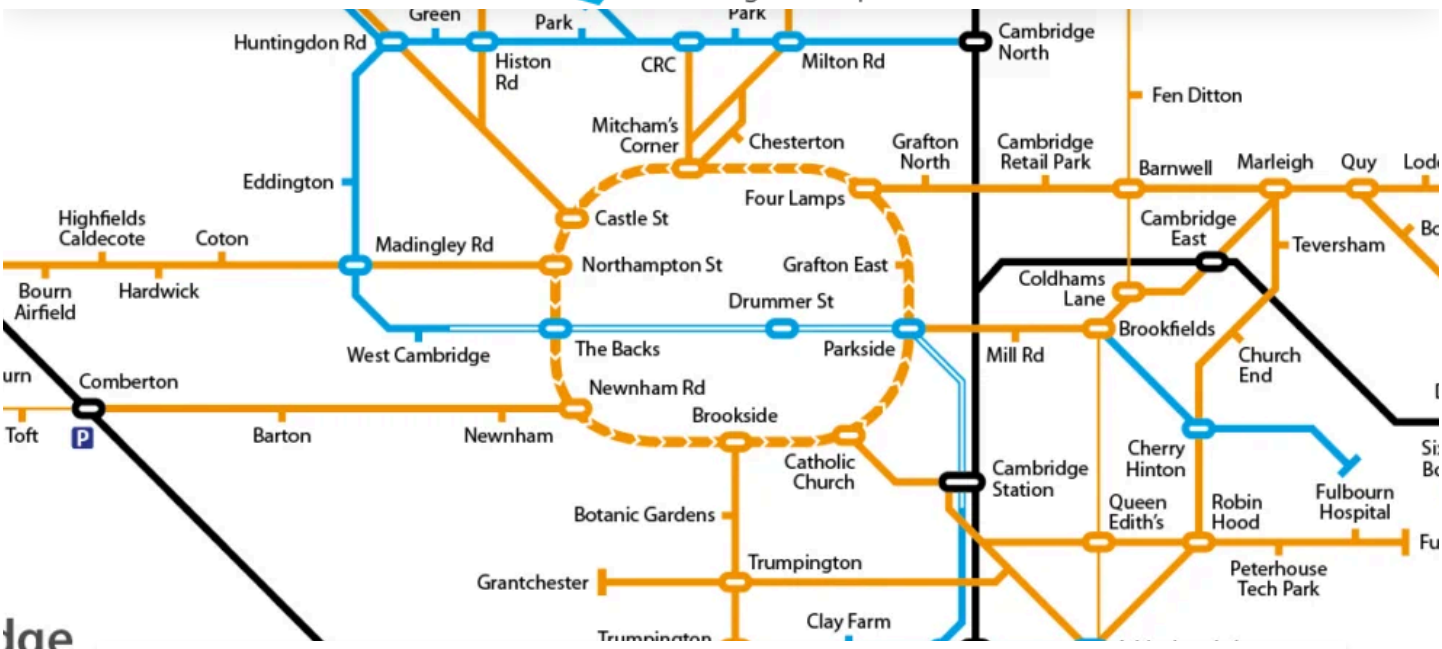


Cambridge city bus hub

Edward Leigh 11 September 2018 34 min read

SEE INTERACTIVE BUS ROUTE MAP

The current arrangement

Cambridge has one central hub, and secondary hubs at Cambridge station and Addenbrooke's hospital.

The central hub comprises a bus station with 11 bays, and another 15 dispersed around the surrounding streets in six locations. (The bus stop on Emmanuel Rd is included because it is the most central stop for the Busway A service; the ones on Parkside are used by the X5 Oxford–Cambridge and National Express intercity services.) Interchanging can involve a walk of up to 600m and crossing roads without designated, let alone controlled, crossing points. There is no central information point and no signage to guide people to the right stop.



Locations of Cambridge city centre bus stops, labelled with the number of bays. Circle diameter is 520m. (Map © OpenStreetMap)

Many buses are routed to and from the central hub via narrow streets, bounded by historic buildings, including Magdalene College (started in the 15th century), Round Church (started in the 12th century), St Botolph's Church (started in the 14th century), Queens' College Old Hall (started in the 15th century) and Christ's College (started in the 15th century).



Bus routes through the centre of Cambridge. Red circles indicate areas of conflict with people walking and cycling. (Map © OpenStreetMap)

Buses sweep over pavements at corners, obstructing pedestrians and making them – especially those with impaired vision – feel unsafe. In several locations, people cycling have to wait or get on the pavement to let an oncoming bus pass. Pollutants (especially particulates and nitrogen oxides) build up in narrow streets, exposing people to dangerously unhealthy concentrations. The weight and vibrations caused by 15 tonne buses damage the roads and surrounding buildings.

Future growth in population, mainly in settlements beyond the green belt, and in employment sites around the city will require a large expansion in the frequency and coverage of bus services into the city – potentially tripling inside ten years. The current bus hub has little capacity to absorb that growth, and more buses in the city centre would further degrade people's experience of walking and cycling in the city.

What are the alternatives? Hubs have an essential role in enabling people to interchange. It's not possible to run public transport services from every village and suburb to every destination (employment site, school, shop, leisure facility, etc.) So the success of public transport is largely dependent on making it easy and intuitive for people to complete a journey with a change of mode or vehicle, e.g. walk → bus → bus → walk, or cycle → train → bus → walk.

Types of bus hub

- **Hub-and-spoke**: Services connect at a specific location ('hub'), usually a central terminus. Preston or Swansea bus stations are pre-eminent examples of large, purpose-built bus stations in the centre of a city.
- **Ring-and-spoke**: Services follow a circular route ('ring') within or around the city, so that interchanging is possible anywhere around the ring. Oldenburg is a pre-eminent example of this, with all bus routes going via the inner ring road rather than the city centre.

Hub-and-spoke routing

Hub-and-spoke routing works where the bus station:

1. is well-connected to the road network;
2. has space for enough bays for the peak rate of arrivals, departures and layovers;
3. is compact and well-signed, allowing for quick and easy connections.

Cambridge currently uses hub-and-spoke, but fails on all three accounts:

1. The hub is connected to congested and narrow streets, which hold up buses unpredictably and compete for space with people walking and cycling.
2. Emmanuel St gets congested, indicating that there is little spare capacity to increase the number of services, which will present a problem in coming years. By a rough estimate, we will need bus services to convey three times as many people in ten years' time.
3. The hub is spread across several streets, requiring walking up to 600m and crossing roads to make a connection. Signage is largely lacking, and it would be challenging to rectify this in such a complex environment.

The managing director of Stagecoach East has proposed relocating the Drummer Street bus station to the south-east corner of Christ's Pieces, where currently there is a bowling green. The proposed design includes twenty bays and access at both ends (from Drummer St and Emmanuel Rd). The land currently used for the bus station would be returned to Christ's Pieces in a land swap. From purely functional point of view, this would be more efficient. However it does not address the problem of the limited capacity of access roads, and their unsuitability for large volumes of large buses. It also doesn't provide capacity for significant growth in bus services in and out of the city.

Another option is to have multiple hubs around the city. Possible sites include: Cambridge railway station, Addenbrooke's bus station, Cambridge North station, Grafton Centre on East Rd, and Sun Street. These sites are well-connected to only one or two radial routes, and are not evenly distributed around the city. There is neither the space at all the sites, nor would it be operationally efficient, to serve all

Ring-and-spoke or 'lollipop' routing

Ring-and-spoke or 'lollipop' routing could work well in Cambridge because there is an inner ring road close to the city centre. The most intuitive way to run buses is counter-clockwise, so that doors open towards the city centre. Some buses would still enter the city centre via Parkside, Emmanuel St and Regent St. Some of the benefits include:

- To reach any destination in Cambridge requires at most one change of bus anywhere on the inner ring road.
- To interchange between buses entails walking no further than the length of two bus bays, and does not require crossing a road.
- More of Cambridge would be within easy walking distance of a high frequency bus service, making bus travel attractive to many more people in the city. This reduces car traffic and increases demand, and hence revenue, to run the buses.
- Removing bus – and potentially all large vehicles – from the city centre opens up opportunities to widen pavements, add cycle lanes, and pedestrianise more of the city centre.
- Many streets would see a renaissance, either because they become more attractive places to be (e.g. Hobson St, King St, Round Church St) or to get to (e.g. the Grafton Centre, Sun St, Chesterton Rd).

There are however some disadvantages that need to be taken into account (which we cover later):

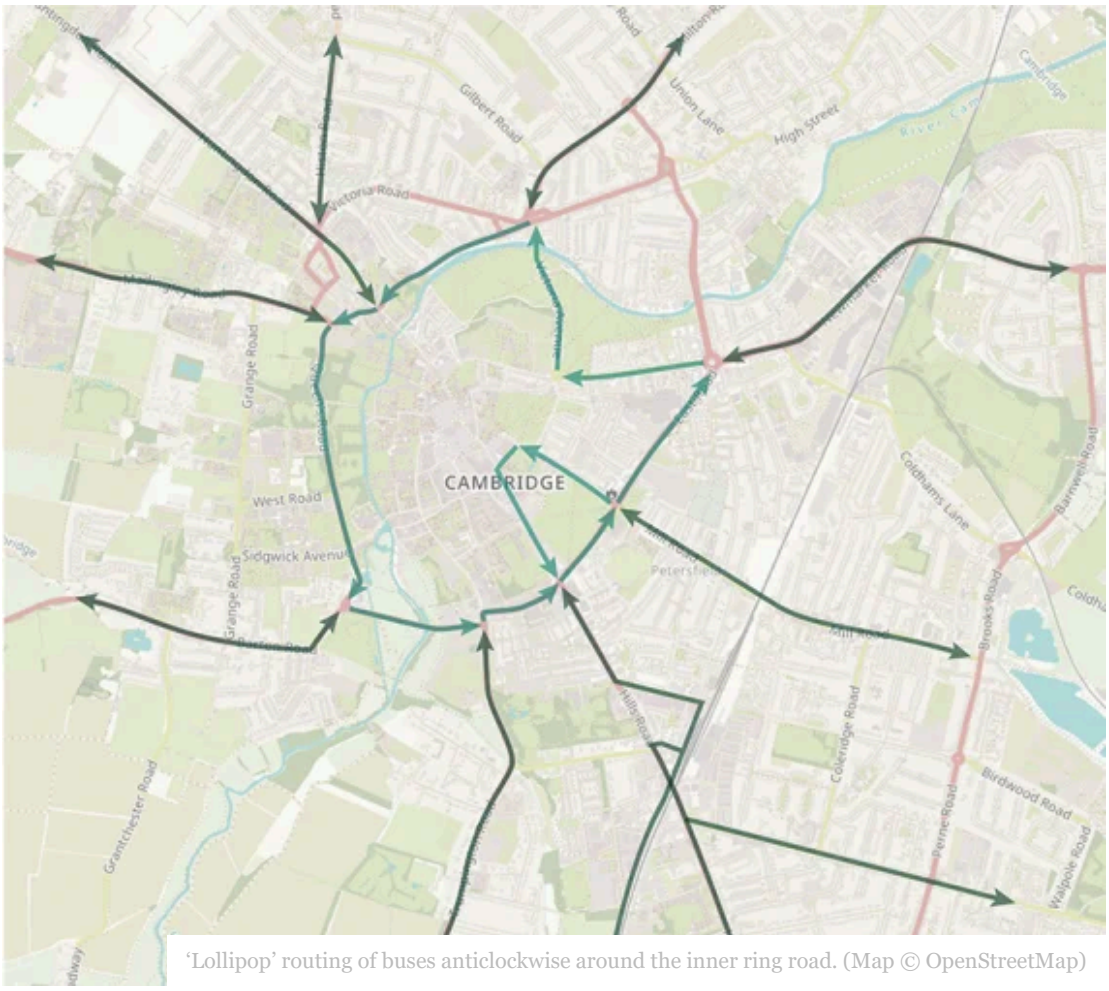
- Bus turn-around time (between reaching the inner ring inbound and leaving it outbound) is slower than going in and out of central Cambridge. This makes services slightly less cost efficient.
- Bus drivers need to lay over at the outer end of their route rather than in central Cambridge.
- Queen's Rd and The Fen Causeway will carry many more buses than they do now.

Tackling congestion

How could this work when the inner ring road is so congested in places at peak times? We consider three possible solutions here:

1. Make the inner ring road one-way clockwise for general traffic, and buses only counter-clockwise.
2. Introduce access controls to divert general traffic, perhaps just at peak times, onto alternative routes.
3. A congestion charge that disincentives using the inner ring road at times when it would be congested.

centre), with all other traffic required to run clockwise. In other words, the inner ring road becomes one-way clockwise with a contraflow bus lane.



'Lollipop' routing of buses anticlockwise around the inner ring road. (Map © OpenStreetMap)

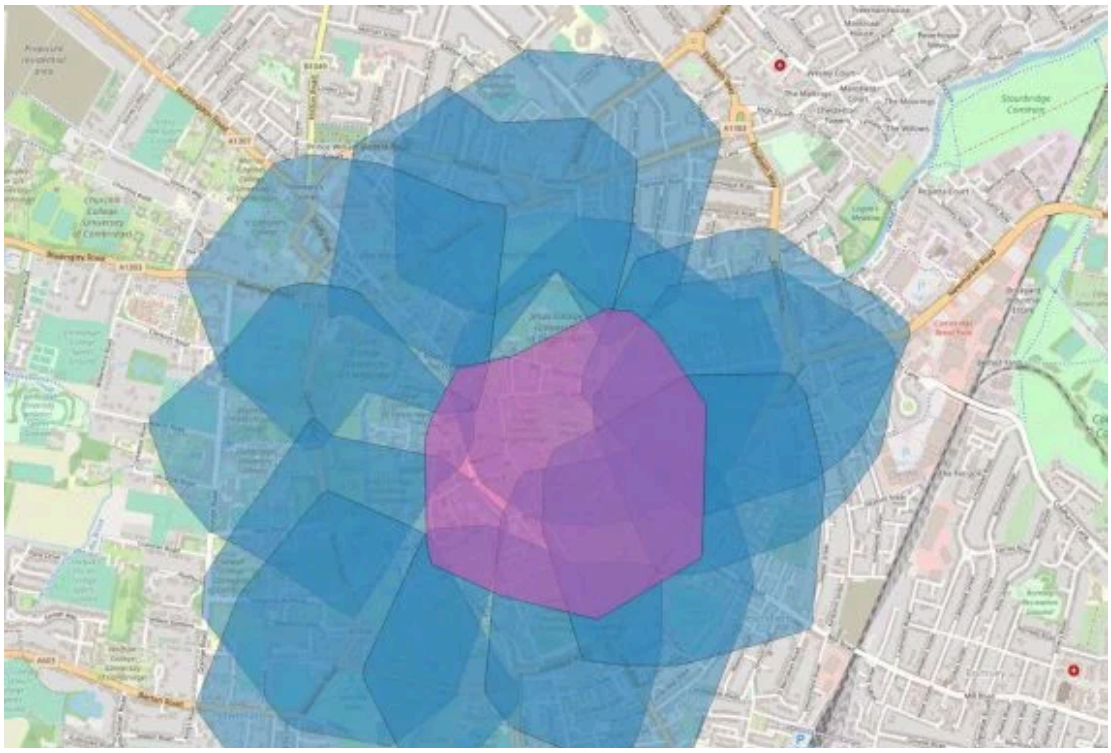
The ring road is 6.5km in circumference. At an average speed (including stops) of 22km/h (13.5mph), a complete circuit by bus would take 18 minutes. (The assumed speed is taken from Singapore, where buses encounter relatively little congestion. It assumes that dwell times at stops are minimised through efficient ticketing, clear and accurate information provision, and use of two-door buses).

There would be at least one bus stop between each major junction (with a radial road). If each bus stop on the route has three bays, it will be possible to accommodate 180 buses per hour, each stopping for up to one minute.

Pros for bus users

- Buses gain the speed and reliability benefits of an inner city bus lane without any requirement to widen roads.
- Much more of the city is directly accessible by bus.
- Almost all of the city is accessible with just one change of bus at any point on the inner ring road.

- Smart Traffic Management could ensure that buses are held for a minimal amount of time at junctions, reducing journey times.
- All of the centre of the city is within 600m of the inner ring road (an 8 minute walk at a leisurely 4.5 km/hr or 2.8 miles/hr). Stops on Emmanuel St would be closer, but would serve fewer destinations directly (e.g. Cambridge station and Addenbrooke's).
- People can choose where on the inner ring road to alight and board to reduce either walking distances or bus journey times.



Areas of the city centre within 650m walking distance (10 minutes at 4km/hr or 2.5mph) of a bus stop on the inner ring road (shown in blue), compared with the same distance from existing Emmanuel St bus stops (shown in purple). (Map © OpenStreetMap)

Other pros

- No road-widening is required.
- One-way systems are easy to sign and understand.
- It would be possible to trial the change with temporary road signs and traffic lights.
- Non-bus traffic will flow more smoothly because of the limited movements at each junction, with few vehicles making right turns.
- This in turn makes it easier to give more time and priority at junctions to people walking and cycling.

Cons

or alternative (similarly direct) cycle route would ideally be identified for all parts of the inner ring.



Main routes for general traffic in and around the city centre

2. Access controls

The objective is to divert traffic away from the inner ring road where a reasonable alternative route exists.

This might be achieved by restricting access along certain sections of the inner ring road, using 'virtual bollards' (monitored by automatic number plate recognition cameras). Locations to consider include Northampton St (with traffic diverted via Lady Margaret Rd and Mount Pleasant) and Lensfield Rd (with traffic diverted via Brooklands Ave). Map 4 illustrates these and other possible locations.

Access through these points, known as 'bus gates' would be restricted to buses, cycles, and certain other permitted motor vehicles, including emergency services. Other vehicles, such as taxis and certain low-emission commercial vehicles, could also be granted access, possibly on payment of an annual fee.

Another option to divert traffic is to restrict what turns are permitted at junctions on the inner ring road. For instance not turning between Hills Rd and Lensfield Rd in

Pros

- Some improvement to bus journey times and reliability on most parts of the inner ring road.
- Relatively easy to trial each intervention in isolation or together.

Cons

- Far less effective than a continuous bus lane in giving buses an unobstructed run around the city.
- Confusing for drivers unfamiliar with the restrictions or new to the area.
- Part-time access rules are complex to explain and sign.
- Bus gates require multiple signs to warn people not to proceed or make a turn that could lead them to an active bus gate.
- Some access restrictions needed to reduce congestion could require general traffic to make a long detour.

3. Congestion charge

Charge a daily access fee ('road pricing' or 'congestion charge') for any private vehicle using or crossing the inner ring road. However it cannot be introduced quickly at a price level that would eliminate congestion on the inner ring road, and there is a chicken-and-egg problem of improving bus services first to the point where people have a credible alternative to driving.

Pros

- Some improvement to bus journey times and reliability on most parts of the inner ring road.
- Raises revenue which could be invested in public transport, to subsidise bus ticket prices and/or provide more services for more hours at a higher frequency than would be commercially viable.

Cons

- Far less effective than a continuous bus lane in giving buses an unobstructed run around the city.
- Confusing for drivers unfamiliar with the congestion charge.
- Variable pricing or time-dependent charging is difficult to communicate, but a flat fee (as in London) is likely to be regarded as unfair and overly burdensome on those who need to drive.

Conclusion

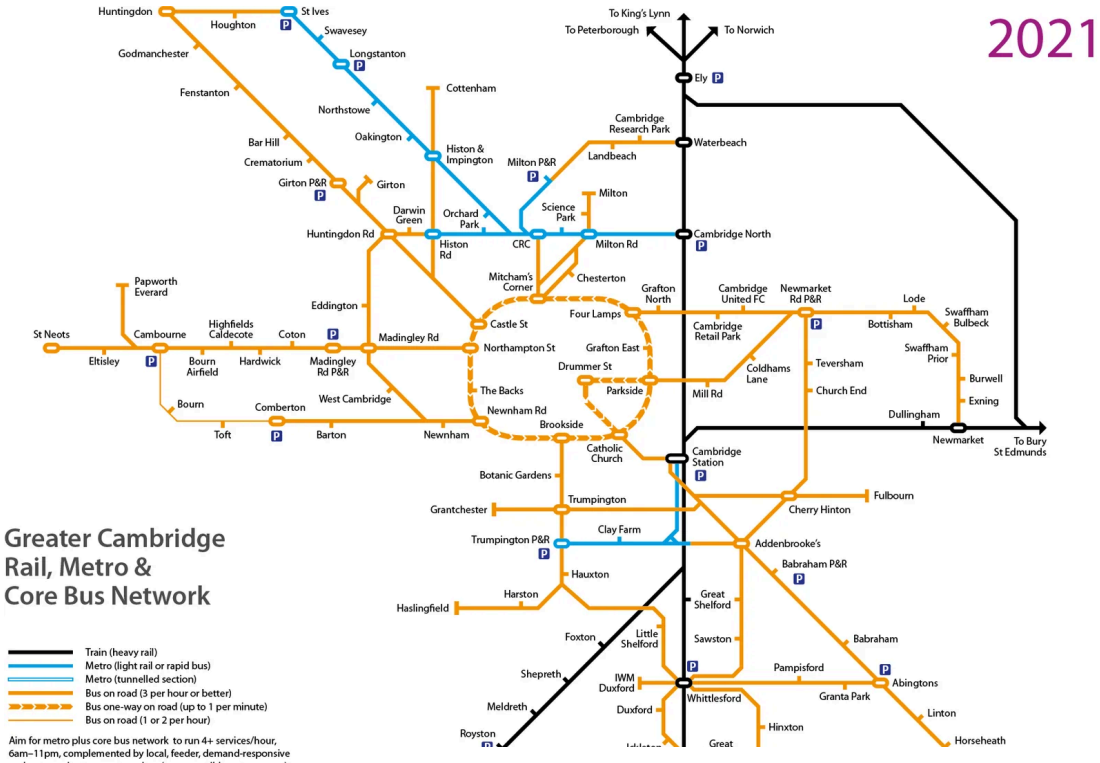
Acess controls would not eliminate congestion, and would not reduce it at all on some parts of the inner ring road (e.g. The Fen Causeway). However, some access or turn restrictions would complement a one-way system to promote smooth traffic flows and discourage or prevent rat-running through residential areas.

Some form of road pricing has a role to play in future, as we will cover in a future paper. However, trying to introduce it before people can see that bus services have been radically improved is likely to be politically difficult and undoubtedly slow.

The one-way system solution is the most elegant solution. It's also technically and politically the easiest to trial and, following a successful trial, to implement.

The benefits of a ring-road bus hub

The principal benefit is the greater intuitiveness of the bus network and ease of interchanging.



Potentital bus network plan with ring-and-spoke ('lollipop') bus routing

SEE INTERACTIVE BUS ROUTE MAP

A high frequency service around the inner ring road brings much of the city centre within a 15 minute bus ride and walk. Areas that are currently neglected would be revived: for instance, Burleigh St and the Grafton Centre, Newmarket Rd around Sun Street, and Chesterton Rd.

Christ's Pieces. That latter could be connected to New Square in a much more pedestrian-friendly way.

There would be no need for any road widening, or other infrastructure to work. Pollution levels would fall dramatically in the city centre. Medieval buildings in the city centre would no longer be affected by the damaging impact of large numbers of heavy vehicles.

Appendix: answers to questions about the ring-road bus hub

How would this affect me when I need to drive in the city?

Traffic signals would make clear to road users which turns are permitted at each of the junctions on the inner ring road. At the Catholic Church junction, for instance, Hills Rd inbound traffic would be permitted only to to turn left; outbound traffic would be permitted to go straight on or turn right. Filter arrows on the traffic lights would make this clear.

People would still be able to park their cars at the multi-storey car parks for the foreseeable future (in part because the City Council is heavily dependent on the revenues from these car parks). Streets within the inner ring road would still be accessible for residents, buses (with size/weight restrictions on roads between Emmanuel St and Magdalene St) and licensed taxis.

Won't this require people to make long detours to drive across the city?

The ring road is 6.5km in circumference. Driving at an average speed of 25km/h (16mph), a complete circuit would take 15 minutes. 50% of trips would be unchanged if the ring road were one-way. Only 17% of trips would be 10–15 minutes longer following the ring road, and most of those could be shortened by choosing a different route.

The question is whether adding no more than 15 minutes to a small percentage of trips is a fair and reasonable imposition.

There isn't a solution that will make it no less convenient to drive *and* better for buses. Improving bus reliability requires a reduction in car traffic. That will incentivise more people to use buses *and* ensure they experience a better service. More people using buses makes it possible to run more frequent services to more

How would this affect emergency services?

These would have use of the bus lane (as well as the general traffic lane), so they would benefit from having an uncongested route around the city at all times of day.

How would this affect deliveries?

All parts of the city would continue to be accessible. Companies providing commercial services, from deliveries to boiler maintenance, can plan routes for their vehicles that follow the direction of flow of the inner ring road, minimising wasted mileage. In most cases, re-ordering visits would ensure that the total journey time was no greater than now.

Cycle couriers will continue to have the advantage of being able to travel along access-restricted streets in the city centre.

