 14(3): 239-266.

⁴ May, A.D., 1975. Supplementary licensing: an evaluation. Traffic Engineering and Control, 16(4).

⁵ Cohen, Y., 1987. Commuter welfare under peak period congestion tolls: Who gains and who loses? International Journal of Transport Economics, 14(3): 239-266.

⁶ Community Service Society. Congestion Pricing: CSS Analysis. Accessed 16 December 2017. http://http.58547.nexcesscdn.net/803F44A/images/nycss/images/uploads/press-pdfs/171024_congestion_pricing_release_FINAL.docx

from for-hire vehicles are directed toward local transit improvements. While yellow and green cabs currently are subject to a surcharge dedicated to the MTA, app-based services like Uber and Lyft pay sales taxes, which are then remitted to Albany. We should ensure revenues raised from all for-hire vehicles in New York City contribute to funding public transit.

Voters Support Congestion Pricing

In 2007, lack of support from the governor and state legislature doomed the Bloomberg congestion pricing plan. Had road pricing been enacted ten years ago and the funding dedicated to public transit, that increased revenue could have funded the preventative maintenance that would have kept our transit system from falling into its current dire state. The lesson is clear: while congestion pricing takes political will, the ramifications of elected officials' failure to deal with rising congestion in our urban core and fully fund public transit are far worse.

By contrast, the congestion pricing programs in London, Stockholm, and Singapore enjoy wide public support. Education programs to build awareness among commuters were critical in London and Stockholm. In each city, those programs framed congestion pricing in the context of each city's social norms: in Stockholm, which saw congestion pricing disapproval rates as high as 80% before implementation, campaigns emphasized the environmental benefits of the congestion pricing trial. After the conclusion of the trial period, a majority of voters favored the road pricing scheme and even supported its expansion years later.

Meanwhile, in the 1980s and 1990s, London found itself in a similar position to New York City today: declining investment in public transit had led to an Underground network that was rife with delays and breakdowns. By the 2000s, polling showed that 90% of London residents believed there was too much traffic, and majorities were concerned about travel times and air



Image: Ricardo Giaviti/Flickr, 2012

pollution. Then-Mayor Livingstone argued that congestion pricing would directly address those concerns. While a later westward expansion of London's congestion zone was canceled, the core congestion zone in London has remained remarkably durable, and tolls have risen multiple times since its implementation.

The lesson for policymakers in New York City is clear: congestion pricing not only works, but when it is employed, it also enjoys popular support. It does, however, require political will—a political will our elected leaders lacked in 2007. Now, with a deepening subway crisis that costs New Yorkers as much as \$389 million a year⁷ and gridlock that leaves city buses crawling, our representatives need to take bold action. The lessons of London, Stockholm, and Singapore offer a way forward for New York City. It's time for us to follow their examples.

⁷ New York City Comptroller Scott Stringer. The Economic Cost of Subway Delays. Accessed December 16, 2017. <https://comptroller.nyc.gov/reports/the-economic-cost-of-subway-delays/>

Primary Author

Emily Provonsha, Data & Policy Analyst

Secondary Author

Nickolas Sifuentes, Executive Director

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Jon Orcutt, TransitCenter
Charlie Komanoff, MoveNY

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Janna Chernetz, New Jersey Policy Director
Dana Dobson, South Jersey Coordinator
Vincent Pellechia, Associate Director

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