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Peak Car in the Big City: Reducing London's transport greenhouse gas emissions

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ABSTRACT

Road transport is substantially dependent on oil. Car ownership is expected to continue to grow, particularly in the developing economies. The transport sector is therefore seen as more problematic than other sectors as regards reducing greenhouse gas emissions. However, there is emerging evidence that per capita car use in many developed economies has ceased to increase. Moreover, a marked decline in the proportion of journeys by car is evident in a city such as London, with a growing population where road capacity is not being enlarged to meet demand. The expected global growth of urban populations suggests that car ownership and use, and the resulting greenhouse gas emissions, may be significantly lower than usually supposed.

1. Introduction

Transport accounts for over 60 percent of global oil consumption and about a quarter of energy-related CO_2 emissions (IEA, 2013; Kahn Ribeiro et al., 2007). Typical forecasts of future world transport energy use project growth rates of around 2 percent per year. Vehicle ownership is expected to continue to grow, particularly in the developing economies where passenger transport volumes measured in vehicle-km could be 4–5 times higher in 2050 (OECD, 2013a). The transport sector, with its reliance on oil for motive power, has been seen as more problematic than other areas of the economy as regards reducing greenhouse gas emissions. Most emphasis has been on new technology, in particular electric propulsion, where the present state of battery technology limits widespread adoption (Sperling and Gordon, 2009; Inderwildi and King, 2012; Burns, 2013) Demand-side measures are expected to have only modest impact (Fankhauser, 2013; Marsden et al., 2014).

There is, however, emerging evidence that the growth of car travel may be less than hitherto supposed on account of global urbanisation at population densities that limit car use. The argument developed in this paper is based largely on analysis of UK travel and transport statistics, which are exceptionally extensive, and in particular of developments in London, a case study to exemplify changes in travel patterns as a consequence of population growth at increasing density. Evidence is presented for a marked shift away from car use in London, as a result of policies that respond to population growth by investing in public transport, especially rail, and by measures that constrain car use. This shift away from car use should help achieve a significant mitigation of transport greenhouse gas emissions.

The trends identified seem to apply generally to developed economies, to the extent that data are available. The policy responses are likely to be relevant to cities in both developed and developing countries. The thesis of this paper has been outlined briefly elsewhere (Metz, 2014).

2. Cessation of growth of travel

There is evidence that the average annual distance travelled by car has ceased to grow in most of the developed economies, starting well before the recession, and may be declining in some cases—a phenomenon known as 'Peak Car' (Puentes and Tomer, 2008; Lucas and Jones, 2009; Metz, 2010; Millard-Ball and Schipper, 2011; Le Vine and Jones, 2012; Kuhnimhof et al., 2012; Goodwin and Van Dender, 2013; OECD, 2013b). A number of explanations have been proposed for this phenomenon, which are not mutually exclusive and which include: decline in younger people holding driving licences (Kuhnimhof et al., 2012; Delbosc and Currie, 2013); car

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taxation changes (Le Vine and Jones, 2012); travel demand saturation (Metz, 2010); a shift away from car use in urban areas, and technological factors constraining faster travel (Metz, 2013).

The annual National Travel Survey has tracked the key trends in England over a 40-year period for personal travel by all modes of transport (other than international aviation) (NTS, 2014). The average trip rate has remained broadly unchanged at about 1000 journeys per person per year, while average travel time has stayed at about 370 h a year or about an hour a day, a general finding for populations (Schafer and Victor, 2000). What has changed over the period is the average distance travelled, which has increased from 4500 miles a year in the early 1970s to reach about 7000 miles by the mid-1990s, the result of investment in more and better cars and roads, and also in railway improvements. These investments allowed people to travel faster and hence further in the unchanged time utilised for travel.

However, the average distance travelled in Britain ceased to grow around 1995, since when it has remained broadly unchanged. Since household incomes continued to grow over most of the period, the historic relationship between travel and income no longer applies (Metz, 2012). 77 percent of current distance travelled is by car (NTS, 2014, Table 0302), hence the cessation of growth of travel is consistent with the cessation of growth of per capita car use noted in the above discussion of the Peak Car phenomenon.

3. Travel in London

The cessation of growth of per capita car use implies that demographic factors are now the main future determinants of travel demand, in particular population growth and the location of additional inhabitants, whether on greenfield sites or urban brownfield (Metz, 2012). Because the road capacity of cities is limited, car use is constrained, despite the growth of both population and incomes.

