POLICIES FOR SUSTAINABLE ROAD TRANSPORT

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ABSTRACT

Road transport imposes negative externalities on society. These externalities include environmental and road damage, accidents, congestion, and oil dependence. The cost of these externalities to society is in general not reflected in the current market prices in the road transport sector.

An efficient mobility model for the future must take into account the true costs of transport and its regulatory framework will need to create incentives for people to make sustainable transport choices.

Economics offers two types of instruments for addressing the problem of transport externalities: command-and-control, which can be defined as government regulations that force consumers and producers to change their behaviour, and incentive-based policies, which include price controls, such as taxes, and quantity controls, namely cap-and-trade.

On top of these economic instruments, and without questioning the fact that to achieve efficiency emitters should pay for the true costs of their actions, we find sufficient evidence in the literature to demonstrate that many other policy instruments can be used in combination with taxes and permits to ensure that the transport needs of the present generation can be met without compromising the ability of future generations to meet any needs of their own.

These policies fall into three categories: physical policies, soft policies, and knowledge policies. All three aim to bring about changes in consumers' and firms' behaviour, but in different ways. The key finding is that they can help achieve more efficient levels of externality when used in combination with economic policies, rather than on their own.

Keywords: Sustainable road transport. Corrective charges. Cap-and-trade. Fuel taxes. Soft policies. Public transport. Land use planning. Walking and cycling. Car-pooling. Teleworking. Advertising campaigns. Teleworking and teleshopping.

INTRODUCTION

Although road transport is essential in today's world, it causes a number of negative externalities: road damage, accidents, congestion, environmental damage (such as global warming, air pollution and noise) and some authors argue, oil dependence (Newbery, 1990; Parry et al., 2007; Maibach et al., 2008).

In this paper we review economic policies, such as cap-and-trade and corrective charges, and also other instruments for sustainable transport, such as incentives to walking and cycling or advertising campaigns aimed at changing people's behaviour. Although this paper does not make an original theoretical or practical contribution to transport economics or transport studies, it does put together a good review of the policies that have already been or are being suggested or implemented. While keeping the length to a paper-format standard we endeavour to include as many examples as possible in our discussion.[1]

We concentrate on global warming, not because we think it is more important or serious than other externalities, such as road accidents, but because it is challenging, in the sense that neither policy changes nor technological advances have managed to reduce CO_2 emissions from road transport on a global scale.

[1] An extended (older) version of the work carried out under this project is reported in Santos, Behrendt, Maconi et al. (2010) and Santos, Behrendt and Teytelboym (2010).

The standard microeconomics approach to analyse and deal with externalities does not seem sufficient in the context of climate change. The methods are useful but they tend to focus on marginal changes and 'can only be starting points for further work' (Stern, 2006, Chapter 2, p.23).

Thus, as important, fair, ethical, and efficient emitters facing the true costs of their actions might be, we argue that there are a range of other measures which can be used to complement (rather than substitute) economic policies. Our main conclusion is that economic policies implemented on their own can go a long way towards reducing the impacts of road transport on climate change, but the results can be even better if supplemented by softer policies. Softer policies on their own, on the other hand, without the help of any economic instruments, can only achieve small (probably marginal) changes.

ECONOMIC POLICIES

On top of command-and-control regulations, so widely used around the world, there are also incentive-based policies.

Command-and-control regulations are essentially standards set by governments, which consumers and producers must abide to. The list of examples is endless: environmental standards, caps on emissions of certain pollutants, constraints on production or consumption activities, etc. In road transport, command-and-control examples include vehicle safety standards, emission and fuel standards, parking restrictions, to name just a few. It is a standard result in economics that command-and-control, although effective if it can be enforced, does not typically yield an efficient equilibrium. This is because even if the optimum quantity of a production or consumption activity is achieved, it is not achieved at minimum cost. Despite this, political and public acceptability usually means that command-and-control is preferred to incentive-based instruments.

Incentive-based policies affect consumption and production incentives, and can be used to achieve the optimal outcome in the presence of externalities. They can be divided in quantity controls (cap-and-trade systems) and price controls (corrective or Pigouvian[2] fees).