One of the key objectives of this proposal is to provide an attractive bus service to shift a significant number of car trips to bus. That will relieve congestion in the city, which currently delays delivery and service vehicles. (Complementary measures will also be needed to ensure that new car trips do not replace those the switch to bus.)

Won't this require people to walk much further than now?

For most trips, the answer is no – for two reasons: firstly, people can get off and re-board wherever on the inner ring road is closest to where they're going or returning from. For many trips that will involved less walking than now.

Secondly, other services will provide additional connections: high frequency shuttle services between the city centre, Cambridge station and Addenbrooke's via Gonville Place will offer people the option to go to/from Emmanuel St; and small electric buses would run through the city centre, providing a similar service to the courtesy bus at Addenbrooke's (see *Local services (city)* in our paper on *Buses*).

There will of course be some trips that require a longer walk than now or a transfer to a local service. But this should be considered alongside all the places that will be much more accessible than now, such as the Job Centre on Chesterton Rd, the Grafton Centre, West Road Concert Hall or the Scott Polar Museum.

All parts of the city will be within a 600m walk of a stop on the ring road. To put this into perspective, that's about the distance from the Trumpington Park & Ride bus stop outside John Lewis to the front of Great St Mary's Church; or from the Drummer St bus station to the entrance to the Grafton Centre. This is the upper limit on walking distances; most destinations will be much closer to a bus stop.

How will this affect me cycling around the city?

Cycling around the inner ring road will always be unappealing and relatively unsafe because of the volume of traffic. In some places, for instance along Gonville Place, there is sufficient road space to provide segregated cycle lanes by removing filter lanes or central reservations. Elsewhere, the priority should be to develop a continuous network of cycle routes within the inner ring road that obviates the need to cycle on the ring road itself. The removal of buses, and possibly also taxis, from, for instance, Bridge St and Hobson St, will make these more attractive for cycling.

The simplification of movements that vehicles can make at junctions on the inner ring road makes it easier to design junctions with more frequent pedestrian crossing phases and to provide an advance green phase for people cycling.

How will it affect my journey time?

One of the tools we need is a future journey planner that allows people to compare a trip now, by car or bus, based on observed journey times, with the same trip in the proposed scenario. It would then be much clearer who would benefit and who would lose out. If every before-and-after trip that people test is stored and evaluated together, then it would be much clearer what the social benefits and penalties would be.

Would cycles be permitted in the bus lane?

By default cycles are permitted to use bus lanes. However this would slow down buses. Therefore, wherever possible, cycle lanes should be accommodated outside the bus lane.

Would taxis be permitted in the bus lane?

Normally taxis are permitted to use bus lanes. However, they impede buses when they stop to pick up and drop off. If taxis are permitted to use the inner ring road bus lane, then it should be on condition that they may not stop in the bus lane or on the adjacent pavement.

Where would taxis wait?

There needs to be a separate debate about where taxis should wait, and which streets they can access when. For instance, it might be desirable to exclude taxis from the city centre during the day, in order to create a more pedestrian-friendly environment. In

What about long distance services?

National Express and other long-distance services could occupy vacated bays at Drummer St bus station. Other options should be considered in the longer term, for instance terminating services at hubs, such as Park & Ride sites adjacent to the A14 and M11, if and when those are also linked to the city centre by a metro.

Where would bus stops be located?

The exact locations would need careful consideration and consultation. Some are fairly obvious, such as at the back of the Grafton Centre.

A possible location on Queen's Rd (The Backs) is just south of the West Rd junction, where there are currently pay-and-display parking bays.

On Lensfield Rd, the existing bus stop location, just east of the Trumpington Rd junction, could be used. The road there is currently three lanes wide (the centre lane is hatched), so there would be space for buses to pass each other.

What would the bus stops look like?

There would probably be three sawtooth bus bays at the edge of the road (as on St Andrew's St), mostly close to junctions with radial roads. Ideally they would have bus shelters. Where there is space, they would have a bank of short-hire bikes close by.

Could the one-way system be peak times only?

The simpler the system, the easier it is for people to understand and the better it will work. Congestion can occur at any time of day. Stopped delivery vehicles and taxis frequently block traffic. If we are serious about making buses a highly attractive alternative to driving, we need to keep other traffic out of their way.

Where would the pedestrian crossings be?

There should be a pedestrian crossing close to every bus stop. Locating bus stops close to junctions with light-controlled crossings is the simplest way to achieve this. Unlike zebra crossings, light-controlled crossings can be programmed to operate smartly: when a pedestrian presses the call button, if a bus is approaching the lights do not change until the bus has passed; otherwise they change immediately, so long as a minimum time has elapsed since the pedestrian phase was last active.

How many buses would be circulating the inner ring road?

Currently about 130 buses arrive in the Drummer St area bewteen 8am and 9am on a weekday. There is spare capacity on those buses, but a combination of modal shift and growth in population and employment will mean that the total number of buses required to move everyone around will grow significantly.

Between 2012 and 2017, there was a 13% increase in personal trips into Cambridge. On current growth trends, an additional 27% can be expected over the next ten years. Assuming that trips made by walking, cycling and train all increase by 27%, then we are left with about 25,000 additional daily trips that will need to be made by means other than driving.

The current best growth forecast for employment in the city in 2031 is that it will be between 32% and 82% higher than in 2011 (based on research at the University of Cambridge). We have used 27% growth to 2028 on top of 13% growth from 2012, which equals about 44%, so comfortably within the forecast range.

On top of that, the Greater Cambridge Partnership has an objective to reduce traffic in the city by 10-15% from 2011 levels. This would decongest the city centre, enable buses to move freely, and improve air quality. But it means shifting another 20,000 daily car trips to other modes.

Taken together, that means getting an extra 45,000 daily trips into Cambridge to be made by train, bus, cycling or walking – on top of expected growth in number of people walking, cycling and taking the train. Cambridge North and South stations will absorb some of that; as will improvements to cycling infrastructure. But a large proportion of that extra demand will have to be absorbed by buses. Even just 50% of those 45,000 trips equates to a near tripling of bus services.

A large proportion of those buses would not circulate the inner ring road at peak times. Some services would terminate at the Biomedical Campus and railway stations. Some would shuttle between the Biomedical Campus, Cambridge station and the city centre via Gonville Place. At peak times, some services would run from major settlements via the A14 and M11 to major employment sites, such as the Biomedical Campus and Science Park.

This shows how the flow of buses on the inner ring relates to the frequency of services on the nine radial roads into Cambridge:

Frequency on radial road	**Frequency on ring road**	**Distance between buses**	**Carrying capacity***
6/hour (every 10 minutes)	54/hour (every 66 seconds)	400m	4,590 people/hou

15/hour (every 4 minutes)	135/hour (every 27 seconds)	165m	11,475 people/hou
20/hour (every 3 minutes)	180/hour (every 20 seconds)	120m	15,300 people/hou

*Seated and standing capacity, assuming a 50:50 mix of single-decker (capacity 70 people) and double-decker (capacity 100 people) vehicles, averaging 85 people/bus.

Won't this be detrimental to The Backs?

Routing buses along Queen's Rd, alongside The Back is one of the more controversial aspects of the proposal. To be be clear exactly what is proposed:

- The northbound lane continues to carry general traffic.
- The southbound lane carries buses only.
- Car parking is removed from Queen's Rd as this could not be accessed safely from the northbound lane (cars would be manoeuvering in and across the bus lane).
- Unless and until a new location is found for a coach drop-off, coaches also use the southbound lane and continue to use the coach stopping bays at the southern end of Queen's Rd.
- Bus stop bays could be located to the south of the West Rd junction, where currently there are car parking bays.
- The design of the bus bays would be a task for professional designers. For minimal visual impact, the bus bays could simply be marked in paint on the road (as the parking bays are currently), with three poles marking the stops. An electronic information board could replace the parking ticket machine.
- No part of the road would need to be widened.

Queen's Rd is one of the busiest and most critical arterial roads in the city. Also known as the A1134, it is part of the city's inner and (incomplete) outer ring roads. The average daily amount of traffic (last counted in 2016) is:

- 13,102 cars
- 221 buses/coaches
- 1,728 LGVs
- 143 HGVs
- 307 motorcycles
- **15,501 motor vehicles in total**

The only way to reduce the volume of traffic on this road is to reduce it across the entire city. That requires shifting people from cars to alternatives, including buses. The object of routing buses around the inner ring road is to facilitate that modal shift.

under this proposal.

With an average spacing between buses of between 120m and 400m (see above), the visual impact is arguably less than the current stream of traffic and parked vehicles. A bus occupies the road space of two moving cars, yet replaces a queue of up to sixty cars, stretching from Burrell's Walk to Silver St. It can also be argued that giving bus passengers access to this uplifting view on their way to work is a boon.

There is an argument for running only single-decker buses in Cambridge, but this would entail running *more* buses at peak times, and increasing ticket prices.

When considering the negatives of running buses along Queen's Rd, it's important to also consider the negatives of continuing to run ever more large, heavy buses through Bridge St, Magdalene St, Jesus Lane, King St, Hobson St, St Andrews St, Silver St and Trumpington St. Not only are they a visual eyesore in the city centre, they are damaging our built heritage: college buildings and churches dating back hundreds of years.

Could buses use Grange Rd instead of Queen's Rd?

The additional distance alone would add 20% (3–4 minutes) to the journey time to circulate the inner ring. At peak times though the delay would be significantly greater, because all buses would have to mix with general traffic on a stretch of Madingley Rd, and either West Rd (if buses were just excluded only from the stretch of Queen's Rd north of West Rd) or Barton Rd and Newnham Rd. The junctions at the Fen Causeway and Northampton St would also operate less efficiently because flows of buses and general traffic would be crossing and merging. This would undermine the benefits of having buses circulate the inner ring road without obstructions.

There is also a pinch point on Grange Rd between the Cambridge University Rugby Club and Robinson College, where the road is not wide enough (at 5m) for two buses to pass. This would further delay buses, and create conflict with people cycling.

It was decided some time ago that traffic should be deterred from using Grange road, presumably because schools and halls of residence front onto it.

Is there also a proposal for a separate cycle lane along Queen's Rd?

There is a need for an alternative cycle route between west Cambridge and the city centre that avoids Garret Hostel Lane and Senate House Passage, as that route is often heavily congested during the summer, making conflicts and collisions inevitable. However this is a separate issue to running buses along Queen's Rd, and the need for a solution is not altered by whether or not buses are routed along Queen's Rd.

more trips throughout the day, for instance to attend a public lecture at the Sidgwick Site or a concert at West Road. Hence demand for parking spaces will fall.

What about the noise and pollution created by buses?

Buses will soon be electrically-powered. Shenzen in China runs a 100% electric fleet of buses: 16,359 of them. The whole-life cost of an electric single-decker bus is now almost the same as for a Euro 6 (low emission) diesel bus. Once that is also true of double-deckers, it will be in operators' commercial interests to buy electric fleets. The Greater Cambridge Partnership is already working on plans to install the necessary charging infrastructure.

How will this meet the needs of an aging population?

Public transport has a critically important role in allowing people to retain their independence, maintain their social connections, and continue being active. This redesign of the bus network is intended to make buses work better for everyone.

The design of buses does need to adapt to changes in society, and that includes providing better accessibility for people with impaired mobility, with young children, and carrying shopping or luggage. More space is needed to accommodate wheelchairs, strollers, push chairs and luggage. Two-door buses facilitate speedy boarding and disembarking, and hence reduce dwell time at stops. By using optical or magnetic guidance into bus stops, it is possible to align buses precisely with the kerb, making level boarding possible.

We need to incentivise bus designers, builders and operators to invest in making buses a fit form of transport for everyone. We also need to design bus stops and shelters to enable level boarding for two-door buses.

Wouldn't a congestion charge be better?

A congestion charge would deter people from driving in the city, but people will still need to make those trips and will therefore require a viable alternative to driving. A congestion charge goes hand-in-hand with running more buses.

Shouldn't we wait until the metro is built?

There is not yet a detailed costed plan for any part of a metro. Such a project will be hugely ambitious for local authorities with no experience of commissioning anything like it before. An optimistic timetable would be for the first metro line to be running in ten years. By itself one line will only serve a fraction of the population. So we need to

If and when we get a metro running through tunnels under the city, it will be possible to re-plan the bus network, with some services terminating at metro stations, where people would transfer to reach certain city destinations. But there will always be a need for buses to reach the large majority of the city that will not be within easy walking distance of a metro station. In other words the metro and buses will complement each other.

Why route buses into the city centre when the jobs growth will be outside?

It is true that future jobs growth is focused on areas around the city: Biomedical Campus, Science Park, Cambridge station, West/NW Cambridge, Cambridge North station, Northern Fringe East (sewage works), Airport (Marshalls industrial sites and, probably at some point in the future, the airport itself). Even if public transport delivers most employees to those sites without traversing the city (but see the answer to the next question), there will still be growth in demand to travel into and around the city.

Much of the 'knowledge intensive' work that goes on in Cambridge involves inter-company meetings. This will contribute to continued growth in trips from Cambridge railway stations to London, Stansted Airport and elsewhere. People working at those sites will want to travel into the city to shop, socialise, enjoy the culture, access health services. So too will people living in new settlements outside the city. Tourism too will continue to grow.

We're already behind the curve in public transport provision. Rail capacity is being increased to the south, but is severely constrained to the north and east. Bus provision is being reduced almost everywhere except the Guided Busway. This is pushing more and more people to drive, even people who previously used public transport.

Wouldn't it be better to run buses along an outer orbital?

Cambridge doesn't have a complete outer orbital. The two most significant gaps are across Grantchester Meadows and Ditton Meadows. Some buses will run along orbital roads, especially at peak times when demand is high and the route is most direct, for instance:

- Cambridge North station to West Cambridge via Darwin Green and Eddington
- Cambourne to the Science Park via the A14
- Cambourne to the Biomedical Campus via the M11
- Teversham to the Biomedical Campus via Airport Way to Queen Edith's Way

school, a workplace, a shop, a restaurant), which are more likely to all be reachable within a reasonable journey time via the inner ring road.

There are some estimated comparative journey times for inner and outer orbital routes in the appendix to our response to the Cambourne–Cambridge busway consultation.

Won't people still prefer to drive than take the bus?

Improving bus services in the city centre is only one of a raft of measures needed to rebalance the incentives for people to use sustainable modes of transport. Other measures include:

1. Reducing parking availability in the city centre, for instance with neighbourhood parking schemes.
2. Prioritising buses on radial routes, for instance using Inbound Flow Control.
3. Making parking in the city more expensive, for instance with increased charges to arrive or depart from multistorey car parks at peak times; increasing on-street parking charges; levying a tax on staff parking spaces provided by employers.
4. Some form of road pricing or congestion charging.
5. Improving train services by adding new stations and reinstating track on the Newmarket line.
6. Running more express bus services from travel hubs throughout Cambridgeshire.

Isn't Park & Ride a better solution

Park & Ride doesn't reduce the number of buses in the city centre, only the number of cars. However there are many reasons why it is preferable to develop a comprehensive bus network that serves the rural community directly, rather than via Park & Ride sites.

Where would buses lay over?

Buses currently terminate on the city and there is a delay before it must leave again as the next outbound service. This is timetable 'recovery time' to compensate for variable delays inbound. This proposal assumes that buses will run at a fixed frequency rather than to a timetable, at least at peak times. The Traffic Commissioners' office does not require a timetable for 'high frequency services', defined as every ten or fewer minutes.

disrupting other buses: Grafton Centre, Sun Street, Victoria Avenue, Chesterton Road. It may also be possible to take buses out of service to lay over in the bus station or on Parker St or Parkside.

[Graphics updated 13 October 2019]

hub-and-spoke lollipop routing ring-and-spoke



Edward Leigh

Edward Leigh is the leader of Smarter Cambridge Transport, chair and independent co-opted member of the Cambridgeshire Police and Crime Panel, chair of the South Petersfield Residents Association, business owner, consultant, and occasional blogger about making the world and Cambridge a better place to live.

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We will all lose out if the GCP abandons large-scale projects to reduce congestion

News, Press release / 15 February 2024

The Greater Cambridge Partnership (GCP) intends to substantially reduce the money it spends on projects to cut congestion in Cambridge, and is vastly scaling down its ambition in this area. It plans to cease work under its City Access programme on large-scale, transformative, city-wide projects such as road charging and reclassifying the road network, and proposes to pursue localised, minor interventions and speculative pilot schemes in their place.

While these schemes may produce some limited, though welcome, benefits we believe that this restricted focus is misguided. The substantial downscaling puts in jeopardy the GCP's ability to tackle Cambridge's widespread motor traffic congestion, which causes daily misery and frustration. Congestion across the city makes walking, wheeling and cycling more hazardous, renders bus services increasingly unreliable and pollutes the air we breathe. It also delays commuters, discourages shopping and leisure visitors, and disrupts business activity. If the GCP is unable to meet its objective of reducing motor traffic congestion in Cambridge by 15% on 2011 levels, it will have let everyone down – people who drive cars or vans, take buses or taxis, and walk, wheel and cycle alike.

The GCP's programme of work is determined by the elected politicians who lead our local councils. If they abandon the ambition of large-scale, city-wide action to reduce motor traffic congestion, they will ultimately be responsible for the GCP failing in its core goal of fixing the region's inadequate transport network, which currently hinders economic growth.

The current high motor traffic levels are hinted at as the reason for abandoning the road reclassification project. The Eastern Access project, Hills Road and Madingley Road schemes are also being watered down due to the need to accommodate large numbers of cars. It is highly inequitable that projects to encourage people to use sustainable transport and reduce car usage cannot go ahead or are compromised because there are currently too many people driving. Many people who drive would like to travel by sustainable means, but cannot. When GCP officers assessed the threats and opportunities of not proceeding with the Sustainable Travel Zone road charge last September, they did not mention that abandoning road charging would leave them unable to deliver other GCP projects. In hindsight, this is a significant omission.

Changing the way Cambridge's roads are classified could have transformed the city for the better. It could have allowed buses to run on time (over half of bus users we interviewed in Cambridge last summer thought non-Park&Ride services were late or unreliable), made walking, wheeling and cycling much easier, safer and more pleasant, given us cleaner air to breathe and made the city a much more attractive place to live, work, do business, visit or spend time. In the consultation on road reclassification, 62% of respondents were in favour of the key principle of using modal filters to ensure motor vehicles use main roads as much as possible.

Unless local political leaders summon the courage to work together to deliver a road reclassification project, bring about another transformative option, such as a workplace parking levy, or, at the very least develop a full package of incremental improvements that act powerfully in combination, by 2030 – the year in which the City Deal concludes and Cambridge City aims to reach net zero – Cambridge will still largely be encumbered with a 1980s road system designed to prioritise the private car over sustainable travel.

Silviya Barrett from national transport charity Campaign for Better Transport (a member organisation of the Cambridgeshire Sustaianble Travel Alliance) said:

> *"The only way to tackle congestion is to reduce the number of cars on the roads. Traffic reduction measures, coupled with public transport improvements have been proven to cut congestion, reduce air pollution and make places more pleasant to work and live."*

Richard Wood from Cambridge Area Bus Users said:

> *"Cambridge Area Bus Users has received multiple complaints about unreliable bus services; one member reported walking from the city centre to the Catholic Church faster than five buses crawling along in road congestion. The group cannot envisage significant improvements in bus reliability until congestion is tackled by reallocating road space away from private cars to buses and active travel. Likewise, David Boden, Director of Business Development at Stagecoach East, Chair of the recently-formed Cambridgeshire and Peterborough Bus Alliance, is calling for local authorities'*

> *support in delivering a road network on which bus operators can deliver punctual services.*"

Many other UK cities are planning or have taken bold steps to transform transport. Edinburgh will further restrict private vehicles through its city centre to reduce journey times by public transport, Oxford is going ahead with traffic filters and Low Traffic Neighbourhoods (LTNs), Bristol has a Clean Air Zone, central London has an effective congestion charge and recently extended the Ultra-Low Emissions Zone to all Greater London boroughs, and Nottingham's Workplace Parking Levy helps support its admirable integrated public transport system. Why does progress in this area continue to elude Cambridgeshire's politicians?

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September Bus Changes

Uncategorized 27 August 202423 November 2025 4 Minutes

Two steps forward; one step back?

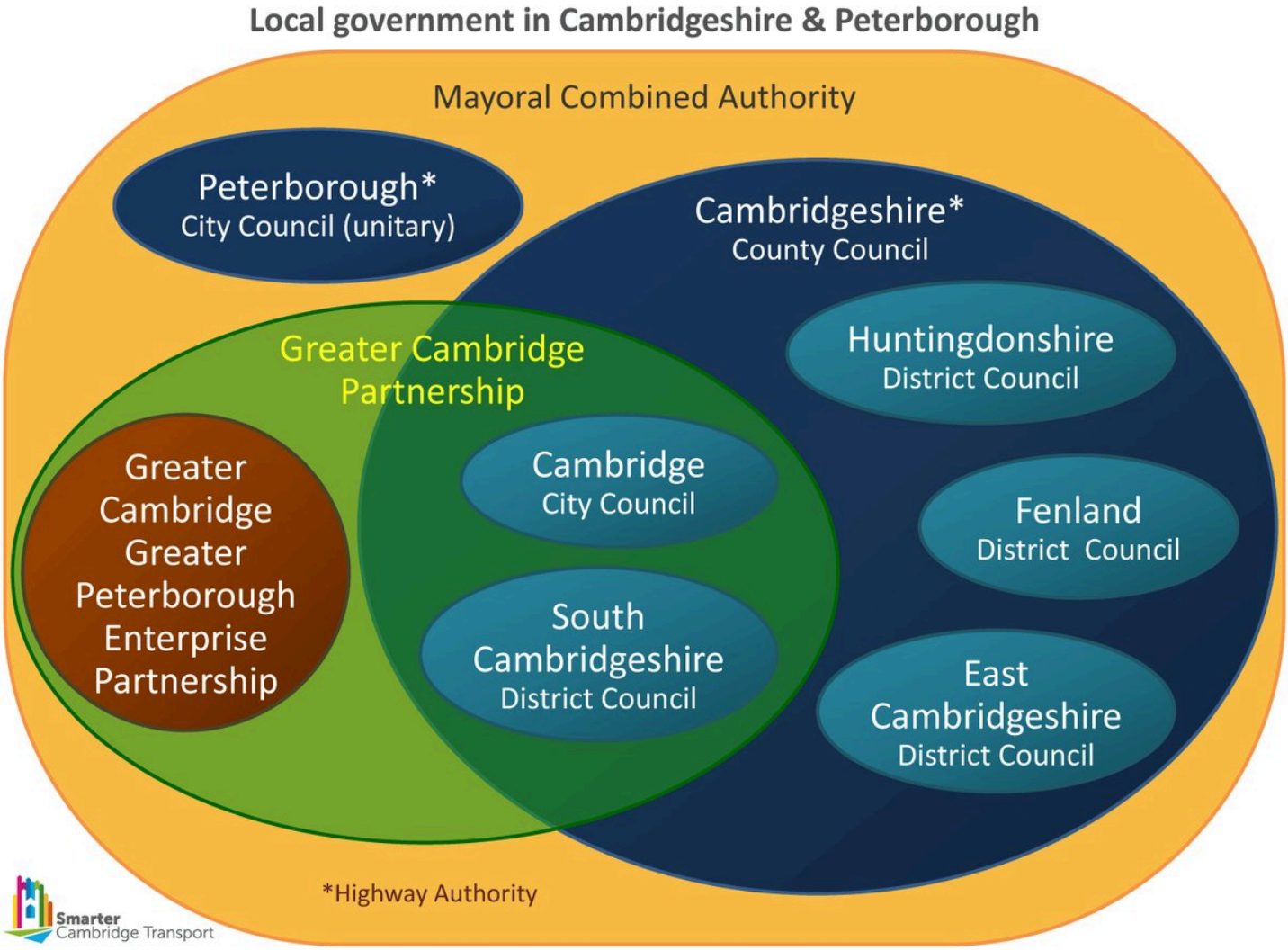
There is much to welcome in the September changes to bus services in and around Cambridge announced by Stagecoach (https://www.stagecoachbus.com/about/east) and Whippet (https://www.whippetbus.co.uk) – Stagecoach changes from Sunday 1st September (https://cbgbususers.wordpress.com/2024/08/17/stagecoach-changes-from-sunday-1st-september/), New Whippet service 18a from 2nd September (https://cbgbususers.wordpress.com/2024/08/16/new-whippet-service-18a-from-2nd-september/) – with increasing funding from Cambridgeshire and Peterborough Combined Authority (https://cambridgeshirepeterborough-ca.gov.uk/news/students-employees-and-communities-to-be-better-connected-with-first-batch-of-upgraded-bus-services/).

However…

Some services are being 'rationalised' (Stagecoach's citi1 in Fulbourn) others have longer journey times (citi7) or reduced frequency (citi6) whilst others have, currently, no prospect of returning to pre-Covid frequency levels (citi2 every 20 mins, 10 mins pre-Covid).