London, a city with a historic centre and mature suburbs, has no greenfield land for building but has considerable brownfield sites. London has not attempted to increase road capacity in recent years, and indeed has allocated more road space to bus and cycle lanes and pedestrians, with the result that both car traffic and trips have declined somewhat, as shown in Fig. 1 (which refers to the whole metropolitan area, inner and outer suburbs). Because the population has been growing, the share of all journeys that are taken by car has declined, currently 37 percent, down from a peak of 50 percent around 1990, while use of public transport has increased correspondingly, as shown in Fig. 2 (Metz, 2012; Transport for London, TfL, 2013). Consistent with this shift in mode shares, per capita distance travelled by car in London has steadily declined, in 2013 by 39 percent compared with 1996 for car drivers and by 27 percent for car passengers (NTS, 2014, Table 0107).

On the present central case projection, London's population, at present 8.6 m, is expected to grow to 11.3 m by 2050 within existing boundaries (Greater London Authority, GLA, 2013). To cope with this growth, investments have been made in the public transport system and further substantial investments are planned in additional rail capacity, but it is not intended significantly to increase road capacity (Mayor, 2012, 2013a, 2014). On this basis, car use in London is likely to decline to about 27 percent of all trips, as discussed next, which would be less than half the level of car use in Britain as a whole.

An estimate of the share of journeys made by car in London over the century 1950–2050 is shown in Fig. 3. The data for 1993 to the present are as in Fig. 2. Data prior to 1993 are estimated on the assumption that car use in London increased at the same rate as car ownership nationally, which is known from vehicle registrations. The extrapolation to 27 percent share for car use by 2050 is based on the official population projection (GLA, 2013), assuming no additional car trips are made, consistent with Fig. 1. Fig. 3 exemplifies the concept of Peak Car in the Big City. There is evidence from two other UK cities, Birmingham and Manchester, that car use in their centres is declining (Metz, 2013). There is also evidence for declining car use per capita in the main Australian cities since 2003–2004 and a rise in public transport use (Stanley and Barrett, 2010). Comparable data is difficult to locate for large cities in other countries, although anecdotal evidence suggests similar developments may be occurring.

As well as car traffic, road freight also contributes to traffic in London. Based on cordon counts, there has been a decline in medium and heavy goods vehicles entering central London since 1990, while light goods vehicle volumes have remained stable. Goods vehicle traffic entering inner London has been stable over this period, while such traffic crossing the outer boundary has increased by about twenty percent (TfL, 2014, section 3.17).

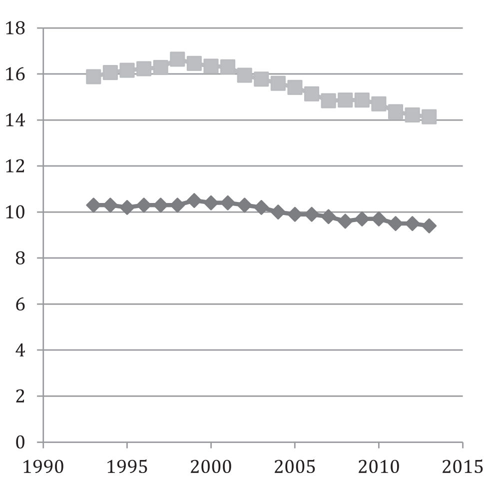

Fig. 1. London car trips (driver and passenger, million per day) and car-miles (billion per year).
Source: Transport for London, Travel in London Report 7 (2014); Department for Transport, Road Traffic Statistics.

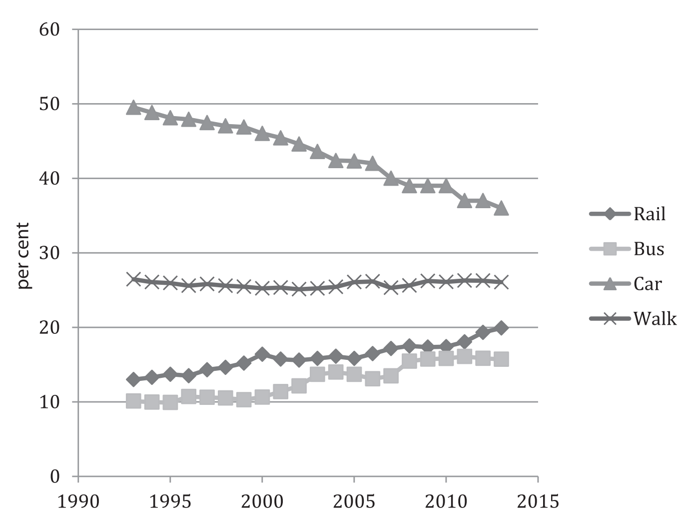

Fig. 2. Travel in London: trip-based mode share.
Source: Transport for London, Travel in London Report 7 (2014).