Quantity controls cap the aggregate amount of the externality or production or consumption activity by allocating permits or rights to those causing the externality. Those causing the externality can then buy and sell these permits or rights amongst them. Although in theory, according to the Coase Theorem and its restrictive assumptions (Coase, 1960), the initial

[2] They are called 'Pigouvian' in honour of Arthur Pigou, who was the first to highlight the difference between private and social costs and the need to bridge the gap with a charge.

allocation of permits does not matter from an efficiency point of view, in practice, it does matter for the parties involved. Also the Coase's assumptions of no transaction costs and no wealth effects are not verified in reality. On top of that, stakeholders will typically push for some proportional allocation based on historic emissions. The biggest example of cap-and-trade is the EU Emission Trading Scheme. However, no such policy for CO_2 emissions in road transport has been implemented anywhere in the world to date.

Corrective charges are, like command-and-control, also widely used in road transport. It should be borne in mind, however, that in most cases, they were implemented as a means to raise revenues, rather than as a means to internalise any external costs. Governments find charges and taxes relatively cheap to implement. In the early 1990s it became politically convenient to defend them on the basis of the negative externalities argument, especially in what concerns climate change. In theory (not that governments initially thought this through when they first implemented them) corrective charges are equal to marginal external costs and lead to an efficient market solution. In practice, they are rarely equal to marginal external costs.

Vehicle registration, ownership, fuel, emissions, usage taxes, and parking charges are in place in many countries. Singapore, London and Stockholm have implemented congestion tolls and many states in the US have introduced high occupancy/toll lanes. Subsidies, on the other hand, can also be used to create incentives. For example, the purchase of a fuel-efficient vehicle can be encouraged by a subsidy, either with no conditions, or with the condition of the scrappage of an old car.

The impact of these taxes and charges varies across countries. Ryan et al. (2009) argue argue that registration taxes are significant in purchasing decisions in the EU-15 when the specificities of each country are ignored, but they stop being significant when country fixed effects are included in the model (p.372-373). They also find that registration taxes, which are imposed mainly on cars rather than commercial vehicles in the EU, are not significant in changing average vehicle CO_2 emissions (p.372). Finally, they show that annual ownership taxes, in contrast with registration taxes, have an important impact on total new car sales. Consumers in the EU-15 are sensitive to taxes they will pay every year for as long as they own the vehicle than to one-off registration taxes.

There are several **usage taxes** that can be levied on vehicles. One such type of tax is the carbon tax, which is a tax on the carbon content of the fuel on which the vehicle runs or on the estimated CO_2 emitted in the fuel combustion process.

Very few countries have implemented a carbon tax. In Europe, these countries are Finland, which introduced a carbon tax in 1990, Sweden and Norway, in 1991, the Netherlands in 1992, Denmark in 1993 (Richardson, 2002, p.194), and Italy, in 1999.

Interestingly, the carbon taxes levied in these countries, have not achieved any visible differences relative to countries that have not implemented carbon taxes. They claim that their CO_2 emissions have been reduced (Vehmas, 2005, p.2180), but their fuel duties are ultimately not significantly higher from fuel duties in countries such as Turkey, Belgium, France or the UK.

In July 2008 British Columbia in Canada implemented a carbon tax per tonne of carbon dioxide equivalent (CO_2e)[3], which will be increased by CA$5 (£2.5, €3.2, $4.7)[4] per year reaching CA$30 in 2012. The petrol tax will then reach 7.24 Canadian cents per litre (British Columbia Government website), equivalent to 4.6 Euro-cents, which represents a very small increase relative to the current tax component of 22 Euro-cents.
Fuel taxes vary greatly from one country to another. No other product seems to be subject to such divergent treatment (Gupta and Mahler, 1995, p.101).Mexico and the US, for example, have remarkably low petrol taxes, when compared to the rest of the OECD countries. Unsurprisingly there is not that much difference in the pre-tax price across countries, except, as expected, for Mexico. There is, however, considerable variation regarding taxes. This is also the case in African countries (Smith, 2006).

The European Commission aims at harmonizing energy taxes within the EU and a European approach to reducing emissions requires that each country and GHG source face the same charge per tonne of carbon (Newbery, 2005, p.6). The challenge is then to getall EU member states to agree on a uniform rate of petrol and diesel taxes.

This is not a problem easy to solve. In the UK, for example, and probably in other countries with comparable fuel tax rates, the global warming externality seems to have *already* been internalised (Parry and Small, 2005; Newbery, 2005). Therefore further increases in tax rates would be inefficient. CO_2 emissions from road transport in these countries are probably lower than they would have been had no such high taxes been in place (Sterner, 2007), but they still seem to be too high to meet the various commitments that different governments have adhered to. The only way to defend higher fuel tax rates would be to use a much higher shadow price of carbon.