And the elephant in the room (or on the streets)? Traffic congestion

Cambridge Area Bus Users recognise that commercial bus companies cannot run services at a loss. Adding extra buses to maintain frequencies adds costs, without any certainty of increased farebox revenue. Unless our plethora of overlapping local governance bodies (see graphic, below) take radical action to tackle traffic congestion bus services will be in a spiral of decline: reduced speeds ➞ increased costs ➞ lower ridership ➞ reduced income ➞ service reductions ➞ lower ridership ➞ reduced income ➞ further service reductions.



Tackling traffic congestion: the need for bold action

In February 2024 sister organisation Cambridgeshire Sustainable Travel Alliance (https://cambstravelalliance.org/) issued a press release – We will all lose out if the Greater Cambridge Partnership abandons large-scale projects to reduce congestion (https://cambstravelalliance.org/we-will-all-lose-out-if-the-gcp-abandons-large-scale-projects-to-reduce-congestion/).

> *The current high motor traffic levels are hinted at as the reason for abandoning the road reclassification project. The Eastern Access project, Hills Road and Madingley Road schemes are also being watered down due to the need to accommodate large numbers of cars. It is highly inequitable that projects to encourage people to use sustainable transport and reduce car usage cannot go ahead or are compromised because there are currently too many people driving. Many people who drive would like to travel by sustainable means, but cannot. When GCP officers assessed the threats and opportunities of not proceeding with the Sustainable Travel Zone road charge last September, they did not mention that abandoning road charging would leave them unable to deliver other GCP projects. In hindsight, this is a significant omission.*
>
> — **CSTA press release as above (https://cambstravelalliance.org/we-will-all-lose-out-if-the-gcp-abandons-large-scale-projects-to-reduce-congestion/)**

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And the bus operators' view?

We contacted David Boden, Business Development Director of Stagecoach East, Chair of the recently-formed Cambridgeshire and Peterborough Bus Alliance, who was kind enough to provide the following statement.

> *As people who run local buses, we tend to talk about two connected but different concepts: 'reliability' and 'punctuality'. We are very willing to be held accountable for the aspects of reliability we can control – that is to say, providing a bus and a driver when we say we will. But, once the bus leaves the station or depot, its punctuality is overwhelmingly dictated by issues like congestion, parking enforcement and roadworks, none of which are in our power to change.*
>
> *All this slows the bus down, increases journey times and the cost of service provision, and makes it really difficult to rebalance using the bus over car. There is no secret formula to all this, put simply, if you want a world-class bus network, you need a world-class road network and bus infrastructure.*
>
> *Our local authorities work very hard to try to mitigate the negative effects of roadworks where they can, but there are sadly limits to their powers. Now is the time for everyone, including the utility companies, Highways and other key stakeholders, to engage with bus operators directly in a meaningful and productive way.*
>
> *Buses are a key lifeline for our region, and with a genuine desire from everyone to go that extra mile in minimising disruption to bus services, we can offer the residents of Cambridgeshire the excellent service that we all want them to have.*
>
> ***It is a burning issue. Bus services are not going to get any better – and will continue to get worse – until we have those conversations, and elected officials then are willing to make bold and difficult decisions.*** *[Our emphasis]*
>
> *I will say that, in recent times, we have seen some elements of progress. We recently praised the communication from UK Power Networks for their Mill Road works, for example. They gave us proper notice and this led to high-level discussions between the two companies, with potential ways to keep disruption to a minimum, floated.*
>
> *We hope that this will set a template for all such interactions in the future, so it becomes 'business as usual' that utility companies talk with the major bus operators so we can all work together as best we can.*
>
> **— David Boden, Business Development Director of Stagecoach East, Chair of the Cambridgeshire and Peterborough Bus Alliance**

Ian Lockwood (https://tooledesign.com/people/ian-lockwood/), a recognized national leader in sustainable transportation policy (USA) and urban design (and witty cartoonist) sums up the situation, neatly.



Traffic Inducing Traffic

We recognise that funding for comprehensive, fast, frequent bus services cannot rely on farebox revenue alone. Support from the public purse is also essential. That public purse is not inexhaustible; plans for radical improvements to bus services envisaged by Cambridgeshire and Peterborough Combined Authority (our Transport Authority) could founder unless Cambridgeshire County Council (our Highway Authority) and the Greater Cambridge Partnership (holder of the 'City Deal' purse strings) "**are willing to make bold and difficult decisions**".

Tagged:
bus frequency,
bus services,
Combined Authority,
Stagecoach East,
traffic congestion

Published by CBGbusUsers

Cambridge Area Bus Users • seeks to represent – and campaign on behalf of – bus passengers in and around Cambridge; • is independent of any political party. *View all posts by CBGbusUsers*

4 thoughts on “September Bus Changes”

CBGbusUsers says:
28 August 2024 at 10:52
You ask, Martin, “When are CAPCA going to stand up to the Roads Lobby, and are they afraid of doing so?”

Cambridgeshire and Peterborough Combined Authority is not the Highway Authority in Cambridge/Cambridgeshire; that is Cambridgeshire County Council. Recently abandoned plans for a Sustainable Travel Zone came from the Greater Cambridge Partnership (holder of the City Deal purse-strings). If implemented, this would have required the exercise of Cambridgeshire County Council’s powers (with Greater Cambridge Partnership funding).

You ask, Martin, “… the recent announcement that trams are likely to be coming to Cambridge within the next few years is a game changer.”

We are aware of the recent publicity drive by Cambridge Connect, and the associated plea for feasibility/business-case funding. A well-planned tramway scheme would be of benefit to the Greater Cambridge travel-to-work area, but is far from shovel-ready, and even further away from operation. In the meantime, improved bus services (frequency, times of operation, geographical coverage) will be essential. Buses will also help to expand/prove the market for public transport in general. If/when a tram/metro comes into operation, buses will be needed to link areas that a tracked system will never be able to serve.

You ask, Martin, “Whilst we are on the subject of buses, when are CAPCA going to provide funding for the reintroduction of Evening and Sunday buses on routes radiating from Drummer Street Bus Station?”

Cambridgeshire and Peterborough Combined Authority’s mayor, Dr Nik Johnson, can speak for himself, but could we urge you to read the consultation documents on the way forward for buses? Look out for a forthcoming Cambridge Area Bus Users post on this.) These compare the benefits of a statutory ‘Enhanced Partnership’ and ‘Franchising’ under the Bus Services Act 2017. Considerable levels of funding are proposed, as are the introduction of addition routes, times of operation and fare capping. Currently the Mayor’s powers do not permit him to establish new routes which might be considered to compete with commercial services. Under ‘Franchising’ the Mayor would specify all routes, fares, times and days of operation. Under an ‘Enhanced Partnership’ improved routes, fares, times and days of operation, could be negotiated with operators.

You write, Martin, “I have seen no sign of Stagecoach East restoring the Service 9 frequency to its pre-coronavirus levels.”

As commercially-operated de-regulated route, Stagecoach have no obligation to run it at any frequency, or at all, only the obligation to pre-register changes with the Traffic Commissioner and to pre-notify the Cambridgeshire and Peterborough Combined Authority (as Traffic Authority)to enable the Combined Authority to find an alternative operator. In the case of route 9 the Combined Authority has engages A2B to run some of the withdrawn services.

You write, Martin, “I don’t buy the idea that the route was running at a loss.”

Route 9 is outcompeted by faster, more frequent railway services from Littleport and Ely to Waterbeach, Cambridge North and Cambridge Adult return fares are comparable. It is surprising that Stagecoach kept the route running at the previous frequency for so long. Admittedly, closure of their Ely depôt as an operating centre did not help, but that decision was entirely theirs to make as a commercial company, seeking to restrain costs.

You write, Martin, "If it isn't reinstated ASAP, I will be seeking a FoI request to see the passenger usage data. If they still refuse, I will be seeking Legal Advice."

Route 9's frequency has been partially restored through the intervention of the Combined Authority's contract with A2B. Stagecoach is not a public body; you cannot submit an FoI request for their commercially-sensitive information.

CBGbusUsers says:
28 August 2024 at 10:00
Whilst former Stagecoach East Managing Director, Andy Campbell, claimed that 20mph zones slowed his buses, no proper study has been undertaken to verify this. Given the close proximity of stops and the levels of traffic congestion, over the Cambridge city/citi network, this is a moot point.

On the 1/7/13 route southward on Hills Road, Cambridge, the stop opposite Hills Rd 6th Form College (NaPTAN 0500CCITY060) is around 450 yds (410m) ahead of Cambridge Blinco Grove (near) (NaPTAN 0500CCITY036). If no passengers board or alight at either stop, and there are no turning vehicles, or other potential obstructions to safe running, the time taken will be about 30 sec at 30mph -v- 45 sec at 20mph.

If, however, passengers wish to board or alight, both of these times will be extended by the need to accelerate (gently) away from 0500CCITY060 and to brake (gently) before 0500CCITY036. Under such conditions, a top speed of 30mph, if attained at all, would be for the very briefest of time – maybe 10 sec – with negligible time advantage.

martinthorne1 says:
28 August 2024 at 00:43
When are CAPCA going to stand up to the Roads Lobby, and are they afraid of doing so?

As things stand, Public Transport in Cambridge is no better than that of a Third World country at present. However, the recent announcement that trams are likely to be coming to Cambridge within the next few years is a game changer. Once built and in operation, then a London-style ULEZ scheme for the City Centre could be brought into use.

Whilst we are on the subject of buses, when are CAPCA going to provide funding for the reintroduction of Evening and Sunday buses on routes radiating from Drummer Street Bus Station? Last night, myself and a friend of mine caught the last service 11 bus from the Bus Station to Swaffham Bulbeck at 7-15pm. It was standing room only, so it proved that the demand is there. Such a reintroduction, particularly on Friday and Saturday nights and during School Holidays, would help to reduce the carnage on our roads caused by drunk drivers.

Finally, I have seen no sign of Stagecoach East restoring the Service 9 frequency to its pre-coronavirus levels. What have they got to hide (I don't buy the idea that the route was running at a loss)? If it isn't reinstated ASAP, I will be seeking a FoI request to see the passenger usage data. If they still refuse, I will be seeking Legal Advice.

Martin Thorne, Vice Chairman Cambridge Connect/Cambridge Street Tramways Corporation.

Nigel Pennick says:
27 August 2024 at 18:18
There are suggestions in Cambridge that 20 mph zones should be extended further. Long sections of road at 20 increase the running times of buses, and the Milton service was for a while cut back to the Science Park as the bus company was unable or unwilling to add more buses to the route. I have heard that some bus routes in Wales were cut for the same reason. The unintended consequences of slowing everything down seem not to be understood by those in control of us.

Comments are closed.

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Can we swerve the carbon risks of depending on Park & Ride as we transform visitor travel?

Alistair Kirkbride 5th March 2024

There is a *lot* of talk in relation to rural visitor destinations about pulling visitor traffic back from busy areas, with forms of park & (P&R) as part of the solution. The intention is welcome as it shows that the debate of visitor access management has moved on. But might there be a big carbon monster hiding behind park & ride as a component of the solution?

Firstly, let's look overseas then come back closer to home.

The "traffic free" (= visitor car restricted) destinations in Europe such as Sass Fee, others in the Swiss alps or the car-free Greek islands all hide the inconvenient truth of colossal gateway car parks.



Swiss gateway car parks a. Saas Fee b. Lauterbrunnen (for Murren & Wengen) and c. Tasch (for Zermatt)

These cater for *thousands* of cars; Lauterbrunnen's has 974 spaces, Tasch (for Zermatt) as 2,100 spaces and Saas Fee's car park h 3,000. For context, the places served by these have the following annual numbers of overnight stays: Lauterbrunnen/Wengen/Murren: 807,088, Zermatt/Tasch: 2,634,866, Saas Fee: 1,224,638.

So let's do some crude converting back to somewhere more familiar. Let's assume there are about 3.5m overnight visitors per ye to the Lake District; shifting to an access system where visitor access to the national park is via P&R sites at gateways, the Swiss examples would suggest the need for the following number of P&R parking bays for the Lake District:

- c.f. Tasch/Zermatt – which has a very good rail link: 2,790 P&R bays
- c.f. Lauterbrunnen – which has good rail access but with some local capacity problems: 4,224 bays
- c.f. Saas Fee – c. 27km bus link to main rail station: 8,574

For comparison, the whole of the central & southern Lake District currently has about 4,300 car park spaces – plus the unregula parking at accommodation, attractions etc.

The clear implication is that this implies *very* large new car parks at gateways, the logical locations for which would be within th national park. Is that what we see as success? Would there be any serious countenance of building new car parks on this scale a gateway locations?

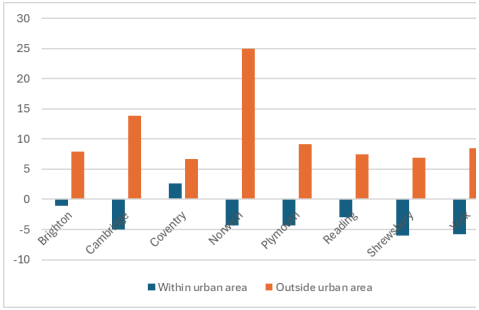
Secondly, does park & ride work?

P&R is an instrument used primarily to pull cars out of congested areas to enhance the quality of the core areas, often for the purposes of economic prosperity and improving air quality[1]. It is common for many towns & cities, with long-standing scheme places such as York or Cambridge. Policy makers like P&R because it shows action and is an acceptable solution in the eyes of th public[2]. In short, the public "get it" – there is a problem with cars, and park and ride is a reasonable way of dealing with it.

There are three inconvenient truths about park and ride.

1. Park & ride leads to an increase in overall miles driven.

Graham Parkhurst's review of data on impacts of various UK urban P&R on car miles[3],[4] is summarised in the chart.



Net change in travel inside and outside urban areas per car parked equivalent km per intercepted car) (From Parkhurst, 2000)

Whilst there are modest decreases in car km within the P&R zone (except Coventry) – the main aim of P&R schemes – there are significant *increases* in car km on the approaches to park & ride sites. Further work published in 2018[5] supports this "a net increase in passenger car unit (pcu)-kilometres may be observed... due to increased car-kilometres in catchment areas of P&R sites"

2. Park & ride leads to a shift to car from public transport on the approaches to P&R sites

There is evidence that the increase in car km in the approach to P&R sites is at least partly explained by people being shifting *from* public transport use. "Bus services outside the site may have to compete for some marginal users for whom park and ride makes it easier to travel the long haul part of the journey by car. This implies less revenue to the public transport operator, reduced bus energy efficiency and in some cases either service cuts or a greater need for public subsidy"[6].

3. Park & ride can attract new *traffic*

Finally, there is also evidence that the existence of a P&R scheme can have the effect of attracting *new* traffic – i.e. journeys that would not have been made at all. Whilst this can be seen as a benefit from an economic perspective (if customers and spend in say – a town centre is a primary outcome), the traffic generation has many disadvantages in terms of the nature and scale of problems that the P&R was designed to tackle.

So what does this mean for park and ride for rural visitor destinations?

The good news? The key benefit of P&R – namely management of access to the core area – would apply similarly in rural visitor destinations as the more normal urban centres. As a policy instrument, there are significant attractions as part of a package of measures to manage visitor access – especially at busy times – so that visitor experience is enhanced, and to enable and trigger other services and possibilities.

However:

If an objective is carbon reduction, overall carbon emissions would almost definitely increase.

This would be because the P&R would lead to both a shift in long approach journeys to car from other modes and is likely to generate new car trips.

Visitor car access in the core area would have to be restricted.

P&R *without* access restrictions can lead to significantly more overall car use as the P&R adds to the existing (car based) transpo system.

Given the high proportion (i.e. volumes) of visitors currently arriving by car (c.90%, translating to millions per year for most natio parks), gateway P&R car parks would have to be enormous. Whilst it might be possible to trade this off to an extent by removing car parks from the core area, on balance, it is difficult to see how this approach sits with mid 21st century policy imperatives and social agendas.

So if not park and ride, what *is* the answer?

Let's not pretend the solution (to the high carbon and negative impacts of cars on rural destinations) is straightforward, but this blog tries to summarise and expose the risks of seeing P&R as a silver bullet.

The wider Low Carbon Destinations agenda is based on the study *Decarbonising the whole visitor journey for rural destination* it's the *whole visitor journey* that is the important part here, hence the 6-component model. This blog leads back to an imperati to focus on enhancing and creating capacity for travel *to* destinations with the enabling interventions (luggage transfer etc) tha make this possible. From a carbon perspective, this needs to be seen as a priority, even if it is hard and falls between the cracks responsibilities. Put another way, if travel *to* is prioritised, then the need for park & ride – with its carbon risks – falls away.

Being pragmatic, sorting out approach travel to the scale required is not an easy task, whereas there is impatience – and broad enthusiasm – to tackle in-destination visitor access management. In this respect, P&R in various guises is likely to be a part of packages of place-focussed access management. If this is the case, it just needs to be acknowledged that whilst it might help s a local problem, any P&R development should be considered as transient as part of a longer term ambition, otherwise it just displaces a problem (congestion) or makes a different problem (carbon emissions) bigger.

[1] https://www.its.leeds.ac.uk/projects/konsult/private/level2/instruments/instrument035/l2_035b.htm

[2] Meek, S., Ison, S., Enoch, M. (2011). *Evaluating alternative concepts of bus-based park and ride*.

Transport Policy, 18 (2), 456–467.

[3] Parkhurst, G. (2000). *Influence of bus-based park and ride facilities on users' car traffic*. Transport Policy, 7 (2) 159-172.

[4] Taken from Parkhurst, G., Meek, S. (2014) *The Effectiveness of Park-and-Ride as a Policy Measure for more*

Sustainable Mobility. Chapter 9 in Ison, S. & Mulley, C. (Eds) Parking Issues and Policies. 185-211.

[5] Mills, G & White, P. (2018) *Evaluating the long-term impacts of bus-based park and ride*, Research in Transportation Econom 69, 536-543

[6] Parkhurst, G. (1995) *Park and ride: Could it lead to an increase in car traffic?*. Transport Policy, 2 (1) 15-23.

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Park and ride: could it lead to an increase in car traffic?

Graham Parkhurst

ESRC Transport Studies Unit, University of Oxford, 11 Bevington Road, Oxford OX2 6NB

The detailed and long-term effects of park and ride are more complex than generally acknowledged. In 1994, studies of park and ride were carried out in Oxford and York. The success of park and ride in attracting users was confirmed, and these users reported high levels of satisfaction. However, some users had switched from modes other than car and others were found to be making additional trips which had been attracted by the opportunity to park and ride. Congestion has remained persistent in the cities studied and there is concern that total travel may have been increased rather than reduced, which was the intention. It is concluded that, for park and ride to be successful, 'package' policies will need to be strengthened to favour conventional public transport and that particular care will need to be taken by other local authorities adopting park and ride.

Keywords: park and ride, public transport, integrated transport policy, interchange

This paper considers some effects of bus-based park and ride systems on the host city and surrounding area.

Bus-based park and ride in the UK originated in the 1960s. Great interest followed in the 1970s and this has re-emerged with considerable influence in recent years. The number of cities considering schemes continues to grow, as does the range of settlement size and type for which park and ride is considered an appropriate strategy. Nottingham has more than 2000 permanently available spaces. Many places, such as Bath and York, although having less than a thousand dedicated spaces, can offer more on Saturdays by negotiating the use of car parks used in the week for other purposes. Bristol, a city of 400 000 inhabitants, currently has one site with 1500 spaces, but plans to provide 12 000 spaces in ten sites. Winchester, Guildford and Brighton have all initiated schemes recently.

Furthermore, the scale of existing and planned schemes continues to increase. Although not in the same league as Bristol, the cities of York, Chester and Oxford are developing proposals to provide more than 4000 spaces each. At Oxford, 20% of central area parking supply is now provided in park and ride car parks. If only public parking space is considered, then this figure approaches 50%.

Despite this fast and widespread expansion, relatively little research exists to demonstrate the wider impact of park and ride policies. The Oxford system provides a case-study which is 21 years old and has often been seen as a test-bed, if not quite a blue-print, for many other schemes. However, observation alone can only provide the conclusions that park and ride is popular with motorists and is successful in attracting users. In fact more detailed research has been carried out on this system.

In the first years of operation, researchers at the Transport Studies Unit of Oxford University (TSU) monitored the introduction of park and ride and were critical of the low

levels of patronage and the corresponding financial liabilities (Papoulias and Heggie, 1975; Heggie and Papoulias, 1976; Papoulias and Heggie, 1976). They were also the first to show, for Oxford's western site, that although most patronage had been derived from motorists who would otherwise had driven to the centre (57–68%), people who had formerly travelled by bus were also using park and ride (5–8%). They also found that 'informal' park and ride had previously been practised by 10–14% of their sample (254 users), and that 12–14% had switched allegiance from Oxford's first, southern, site when the western one opened.

Later, when the future of this western site in particular was in jeopardy, White (1977) found that depending on the day of use, 48–51% of a sample of 415 users would drive to the centre instead, whilst 22–30% would travel by bus if the site were to close, which was rather more than the number who would use another park and ride site (13–16%). This suggested that bus services were seen by many to be a better option than travelling (an extra) three miles by car.

Future surveys would tend towards White's account of significantly overlapping demand for the various mode-sectors, rather than the modest levels identified by Heggie and Papoulias. In any case, the strength of political will in favour of park and ride proved to be the most

important factor in deciding the fate of park and ride in these early years, and the system survived further trials to give rise to more favourable patronage statistics.

Since the mid-1970s, research on the system has largely been the preserve of another Oxford-based group, Bixby and his students at the Department of Town Planning, Oxford Polytechnic.[1] Examination of their survey reports shows that, in addition to recording the build up of park and ride patronage over the decades, they identified persistent behavioural responses that were not anticipated, or not intended, by the architects of park and ride.

In 1978, four years after the first of the present sites opened, Devonald *et al.* (1978) surveyed 1000 users. From their Wednesday survey, around two-thirds of their sample saw the car as their alternative mode, whilst a quarter would travel by bus. However, on Saturday, more would use the car, and bus use would be trivial. They noted that for the two sites, at least a quarter and a third of patronage respectively seemed to originate from relatively urban areas. Also, there was evidence that walk trips were making up 5–10% of the trips to one site. Bixby (1978) was sufficiently confident of these results to conclude that about a quarter of users did have a bus alternative and also suggested that park and ride had the power to generate travel.

Collins *et al.* (1987) in a survey of 550 users on the re-launched east–west route in Oxford found that 41.5% of users had switched from the car, but 39.3% from conventional bus routes and 7.3% had already been using park and ride. To some extent this seems to have been due to significant numbers of users walking to the sites to take advantage of a cheaper service.

Newson (1993) discusses another study carried out by the same institution a year later which contacted 745 users and found that 58% saw driving to the centre as their alternative, whilst 29% would use bus or rail services and 8% would suppress their journeys.

More recently Cooper (1993), working in York, found that 15% of trips to the site by her sample of 150 high frequency users had been made on foot and that 19% had previously travelled by bus. She further notes that 35% of the sample thought their alternative to park and ride was a conventional bus, but the full implications of the implied mode-shifts are not considered.[2]

Although some professionals may have had concerns that the impact of park and ride was not being fully monitored, only in a very few cases have these concerns been publicised. Huntley (1993), for example, notes the absence of traffic reduction effects.

One reason for this seems to be that the work carried out on park and ride has often been in the form of student projects. Once completed, the authors have tended to move on to other concerns and the usual machinery of dissemination has not operated.

Other contributory reasons may be that the apparent benefits of park and ride were irresistible, or that those with an interest in over-viewing the subject lacked the necessary survey-budgets for the provision of empirical evidence. Certainly, local authorities seem to have been primarily concerned with collecting data to confirm the viability of existing park and ride sites or to assist in negotiating their implementation.

For these reasons, it was felt that a large-scale and objective overview of park and ride was long overdue. To this end, studies of two park and ride operations were carried out as part of a project to consider the current state of transport interchange, funded by the Rees Jeffreys Road Fund, with additional support from the ESRC. The case-studies selected were the schemes at Oxford and York. Oxford's is currently the largest in the UK, with 3700 spaces, and the oldest, this being the 21st year of continuous operation. York's, with 563 spaces, was a success soon after launching as a permanent, full-time facility in 1990.

The survey in York contacted 600 users and was conducted by York City Council and analysed by TSU. The Oxford survey, involving 1750 users, was a TSU venture. Both surveys involved a Friday and a Saturday. Survey forms were handed to users of the bus service for self-completion whilst waiting to depart and collected at the alighting stop. Buses were sampled at the same rate from the start of operations until the late afternoon, with the intention of approaching a representative sample of users arriving at different times. The data were weighted to correct for different overall sampling rates between the two survey days, and to provide an estimate of weekly use.

It should be noted that although the size and historic quality of the cities are at least comparable, there are other important regional, socio-economic and contextual policy differences. In addition the surveys were similar, but not identical; there were a few questions that were difficult to ask in Oxford, due to the length of time since opening. Conversely, some questions could not be asked in York because sufficient experience does not yet exist. Other questions had to be asked differently in each city. For these reasons, the analysis should not be considered to be a direct comparison of the two cities, but rather an investigation as to whether similar conclusions can be drawn despite these differences.