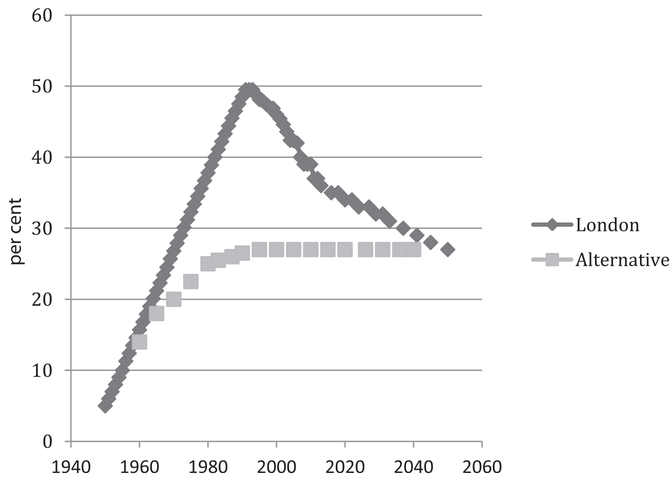

Fig. 3. Estimates of car mode share in London. Data from 1993 to the present are as in Fig. 2. Data prior to 1993 are estimated, based on the growth of car ownership in Britain generally. The extrapolation to 2050 is based on expected population growth to 11.3 m, assuming car use remains unchanged (Fig. 1). For explanation of 'Alternative' see text.

4. Travel in big cities

The global population is expected to increase from the present 7.0 billion, of whom half live in urban areas, to 9.3 billion by 2050 on the UN's Medium Variant case, with the urban population projected to gain 2.6 billion, reaching 6.3 billion by 2050. Population growth is mainly becoming an urban phenomenon concentrated in the developing world, resulting in larger cities. At present some 40 percent of the world's urban population resides in cities of one million or more, projected to increase to 47 percent by 2025 (UN, 2011).

It is generally assumed that car ownership in the developing economies will increase as incomes rise, following a trajectory similar to that of the developed economies. Globally, however, populations are both growing and urbanising. An increasing proportion of the global population is living in urban areas: half at present, projected to grow to two-thirds by mid-century or soon after. Higher density cities are therefore likely to become more prevalent, where the car is less useful. Accordingly, there is the possibility of avoiding the interim phase in which, as in London, there is a pronounced peak in car mode share, moving instead directly to a more sustainable level of car use.

Fig. 3 shows an 'alternative trajectory', which illustrates hypothetically how car mode share might reach the level of around 27 percent projected for London in 2050 without climbing to the peak of 50 percent. For developed cities such as London, this counter-factual—the path not taken—is of no practical relevance. However, for cities in developing economies where car use is still relatively low, the alternative trajectory suggests a route to a balanced transport system to meet the needs of a successful city that avoids unnecessary investment in vehicles and undesirable emissions of greenhouse gases and pollutants. But whichever route taken, the 27 percent mode share is relatively low, and may be less than half that for the country as a whole.

The proposition is that for a medium-density city of around 10 m people, limiting car mode share less than 30 percent of journeys will allow the travel needs of the population to be met without excessive traffic congestion and with substantially less greenhouse gas emissions (discussed in Section 5). Experience in London suggests that the key policy requirement to achieve such an outcome is investment in rail systems. Also needed are constraints on car use to avoid congestion that detracts from the efficient functioning of essential urban road traffic.

Rail routes—whether under- or over-ground, classic heavy rail or light rail metros or trams—serve to move commuters to and from work in central business districts as well as provide for work journeys, speedily and reliably. There is currently a major revival of urban rail underway, associated with the peaking of car use (Newman et al., 2013). Because rail is relatively expensive, Bus Rapid Transit (BRT) is a lower cost alternative, operated on dedicated routes that are not impeded by road traffic (Cervero, 2013). Rail can attract business and professional people out of their cars for work journeys because it is faster and more reliable than the car on congested roads. For example, the new financial centre at Canary Wharf in London's former docks now accommodates 100,000 well-paid employees who very largely use new rail routes to get to work. It is much harder to attract such people onto buses that are no faster than car travel, as well as often being uncomfortably crowded.

Because roads are open to all vehicles wishing to use them, they tend to be congested at times of peak use in dense urban areas. A successful city needs a street network that gives priority to those functions for which rail is not an alternative: buses, taxis, goods delivery, construction and emergency vehicles. The simplest means for achieving this is to control on-street parking during working hours, whether by prohibition or charging, since car trips are not made without the assurance of parking at both ends. Traffic management techniques using coordinated traffic signals are a valuable additional measure for limiting congestion (Emmerson, 2014). Both parking control and traffic management can be introduced incrementally, according to need, with the feasible aim of reducing systemic traffic congestion to an acceptable minimum, so that gridlock is avoided. London also employs congestion charging, a form of road pricing, to manage demand for vehicle use in a central zone. However, such schemes require political consent to introduce, often difficult to obtain, and involve substantial operating and enforcement costs, and hence seem unlikely to be widely adopted.