Similarly, Jin (2010) finds that the petrol tax in Canada, which is the third lowest of all OECD countries (Santos, Behrendt, Maconi et al., 2010, Fig. 2, p.32) should not be raised on efficiency grounds. The main reasons are the following: (a) there is no cost of oil dependency, (b) the fuel duty in Canada is over twice as high as the fuel duty in the US, (c) the average fuel economy is higher in Canada than in the US. Also, due to the pre-tax petrol

[3] Using a stoichiometric conversion factor of 44/12 = 3.6667, this is equivalent to CA$ 2.23 per tonne of carbon.

[4] The average exchange rate in the period Jan-Dec 2008 was CA$1= £0.51= €0.64 = $0.94 (IMF Exchange Rate Query Tool).

price as well as the fuel duty being higher in Canada than in the US, the petrol tax in Canada is less effective at reducing distance-related externalities. Raising the fuel tax would cause overcharging of fuel-related externalities.

Whilst there are countries with significant scope to increase fuel taxes, especially when the idea of harmonisation is brought into the discussion, the externalities to be internalised should be agreed upon, and tax components should be transparently defined. This points raises another issue: fuel taxes are effective at targeting CO_2 emissions, which are closely correlated to fuel consumption, but congestion, accidents, and local air pollution are externalities which are only *indirectly* targeted by fuel taxes. A tax based on local emissions, distance driven, or peak-time congestion would be better suited than a fuel tax to internalise these other externalities (Parry and Small, 2005, Newbery, 2005).

A **distance-based tax**, which could be levied annually, could potentially reduce congestion (Ubbels et al., 2002) and it would avoid the rebound effect, i.e. consumers buying more fuel efficient cars, facing a lower cost per km and travelling longer distances. The distance-based tax vould be further differentiated on the basis of the vehicle's fuel economy (European Commission, 1995).

An example of a distance-based tax is the Heavy Vehicle Fee (HVF), implemented in Switzerland in 2001. The HVF is levied onlorries over 3.5 tonnes and varies with their gross weight, kilometres driven within Switzerland, and emission category of the model (Suter and Walter, 2001, p.383). As a result, the total volume of goods transported by road through the Alps increased by 3 per cent but lorry trips declined 14 per cent between 2000 and 2005, indicating that pricing encourages more efficient use of lorry capacity.

Another type of distance-based charge is the Pay-as-you-drive (PAYD) insurance. PAYD insurance is computed on the annual distance travelled (Litman, 2008). As in standard insurance, the premium can be conditioned on the driver's rating factor (Parry et al., 2007, p.394), which is a function of age, crash record, and region (Parry, 2005, p.288). The advantage of PAYD insurance over conventional insurance is that it price-discriminates more successfully between travellers: those driving longer distances pay more. Since PAYD insurance reduces premia for short distances driven, implementing such insurance schemes can be expected to reduce the number of uninsured drivers (Parry, 2005, p.288). Under PAYD, travellers do not "over-consume", or "over-drive", as the amount they pay increases with distance, very different from a scenario where they pay a fixed sunk-cost at the beginning (Evans, 2008).

Parry (2005) argues that PAYD insurance, politically more acceptable than fuel duties, reduces distance-related externalities, such as congestion, accidents and local emissions (p.288). He also shows that PAYD is slightly more efficient than a VKT tax for a given reduction in demand for petrol. Evans (2008) also argues that the extra-premium paid by drivers who drive longer distances will net-out with the lower premium paid by drivers who drive shorter distances.

Parry et al. (2007) report that PAYD schemes are slowly emerging at state level in the US. In May 2009 the New America Foundation Climate Policy Program published a survey of 33 US states climate change emission reduction plans (New America Foundation website). Twelve include PAYD as a transport emission reduction strategy.[5] These states include Arizona, California, Colorado, Maryland, Maine, Minnesota, New Hampshire, New Mexico, North Carolina, Rhode Island, Vermont and Virginia. Everett (2009) reports that despite twelve states supporting PAYD, few insurance companies in the UK currently offer PAYD.

Things are not too different in other countries. In the UK Norwich Union launched PAYD in 2007 and put it on hold in 2008 due to the high costs of measuring distance driven (Everett, 2009). There are ome companies offering PAYD in Australia, Israel, the Netherlands and South Africa. PAYD is not widely spread yet, and so there are not many implementation examples to report on or assess.