The effects of park and ride

Transport policies can be expected to have their intended beneficial effects, but also unexpected neutral effects and perhaps unintended negative effects. The benefits of park and ride are well established, accepted and publicised. However, the dis-benefits have received much less concern or discussion. In coming to a balanced view, we need to consider potential disadvantages or problems, in order to judge in which direction to strengthen park and ride in the future, and whether suc-

[1] Now School of Planning, Oxford Brookes University.

[2] However, after completing this research, a study carried out in Chester came to light (Jones, 1994) which had considered many similar issues. Due to resource constraints, this research was confined to shopping trips from one of the three Chester sites, however there were similar findings, some of which are noted later in this report.

cess requires changes in other related aspects of transport policy.

Summary of benefits

(i) The most important benefit of park and ride that has emerged is the enabling effect on plans for economic and environmental enhancement. In political terms, a successful park and ride scheme can also help to win support for other plans for transforming town centre environments, such as pedestrianisation, which might otherwise be resisted.

(ii) Some vehicle movements can be removed from that part of the urban road network 'inside' the park and ride site. This provides local congestion relief, reduced energy consumption, and some reduction in air pollution.

(iii) The parking space provided at the edge of the city can increase the overall supply, whilst allowing central land to be used for a more economically beneficial purpose. There is also the potential to reduce central parking supply, rather than just restrain use, although there are no convincing demonstrations of this having happened in the UK, in some cases because of the predominance of privately controlled parking supply.

(iv) Traffic and parking capacity can be restrained in the centre of a major urban area without needing to reduce the overall access to the centre of the city from outside. Even if the volume of car use in the centre is not reduced, it is possible to increase the total numbers of travellers to the centre without the additional congestion and environmental intrusion that would have happened if those extra people had come by car.

(v) Motorists report favourable experiences with park and ride. The opportunity to travel in a stress-free manner, often via bus lanes, is valued. Upon arrival, preferential access may be given to the shopping area and difficulties encountered with multi-storey parking are avoided. At the same time, the benefits of car use — flexibility, immediacy of access, speed and privacy — are enjoyed for the main part of the journey. It is possible that a favourable experience with public buses will encourage further use of public transport.

(vi) By increasing the accessibility of the central core, pressures for suburban development and out of town relocation may be reduced.

Summary of dis-benefits

(i) The most obvious drawback is the environmental impact of constructing large car parks in sensitive land, often green belt, on the urban fringe.

(ii) However, a more serious shortcoming is probably the ineffectiveness of park and ride in reducing traffic downstream of the sites. No long-term reductions in traffic levels have been attributable to park and ride schemes. In both Oxford and York, the trips removed from the road network have been replaced by new car trips and a congested equilibrium has been maintained (Parkhurst, 1993).

(iii) A cost–benefit assessment of overall resources may show that a subsidy is justified, and County Councils are increasingly prepared to promote and fund schemes. However, on occasion in the past, the costs of park and ride have fallen on the urban resident. Some schemes have sought to discourage people travelling on park and ride buses unless arriving at the site by car.[3] In these cases, there is an equity problem since local people are denied the opportunity to walk or cycle to the site, to take advantage of a favourable bus service, despite contributing financially to it.

(iv) Although the total market for bus travel inside the site is increased, and the park and ride bus service can often be run commercially once patronage is established, some form of subsidy is typically required for the site itself. Bus services outside the site may have to compete for some marginal users for whom park and ride makes it easier to travel the long-haul part of the journey by car. This implies less revenue to the public transport operator, reduced bus energy efficiency and in some cases either service cuts or a greater need for public subsidy.

(v) Although increased accessibility may favour the centre of the host urban area, the natural result is also more trips, from greater distances. As park and ride is often associated with an increase in total parking stock, additional trip-end opportunities will exist. Furthermore, the separation of home, work and other travel-generators becomes more acceptable as the penalties of access are reduced. The cost of tackling transport problems by focusing only on the city in isolation may be increased rural development.

Survey evidence

The information from the Friday surveys is marked in the tables by an 'F', Saturday surveys by an 'S' and the derived 6-day estimation by a '6'.

Current demand for park and ride

Table 1 shows the journey purpose for visits to the two cities. Commuter journeys are the most important travel purpose, especially for Oxford where study trips were separately identified. In both cities, work and shopping trips account for three-quarters of park and ride demand. Table 2 identifies how users arrived at the site. Car arrivers account for nearly all park and ride bus trips in Oxford, but in York, nearly one in five walk or cycle to the site. From the figures for car drivers and passengers, car occupancy to the sites in both cities is around 1.25 per vehicle, although it is lower on weekdays and much higher on Saturdays.

[3] At Canterbury, for example, a parking ticket is required for travel on the bus; tickets are issued only at a vehicle-detecting barrier.

Table 1. Journey purpose of bus service users

City	Oxford (%)			York (%)		
Day surveyed	**F**	**S**	**6**	**F**	**S**	**6**
To/from place of work	47.9	8.8	39.7	44.4	15.0	38.6
To/from place of study	6.1	2.5	5.3	N/A	N/A	N/A
Shopping	27.8	71.2	6.9	31.0	58.4	36.4
Personal business	6.9	2.4	6.0	7.3	2.4	6.3
Social/leisure	6.4	11.1	7.3	11.9	17.1	12.8
Tourism/overnight stay	1.5	2.2	1.7	1.9	6.3	2.9
Other	3.5	2.0	3.1	3.4	0.7	2.9

Table 2. Mode of arrival at car park of bus users

City	Oxford (%)			York (%)		
Day surveyed	**F**	**S**	**6**	**F**	**S**	**6**
Drove self	75.4	62.8	72.9	58.3	70.3	60.7
Car passenger	15.8	4.0	19.7	14.9	18.5	15.6
'Kiss & Ride'	2.0	1.3	1.9	4.3	1.3	3.7
Cycled	0.7	0.1	0.4	1.4	1.0	1.4
Walked	5.1	1.7	0.6	19.2	7.9	17.0
Other	0.9	0	0.1	1.8	1.0	1.6

The mean distance of trips to the sites in Oxford was 20.2 km, with the median trip-length being 14.4 km. In York, the crude calculation yielded a lower figure of 13.2 km, with a median of 3.2 km, due in part to those walking to the site. However, the median for car driver and passenger trips alone was still lower than Oxford, at 9.4 km.

Previous travel behaviour of park and ride users

In ideal circumstances, each car parked at a site represents a car removed from the inner part of the city road network. Clearly, the real situation must fall short of this ideal to some degree. Assessing how many users fit into this description is vital for a balanced assessment, but fraught with difficulties. Two questions were asked which can give an indication; first, about the mode that respondents reported they used before the park and ride site was opened, and secondly, their alternative to park and ride.

For Oxford, most current users had no directly comparable experience of travel to the city centre before park and ride. Consequently, for this particular analysis, only those respondents were included who claimed to have been commuting since before park and ride services began, and from the same settlement (27.9% of respondents — 369 users). For York, respondents were simply given the option to specify that they didn't visit the city prior to park and ride opening. Just 8.3% fell in this category.

Table 3 shows that, of those who met the criteria for the Oxford survey, little more than half (56%) had previously travelled by car, with most others arriving by bus. In York, where the situation is different for a number of reasons, more had arrived by car (70%). None the less, nearly a third of York respondents had previously travelled by bus, train or cycle, and most by bus.

In interpreting this result, it is necessary to take account of the fact that over the whole period of park and ride in Oxford, car ownership has increased substantially, and (in the early part of that period) bus services became less attractive and usage fell. Therefore the current users who said they previously (10 to 20 years ago) used buses include an unknown proportion who, without park and ride, might now be using a car anyway. Furthermore, the settlement structure in the Oxford region was, and remains, more favourable to operating bus services than that around York.

Jones (1994) found for 124 Chester park and ride users travelling for shopping that the vast majority, 84.8%, drove all the way but that 14.3% had switched from bus and train. Also, 7.1% had switched from park and ride at another site, and a proportion of those probably did not use a car to access Chester prior to park and ride commencing. Shoppers would be expected to be one of the most public transport-averse groups due to their ability to alter their destination.

As mentioned in the introduction, Cooper (1993) also found a shift from buses in York. It is notable that in both the example of previous travel (Oxford) and more recent travel (York), a significant switch from bus use to park and ride occurred. Although the national popularity of car and bus travel have changed between the two opening dates, there are still a significant number of bus passengers who have a car available for journeys they make by bus. This phenomenon is considered further below.

Main reason identified for deciding to use park and ride

The benefits to motorists of using park and ride were strongly identified from prompted options and are shown in Table 4.

For the majority, the push factors of perceived high cost and low availability of central parking space were the principal motivations. For Oxford, cost is much more important than availability, but in York, availability is as important, mainly because parking charges are typically one-third of those in Oxford. In both cities, a sizeable minority valued most the reduced stress on vehicle and self when travelling by park and ride. The

Table 3. Mode of travel of park and ride bus users prior to introduction

City	Oxford (%)			York (%)		
Year of Full-Time Operation	1973, 1973, 1976, 1985			1990		
Day Surveyed	F	S	6	F	S	6
Drove and parked in centre	51.0	44.3	49.8	60.0	71.8	62.6
Car passenger	3.8	13.9	5.7	6.4	12.7	7.5
Conventional bus	35.2	30.4	34.1	23.1	7.3	20.1
Train	0.7	4.2	1.1	3.2	6.1	3.7
Cycle	5.5	4.2	5.4	3.2	1.2	2.7
Other	3.8	3.0	3.9	4.1	0.8	3.4

Table 4. Park and ride bus users rationale for choosing this mode

City	Oxford (%)			York (%)		
Day surveyed	F	S	6	F	S	6
Lack of parking	21.9	23.3	22.2	26.9	32.8	27.9
Cheaper than parking in centre	41.7	38.6	41.1	31.2	21.0	29.3
Avoid stresses on self/vehicle	9.6	13.1	10.3	13.4	24.0	15.7
Easier access to destination	13.0	12.0	12.7	19.4	13.7	18.2
Good for the environment	2.8	2.3	2.7	5.9	2.6	5.3
Unfamiliar with city	2.5	5.0	3.0	1.2	3.7	1.7
Bus service more attractive	6.2	3.3	5.5	N/A	N/A	N/A
Other	2.5	2.6	2.5	2.0	2.2	2.0

Table 5. Alternative travel behaviour of users if park and ride unavailable

City	Oxford (%)			York (%)		
Day surveyed	F	S	6	F	S	6
Not travel today/travel elsewhere	7.2	21.0	10.1	10.5	14.9	11.3
Travel to city by car	57.0	56.6	56.9	55.5	67.9	58.0
Travel to city by bus	26.1	15.8	23.9	24.3	9.3	21.3
Other	9.7	6.5	9.2	9.7	8.0	9.3

relatively attractive service provided by park and ride buses was a factor for Oxford users, presumably reflecting comparisons by former bus users. This option was not specified in the York survey.

How dependent are users on park and ride?

Surveys of intended behaviour do not necessarily give accurate figures of what people would actually do, but with this caveat, questioning users about the alternative mode of travel they would use in the absence of park and ride does reflect their current preferences and perceptions, and draws on any experience they have of travel by different modes to the city on other occasions. The results provide an interesting comparison with the analysis above of travel prior to park and ride, together with an impression of how essential the park and ride service is perceived to be by its users. These results are shown in Table 5.

Notably, 10% of users thought they would either suppress their journey or re-direct it to another location. This suggests their trips to the study cities were either attracted away from another place, or entirely freshly generated, which is important if one of the objectives of local economic policy is to increase the total number of visitors to the city. However, some respondents may have answered tactically to emphasise park and ride's importance, or might intend to make the journey on a different day.

For Oxford, a third of the 56.9% who claimed they would still travel to the city by car indicated that they would seek parking space in the suburbs and then walk or catch a bus to the centre (informal park and ride). However, whilst this may be their intention as individuals, it is not clear how much parking could actually be accommodated in the suburbs. Many possibilities have been removed by residents' zones, but some still exist. This leaves 32% of all Oxford users who report that they would use a car and park in the centre. In York, where the option to park in the suburbs was not prompted, somewhat more than half would choose to travel by car to the centre, whilst nearly a third would use public transport or other means.

From his sample of shoppers only, Jones (1994) found that, of those who would continue to visit, 71.8% identified the car as their alternative, and 15.5% public transport (essentially the bus). However, direct comparison with the York and Oxford case-studies is difficult. First, shopping trips are discretionary, and secondly, the option to transfer to another site was offered, and this would attract almost a fifth of users.

Significant differences in second-choice mode of travel were evident between users travelling for different journey purposes when surveyed. Table 6 shows these results for Oxford. Few trips for work or study could have been avoided or redirected. Conversely, those on shopping trips accounted for three-quarters of the travel-

Table 6. Alternative mode of travel of users travelling for different purposes

Purpose (%)	Work/study	Shopping	Other	All
Not travel/travel elsewhere	8.2	76.4	15.4	100
Travel by car	41.6	36.6	21.8	100
Travel by bus/train/cycle	64.3	23.9	11.8	100
Other	40.2	43.9	15.9	100

Table 7. Degree of consideration by Oxford users during residential relocation

Day Surveyed (%)	F	S	6
None	83.3	90.8	84.7
Slight	5.0	1.9	4.3
One of a number of factors	3.5	1.9	3.3
The most important factor	0.9	0.3	0.8
Didn't exist when last moved	7.3	5.1	6.9

lers who claimed they would not travel at all. The majority of those who would travel by bus, train or cycle were making work journeys, but a significant number of shoppers would also come by bus.

Table 7 shows the influence park and ride has had on residential location. Accessibility is only one of a number of considerations when moving home, so it might be expected that one aspect of travel would not receive extreme prominence during decision making. None the less, nearly 10% of those who had relocated thought it had been a factor. When asked if they would have to consider moving if park and ride became unavailable, 7% of the sample thought they would have to.

The result that needs to be scrutinised most carefully is the rather high proportion of people who claim that, in the absence of park and ride, they would be using public transport for the same journeys. They might be making rather unrealistic assessments of their own behaviour. In order to test this, we investigated how many users really had a reasonable level of public transport service available to them, measuring the level of service offered in each of the settlements from which park and ride users came, by an analysis of timetables for services to settlements within a 45 km radius of Oxford, for the weekday morning peak.[4]

Of the sample, 36.1% were identified as having access to either 'very good' public transport (7 areas) or 'good' public transport (9 areas). In addition, a small number of users living in rural areas together with a proportion of those living beyond 45 km also have access to high frequency services. However, for this analysis, villages smaller than 1 km^2 or outside 45 km were assumed to have poor services.

Table 8 indicates that public transport is less likely to be an acceptable alternative as the area of origin becomes more rural, and there is a higher chance of trips not being made to Oxford. However, for areas with 'very good' services, half see their next best alternative as being public transport or cycling.

This analysis has two important implications. First, it is an indication that public transport policies within the Oxford catchment area may be considered to be notably successful, at least for some of the settlements served. It is by no means always the case that the hinterland of a city the size of Oxford offers reasonable standards of bus service over such an area. Secondly, it does tend to support the plausibility of the respondents' replies, since most of those reporting 'bus' as their alternative mode did have reasonable bus services, and very few of those in areas served by poor bus services chose that response.

Clearly, park and ride users from urban areas with very good or good public transport are still deriving benefits. These perhaps take the form of greater convenience, comfort or perceived cost, rather than journey time by park and ride. However, for this particular group, the benefits of car use itself are not so great that in the absence of park and ride they would still travel by car; for some of them it would be the least favoured alternative option due to high parking charges, time spent parking and loss of access to bus priorities.

The intention that transport policies should be tailored to enhance, rather than detract from, the appeal of public transport services is widely, but not universally shared. It might be argued that park and ride may represent an opportunity largely to abandon public transport outside the urban areas, except for social transport fulfilling a minimum-access function. However, the travel-demand implications of such a strategy are worrying, especially if the levels of trip generation suggested by this survey were to be generalised.

Stokes (1994) has carried out a provisional analysis of the implications of the stated hypothetical alternative mode on total distance travelled. Although it is by no means straightforward to consider changes to park and ride alone, within the total complex transport system, it seems likely that the park and ride provision may imply increased travel. A significant factor behind this is the

[4] For details of this procedure, see Parkhurst and Stokes, 1994.

Table 8. Choice of alternative modes by attractiveness of public transport

Origin	Within Oxford (%)	Urban (%) V Good	Good	Poor	Rural (%)	>45 km (%)
% of Sample	5.9	20.3	9.9	12.2	39.8	11.9
Not visit Oxford	5.6	6.3	11.3	14.8	11.9	6.8
Car-borne	22.5	43.6	53.3	61.1	61.5	79.1
Bus/Train/Cycle	64.3	49.2	33.8	18.3	24.3	13.8
Other	7.5	0.9	1.6	5.8	2.2	0.2
All	100	100	100	100	100	100

large mean distance travelled using the private mode before switching to public transport.

His estimate for the sample, assuming that people who suppress their visit to Oxford would travel the same distance somewhere else, is that 10% more vehicle-kilometres would be travelled (around 30 000 vehicle-km/week in absolute terms). In addition, more than 20 000 bus-km are operated per week by park and ride bus services, whilst in the post-regulation operating environment there is typically capacity available on conventional bus services, even at peak times.

A fuller analysis would need to consider the impact of the extra car trips on the Oxford road network. Some car-km would replace bus-km saved. However, on some routes, and at some times outside the peaks, capacity is available to provide for some extra car trips. The rate of trip suppression recorded assumes the current degree of congestion. The actual level might be expected to be higher if congestion were to be more severe, although elasticities affecting demand for other modes might tend to return the level of congestion towards a robust equilibrium.

The assumption that suppressed trips are relocated elsewhere travelling the same distance is even more problematic. A certain proportion of these trips would not be made at all or an acceptable, although not perhaps ideal, trip-end may exist locally. For others, however, Oxford could be considered the most local of an acceptable range of destinations, and greater travel will be made to the next satisfactory place. The likelihood of this latter response should not, however, be exaggerated. It seems likely that park and ride has made Oxford unusually accessible, and that in some cases other locations which are in fact closer might prove to be acceptable alternatives if the total cost of the travel opportunities from a particular origin were to be increased.

Finally, it would be desirable to make some allowance for the use of cars left at home by those switching to public transport. However, given the mean range of trips made to park and ride sites (40 km return trip), this travel would have to be considerable to offset the saving by the primary driver using a bus all the way.

Economic effects on city centre

It was noted above (Table 6) that respondents travelling for shopping were much more likely to indicate they would not visit Oxford without the chance to park and ride, and also that fewer were prepared to consider alternative modes to the car for travel to the city. Table 9 considers, for all users travelling for any purpose when interviewed, the effect of park and ride not being available for shopping trips to Oxford.

Hence, the loss of park and ride would have economic impacts. There would be a reduction in the total number of shopping trips with some being made in favour of other towns. However, from Table 6, it appeared that a fifth of shopping trips might be made differently, but when all users were asked, more reasonable levels of change were implied. This may be partly because some users of park and ride choose other modes when they visit Oxford for shopping anyway.

Jones (1994), who interviewed only those users actually travelling for shopping, found that 12% would stop shopping in Chester if park and ride were unavailable, and that a further 25% would come less often. Rather more of his sample would stop visiting altogether, but rather less of those who would continue to patronise that city would cut down their rate of visiting.

Table 10 shows the change in frequency of visits made (by any mode) to York city centre by park and ride users since the service was established. Virtually no one had visited less frequently, but a large minority claimed to have visited more.

Using a similar question in Chester, Jones (1994) found that 14.5% of shoppers had visited this city less until given the opportunity to park and ride, with evidence of both redirection and generation of extra trips. Overall, the number of trips made by the sample would be expected to increase by 13.4%. This effect seems to be rather more modest than for York, despite considering only shopping trips. This may reflect Chester already being extremely popular as a shopping destination within the Cheshire–Merseyside–Greater Manchester region. It may also be an effect of phrasing the question to refer to behaviour *pre* rather than *post* the introduction of park and ride.

Discussion and conclusions

Given the restricted range of policy tools available to local authority planners and engineers, park and ride has naturally been a leading component of 'balanced' policies. Local authority powers and finance are constrained, and some authorities feel that park and ride systems can give (relatively) quick and easy benefits, compared with the long haul to implement some other radical policies.

Park and ride offers real benefits to motorists. Some people value savings in parking costs, effort, and sometimes travel time. Others enjoy an environment which is

Table 9. Effect of losing park and ride on shopping trips to Oxford (%)

Day surveyed	F	S	6
Shop in Oxford similarly to now	36.8	34.4	36.3
Shop in Oxford less and other places similarly	20.1	18.4	19.9
Shop in Oxford less but other places more	34.8	34.3	34.6
Stop shopping in Oxford altogether	6.6	11.6	7.6
Other	1.7	1.3	1.6

Table 10. Visits by park and ride users to York city centre since introduced (%)

Day Surveyed	F	S	6
More frequently	39.7	48.4	41.8
Similar amount	52.1	39.7	48.5
Less	0.8	0	0.6
Moved to area since opening (June 1990)	5.8	7.4	5.8
Don't know	1.6	4.6	3.2

more pleasant than driving in congested traffic, perhaps in an unfamiliar area. Some users have been given the chance to consider living in places that would otherwise create difficult travel problems. Central area parking policies based on restraint have been implemented without deterring visitors. Indeed, in economic terms, more people have been able to visit the two city centres, and land that might have been reserved for parking has been available for other uses.

Provided park and ride services are well used, they have the potential to increase the space efficiency of the *urban* transport system in the area within the park and ride provision, and this is the area usually most seriously affected by congestion. If lower levels of traffic are identified in the urban area, and similar levels in the hinterland, then the overall system is more efficient. If we find higher levels in the hinterland, that may not contradict overall policy, but it is necessary to examine whether these increases can be justified by the savings in the city.

However, what this research has shown is rather more worrying. Not only does the 'energy audit' approach of vehicle-kilometres travelled seem to strongly suggest significant increases in travel, but there is apparently no 'decongestion dividend' in the urban areas studied against which this can be offset. This means that the success of park and ride has to be justified in terms of politics and economics; that it makes the 'package' approach an acceptable one and that it facilitates visitor growth without encouraging traffic growth.

What seems to be missing amongst the various strands of policy is a need to consider the region as a whole, including the impact on traffic growth, trip generation and attraction, residential location and switching from modes other than the car. Jones (1994) has argued that models used to predict the cost–benefits of park and ride could be made more robust by including some of these effects, and by avoiding the assumption that travel demand, both on the part of users and non-users, is inelastic. He implies, however, that some schemes would not be affirmed on that basis.

For two reasons the 'balanced' strategy has, to some extent, been undermined. First, park and ride actually increases the share of road space available for that portion of traffic which does not intend to park centrally, or has access to private spaces.

Secondly, rather than reducing economic inequalities, the inducements to users mean that further anomalies have resulted. The cost of providing the necessary facilities has often been met by public resources rather than user-charges. Consequently, new car trips to the edge of the city have been encouraged and some trips are now made by car which were previously made by other modes.

The question that arises, therefore, is whether it is possible to keep hold of all the positive effects, while using other policy instruments to offset any negative effects. In particular, is it possible to attract the maximum number of people who would otherwise use a car, but with the least possible encouragement to divert people who would otherwise use the bus, walk or cycle to start using park and ride instead?

Three policy levers are worthy of consideration. First, there is already widespread support for the idea of further discouragement of car use, by more intense central area parking control, pedestrianisation, area-wide traffic calming, and perhaps by road pricing, all designed to ensure that the personal benefits of car use to the user are not outweighed by the social and environmental costs to everybody else. The argument here would support that, and raises the question of its extension to areas outside the city centre.

For example, the current practice for the construction of bus priorities in urban areas focuses on where provision is possible rather than where need is greatest. At many junctions and bottlenecks, the only way to achieve further priority on main routes will be through apportioning road space on a 'time-share' basis rather than physical segregation. Consequently there is a growing interest in the use of traffic light priorities and queue relocation arrangements. These incorporate variable timing which gives the option to manipulate the flow of general traffic. As car trips are diverted, reductions in traffic volume are not offset by further growth.

Secondly, it is necessary to improve the attractiveness of public transport outside the centre, so that it can compete on the long-haul part of the journey, not only the town centre part. The provision of bus priority measures on major routes outside urban areas would enable buses to offer a more competitive overall journey time over the route to the edge of the city. For some users, this might be expected to restore the advantage of travelling by bus for the whole journey. In addition these measures would benefit all inter-urban bus travellers, some of which may not currently possess the opportunity to park and ride.

Thirdly, it would be desirable to find a way of using the pricing structure of the park and ride sites to encourage this effect. A strategy which sought to impose some or all of the costs of car park provision on users would deter some current marginal users. However, this is complex, since it is not practical (and would in any case be very inequitable) to charge different prices to different users, and because trips would divert to different modes depending upon a number of factors. But, a more detailed study should perhaps consider whether some additional charge, applied at the same time as an improvement in public transport services as suggested above, would have the desired effect.

Charging users of the site would also assist in the cost of site provision and a charge levied on the car would favour higher car occupancy. Charging for the bus and site could be administered in a number of ways. One possibility would be to include a permit-to-travel for the driver with the parking ticket, with other passengers paying on the bus.