Cycling is an important mode in some successful developed cities (Pucher and Buehler, 2008), which can relieve crowding on public transport and may allow some deferral of investment in expensive new rail routes. Cycling is growing in London, with trips almost doubling since 2000, albeit from a low base (2 percent of all trips), with plans for substantial investment in cycle routes (Mayor, 2013b). Cycling is an important mode in low-income cities, to be replaced as incomes rise successively by motorised two-wheelers and then by cars. However, cycling can be revived and can make an important contribution if promoted by putting in place cycle lanes and low cost bike hire. The southern Chinese city of Hangzhou is reported to have the largest public bicycle rental scheme in the world (Shaheen and Guzman, 2011).

5. Greenhouse gas emissions from urban transport

Given the expected growth of urban populations noted above, the contribution of urban transport to greenhouse gas emissions is set to increase and accordingly the possibilities for mitigation are being addressed. The main measures comprise improved operational efficiency, promoting low carbon technologies, and improving the attractiveness of walking, cycling and public transport. In London, a target has been set of a 60 percent reduction in all carbon dioxide emissions by 2025 from a 1990 base, with transport contributing proportionately (Mayor, 2010). However, estimating progress is methodologically difficult, and the recent rate of reduction in ground-based transport carbon emissions of just over one percent a year falls well short of the three percent required to meet the target (TfL, 2013).

While technological and behavioural changes have attracted most attention as ways to mitigate transport greenhouse gas emissions, much depends on how cities respond to growing populations—whether by building upwards at higher densities, as is common in China, or by spreading out at low densities. In the past, densities of cities have tended to decline as incomes have risen and people have sought better quality living in new suburbs (Angel, 2011). The European Commission (EC), in its 1990 Green Paper, recommended urban strategies that emphasise mixed use and denser development that would be more likely to result in people living closer to working places and the services they require, such that the car could then become an option rather than a necessity (EC, 1990). Critics questioned the feasibility of this approach, arguing that it was naive to attempt to reverse the deep-seated counter-urbanisation trend, which had been the dominant urban force since 1945 in most Western countries (see for instance Breheny, 1992; Gordon and Richardson, 1997).

However, recent experience in Britain suggests that this counter-urbanisation trend can reverse as people see the attractions of city living (Headicar, 2013). Thus the population of London fell from 8.6 m in 1940 to a minimum of 6.7 m in the late 1980s, as people left an overcrowded and damaged city; but then the tide turned and the number of inhabitants recently returned to 8.6 m and is projected on a central case to reach 11.3 m by 2050. More generally, the importance of cities for economic activity is increasingly recognised (Florida, 2005; Glaeser, 2011). If urban population density increases, catchment areas shrink, whether for schools or supermarkets, which in turn makes the slow modes of cycling and walking potentially more practicable. Improving the pedestrian environment to enhance the quality of city life facilitates walking. Quality urban life attracts young people seeking economic and cultural opportunities, who see fewer attractions in the car. Creation of car-free public spaces facilitates high quality urban life which fosters creativity and agglomeration benefits.

To the extent that growth of urban populations leads to increasing densities, this may be expected to inhibit the increase in car use that would otherwise take place, a possibility that needs to be taken into account in projections of transport sector greenhouse gas emissions. For instance, the UK Department for Transport (DfT) projects CO_2 emissions from road vehicles to decline by 20 percent by 2030, reflecting improved vehicle fuel economy, but then to begin to rise again due to increasing travel demand (DfT, 2013a). However, this projection is based on travel demand forecasts generated by a model that does not recognise the Peak Car phenomenon (DfT, 2013b) and indeed forecasts growth of traffic in London of 36 percent by 2040, notwithstanding the absence of growth over the past 20 years as shown in Fig. 1. More generally, such econometric forecasting models project forward by looking back at historic relationships between demand and key parameters such as GDP and income growth and oil prices. Changes in behaviour of the kind underlying the Peak Car phenomenon are not taken into account.

The implications of cessation of growth of per capita travel demand and car use for UK transport sector carbon emissions can be considered by reference to the online 2050 Calculator issued by the Department for Energy and Climate Change (DECC) to explore possible approaches to meeting the target set in law to reduce UK greenhouse gas emissions by at least 80 percent by 2050 (DECC, undated). For each sector of the energy economy, four trajectories are considered, reflecting increasing efforts to reduce emissions. For domestic passenger transport, the least ambitious case ('Level 1', consistent with current plans) assumes a 9 percent increase in average distance travelled by 2050, with little change in mode share. The most ambitious trajectory for travel demand ('Level 4') assumes the same per capita distance travelled in 2050 as today, with a reduction in private vehicle use from 83 percent of total distance travelled in 2007 to 62 percent in 2050. However, although Level 4 supposes strong policy interventions (details not specified), the outcome is in fact consistent with a continuation of the trends discussed above: a continued absence of growth of per capita travel nationally, with growth of the urban population in London and other large cities resulting in a shift away from car use. So Level 4 outcomes may be achievable with no additional policy intervention.

The impact on greenhouse gas emissions depends also on the uptake of zero emission technologies and improvements to the fuel economy of conventional vehicles. For cautious assumptions in this regard, the reduction in transport energy use by 2050 from Level 4 travel demand behaviour is estimated from the Calculator as 60 percent, compared with 45 percent for Level 1 behaviour, a significant additional decrease which contributes usefully to the overall target of an 80 percent reduction in greenhouse gas emissions by 2050 against a 1990 baseline. Moreover, adding the strong policy interventions envisaged with Level 4 could achieve an outcome close to this target.

6. Conclusions

The policy conclusions discussed here derive from an analysis of travel and transport in London, a city for which extensive statistics are publicly available. In particular, it is possible to construct a time series that shows car use declining relatively as population density increases. Other studies of the relationship between car use and population density have employed cross-sectional analysis, where causality is harder to demonstrate (for instance Newman and Kenworthy, 1989; Mindali et al., 2004; Ewing and Cervero, 2010).

This paper is substantially a case study of travel developments in London, taking place in the context of UK transport policy. The data presented provide clear evidence of the scope for achieving a marked shift away from car use in a successful city. London is experiencing a fall in car use, from 50 percent of all trips in around 1990, when the population was at a minimum following half a century of decline, to 37 percent currently, and projected to fall further to 27 percent on current policies, as the population grows to 11.3 m by mid-century.

This shift away from car use may largely be attributed to key investment decisions: not to increase road capacity for car traffic but instead to expand rail transport. While a wide range of approaches to achieving sustainable urban mobility has been suggested (for example Hickman et al., 2013; Hickman and Banister, 2014), the experience of London suggests that, for a city with a growing population, the key policy levers may be few in number. However, by its nature, a case study focused on a single city offers limited opportunity for critical assessment of the whole range of policy measures—for that it would be necessary to have a larger sample of cities with time series data.

Population growth prompts a range of policy and investment responses. In the case of London, plans are being developed for substantial investment in transport infrastructure, rail in particular (Mayor, 2014). The main aims are to reduce overcrowding on existing rail routes, to accommodate the expected growth of passenger numbers, and to make land accessible for residential and commercial property development. Such rail investment will contribute to the shift away from car use and thus to mitigating transport greenhouse gas emissions, although this is not the main purpose. It may generally be the case that such indirect approaches to greenhouse gas reduction are more cost-effective and publicly acceptable than direct approaches such as subsidising electric vehicles.

Hickman and Banister (2014, p. 136) have suggested that reducing urban transport carbon emissions to a significant degree would involve significant breaks against current trends and are likely to be difficult to implement. However, population growth and increasing population density in big cities is a current trend that prompts helpful policy responses that in turn reduce carbon emissions on a significant scale. Successful big cities have growing populations, because people are attracted to work, study and live there. The city authorities recognise the difficulties and disadvantages of expanding the road network to accommodate more vehicles and so invest in alternative modes, particularly rail which can provide fast and reliable travel. So the share of journeys by car declines.

More than one billion motor vehicles populate the earth today. Sperling and Gordon (2009) estimated that there could be two billion by as early as 2020, assuming continued rapid growth of ownership in the developing economies. But such growth may not be inevitable given urbanisation of populations, the economic attractions of denser cities, unavoidable constraints on car use in dense urban areas, and the possibilities for alternative modes of travel that allow cities like London to prosper. Car use in a large city may be only half that in a country as a whole. The key policy interventions for ensuring efficient travel for the growing populations of successful cities are a rail and/or Bus Rapid Transit network to get business people out of their cars for work journeys, and constraints on car use to avoid congestion that impedes essential urban road traffic. For cities in developing countries with low car use at present, the Peak Car experience may be avoided and a more sustainable outcome achieved. The future growth of transport sector greenhouse gas emissions could therefore be significantly lower than is generally projected.

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