If these levers could be applied in such a way that the predominant mode switch was from park and ride to bus, then a useful by-product would be that the spare capacity at sites could contribute to stimulating and

accommodating demand for park and ride services.

Extra peak public transport services might have to be provided if some commuters switched to this mode, although capacity may currently exist within the system. However, additional peak services would tend to be profitable and to enhance the overall service frequency.

At best, for the case-study of Oxford, this could free up to 800 spaces per day, a number equivalent to providing a proposed fifth site, although it is unlikely that these would all be divertible in practice. The construction costs saved by not building extra capacity would typically be of the order of £1100/space plus land acquisition costs.

Hence, the intention would be to create a hierarchy of costs which favoured public transport by charging for the benefits of car access to park and ride sites. At the same time, the relative advantages of park and ride over driving to the centre need to be increased, so that more of the motorists who currently drive to the centre are intercepted. Such a scenario is not contingent upon, but might be easier to pursue, if measures became available in the future to control private parking or road use.

It is necessary to emphasise that such policies cannot be implemented by local authorities alone, especially in the context of the trunk roads programme, bus deregulation, rail privatisation, constraints on public expenditure, and the need to obtain Department of Transport approval for such innovative policies. There would need to be encouragement from central government.

Finally, we should note that in practice, at least, park and ride by rail typically differs from bus-based systems in a number of respects. Consequently, caution must be observed in generalising results and conclusions beyond the scope of this study.

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Congestion Charging: Challenges and Opportunities



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EXECUTIVE SUMMARY

Surface transportation congestion is an urgent and growing problem in many urban areas. Congestion contributes to frustrating and costly delays for drivers, urban and regional air pollution, national energy security concerns and global climate change. Congestion charging addresses these issues by charging drivers for operating vehicles at highly congested times and locations to reduce travel times, improve air quality and decrease greenhouse gas emissions.

This paper presents a brief overview of several congestion charging systems in use, reviews the benefits and challenges of the strategy and presents best practice recommendations for policy makers and planners globally who are considering congestion charging. It considers congestion charging experiences in London, Singapore and Stockholm, as well as a Hong Kong pilot program that did not lead to full-scale implementation. In addition, it describes the results of an ICCT-sponsored study of the potential for congestion charging in Santa Clara County, California, an area representative of less concentrated development patterns.

Key observations include the following:

- **Congestion reductions of 13 to 30%, greenhouse gas reductions of 15 to 20%** and significant reductions of ozone and fine particulate pollution have been achieved from implementing congestion charging systems in London, Singapore and Stockholm (based on empirical data), and similar benefits would be expected in Santa Clara County (based on a travel model). Public health benefits may be compounded by increased walking and cycling. Discounts for low-emission vehicles can encourage a transition to cleaner transportation but must be weighed against congestion reduction goals.

- **Cost-benefit results can be favorable. In the two cases where monetized time** savings calculations were available, Stockholm and Santa Clara County, time savings were higher than operating costs by a wide margin. While these are not the only costs and benefits, they likely represent the largest portion of each and thus provide an indicator of overall costs and benefits. Studies found no difference in economic growth inside the charging perimeter compared to surrounding areas in London and no effect on retail sales in Stockholm.

- **Multiple technologies have been proven in congestion charging or closely** related road pricing applications, creating flexibility in implementation. These include camera-based recognition, radio-frequency identification, dedicated short-range communications, and global positioning satellite systems combined with cellular radio communications.

- **Initial public acceptance can be difficult to secure, and implementation of** congestion charging can require time to build consensus. London first studied the

concept of congestion charging in the mid-1960s. Singapore used these studies and concepts to implement its first Area Licensing Scheme in 1977. In London and Stockholm - the two most recent examples covered in the paper – initial public opposition did not prevent implementation of congestion charging, and public support increased after the program began. In Hong Kong, uncertainty and local political opposition helped stop an initial 1983-1985 congestion charging technology pilot test from resulting in full implementation though the idea has since been reconsidered. Because some drivers will perceive a net loss from the charge, effectively communicating overall benefits is very important, as is addressing concerns about privacy and the concerns of business owners about possible economic impacts.

- **Upfront investments in public transit may be necessary to absorb increased** ridership and to provide affordable mobility for low-income populations. These investments can also help create confidence that implementation of a congestion charging system will provide tangible benefits. Congestion charging systems are more effective when they provide net benefits for the majority of travelers through reduced driving times and improved transit access and reliability.

- **Net revenue generated by congestion charging can be used for transit** enhancements and other benefits. Providing increased transit can enhance the effectiveness of congestion charging. After funding transit improvements, revenue may also be available to make improvements for pedestrians, cyclists and drivers. Some targeted revenue recycling back to area residents or for other purposes may also be viable. Public confidence that revenues will be used for transportation improvement is an important element of any congestion charging strategy.

- **Convenient, flexible payment systems are important components to facilitate** congestion charging implementation as well as shifts to public transport. Existing congestion charging systems in Singapore, London, and Stockholm have various convenient payment options. In addition, these areas and Hong Kong have introduced various smart/debit card systems for commuters of all forms of public transport.

I. *Introduction*

The United Nations estimates that urban areas are currently home to 50 percent of the world's population, and predicts that figure will reach 70 percent by 2050 (United Nations Expert Group, 2009). Growing urbanization provides both opportunities and challenges from the perspectives of transportation mobility, climate change and air quality. Higher population densities generally support greater levels of transit and can make destinations more easily accessible by walking or cycling, thus providing increased mobility while allowing reduced usage of passenger vehicles.

At the same time, urbanization leads to higher competition for space on roadways and tends to increase surface transportation congestion. In the United States, congestion costs were estimated at $63.1 billion annually in 2000 and $87.2 billion annually in 2007, with approximately 28 million tons of carbon dioxide (CO_2) emitted per year due to fuel wasted from inefficient vehicle operation due to congestion (Shrank, 2009). In China, sharply escalating vehicle ownership rates (Figure 1) have led to increasing congestion in recent years. The cost of congestion in terms of traveler delays and air pollution (including CO_2) in Beijing is estimated at approximately 50-101 billion RMB annually (US $7-15 billion) (Creutzig, 2009).[i]

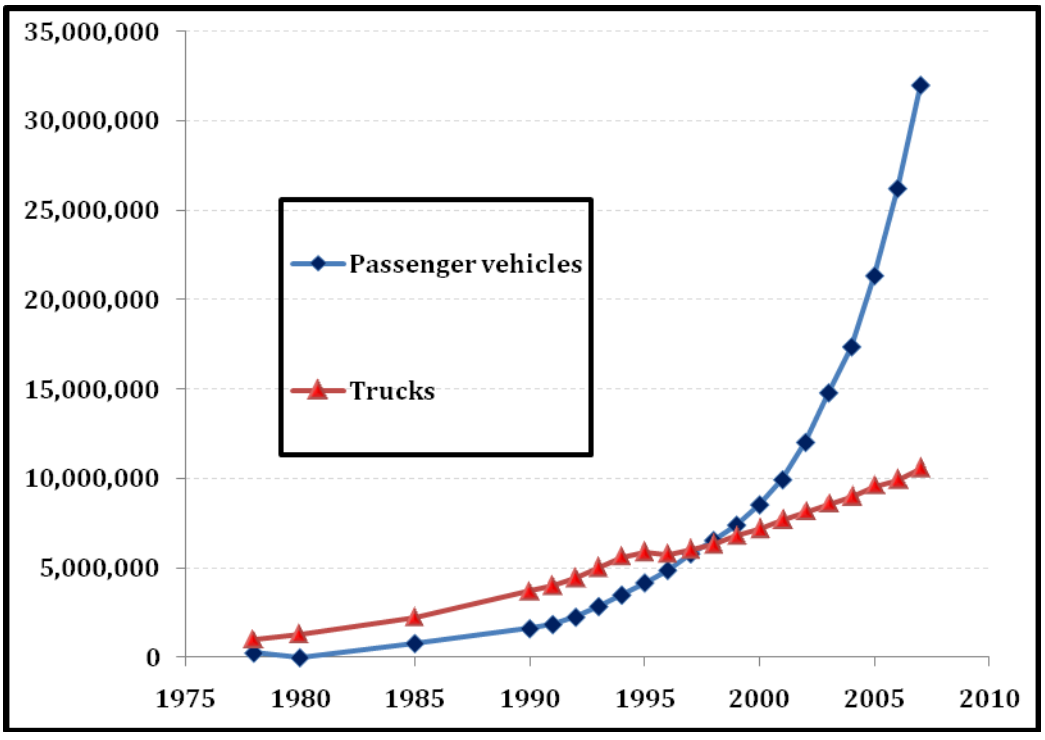


Figure 1: China's Civilian Vehicle Population
(Source: China Statistics Yearbook 2008, Table 15-27)

The concentration of both emissions sources and exposed populations in urban areas creates a significant challenge for air quality regulators seeking to protect human health.

Efforts to reduce congestion through road building frequently fail to keep pace with transportation demand and are likely to generate additional vehicle traffic, which can worsen air quality and create further demand for road building. While economic downturns may temporarily moderate the sharp upward trend of private automobile use, the twin challenges of surface transportation congestion and air pollution will remain. Congestion charging addresses these issues by charging drivers for operating vehicles at highly congested times and locations to reduce travel times, improve air quality and decrease greenhouse gas emissions. Policy-makers and planners around the world may find congestion charging to be an important strategy to increase livability and reduce pollutant emissions in their cities.

This paper begins by evaluating congestion charging programs in three cities where it has been successfully implemented: Singapore, London, and Stockholm.[ii] Appendix A contains a table comparing a number of features for these three examples. Next the paper considers Hong Kong, where a pilot trial did not lead to full and permanent implementation. Finally, the paper summarizes a study sponsored by the International Council on Clean Transportation (ICCT) of the potential use of congestion charging in the United States. The paper concludes with best-practice recommendations based on these examples.

II. *Congestion Charging Example: Singapore*

Singapore was an early leader in adopting congestion charging. Following a one-year public dialogue in 1975, Singapore implemented a paper system of daily licenses for vehicles entering the central zone during peak traffic periods. The system was implemented as part of an overall strong focus on restraining traffic, including increased vehicle and parking taxes, land-use planning and enhanced public transit (Keong 2002). Two types of licenses were sold, one valid all day and one valid for midday.



Figure 2: Electronic Road Pricing Gantry in Singapore (Copyright © 2005 Mailer Diablo)[1]

Traffic entering the zone dropped by 44 percent after implementation, while travel speeds increased from 11 mph to 21 mph (Keong 2002, EDF 2006). More than 10 years later (1988), traffic levels remained 31 percent below original levels even as employment in the city had increased by a third and vehicle ownership by 77 percent (Keong 2002). Bus ridership increased about 20 percent due to congestion charging, transit improvement and related policies.

The system was significantly overhauled in 1998 with the introduction of Electronic Road Pricing (ERP). In-vehicle units (IUs) were permanently installed in 680,000 vehicles at no charge to the user (they can now be purchased for approximately 156 Singapore dollars, S$, or $110 in U.S. currency) (Keong 2002, Singapore Land Transportation Agency 2008). The units communicate with overhead gantries (Figure 2) at charging points and deduct the appropriate charge from a smart card (which can also be used for other transactions such as parking and public transportation) inserted into the IU. The transaction occurs onboard as a debit on the smart card rather than through a central processing system. As long as the vehicle has a valid IU and smart card, no information collection is needed at the charging point, avoiding privacy concerns. In addition, the government has committed to erasing bank transaction records within 24 hours (Keong 2002).

If a vehicle does not have an IU installed or the smart card does not have an adequate balance, enforcement cameras on overhead gantries photograph the vehicle in order to assess a fine. The fine, which can be discounted by paying online or through other automatic methods, is S$10 ($7 U.S.) for failure to carry a sufficient balance and much higher for driving without an IU. Foreign drivers entering the charging zone can choose to rent or purchase an IU. Otherwise, they pay a flat fee (Singapore Land Transportation Agency 2008).

The peak fee for passenger cars was dropped to about S$4 (approximately $3 U.S.) with ERP, but a flat daily rate was eliminated in favor of a charge imposed for each entry into the charging zone. Motorcycles and heavy vehicles were also added to the system (with different tolling rates). Rates are graduated to avoid spikes just before and after charging periods.

Traffic levels are reviewed every three months to determine appropriate toll levels—for instance Saturday tolls have been dropped as a result—and the possibility of predictive pricing to account for anticipated traffic levels is under study to potentially replace the current practice of looking backward at the recent past. Since 2008, it is official policy to adjust fee rates at each of the 70 charging points as needed to ensure traffic moves at uncongested target speeds 85 percent of the time or more. For example, when average travel speed on highways is observed below 45 kilometer per hour (kph) or above 65 kph, the rates are increased or decreased respectively.

Operating costs are 10 percent or less of the revenue collected through the system. Initial capital expenses were approximately 40 percent of initial annual revenue (European Conference of Transport Ministers, 2006). Net operations revenues are not earmarked for transportation. At the same time, the government has taken a number of steps, such as dropping the Saturday charge, to demonstrate that the system is not primarily motivated by revenue generation. A 2008 expansion that was projected to raise an additional S$70 million ($49 million U.S.) was coupled with a larger drop in vehicle ownership taxes, as well as additional bus service in the expanded zone (Lim, 2008).

Raymond Lim, Singapore Minister for Transport, January 30, 2008

"Of all the different measures to deal with congestion, ERP is the only one that addresses the problem directly by requiring individuals to take into account the costs of congestion caused by their driving to others… Without ERP, Singaporeans would be spending many hours in traffic snarls, just like people in Tokyo, Los Angeles and many other US cities, who pay for congestion, not with their wallets, but with the time that they have lost, stuck in traffic gridlock."

III. *Congestion Charging Example: London*

The London congestion charging system was implemented in 2003 to cut traffic and air pollution with the strong support of then-mayor Ken Livingston. The system was initially implemented in a highly congested 21-square-kilometer (8.4-square-mile) area containing about 200,000 residents and five times as many jobs. Public support for the system grew after it was implemented and the zone was doubled in size in 2007 with the addition of the western extension, as shown in Figure 3. After he was elected Major of London in 2009, Boris Johnson announced a plan to reconsider whether to continue the extension (London Mayor's Press Office, 2008). A final decision has not yet been made.



The system uses overhead cameras to recognize license plates. This data is processed centrally to apply charges to the appropriate account. A number of different payment options are available including retail stations, online, text messaging and phone. The initial charge of 5 British pounds (£) for entering the charging zone was increased in 2005 to £8 (about $12 U.S.), with the expectation that the change would further decrease congestion and provide additional bus system revenue (TfL 2006).

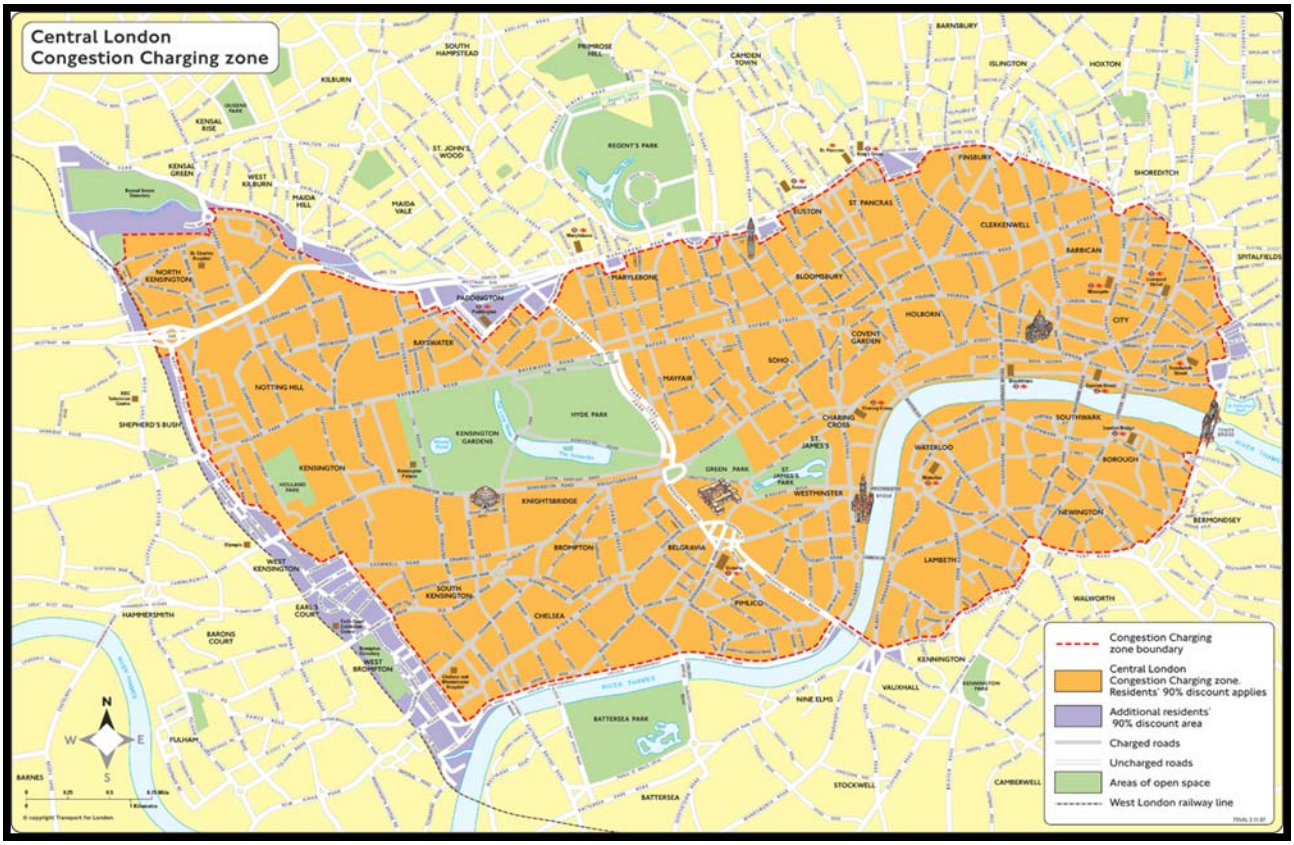


Figure 3: London Congestion Charging Zone (Source: Transport for London)

The London program has cut congestion from the original cordon by 20 to 30 percent (70,000 fewer cars per day), and by 14 percent in the western extension (30,000 fewer cars per day). There has been a 6 percent increase in bus ridership and a 12 percent increase in cycling journeys into the western addition during charging hours; and a 66 percent increase in cycling within the charging zone since it was introduced (Transport for London, 2009). As private vehicle traffic has dropped, some road space has been dedicated to transit and other purposes. Transport for London (TfL) announced that construction-related delays and changing use of road space contributed to increasing traffic congestion in the charging zone back to pre-charging zone levels, but that the number of vehicles was still significantly lower and that construction-related delays would have been worse without the congestion charging zone in place (Mail On-Line, 2008). Many of these delays appear to be temporary, although some alterations to roadways to promote alternative forms of transportation are permanent.

Carbon dioxide emissions dropped 15 to 20 percent, and fine particulates and nitrogen dioxide dropped 10 percent according to the Central London Congestion Charging Impacts Monitoring Sixth Annual Report (TfL, 2008). This is especially important because London currently exceeds European standards for nitrogen dioxide (NO_2) and fine particulates (PM_{10}). Transportation is the largest sources of both, including tailpipe emissions and brake and tire wear (Mayor of London, 2009). Congestion charging can compliment tailpipe

vehicle standards while also reducing particulates from brake and tire wear. Electric vehicles and low-emission alternative fuel vehicles are exempt from the charge in order to promote environmentally friendly vehicles. The number of these types of vehicles registered for the exemption increased from 11,000 in 2005 to 18,000 in 2007 (TfL, 2008).

TfL analyzed effects on business indicators such as sales, profitability, new business formation and rents based on four to five years of data in the central zone. Employment increased within the charging zone during that time period, consistent with broader economic growth trends. The report states, "Overall, five years after the event there is no general evidence of any measurable differential impact from the central London congestion charging scheme on business and economic activity, at the aggregate level, based on analysis and surveys conducted by TfL."(TfL, 2008)

By law, net revenue must be dedicated to transportation and has been used to fund bus improvements at the level of £112 million ($170 million U.S.) in the fiscal year 2007/2008, with similar investments the prior year as well as £4 million ($6 million U.S.) funding for cycling and pedestrian facilities. These investments are necessary both to provide the capacity for travelers to shift modes and to enhance the accessibility of alternative travel options in order to further encourage switching. Additional revenues are spent on road safety and other transportation purposes.

Low Emission Zones

- London has operated a Low Emission Zone (LEZ) in parallel with the congestion charging zone since 2008. The LEZ covers a broader geographic area to combat the regional impacts of air pollution.
- The LEZ covers vehicles greater than 3.5 tonnes (2500 kg), with a €220 ($320) charge for vehicles that do not meet emission standards.
- Milan has also implemented a LEZ for passenger vehicles, resulting in emission reductions of PM_{10}, NO_x and CO_2 by 14 to 23 percent.
- Berlin and Beijing ban passenger cars with inadequate emission controls. Germany also charges variable truck per-mile tolls based on emission control levels.

(Sources: Transport for London website; Agenzia Milanese Mobilità Ambiente (2008-Dec-09); "Monitoraggio Indicatori ECOPASS. Prime Valutazioni" Comune di Milano(in Italian))

Operating costs consumed nearly half of revenue raised by the system in the 2007/2008 fiscal year. System managers are investigating the potential for cost saving measures such as switching to a "tag and beacon" system similar to the systems used in Canada and the United States for toll bridges and roads (TfL, 2008). In these systems, relatively inexpensive on-board transponders placed in vehicles are detected at charging points and the corresponding accounts are debited.

Revenues are also decreased due to the discounts or exemptions offered to 60 percent of vehicle movements within the congestion zone, including large discounts for residents of the charging zone. One unexpected cost has been the theft or counterfeiting of license plates, resulting in an estimated 300 evasions daily and the need for a police program to detect vehicles using stolen plates (Sheth 2007).

IV. *Congestion Charging Example: Stockholm*

The Stockholm experience is unique because the system was turned off after an initial six-month trial during the first half of 2006. During the trial, the system reduced traffic volumes by about 20 percent, with vehicle speed increases of the same amount or more, and transit ridership growth between 6 and 9 percent (U.S. Federal Highway Administration, 2008). When the trial ended, traffic rebounded by a similar amount.

This correlation was likely responsible for a significant shift in public opinion. In autumn 2005, before the trial took place, about 55 percent of all Stockholm residents viewed the congestion charging scheme negatively. After the trial 53 percent of Stockholm city residents viewed the idea favorably, while 41 percent viewed it unfavorably, providing enough public support for the system to be implemented permanently (Stockholmsforsoket 2006).

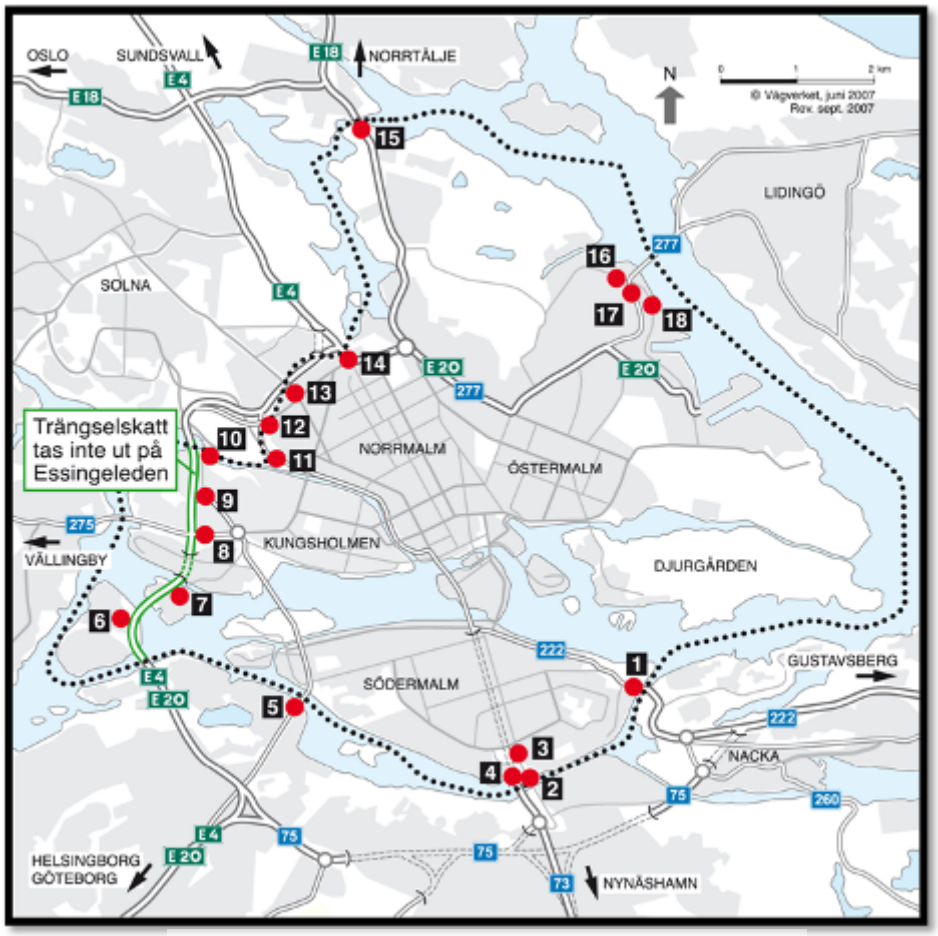


Figure 4: Stockholm System
(Source: Swedish Transport Agency)

The system covers 34 square kilometers (21 square miles) with a charge up to 20 Swedish Krona (SEK) or approximately $3 U.S. to vehicles passing one of 17 charging points while entering or leaving the city's central area (Figure 4) with a daily maximum of 60 SEK,

($8.50 U.S.). There are about 345,000 daily passes (Lamba 2008). System implementation was initially based on detecting vehicles with a combination of automatic license plate recognition (see Figure 5) and transponders, although the system has since shifted primarily to cameras that automatically detect license plates (Stockholmsforsoket 2006). Payment options include automatic account debiting, online payment, and in-person payment including at shops and banks.



Figure 5: Stockholm congestion charging station (Source: Mats Halldin)

The system was found to be extremely cost-effective, with the primary benefits being shorter travel times valued at 600 million SEK ($85 million U.S.) annually, increased road safety valued at SEK 125 million ($18 million U.S.) and health and environmental benefits valued at SEK 90million ($13 million U.S.) (Stockholmsforsoket 2006). Operating costs are 25 percent of annual revenues (Replogle 2008b). Upfront investments included $300 million U.S. in buses, transit and park-and-ride lots, plus $200 million US in system operations. No effect on retail sales was observed (Jenstav, 2007).

In addition, CO_2 emissions were reduced by about 15 percent, with reductions in other pollutants such as nitrogen oxides (NO_x) and PM_{10} as well (EDF 2007).

An expert panel identified the following beneficiaries among transportation users:

- Public transit users who benefit from more options and faster travel speeds;
- Drivers who value their time savings more than the charge or who receive the benefits of reduced traffic without passing the cordon and paying a charge;
- Cyclists who benefit from an improved traffic environment; and

- Commercial drivers who benefit from an improved work environment.

Transportation users who may be negatively affected include:

- Drivers who pay the charge rather than choosing alternatives and value their time savings less than the cost;

- Drivers who forgo a trip due to the charge; and

- Public transport users who encounter more crowded conditions due to increased ridership (Stockholmsforsoket 2006).

V. *Congestion Charging Pilot and Study: Hong Kong*

Hong Kong is an example of an area that also considered congestion charging due to growing urban congestion and environmental concerns. Hong Kong first addressed electronic road pricing (ERP) in 1983-85; again in 1997-2000; and, more recently in 2004-2006. The government is still considering its options but has not decided to implement the system to date. This experience offers additional evidence of the challenges facing planners and policy-makers in regions that consider implementing a congestion charging system.

In the 1980's, Hong Kong had experienced a dramatic increase in traffic and congestion due to a doubling of vehicle ownership over the prior decade. In response, Hong Kong implemented a 21-month congestion charging pilot from July 1983 to March 1985 (while also dramatically increasing vehicle taxes for initial and annual registration fees). A congestion charging study estimated aggregate benefits of up to HK $1.25 billion (roughly U.S. $160 million) in 1990, and options were identified that would achieve the majority of these benefits with an average charge of HK $8 to HK $10 ($1-$1.30 U.S.). Though the pilot demonstrated the economic and technical feasibility of the concept and studies showed that the system would be cost-effective, it was not permanently implemented for a number of possible reasons:

- Diminished urgency due to lessened traffic congestion at the time the pilot expired. This was due to construction of two major public transportation infrastructure projects, a severe recession, doubling of the First Registration Tax and tripling of the Annual License Fee (Government Secretariat Transport Bureau, Hong Kong 2001);

- Newly create local council government bodies were not consulted and did not support the trials;

- Missed opportunities to develop stakeholder support and address concerns about the financial viability of the system through a lack of transparency and stakeholder outreach;

- The agreement between China and the United Kingdom on the transfer of Hong Kong back to the Chinese Government complicated the political landscape; and

- Citizen concerns about whether the government would follow through on promises to reduce other vehicle taxes and privacy concerns about the system information were not successfully addressed (Hau, 1990)

While transit use remained high, vehicle usage and traffic increased as income levels rose[iii] resulting in consideration of options to limit congestion. A study of Electronic Road Pricing (ERP) began in 1997 with a view that technology and system effectiveness had improved over the last decade. The study objective was examining the practicability of implementing an ERP system in Hong Kong and assessing the need for such a system to meet transport objectives.

Two options were selected for field evaluation, namely the Dedicated Short-Range Communications (DSRC) System and the Vehicle Positioning System (VPS). The VPS would levy a charge by using the satellite-based Global Positioning System (GPS) to communicate with the in-vehicle units (IU) and determine the location of the vehicle. No roadside equipment was required at charge points but violation enforcement stations would be required at strategic locations. A wireless data communication network between the vehicles and the control centre would process transaction data transmissions and enforcement verification. VPS technology offered greater flexibility for system implementation and additional navigation and other Intelligent Transport System (ITS) services to drivers than a DSRC system. The DSRC is limited to communicating with IU when a vehicle passes a fixed charging point. Although the cost of VPS was higher than DSRC at the time by a factor of five, the projected cost of VPS was projected to drop at a faster rate than that of DSRC. Thus, the study determined that VPS technology was the best-balanced choice for ERP in the longer term for Hong Kong.

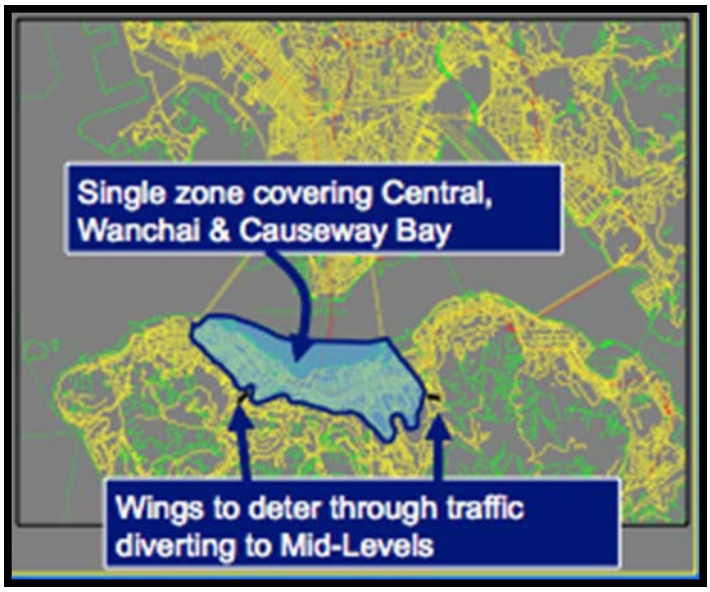


Figure 6: Potential Hong Kong Congestion Charging Zone

An overall concept of the entire system was designed in the study. Its major highlights were:

- Charging Method - A cordon-based charging scheme was preferred in comparison with distance-based, time-based and congestion-based for its simplicity in both operation and enforcement, and technology readiness. Directional charging, i.e. charging on entering in the morning and exiting in the afternoon, was preferred to charging both directions.

- Charging Zone – The zone would only cover the areas that are perceived to be the most congested and are well served by public transport to provide opportunities for road users to change mode of travel. A single zone encompassing Central, Wan Chai and Causeway Bay as shown in Figure 6 was preferred to multiple charging zones that would add complexity to the scheme.

- Charging Period - Charging periods were considered in terms of their overall economic benefits according to traffic volume at different times of the day. Charges would be highest during peak hours (with a lower 30 minute "shoulder" charge to reduce the problem of "bunching"), and no charge was envisaged for the overnight period from 7:30 pm to 7:30 am or on Sundays and holidays.

- Charging Rate - Charges needed to meet the target speed range on 20 km/hr ranged from HK $8 to HK $31 ($1-$4 U.S.) depending on the period of the day and the traffic demand growth scenarios.

- Exemptions - ERP provides the flexibility to differentiate charges by vehicle type and to exempt a particular vehicle type from charge. However, exemptions other than for emergency vehicles must be carefully considered because all trips contribute to congestion. Any potential exemption should be evaluated against the basic principles of equity, efficiency and public acceptability. Discounts rather than exemptions were proposed, which could be administrative tailored or phased-out if appropriate. (Opiola, 2010)

The study estimated that this possible ERP design would divert 40% of car trips in the morning peak to public transport and may change travel time for an additional 10%. The remaining 50% would be subject to the charge while benefiting from higher travel speeds and less congestion. Transport operations such as bus services would benefit from increased speed and increased utilization. Improved service times and greater reliability for delivery vehicles would benefit businesses. Complementary measures were incorporated to facilitate increased transportation usage. (Opiola, 2010)

The economic benefits derived from reduced traffic delays accrued to all road users and to the community at large. The estimated net economic benefit resulting from journey time savings and lower vehicle operating cost was about HK $2 billion/year ($260 billion U.S.). On the other hand, the estimated cost for the proposed ERP scheme was $1 billion ($130 million U.S.) including the cost of in-vehicle units for existing vehicles with an annual recurrent cost of HK $200 million ($26 million U.S.). ERP was forecast to generate annual gross revenue of HK $0.4 to HK $1.3 billion ($50-170 million U.S.) for transport infrastructure investment. (Opiola, 2010)

The environmental benefits include reduced vehicle emissions and reduced exposure to traffic noise inside the charging zone. However, the environmental conditions of other areas, especially the by-pass routes and areas surrounding the charging zone would witness some deterioration due to the overall redistribution of traffic. ERP therefore would assist in the overall improvement to the environment, but was not seen as the sole solution

to the complex issue of air quality and noise abatement. The overall improvements in the charging zone were estimated to be approximately 12% to 16%. (Opiola, 2010)

The major findings of the study were:

- Both DSRC and VPS technologies can be adopted for a possible ERP system in Hong Kong. VPS was considered to offer the best-balanced choice in the longer term because of its adaptability, flexibility and better integration with ITS applications.

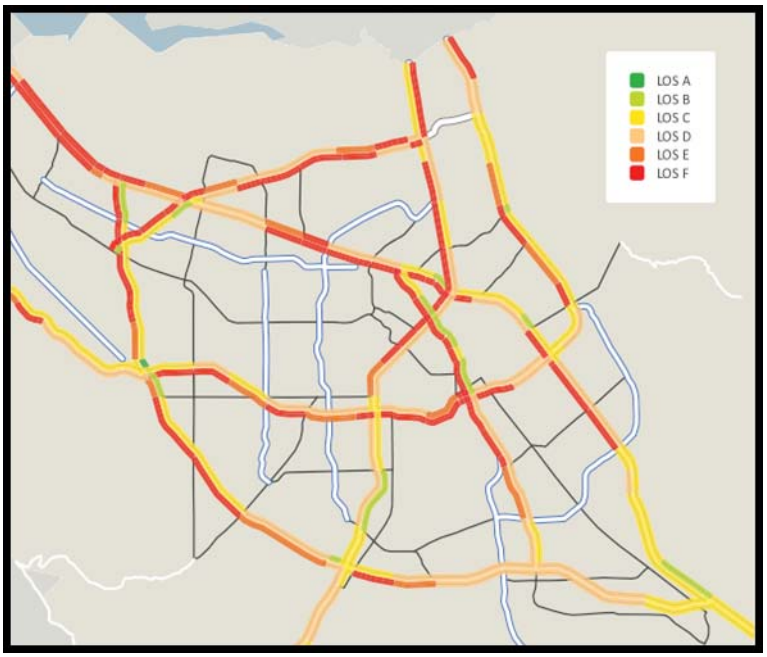


Figure 7: Santa Clara County congestion afternoon peak levels, with red indicating worst levels (source: Valley Transportation Authority "2008 Monitoring and Conformance Report")

- ERP could generate transport operation, economic and environmental benefits.

- ERP and other alternative traffic management measures such as parking charges and taxes are not mutually exclusive.

- Reducing the number of vehicles on the roadway would delay or eliminate the need to build more infrastructure.

The updated study results occurred at the same time that an economic downturn and new infrastructure reduced congestion, similar to the historical background after the release of the 1985 study. However the study predicted that congestion would increase once the economy bounced back, and recent traffic increase along with environmental concerns has led to further consideration in Hong Kong.

VI. *Study of an Area-Wide Congestion Charge in California*

The ICCT commissioned an analysis of the potential benefits and costs of implementing a congestion charging system in Santa Clara County, California. Santa Clara County is a region of the San Francisco Bay Area that has less concentrated development than the cities examined earlier and is among the ten most congested areas of the United States. The county has a total population of 1.8 million, including most of Silicon Valley and the city of San Jose, where the average driver experiences 53 hours of travel delay annually. Because Santa Clara County is highly developed but less concentrated around a single urban center, it offers a good opportunity to study whether congestion charging could be applied on a

regional basis.

As seen in Figure 7, congestion hotspots are widespread in the county. The red zones represent the most congested areas during the afternoon peak travel period, when uncongested green zones are mostly nonexistent on major freeways and highways.

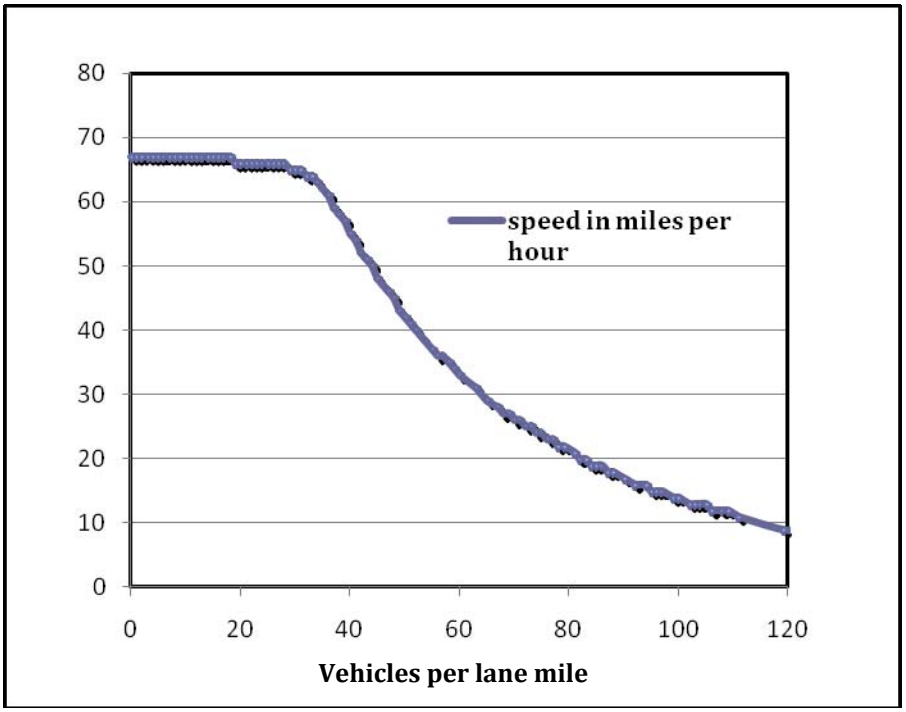


Figure 8: Vehicle Speed vs. Traffic Density (source: ICCT analysis of data from Valley Transportation Authority "2007 Monitoring and Conformance Report")

The study was designed by ICCT and Komanoff Energy Associates (KEA) and implemented using a KEA spreadsheet model. A per-mile charge was assessed on highways (colored to match their congestion levels) and expressways (in white) shown in Figure 7 to target widespread congestion.[iv] The model also allowed different scenarios to be tested in order to tailor the timing and amount of the congestion charge. Figure 8 illustrates a key relationship between vehicle density and travel speeds that was applied in the model. This relationship shows how reducing vehicle density can lead to dramatic time-savings. For a short summary of the model and inputs, please see Appendix A.

A per-mile charge over a wide area is an alternative to a cordon approach, in which a vehicle is charged upon entering a defined central urban area. The cordon approach has been used by every city that has thus far implemented congestion charging, is under consideration in San Francisco and has been considered by other cities. However, as vehicle ownership continues to rise around the world, congestion levels are also likely to rise in more regions outside core urban areas that have less concentrated development. These regions could potentially benefit from this type of a per mile congestion charge.

The ICCT-KEA study found that the societal benefits of a congestion charging system that targets areas and periods of high congestion in Santa Clara County would be several times larger than the costs (Table 2). The largest predicted benefits are 22 million hours per year in time-savings from avoided congestion and $250 million in gasoline savings. Reductions in air pollution and greenhouse gas emissions added significantly to the expected net societal benefits. Estimated greenhouse gas emissions reductions of over 600,000 tons of CO_2, representing an approximately 17 percent reduction from baseline weekday CO_2 emission rates, are comparable to the reductions achieved in London and Stockholm. Reduced accident costs were expected but not quantified. These benefits are for the year 2012, while the model predicts even greater benefits for the year 2020.

Vehicle travel reductions	2 billion km (1.3 billion miles)
CO_2 reduction	600,000 metric tons
Gasoline savings	260 million liters (70 million gallons)
Time savings	22 million vehicle-hours

Table 1: Santa Clara County study estimated benefits

Costs were estimated by KEA at $150 million for system operation and about $120 million in decreased convenience for drivers who decide to forgo a trip that they would otherwise have taken by driving (about 10 to 15 percent of the benefits of time savings).[v] The $860 million in estimated annual tolls would more than cover system administration costs, resulting in a net balance of close to $700 million annually. Technology options for an area-wide congestion charge could include GPS-based technology, which has been used in Germany since 2005 to toll trucks over 12,000 kilometers (7,500 miles) of roads along with overhead gantries (Kossak 2007). Transponders with overhead tolling gantries are another technology option for area-wide systems and are used to toll trucks on approximately 3,000 kilometers (1,800 miles) of roads in Austria and the Czech Republic (Czako 2007).

Predicted Benefits	
Time savings	$738,000,000
Gasoline savings	$255,000,000
Pollution reduction (ozone, fine particulates)	$27,000,000
CO_2 reduction	$30,000,000
Total Benefits (excluding charging revenue)	$1,050,000,000
Predicted Costs	
System administration	$150,000,000
Vehicle travel reductions - lost amenity/convenience	$114,000,000
Total Costs (excluding charging revenue)	$264,000,000
Tolls paid by drivers and received by implementing agency	$862,000,000

Table 2: Estimated monetized benefits & costs

While there are uncertainties in these estimates, a large amount of net tolling revenue is expected. Net toll revenue was not considered a cost or benefit in this comparison, as it could be returned to residents or drivers directly as a "dividend" or used to augment transit operations and other mobility options. Congestion charging works best when alternate transportation options are available. Public transit may require funding from net congestion charging revenue or other sources to provide capacity expansions and accommodate higher demand, and to provide options for travelers less able to afford the charge. Expanded service and improved bicycling and pedestrian facilities would provide additional choices and further increase the effectiveness of the congestion charging system.

Congestion charging study for Beijing
Congestion charging studies have also been conducted for other areas. A study by Creutzig and He includes an analysis of a potential congestion charge for Beijing (Creutzig 2009). The study estimated congestion benefits of 11 billion RMB ($1.6 billion U.S.) with opportunity costs of 4 billion RMB ($0.6 billion U.S.) from a charge of 1 RMB /km ($0.24 U.S./mile). Similar to the Santa Clara study, congestion reductions are the largest benefit and air quality improvements are a significant additional benefit. The Beijing study also found that bus riders would enjoy significant time savings (which was not evaluated in the Santa Clara study). Shenzen China is another example of an area where congestion charging is under evaluation.

In the Santa Clara example, additional surplus revenues may remain after funding transit and other traveler mobility options. Policy makers could choose from a number of options, such as land-use planning that further reduces congestion and pollution while providing travelers with additional choices.[vi] Revenues could also be used for road maintenance, safety and/or other public purposes. Per capita dividend or sales tax reductions would be options for policy makers to consider for addressing concerns about higher impacts on local residents and/or mitigating concerns that the charge is a "tax" that would increase overall taxation rates.

VII. *Status of Congestion Charging Efforts in California*

The California Air Resources Board (CARB) has identified congestion charging as an option for achieving California greenhouse gas emissions reductions required by the California Global Warming Solutions Act of 2006. A related law (Senate Bill 375) also sets vehicle travel reduction goals (CARB 2008). CARB has noted that the California state legislature needs to provide authority for local jurisdictions to implement congestion charging, and in some cases federal authority may also be needed.

The San Francisco County Transportation Agency (SFCTA) is completing a detailed congestion charging study for the San Francisco area that is scheduled for release in early 2010. The proposal under study focuses on a cordon approach, with fees levied for entering a defined region (San Francisco Country Transportation Authority 2010). Most options focus on the most densely developed downtown core, which is a compact area that draws a large number of trips during congested times. Other local areas in California are also considering road-pricing options, although some focus on charging single-occupancy

drivers to pay for driving in carpool lanes.

The reduction of traffic due to the economic downturn in California has temporarily reduced the need for congestion relief, but traffic volume can be expected to rise once the economy rebounds. Figure 9 from Santa Clara County illustrates the rebound in congestion following recovery from the 2001-2002 recession. About 60 percent of lanes achieved free-flow traffic (Level of Service or "LOS A," in green) during the last recession. Once the recession ended, virtually every lane was moderately or severely congested. The 2009 Urban Mobility report examined past recessions in California, the Northeast and Texas and found that "in every case, when the economy rebounded, so did the congestion problem" (Shrank 2009).

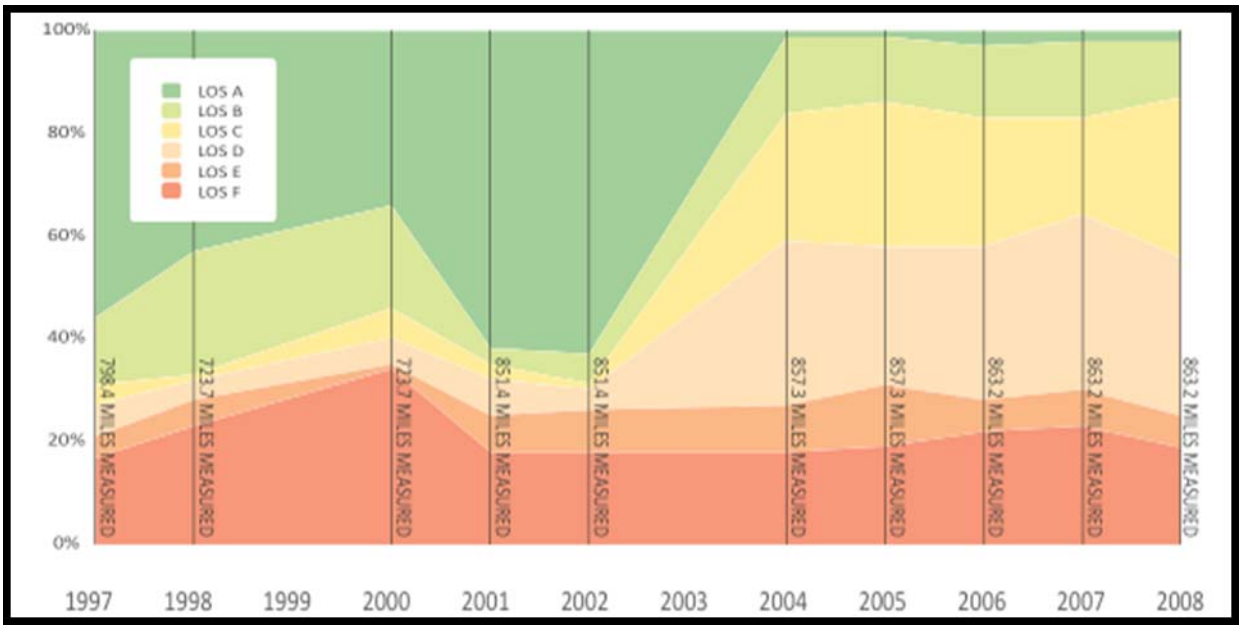


Figure 9: Santa Clara County congestion trends (source: Valley Transportation Authority "2008 Monitoring and Conformance Report")

VIII. *Equity Issues*

Addressing equity issues may be important to preserve mobility for disadvantaged groups and avoid a potential point of public concern, depending on the location. Most U.S. households, even at lower income levels, own a private vehicle and thus would potentially be subject to a congestion charge (Bureau of Labor Statistics, 2008). In China, on the other hand, only 9 percent of all households own a private vehicle and car ownership is typically beyond the reach of lower income brackets (National Bureau of Statistics China, 2009).

Ecola and Light reported that most studies analyzing the payment of congestion charges (which tend to focus on developed countries) found these systems slightly regressive. Studies that consider revenue usage "suggest that the way in which toll revenues are spent

can have a large effect on who benefits and who loses from congestion pricing" (Ecola 2009). Transit enhancements tend to be progressive, especially in areas with the greatest access to transit resources for low-income groups. Revenue redistribution on a per capita basis or income-based discounts are also options to address potential impacts to low-income residents, including those that do not use transit. Other forms of equity concerns, such as regional equity, should also be taken into consideration for any revenue redistribution.

Environmental impacts are another aspect of equity. One study of the London congestion charging system found that "the scheme appears to have led to a modest reduction in socioeconomic inequalities in air pollution exposures and associated mortality." The study predicted benefits of 183 fewer years of life lost per 100,000 people in areas with a congestion charge (Tonne, 2008).

IX. *Conclusion and Best Practice Recommendations*

Traffic congestion is a persistent and growing problem in metropolitan regions worldwide. As passenger vehicle population and usage grows, most dramatically in rapidly developing countries such as China and India, local governments will require innovative solutions such as congestion charging to maintain the flow of traffic and reduce transport emissions. Congestion charging has significant benefits as well as noteworthy challenges as summarized below in Figure 10. Though it may not be appropriate in all cases, a review of its application in Singapore, London and Stockholm shows that congestion charging has increased mobility in densely populated urban areas and studies in Hong Kong suggest it would provide the same benefit in that city as well. A modeling study of Santa Clara County, California, suggests it can offer solutions on a regional scale as well. From a fiscal standpoint, these congestion charging systems have provided greater savings in the form of decreased travel time than they cost to implement.

Congestion charging can also provide additional benefits in the form of reduced emissions of CO_2 and local air pollutants such as ozone and fine particulates, and compliment other efforts such as vehicle emission standards. Environmental improvements may be supplemented by additional public health benefits due to decreased traffic accidents and increased walking and cycling.

Potential Congestion Charging Benefits:

- Reduced travel times and improved reliability for drivers, buses, taxis and deliveries
- Potential source of funds to improve transit frequency and coverage; for bicycle and pedestrian improvements; and to increase road safety and cover road maintenance
- Reduced emissions of greenhouse gas and local air pollutants
- Does not restrain (and may encourage) economic growth
- Public health benefits due to increased cycling/walking and potentially lower accident risk due to decreased private vehicle use
- Can encourage use of the cleanest vehicles through discounts to the charging system

Potential Congestion Charging Challenges:

- Securing public acceptance
- Need for upfront investment in transit
- Ensuring low income populations realize improved mobility
- Addressing public concern over privacy issues
- Allaying business owner concerns
- Designing the system to meet technical and cost-effectiveness criteria
- Assuring net benefits for most drivers in the form of reduced congestion and/or improved transit

Figure 10: Summary of Potential Challenges and Benefits

However, realizing these benefits requires careful design, planning and public outreach. While congestion charging systems must be tailored to local circumstances, the following best practice recommendations provide principles to address a number of common key issues:

System Design:

Geography, traffic patterns, and other local factors are important considerations for choosing the charging strategy and the most cost-effective system for implementing that strategy. The geographic scope should be designed to target areas where congestion reduction benefits will be maximized while also taking into account practical issues such as political boundaries.

A single charging rate offers simplicity and is most appropriate for areas without a sharp morning or afternoon congestion peak. Systems (such as London) where the consumer pays in advance or the day after will likely work best with flat rate pricing so that consumers don't lose track of the amount they need to pay. Flat-rate systems will likely impose the least constraints on system technology options. Areas such as Santa Clara County, where weekday peak traffic delays are severe but midday traffic

is not highly congested, may benefit by adjusting charging levels throughout the day. Variable charging levels for these types of areas would likely work best with automatic payment options, such as the smart cards or transponders with automatic debit used in Singapore and Stockholm and used by many drivers for toll bridges in the Santa Clara County area.

Targeted Discounts:
Discounts or exemptions for disabled persons, emergency vehicles and others should be considered. Discounts for residents of the charging zone may be important to improve public acceptance, but should be weighed against potentially higher operating cost ratios (due to losses on the revenue side of the equation) and potentially diminished effectiveness of congestion charging systems.

Discounts or exemptions for zero-tailpipe emission or low-emission vehicles can enhance the environmental benefits, and caps or periodic reviews of such discounts can ensure that congestion reduction goals are still achieved. Regions with significant variations in vehicle air pollution emission rates can also consider charging rates that vary based on vehicle emission rates, as Milan, Italy has done (as noted earlier under low-emission zones).

Up-Front and On-going Investments in Transit and Transportation:
Transit demand is likely to increase significantly, leading to the need for up-front investment in additional capacity to serve existing routes as well as additional routes to further increase the benefits of the congestion charging system.

Once the congestion charging system is in place, revenues from congestion fees are a potential source of funding for continuing transit improvements and other transportation projects including pedestrian and bicycling facilities to provide improved mobility options. Indeed, a key to public acceptance likely lies in showing the public that new congestion charges will lead to better system performance with less congestion and better travel choices (Replogle, 2008a).

In some regions, net revenue after system administration costs may be sufficient to provide for potential uses in addition to improved transportation. For regions that choose to redistribute net revenue to make the charge revenue neutral, Singapore's example of adopting policies up-front are likely to maximize public acceptance. Congestion charging will be more likely to succeed if fees are not perceived as a tax increase on drivers.

Privacy and Equity Concerns:
Effectively addressing privacy concerns without creating an overly costly or complex system requires careful consideration. Some tolling agencies allow drivers to use a transponder or smart card with no record of the user's identity as long as the charge is paid.[vii] Systems can also be set up to delete user-specific information once payment has been processed such as in Singapore.

As noted earlier, perceptions of equity can also influence political acceptability. While specific equity issues will vary based on local circumstances, a planning process to identify potential equity issues and responses is an important first step. This can be followed by outreach to improve public education and provide meaningful consultation with potentially affected groups. Monitoring actual impacts for specific groups of concern, such as the low income and disabled persons surveyed in London, can help educate both policy makers and the public about actual effects.

Public Outreach:

Public acceptance is a major challenge. While existing systems have generally been accepted once in place, they have sometimes had to overcome intense initial resistance (Lamba 2008 and Replogle 2008a).[viii] Costs may seem more immediate and tangible than some of the benefits such as improved health from better air quality. An effective public outreach and education strategy is likely to be essential for any new system in addition to addressing the issues above. In Singapore, London and Stockholm officials have garnered support with extensive efforts to demonstrate the public benefits of congestion charging. Stockholm followed an especially dramatic course by turning off the system after a temporary trial to demonstrate its effectiveness. In Hong Kong, by contrast, the failure to communicate benefits and address fiscal and privacy concerns may have created roadblocks during initial consideration of a congestion charging plan. Key outreach topics include each of the best practice topics highlighted above in this section.

While technical and public acceptance challenges are significant, they can be addressed for areas that wish to implement congestion charging. Economic downturns may temporarily reduce congestion and public pressure for policies to address congestion, but the long-term need will continue to grow. In conclusion, congestion charging can often play an important role in reducing the negative effective of congestion while providing environmental and other additional benefits.

ENDNOTES

[i] On the other side of the world, the Australian government found that the cost of road congestion in Australian cities, if left unchecked, could grow from $9.5 billion in 2005 to $20.4 billion Australian by 2020. (Infrastructure Australia, Major Cities Unit, 2010. "State of Australian Cities 2010" available at http://www.apo.org.au/research/state-australian-cities-2010)

[ii] A number of other cities have also implemented congestion charges (Replogle, 2008a).

[iii] In Hong Kong there are less than 50 private cars vehicles per 1,000 population, half as many as Singapore and Seoul. Only about 11 per cent of daily person trips at the time were made by private cars vehicles while 89 per cent use public transport; however, this percentage had rapidly declined from 91 percent in the previous two years due to the high discretionary capital of a booming economy.

[iv] While the model contains the capability to assess a toll on local roads, that option was not included in this assessment. A lesser toll on intermediate-level roads will reduce pressure on local roads, and tolls are assumed to be set low enough to discourage shifting traffic onto the most local roads; which are generally low speed residential streets with frequent stops. In addition, any shifting to local road would be offset at least in part by the local portion of trips avoided due to the congestion charges and improved transit service.

[v] Costs are estimates based on the Puget Sound Regional Council "Traffic Choices Study" Appendix 21, which used a GPS-based system. Guests could obtain a flat-fee license similar to the Singapore ERP system. Another option would be "tag and beacon" such as the "Fast-track" system used in Southern California (https://www.thetollroads.com/home/pdf/F10_visor_map_6_22_09.pdf) for a system that monitors about three dozen intersections or other charging points and is also used in the San Francisco Bay Area for bridge tolls and tracking vehicle travel time for informational purposes.

[vi] Some potential options include new transit service, telecommuting choices, pilot projects for mileage-based automobile insurance, and planning efforts that decrease the separation of homes, jobs, and goods & services.

[vii] Singapore uses on-board "smartcards" that do not require the collection of data outside the vehicle if the charge is properly paid using an on-board "smartcard." Toronto RT 407 users can set up a cash account with no identification on request. In Singapore banking transaction data is promptly deleted.

[viii] Ecola and Light also reference Glaister and Hugosson finding that implementation has improved after implementation.

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APPENDIX A: Comparison of Singapore, London, and Stockholm Congestion Charging Systems

	Singapore	London	Stockholm
Key Objectives	Reduce congestion and encourage shift to transit and off-peak driving	Reduce congestion and air pollution	Improve mobility and reduce congestion
Date Introduced	1975	2003	2007
Congestion Reduction	13%	30% for original zone; 10% for western extension	25%
Size of Area Covered	Original area was 7.25 sq km (4.5 sq mii); additional charging locations added in 2008	Original zone of 22 sq km (8 sq mi); 2007 expansion to 24 sq km (15 sq miles)	34 sq km (21 sq miles)
Motor Vehicle Trips Into Zone (Weekday)	235,000 daily entries into charging zone	292,000 daily entries into charging zone	345,000 passes including both directions
Discounts	Emergency vehicles are exempt	Emergency vehicles, residents, vehicles used for disabled persons, alternate fueled vehicles, are exempt	Emergency vehicles, taxis, environmental vehicles, and foreign registered vehicles.
Current charge amount	S$0.35-4.0 ($0.25-2.90 US)	£8($12 US)	10-20 SEK, 60 SEK/day max ($1.40-$2.80 US, $8.50 max)
Technology	Implemented on-board unit in 1998 with smartcard instantly debited; camera enforcement	Payment via text message, phone, internet or pay stations; camera enforcement	most payments direct debit; transponder with camera enforcement
Mode split	40% transit when initiated; 60% transit mode split today	40% of weekday inner London trips via public transportation; 31% via walking; 29% via private vehicle	Originally 75% transit on-peak; 34% car & 41% transit off-peak; transit split increased 4.5% due to charge
CO_2 Reductions	Not available	15-20%	15%

(Sources: EDF 2006;GTZ 2009; Keong 2002;London Travel Demand Survey Supplement 2007; Luk 1997; Reuters 2007, Söderberg 2008; Swedish Transport Authority 2010, Tfl 2007; TfL 2009; Yam 2005)

APPENDIX B

Summary of California Congestion Charging Study Methodology and Inputs

The study developed a speed-traffic density relationship that is linked to dynamic modeling of the effects of road charging on traffic volumes. The model includes effects based on both price and time elasticities, i.e. the effect of increased dollar cost and decreased time cost on the number of auto trips. The model allows the user to model results for either 2012 or 2020, and is designed to estimate aggregate results consistent with the limited scope of this project. The model assesses both benefits and disbenefits – including lost convenience for trips foregone due to the road charge. The model includes the "rebound effect" of drivers attracted to take more trips by shorter trip times. It does not include the benefits of travelers that further reduce driving due to increased transit availability or other enhancements that could be funded by net congestion charging revenue, nor the potential benefits of reduced accidents and noise as they were outside the scope of this study. Carbon monoxide reductions were calculated but not monetized as the cost-effectiveness estimates used for the study do not include carbon monoxide, and calculating air toxics benefits was not within the scope of the study.

The average tolling rate during congested times was set at $0.18/mile, compared to an average fuel price of $0.15/mile at 25 mpg. This figure is based on a $3.75 gallon fuel price in effect when the analysis was conducted, and lower fuel prices would likely increase benefits because baseline congestion levels would be higher. All freeways (102 miles) and expressways (86 miles) in congested areas (70 % of Santa Clara County) were charged in the analysis. Freeways charges were set at $0.40-$0.50 per mile during peak congestion times (5 hours), $0.15 mid-peak (8 hours), and no charge was imposed off-peak (including all weekends and holidays). Charges for limited-access expressway (typically with speed limits of 45 miles per hour) were set 25% lower. The average tolling rate was $1.74 per trip.

The study also varied inputs, including price elastiticity, and found that congestion charging results in net societal benefits under low, high, and mid-point price elasticities varying from -0.2 to -0.8, with the primary scenario using a price elasticity of -0.5 based on a recent pilot study by the Pugeut Sound Regional Council (http://www.psrc.org/projects/trafficchoices/index.htm). Time elasticities, i.e. willingness to change the time of a trip to avoid or reduce toll costs, were included in the model and can be varied by the user. For more details, the technical appendix for the technical is available on request.

Readers interested in an example of a spreadsheet model applying these same principles to a potential future New York City cordon fee can also download that Komanoff model for New York City at http://nnyn.org/index.html.

House of Commons

Transport Committee

Road pricing

Fourth Report of Session 2021–22

Report, together with formal minutes relating to the report

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Summary

The two principal motoring taxes, fuel duty and vehicle excise duty, make a significant contribution to HM Treasury revenues. Taken together, vehicle excise duty and fuel duty raise some £35 billion a year, which comprises approximately 1.5% of UK GDP. That sum is forecast to equate to approximately 4% of overall tax receipts in 2021–22. We estimate that the revenue raised by fuel duty is equivalent to approximately five pence on the rate of income tax. Policies to deliver net zero emissions by 2050 are likely to result in zero revenue for the Government from motoring taxation by 2040. In addition to generating taxation to fund essential public services, motoring taxation plays a key role in managing congestion by regulating demand to use public roads. If the Government fail radically to reform motoring taxation, the UK faces an under-resourced and congested future.

In our inquiry, we heard that the public are concerned how new forms of motoring taxation might affect their household budgets and mobility. We recognise those concerns. In designing a replacement for fuel duty and vehicle excise duty, the Government must ensure that any new motoring taxes entirely replace fuel duty and vehicle excise duty, rather than being added alongside those taxes, and result in most motorists paying the same or less than they do currently.

The Government must act now on this agenda. The taxes imposed by fuel duty and vehicle excise duty are increasingly duplicated by local schemes that charge motorists for entering congestion zones and clean air zones. The growing patchwork of devolved schemes may make it impossible to deliver a national road pricing scheme, because the simultaneous operation of local and national road pricing schemes would create confusion and unfair double taxation.

The Treasury is responsible for taxation policy, including motoring taxation; the Department for Transport is responsible for road connectivity. The Government must work on a cross-departmental basis to join up policy on maintaining tax revenues, facilitating road connectivity and supporting the shift to zero emission vehicles. To that end, the Department for Transport and the Treasury must work together to (a) set out their preferred options for replacing fuel duty and vehicle excise duty and (b) establish an arm's-length body with an appointed individual to evaluate the potential merits of those options.

The situation is urgent. The arm's-length body should be tasked with recommending an alternative road charging mechanism to replace fuel duty and vehicle excise duty by the end of 2022. One of those options should be a road pricing mechanism that uses telematic technology to charge drivers according to distance driven, factoring in vehicle type and congestion. If motoring taxation is linked to road usage, the Committee has not seen a viable alternative to a road pricing system (based on telematics).

1 Road pricing

Introduction

1. Road pricing involves direct charges levied on motorists for driving on public roads. It has two purposes: first, to generate revenue; and, secondly, to manage the costs of motoring such as pollution, emissions and congestion. Local road pricing schemes currently operate across the UK. They include toll roads, charges to enter bridges and tunnels, zonal charging schemes such as the London congestion charge, where drivers pay a fee to enter a certain area with a certain vehicle, and the HGV Road User levy, which is currently suspended.[1] Various road pricing schemes have been introduced in Sweden, Germany and the United States. Singapore has arguably implemented the world's most advanced scheme.[2]

Inquiry

2. We launched an inquiry in December 2020 called Zero emission vehicles and road pricing. We chose to split the inquiry into two parts. We reported our findings on Zero emission vehicles in July 2021. That Report addressed the opportunities and challenges presented by the advancement of the ban on the sale of new petrol and diesel vehicles to 2030.[3] This Report on Road pricing covers the second part of our inquiry. It examines the consequences of the shift to electric vehicles, including tackling the decline in fuel duty and vehicle excise duty. We held two oral evidence sessions on road pricing, at which we took evidence from four panels of witnesses. We received 148 written evidence submissions. We are grateful to everyone who contributed to our inquiry.

Vehicle excise duty and fuel duty

3. Drivers in the UK are currently subject to two principal motoring taxes.[4] Vehicle excise duty is levied on vehicles registered in the UK. Fuel duty is levied on fuel used by motor vehicles. Mike Williams, Director Business and International Tax, HM Treasury, told us that taken together vehicle excise duty and fuel duty raise some £35 billion a year, which comprises approximately 1.5% of UK GDP.[5] That sum is forecast to equate to approximately 4% of overall tax receipts in 2021–22.[6] We estimate that the revenue raised by fuel duty is equivalent to approximately five pence on the rate of income tax.[7]

1 HoC Library, Road pricing, CBP 3732, 6 August 2020; Midland Expressway Limited (EVP0071); Go-Ahead Group (EVP0108); TfL (EVP0138); RAC Foundation (EVP0045); BBC News, Birmingham's Clean Air Zone charging begins, 14 June 2021; DfT, "HGV Road User Levy", accessed 9 December 2021; HC Deb, 27 October 2021, col 275

2 Q48; HC 27 Qq49–50; Jacobs (EVP0030)

3 Transport Committee, First Report of Session 2021–22, Zero Emission Vehicles, HC 27, 20 July 2021

4 VAT is applied to fuel duty. It is arguable whether this is a tax on motoring or a tax on a tax. In addition, the electricity used to charge electric vehicles may be subject to VAT.

5 Q97. The Treasury's recent net zero review document gives a figure of £37 billion in 2019–20, equivalent to 1.7% of GDP: HM Treasury, Net Zero Review Analysis exploring the key issues, 19 October 2021, para 6.4. As Mr Williams explained the exact amount depends on "which year you use".

6 OBR, Economic and Fiscal outlook: Fiscal supplementary tables; receipts and other, 27 October 2021. That percentage is inflated, because fuel duty is levied on fuel for domestic heating in addition to fuel used for motoring.

7 Institute for Fiscal Studies, Options for raising taxes, 18 October 2018

4. Revenue from vehicle excise duty (£7 billion) is allocated to the National Roads Fund to fund local and strategic road upgrades. That guaranteed allocation to the National Roads Fund provides an important element of hypothecation in motoring taxation. In contrast, fuel duty (£28 billion) is disbursed across the whole of state spending to fund, for example, schools, hospitals and the armed forces.[8]

5. The £35 billion a year generated by motoring taxation is a significant sum when set against the cost of funding essential public services. For example, the Government committed £15.9 billion to fund policing in England and Wales in 2021–22.[9] Total funding allocated to schools in England was £47.6 billion in 2020–21.[10] In 2019–20, the Ministry of Defence disbursed some £39.8 billion to maintain the armed forces.[11]

6. The Treasury described fuel duty as almost a "perfect tax".[12] Duncan Buchanan, Policy Director for the Road Haulage Association, explained that "the fuel duty system, as a proxy for road use, is in itself reasonably transparent and reasonably fair. The more fuel you use and the heavier the vehicle, the more you pay".[13] However, the relationship between usage and taxation will be lost as drivers transition from petrol and diesel-powered vehicles to greener alternatives. The OBR described the growth in electric vehicle ownership as a "large and predictable tax cut on motoring".[14]

7. **Fuel duty and vehicle excise duty raise some £35 billion a year. Approximately 20% of that revenue is disbursed on maintaining and developing the roads. Neither fuel duty nor vehicle excise duty are currently levied on electric vehicles. The Government is phasing out the sale of petrol and diesel cars by 2030. Under the current system of fuel duty and vehicle excise duty, that policy will reduce tax revenues obtained from motoring to zero over the next 20 years. Without radical reform, policies to deliver net zero emissions by 2050 will result in zero revenue for the Government from motoring taxation. A failure to replace existing motoring taxes with an alternative road charging mechanism will lead to either decreased investment in public services, including road maintenance, or increased Government borrowing.**

8. ***The Government must start an honest conversation with the public on the funding implications for road development and maintenance and for other essential public services of decreased revenue from vehicle excise duty and fuel duty.***

9. ***To promote fairness and public acceptance, any alternative road charging mechanism must (a) entirely replace fuel duty and vehicle excise duty rather than being added alongside those taxes; and (b) be revenue neutral with most motorists paying the same or less than they do currently.***

8 Q97. In the 2018 Budget, the Government said it would "hypothecate English Vehicle Excise Duty to the National Roads Fund between 2020–25": HMT, Budget 2018, 29 October 2018.
9 Home Office, Police funding for England and Wales 2015 to 2022, 15 July 2021
10 DfE, School Funding Statistics 2020–21, 28 January 2021
11 HoC Library, UK Defence Expenditure, 21 June 2021
12 Q107
13 Q8
14 OBR, Fiscal risks report, CP 453, 6 July 2021, p151

Zero emission vehicles

10. In 2018, the UK Government published its The Road to Zero strategy, which set out the Government's long-term plans for the transition to zero emission road transport.[15] The strategy committed to ending the sales of all new petrol and diesel-powered cars and vans by 2040. In November 2020, the Government published The Ten Point Plan for a Green Industrial Revolution, which advanced the date for ending sales of petrol and diesel-powered vehicles to 2030.[16]

11. Electric vehicle owners pay no fuel duty or vehicle excise duty.[17] Mr Williams observed that tax revenues will decline as electric vehicle ownership increases.[18] Predicting the rate of decline in tax revenues from vehicle excise duty and fuel duty is problematic. In July 2021, the Office for Budget Responsibility (OBR) forecast that electric vehicles would comprise 16% of new registrations and 4% of total registered cars by 2025–26.[19] However, electric cars made up 10.9% and 11.6% of all new registrations in August and September respectively, which indicates that electric vehicle ownership may be growing more quickly that the OBR July forecast. In October 2021, the OBR adjusted its fuel duty forecasts to reflect "faster than expected take-up of electric vehicles reducing revenues".[20] In 2021, however, 11.6 % of new car registrations had a battery electric powertrain, which shows how far UK drivers will need to change their driving preferences before and after the 2030 ban on the sale of petrol and diesel-powered vehicles.[21]

12. Government policy is predicated on the transition to net zero reducing fuel duty and vehicle excise duty receipts. The Net Zero Review Final Report argued that "were the current tax system to remain unchanged across the transition period, tax receipts from most fossil fuel related activity will decline towards zero during the first 20 years of the transition, leaving receipts lower in the 2040s by up to 1.5% of GDP".[22] The Ten Point Plan for a Green Industrial Revolution highlighted the "need to ensure that the tax system encourages the uptake of EVs and that revenue from motoring taxes keeps pace with this change, to ensure we can continue to fund first-class public services and infrastructure."[23]

13. If electric vehicle drivers become accustomed to no-tax motoring, it may become socially and politically difficult for the Exchequer to extract motoring taxes from them in future. Claire Haigh, founder and chief executive officer, Greener Transport Solutions, warned that

> if we do not move fast, people will just bank the fact that if you buy your electric vehicle you do not have to pay much in running costs. If that becomes part of the psychology of owning an electric vehicle […] we have no hope of filling that hole and changing how we pay.[24]

15 DfT, The Road to Zero, 9 July 2018
16 HM Government, The Ten Point Plan for a Green Industrial Revolution, 18 November 2020
17 Electric vehicles are zero rated for VED and exempt from the expensive car supplement until at least 31 March 2025: HC Deb, 3 July 2020 col 64046W
18 Q97; HM Treasury, Net Zero Review Analysis exploring the key issues, 19 October 2021, para 6.4
19 OBR, Fiscal risks report, CP 453, 6 July 2021, pp 111–112 & 147
20 OBR, Economic and fiscal outlook, CP 545, 27 October 2021, p170
21 SMMT, Covid stalls 2021 UK new car market but record EV sales show future direction, 4 January 2022
22 HM Treasury, Net zero review final report, 19 October 2021, p89
23 HM Government, The Ten Point Plan for a Green Industrial Revolution, 18 November 2020, p14
24 HC 27 Q68

14. **Zero fuel duty and vehicle excise duty help motorists to offset the higher purchase price of electric vehicles compared with petrol and diesel alternatives. Those prices are predicted to decrease as sales of new and second-hand electric vehicles increase. As prices decrease, more motorists will purchase electric vehicles, which will in turn decrease fuel duty and vehicle excise duty yields.**

15. ***In signalling a shift to any alternative road charging mechanism, the Government must make it clear to motorists who purchase electric vehicles that they will be required to pay for road usage, as is currently the case for petrol and diesel vehicles. It must ensure that any alternative road charging mechanism incentivises motorists to purchase vehicles with cleaner emissions while contributing tax revenues to support the maintenance of the road network.***

Congestion

16. Cheaper driving is likely to lead to more driving.[25] In September 2018, the Department for Transport (DfT) forecast that a shift to electric vehicles would increase national traffic levels by 51% between 2015 and 2050, with the amount of time drivers spend on congested roads rising from 7% to 16%.[26] The Institute for Global Change estimated that by 2040 the average driver will spend an extra nine hours a year in traffic compared with current congestion levels. In that 2040 projection, drivers who travel on A-roads or into major cities more than the average motorist will face even more congestion.[27]

17. Increased congestion will make it harder for the Government to achieve its transport policy objectives. Streets filled with idling petrol and diesel vehicles in major cities will add to air pollution.[28] A congested road network will inconvenience bus users and depress bus usage, because journeys will become longer and less predictable.[29] Go-Ahead Group told us that "a 10% decrease in bus speeds can reduce patronage by 10% or more".[30] Congestion has a negative effect on economic activity because it restricts and delays the movement of vehicles transporting goods and services. Of course, for some drivers, especially those in rural areas, increased congestion will have little impact and the lower running costs of electric vehicles will prove an unalloyed benefit.[31] The potential effect of a replacement charging mechanism for fuel duty and vehicle excise duty on drivers will vary across the regions and nations of the UK. For example, 27% of workers who live in London report using a car for their commute, compared with an overall percentage in England of 67%. Some 68% of workers in Scotland and 83% of workers in Wales commute by car.[32] But for other drivers, increased congestion will bring more delays and more pollution.

25 HC 27 Q62; Institute for Global Change, Avoiding Gridlock Britain, 31 August 2021, p10; IFS, A road map for motoring taxation, 2 October 2019, para 9.2

26 DfT, Road Traffic Forecasts 2018, 14 September 2018, pp 48 & 62. The forecast assumed all car and LGVs sold are zero emission by 2040 and 97% of car and LGV mileage powered by zero emission technologies by 2050. In April 2021 the Department said it had "no immediate plans to publish an update" to the traffic forecasts: HC Deb, 27 April 2021, 185812W

27 Institute for Global Change, Avoiding Gridlock Britain, 31 August 2021, p10

28 HC 27 Q55; TfL (EVP0138); Institute for Global Change, Avoiding Gridlock Britain, 31 August 2021, p4

29 HC 27 Q70; Go-Ahead Group (EVP0108); Jacobs (EVP0030)

30 Go-Ahead Group (EVP0108)

31 Qq11–12

32 DfT, Transport Statistics Great Britain: 2021, 16 December 2021

18. The Government accepted that it must ensure that "revenue from motoring taxes keeps pace" with the transition away from petrol and diesel vehicles, so that it can "continue to fund the first-class public services and infrastructure that people and families across the UK expect".[33] However, Mr Williams told us that the Government currently has "no announced policy" on how it will achieve that objective.[34]

19. ***In designing a replacement for fuel duty and vehicle excise duty, the Government must examine how an alternative road pricing mechanism can use price as a lever for change while subjecting motorists to fair levels of taxation. To that end, it may seek to make concessions in the interests of societal fairness, such as providing an annual allowance of free travel miles or gearing the system to support vulnerable groups, such as those with mobility issues, and people who reside in the most remote areas.***

20. **The introduction of an alternative road charging mechanism that supported motoring and motorists might work against the Government's ambition for half of all journeys in towns and cities to be walked or cycled by 2030.** ***In designing an alternative road pricing mechanism to vehicle excise duty and fuel duty, the Government must ensure that any road pricing scheme does not undermine progress towards its targets on active travel and public transport modal shift.***

Replacing fuel duty and vehicle excise duty

21. The Government could implement a range of potential policy responses to the decline in fuel duty and vehicle excise duty. For example, it could allow those duties to decline. However, that would mean non-drivers subsidising drivers and might result in significant increases to other taxes or reduced public services.[35] Alternatively, a way might be found to price electricity used by vehicles differently. That could be done by introducing a roads surcharge on electricity used to charge vehicles.[36] Yet, as Mr Williams pointed out, this would require potentially costly new infrastructure, because there is currently "no mechanism for my supplier to know if I am using the washing machine or charging a car".[37]

22. Those potential replacements for fuel duty and vehicle excise duty would all introduce inequity for particular groups of people. In addition, effective congestion management requires a demand- and usage-sensitive, equitable system of motoring taxation. None of those potential policies would deliver an equitable system of motoring taxation predicated on usage and environmental impacts.

23. The Committee explored whether introducing some form of national road pricing system could replace declining tax revenues and reduce congestion. A broad range of organisations and individuals submitted written evidence to our inquiry. The majority expressed support in principle for the introduction of a road pricing mechanism to replace vehicle excise duty and fuel duty.[38] Professor Philip Booth, Director of the Vinson Centre at the University of Buckingham, told us that road pricing is the best way to ensure that

33 HC Deb, 1 July 2021, col 23288W
34 Q97
35 HC 27 Q45; Smarter Cambridge Transport (EVP0126)
36 Q61 [Professor Goodwin]
37 Q107
38 For example: BVRLA (EVP0052), Chartered Institute of Logistics and Transport (EVP0096), Jacobs (EVP0030) and Green Alliance (EVP0125) .

"road users are charged for the costs that they impose on the system […] and the costs they impose on other road users".[39] John Siraut, Director of Economics at Jacobs, argued that "the big advantage of road user charging is to tackle congestion, and congestion has a huge economic cost for UK plc."[40] Eamonn Ives, Head of Energy and Environment Policy at the Centre for Policy Studies, observed that the advantages of road pricing include better connectivity for tradespeople, reduced congestion, improved road maintenance and enhanced environmental outcomes.[41]

24. Road pricing would support other Government policy priorities, such as encouraging active travel, decarbonising transport and increasing transport infrastructure investment.[42] Caterina Brandmayr, Head of Climate Policy at Green Alliance, told the Committee that a well-designed road pricing system could deliver "a wealth of benefits, including reducing congestion, improving air quality and improving health through greater walking and cycling".[43] TfL argued that "national road pricing could accelerate mode shift to achieve zero carbon targets".[44] Jacobs speculated that some revenues could be set aside to restore the condition of its road network to an agreed national standard within 10 years.[45]

25. Introducing road pricing is an opportunity for the UK to be a world leader, setting an example of what we can achieve as a country and building valuable commercial expertise to boost future UK exports.[46] John Siraut stated:

> Every country in the world is tackling the same problem. How do they replace vehicle excise duty and fuel duty with something else? There are models that I do not think capture everything that road user charging can do. Singapore probably comes the nearest, but I think there is an opportunity for the UK to push the boundaries and develop its own model.[47]

26. ***The Government must set out a range of options to replace fuel duty and vehicle excise duty. Those options should be revenue neutral and not cause drivers, as a whole, to pay more than they do currently. One of those options should be a road pricing mechanism that uses telematic technology to charge drivers according to distance driven, factoring in vehicle type and congestion. If motoring taxation is linked to road usage, the Committee has not seen a viable alternative to a road pricing system based on telematics. The Government's preferred options should be submitted to an arm's-length body for evaluation [see paragraph 44].***

National and local

27. Witnesses were generally in favour of a nationally run system, rather than implementing a range of local schemes. They cited cost, user friendliness and clear governance as key benefits of a national scheme.[48] Mr Buchanan said:

39 HC 27 Q69
40 Q55
41 HC27 Q86
42 Q77; HC 27 Qq44, 54 & 76; TfL (EVP0138); Jacobs (EVP0030); ASI (EVP0107); RAC Foundation (EVP0045)
43 HC 27 Q42
44 TfL (EVP0138)
45 Jacobs (EVP0030) para 66
46 Qq89–91; HC 27 Q49
47 Q89
48 Qq 22 & 57 & 71–72; HC 27 Q74; BVRLA (EVP0052)

> Our members work nationally and cross-regionally. They deliver everywhere. One of the enemies for us is local complexity. You have different rules in London, different rules in Manchester, different rules in Birmingham, and it just adds more and more complexity.

Some witnesses highlighted the potential virtues of introducing local road pricing schemes. Steve Gooding, Director of the RAC Foundation, argued:

> If there is to be a congestion charge, I think it would make more sense for it to be locally designed […] My preferred model would be that it was a local decision as to whether the charge should be there, a local decision as to what that charge should be, and, almost certainly, that there should be some local benefit from the income, otherwise the package is not going to work locally.[49]

The Adam Smith Institute suggested that Metro Mayors should be able to decide how road pricing revenue raised in their area will be spent on transport.[50]

28. The devolution of road pricing could lead to the introduction of clunky, unconnected schemes that charge users the same price for driving one mile into the zone as those who drive across it for hours in a day. The more regional schemes that are created, the harder it will eventually be for the Government to implement a functional national system. Fuel duty and vehicle excise duty are Treasury taxes that require a national-level replacement rather than a patchwork of incongruous local schemes. Indeed, the introduction of a range of more-or-less-generous local road pricing schemes would risk engendering regional inequality and driving economic disadvantage.

29. **The taxes imposed by fuel duty and vehicle excise duty are increasingly duplicated by local schemes that charge motorists for entering congestion zones and clean air zones. New taxes, and particularly those that rely on new technology, take many years to introduce. The patchwork of devolved schemes may make it impossible to deliver a national road pricing scheme. The simultaneous operation of local and national road pricing schemes would subject drivers to confusion and unfair double taxation.**

30. ***The Government must examine how an alternative road pricing mechanism can be delivered alongside devolved local road charging schemes, while respecting the existing devolution settlement. Any alternative road pricing mechanism must be revenue neutral to the Government rather than causing drivers, as a whole, to pay more than they do currently. Such a mechanism should be phased in before fuel duty and vehicle excise duty decline to zero. The situation is urgent; work must begin without delay.***

Technology

31. Various forms of road pricing operate successfully across the world.[51] We heard that the technology required to facilitate an efficient system of road pricing is currently available.[52] Professor Phil Goodwin, Senior Fellow at the Foundation for Integrated

49 Qq21 & 45

50 ASI (EVP0107)

51 HC 27 Q50; Jacobs (EVP0030); ITS (EVP0119). See the second panel of our second oral evidence session for a detailed discussion of existing international road pricing schemes.

52 Q39; Q51; HC 27 Qq 57–58

Transport, explained: "Anything that, politically, is realistic to design […] the technology can deliver already".[53] Onboard vehicle telematic technology currently permits insurers to charge for the number of miles travelled by a motorist. Mr Siraut stated that "you could have a single unit in your vehicle for both insurance and road user charging payment systems".[54]

32. New technology has the potential to move beyond a simple charge for miles travelled. Mr Siraut discussed dynamic road pricing. He stated that a system where charges vary dynamically based on the road being used and the time of travel are "certainly perfectly feasible to do", even though they do not exist at the moment.[55] Telematics inside vehicles allows real-time data to be recorded and transferred to a pricing mechanism. That technology can, for example, dynamically set the price of insurance policies for young people based on the time and duration of travel.

33. ***The Government must examine the role that telematic technology can play in delivering a replacement road pricing mechanism that sets the cost of motoring based on the duration and time of the journey and vehicle type and size.***

34. ***The Government must assess the potential effect of telematic technology on changing drivers' behaviour and delivering its wider policies on air quality, congestion, public transport and public health.***

35. ***The Government must assess the potential effect of a road pricing mechanism based on telematic technology on high-mileage drivers, such as road hauliers and those in rural communities, and on those least able to adapt to increased motoring costs.***

Data protection

36. Several witnesses stressed the importance of a strong legal framework to protect drivers' privacy.[56] Vivacity Labs argued that to

> maintain public support for any technological solution, it is […] imperative to not just engineer a solution that cannot be used to track individuals, but also to educate the public specifically on why it cannot be mis-used, and how introducing the system will specifically benefit them as citizens.[57]

Other witnesses argued that the significance of data protection has been overstated and that the topic is not a top-level for concern for the public, who are prepared to provide data access in exchange for efficient services and systems.[58]

37. **The successful implementation of a national, technology-based road pricing scheme is contingent on the Government explaining how data capture will work in practice, ensuring that data management is subject to rigorous governance and oversight and reassuring the public that their privacy will be protected.**

53 Q51
54 Q61
55 Q50
56 Q74; Vivacity Labs (EVP0088)
57 Vivacity Labs (EVP0088)
58 Qq75–76

Departmental responsibility

38. The Treasury funds the DfT to maintain and develop the road network for motorists, which allows the economy to function and the Treasury to collect taxes. Simultaneously, the DfT depends on the Treasury to impose motoring taxes to regulate demand for motoring and to manage congestion. The interconnected challenges associated with motoring taxation can only be overcome by functional cross-departmental, joined-up government. DfT policy includes promoting the benefits and increasing take-up of electric vehicles. More electric vehicles imply reduced receipts from fuel duty and vehicle excise duty. The resultant lost tax revenues could have serious implications for the maintenance and development of the road network, on which all vehicles travel. There is a danger that the DfT and Treasury's respective responsibilities might lead them to work towards differing and competing policy outcomes.

39. ***The Government must work on a cross-departmental basis to ensure that equal focus and policy ownership is placed on the delivery of more zero emission vehicles and the continued funding and maintenance of the road network. The Treasury and the DfT should set up a joint unit including Ministers and officials from both Departments to co-ordinate that shared policy space.***

Devolution

40. The UK Government develops the policy and provides the bulk of the funding for local transport in England, including buses, walking, cycling and local highways and rail. In Scotland, Wales and Northern Ireland, those policies and funding are delivered by the relevant devolved Administration. Westminster retains reserved powers in relation to national transport, including aviation, maritime and strategic road and rail. Fuel duty and vehicle excise duty, the principal motoring taxes, are national taxes levied by the Treasury.

41. **Bearing in mind the partial devolution of transport policy, consultation and agreement between the UK Government and the devolved Administrations will be key to developing and implementing an alternative road charging mechanism.**

The way forward

42. Road pricing is not a new idea. UK policymakers first raised it in the Smeed Report in the 1960s.[59] However, the history of road pricing is a history of public unpopularity. Fifteen years ago, for example, a petition against the introduction of road pricing attracted more than one million signatures.[60] As a result, road pricing has acquired the reputation as a policy that is too unpopular to implement.[61] In October 2014, Professor Stephen Glaister, a member of the advisory panel to the 2004 Road Pricing Feasibility Study, pointed out that

> It has become a standing joke that even if any UK politician is unable to deny the logic of the case for some form of road pricing, they are never willing to implement it within the next ten years—by which time they will be long gone.[62]

59 Qq69–70; HC 27, Q44
60 "Roads petition breaks a million", BBC News, 10 February 2007
61 Qq 21 & 70 [Phil Goodwin]; HC 27, Qq44–45
62 UCL, The Smeed Report at Fifty, 7 October 2014

43. Many informed witnesses observed that the greatest barriers to introducing road pricing are political.[63] In the course of British history, several Governments have foundered on the rocks of introducing new taxes. Democratically elected politicians are painfully aware that advocating the introduction of new taxes, however well intentioned, is unlikely to engender general popularity. The political risks associated with road pricing have made it too toxic a prospect for successive Governments. However, fuel duty and vehicle excise duty are increasingly unfit for purpose. The consequences for both the public finances and congestion management are too severe for inaction. New systems of taxation, and particularly those based on innovative technology, can take years to devise and deliver. Botched and rushed taxation policies can and will fail to operate efficiently and to secure public acceptance. The introduction of local charging schemes and the predicted drop in fuel duty and vehicle excise duty from drivers switching to electric vehicles mean that time is not on the Government's side.

44. ***To fulfil their respective and connected responsibilities for managing congestion and maintaining the public finances, the DfT and the Treasury must jointly establish an arm's-length body with an appointed individual to evaluate its preferred options to replace fuel duty and vehicle excise duty [see paragraph 26]. The body should consult experts on road planning, taxation and telematic technology, and it should consider international experience. It should be tasked with recommending an alternative road charging mechanism to replace fuel duty and vehicle excise duty by the end of 2022.***

63 Qq 2, 7 & 52–53; HC 27 Q81; ASI (EVP0107)

Conclusions and recommendations

Road pricing

1. Fuel duty and vehicle excise duty raise some £35 billion a year. Approximately 20% of that revenue is disbursed on maintaining and developing the roads. Neither fuel duty nor vehicle excise duty are currently levied on electric vehicles. The Government is phasing out the sale of petrol and diesel cars by 2030. Under the current system of fuel duty and vehicle excise duty, that policy will reduce tax revenues obtained from motoring to zero over the next 20 years. Without radical reform, policies to deliver net zero emissions by 2050 will result in zero revenue for the Government from motoring taxation. A failure to replace existing motoring taxes with an alternative road charging mechanism will lead to either decreased investment in public services, including road maintenance, or increased Government borrowing. (Paragraph 7)

2. *The Government must start an honest conversation with the public on the funding implications for road development and maintenance and for other essential public services of decreased revenue from vehicle excise duty and fuel duty.* (Paragraph 8)

3. *To promote fairness and public acceptance, any alternative road charging mechanism must (a) entirely replace fuel duty and vehicle excise duty rather than being added alongside those taxes; and (b) be revenue neutral with most motorists paying the same or less than they do currently.* (Paragraph 9)

4. Zero fuel duty and vehicle excise duty help motorists to offset the higher purchase price of electric vehicles compared with petrol and diesel alternatives. Those prices are predicted to decrease as sales of new and second-hand electric vehicles increase. As prices decrease, more motorists will purchase electric vehicles, which will in turn decrease fuel duty and vehicle excise duty yields. (Paragraph 14)

5. *In signalling a shift to any alternative road charging mechanism, the Government must make it clear to motorists who purchase electric vehicles that they will be required to pay for road usage, as is currently the case for petrol and diesel vehicles. It must ensure that any alternative road charging mechanism incentivises motorists to purchase vehicles with cleaner emissions while contributing tax revenues to support the maintenance of the road network.* (Paragraph 15)

6. *In designing a replacement for fuel duty and vehicle excise duty, the Government must examine how an alternative road pricing mechanism can use price as a lever for change while subjecting motorists to fair levels of taxation. To that end, it may seek to make concessions in the interests of societal fairness, such as providing an annual allowance of free travel miles or gearing the system to support vulnerable groups, such as those with mobility issues, and people who reside in the most remote areas.* (Paragraph 19)

7. The introduction of an alternative road charging mechanism that supported motoring and motorists might work against the Government's ambition for half of all journeys in towns and cities to be walked or cycled by 2030. *In designing an alternative road pricing mechanism to vehicle excise duty and fuel duty, the Government must ensure that any road pricing scheme does not undermine progress*

towards its targets on active travel and public transport modal shift. (Paragraph 20)

8. *The Government must set out a range of options to replace fuel duty and vehicle excise duty. Those options should be revenue neutral and not cause drivers, as a whole, to pay more than they do currently. One of those options should be a road pricing mechanism that uses telematic technology to charge drivers according to distance driven, factoring in vehicle type and congestion. If motoring taxation is linked to road usage, the Committee has not seen a viable alternative to a road pricing system based on telematics. The Government's preferred options should be submitted to an arm's-length body for evaluation [see paragraph 44].* (Paragraph 26)

9. *The taxes imposed by fuel duty and vehicle excise duty are increasingly duplicated by local schemes that charge motorists for entering congestion zones and clean air zones. New taxes, and particularly those that rely on new technology, take many years to introduce. The patchwork of devolved schemes may make it impossible to deliver a national road pricing scheme. The simultaneous operation of local and national road pricing schemes would subject drivers to confusion and unfair double taxation.* (Paragraph 29)

10. *The Government must examine how an alternative road pricing mechanism can be delivered alongside devolved local road charging schemes, while respecting the existing devolution settlement. Any alternative road pricing mechanism must be revenue neutral to the Government rather than causing drivers, as a whole, to pay more than they do currently. Such a mechanism should be phased in before fuel duty and vehicle excise duty decline to zero. The situation is urgent; work must begin without delay.* (Paragraph 30)

11. *The Government must examine the role that telematic technology can play in delivering a replacement road pricing mechanism that sets the cost of motoring based on the duration and time of the journey and vehicle type and size.* (Paragraph 33)

12. *The Government must assess the potential effect of telematic technology on changing drivers' behaviour and delivering its wider policies on air quality, congestion, public transport and public health.* (Paragraph 34)

13. *The Government must assess the potential effect of a road pricing mechanism based on telematic technology on high-mileage drivers, such as road hauliers and those in rural communities, and on those least able to adapt to increased motoring costs.* (Paragraph 35)

14. The successful implementation of a national, technology-based road pricing scheme is contingent on the Government explaining how data capture will work in practice, ensuring that data management is subject to rigorous governance and oversight and reassuring the public that their privacy will be protected. (Paragraph 37)

15. *The Government must work on a cross-departmental basis to ensure that equal focus and policy ownership is placed on the delivery of more zero emission vehicles and the continued funding and maintenance of the road network. The Treasury and the DfT should set up a joint unit including Ministers and officials from both Departments to co-ordinate that shared policy space.* (Paragraph 39)

16. Bearing in mind the partial devolution of transport policy, consultation and agreement between the UK Government and the devolved Administrations will be key to developing and implementing an alternative road charging mechanism. (Paragraph 41)

17. *To fulfil their respective and connected responsibilities for managing congestion and maintaining the public finances, the DfT and the Treasury must jointly establish an arm's-length body with an appointed individual to evaluate its preferred options to replace fuel duty and vehicle excise duty [see paragraph 26]. The body should consult experts on road planning, taxation and telematic technology, and it should consider international experience. It should be tasked with recommending an alternative road charging mechanism to replace fuel duty and vehicle excise duty by the end of 2022.* (Paragraph 44)

Formal minutes

Tuesday 25 January 2022

Members present:

Huw Merriman, in the Chair

Mr Ben Bradshaw

Simon Jupp

Robert Largan

Chris Loder

Karl McCartney

Grahame Morris

Gavin Newlands

Greg Smith

Draft Report (*Road pricing*), proposed by the Chair, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 44 read and agreed to.

Summary agreed to.

Resolved, That the Report be the Fourth Report of the Committee to the House.

Ordered, That the Chair make the Report to the House.

Ordered, That embargoed copies of the Report be made available, in accordance with the provisions of Standing Order No. 134.

[Adjourned till tomorrow at 9.30 am

Witnesses

The following witnesses gave evidence. Transcripts can be viewed on the inquiry publications page of the Committee's website. Written evidence from our inquiry on Zero Emissions Vehicles is relevant to this inquiry, and has been included in this list.

Wednesday 28 April 2021

Ed Birkett, Senior Research Fellow in Energy and Environment Policy, Policy Exchange; **Caterina Brandmayr**, Head of Climate Policy, Green Alliance; **Sarah Owen-Vandersluis**, Head of Public Sector Mobility and Trade Lead Partner, KPMG	Q1–42
Mr Eamonn Ives, Head of Energy and Environment Policy, Centre for Policy Studies; **Edward Leigh**, Chair, Smarter Cambridge Transport; **Ms Claire Haigh**, Founder and Chief Executive Officer, Greener Transport Solutions; **Professor Philip Booth**, Director, Vinson Centre, University of Buckingham, Senior Academic Fellow, Institute of Economic Affairs	Q43–86

Wednesday 20 October 2021

Duncan Buchanan, Policy Director (England and Wales), Road Haulage Association (RHA); **Steve Gooding**, Director, RAC Foundation; **Toby Poston**, Director of External Affairs, British Vehicle Rental & Leasing Association (BVRLA); **Dr Nina Skorupska CBE**, Chief Executive, Renewable Energy Association	Q1–46
Professor Phillip Goodwin, Senior Fellow, Foundation for Integrated Transport; **John Siraut**, Director of Economics, Jacobs; **Alistair Hunter**, Highways Business Leader, Arup	Q47–95
Mike Williams, Director, Business and International Tax, HM Treasury	Q96–115

List of Reports from the Committee during the current Parliament

All publications from the Committee are available on the publications page of the Committee's website.

Session 2021–22

Number	Title	Reference
1st	Zero emission vehicles	HC 27
2nd	Major transport infrastructure projects	HC 24
3rd	Rollout and safety of smart motorways	HC 26
1st Special	The impact of the coronavirus pandemic on the aviation sector: Interim report: Government Response to the Committee's Fifth Report of Session 2019–21	HC 28
2nd Special	Road safety: young and novice drivers: Government Response to Committee's Fourth Report of Session 2019–21	HC 29
3rd Special	Trains Fit for the Future? Government Response to the Committee's Sixth Report of Session 2019–21	HC 249
4th Special	Safe return of international travel? Government Response to the Committee's Seventh Report of Session 2019–21	HC 489
5th Special	Zero emission vehicles: Government Response to the Committee's First Report	HC 759
6th Special	Rollout and safety of smart motorways: Government Response to the Committee's Third Report	HC 1020
7th Special	Major transport infrastructure projects: Government Response to the Committee's Second Report	HC 938

Session 2019–21

Number	Title	Reference
1st	Appointment of the Chair of the Civil Aviation Authority	HC 354
2nd	The impact of the coronavirus pandemic on the aviation sector	HC 268
3rd	E-scooters: pavement nuisance or transport innovation?	HC 255
4th	Road safety: young and novice drivers	HC 169
5th	The impact of the coronavirus pandemic on the aviation sector: Interim report	HC 1257
6th	Trains fit for the future?	HC 876
7th	Safe return of international travel?	HC 1341