OTHER INSTRUMENTS FOR SUSTAINABLE ROAD TRANSPORT

We do not wish to question a basic efficiency principle in economics, ie, that those causing external costs should pay for the costs of their actions, but we find enough evidence in the transport and related literature supporting the idea that many other policies can be combined with corrective charges and/or cap-and-trade systems in order to reduce negative externalities.

These complementary policy instruments can be classified into three groups: physical policies, soft policies, and knowledge policies. All three have the objective of changing consumers' and firms' behaviour, albeit in different ways. Physical policies refer to those policies that alter, add or improve physical infrastructure: public transport, land use and walking and cycling. Soft policies refer to actions, guidelines and strategies aimed at changing behaviour by providing information about the consequences of different transport choices, in the hope of persuading actors to change their behaviour. These measures include car-sharing and car-pooling, teleworking and teleshopping, eco-driving, and general information and advertising campaigns. Finally, knowledge policies emphasise the important

[5] The excel sheet summarising the plans is available on www.newamerica.net/files/State%20Climate%20Policy%20Tracker%205-4-09.xls

role of investment in research and development for a sustainable model of mobility for the future.

Physical policies

Public transport provision, walking and cycling facilities and land use planning are important factors influencing car use and therefore carbon emissions. They are not the only factors and people may choose to drive even in the presence of frequent, reliable and comfortable public transport, safe and amenable walking and cycling paths and in the most mixed neighbourhood where most facilities are within walking distance. Nonetheless, they are important determinants that can shape, at least in part, travel mode choices. Needless to say, policies targeting sustainability must be part of an **integrated policy**. Integrated policy refers to integration across different modes of transport, different government objectives (such as the economy, health and the environment), considering the needs of different social groups, and coordinating action between the relevant government institutions.

A sustainable model for transport policy requires integration with **land use** planning. Although these may be somewhat limited within the bounds of existing cities, new developments (either on the outskirts of existing towns or new towns altogether) offer room for careful planning of land use for sustainable transport, allowing public transport as well as walking and cycling to be at the core of urban mobility.

Banister and Hickman (2006, p.277) argue that 'settlement size affects the range of jobs and services that can be supported and influences the quality of public transport that can be provided, and the length of trips'. In terms of transport the most energy efficient population size for settlement is thus found to be between 25,000 and 100,000 or larger than 250,000.

On top of population, density is also an important factor. Banister (2008, p.73) remarks that medium densities (over 40 persons per hectare) support sustainability. Kenworthy and Laube (1996, p.281) argue that 'high densities tend to be associated with lower average trip distances for all modes, improved public transport through higher potential patronage around each stop and in particular, enhanced viability of walking and cycling'. Furthermore, dense urban environments also tend to be characterised by mixed land use, with people living, working and shopping in the close vicinity. Mixed-use developments thus allow further reductions in trip lengths, and allow a prominent role for walking and cycling.

The design of neighbourhoods can also play a role in developing a model of sustainable mobility for cities, by allowing a key role for walking and cycling through appropriate planning. An extreme example of sustainable neighbourhood design policy is the design of entirely car-free neighbourhoods. For instance, Sessa (2007, p.53) describes the Austrian car-free settlement in Vienna, Florisdorf, which was designed as an ecological estate development.

Florisdorf residents can only use the cars of the car sharing company linked to the project and otherwise rely entirely on other modes of transport. The settlement is well-linked to the city centre by tram and cycle routes, and within the neighbourhood services and facilities such as shops and schools are within walking distance.

Cervero and Kockelman (1997) find that density, land-use diversity, and pedestrian oriented designs have a modest to moderate impact on travel demand. They conclude that a compact and diverse development with pedestrian-friendly neighbourhoods can influence people's travel behaviour.

However, Small and Verhoef (2007, p.14) note that the evidence on how land-use policies at the neighbourhood level affect travel is mixed. High-density neighbourhoods with good access to public transport stops clearly support higher use of public transport. However, it is less clear how much of this is simply due to self-selection, i.e. people who want to use public transport choosing to live in less car-dependent areas. It is important to control for this self-selection in order to determine the aggregate effects of policies proposing to build many such developments (Small and Verhoef, 2007, p.14). Van Wee (2009, p.290) thus concludes that 'the accuracy of forecasts, for example of land-use scenarios or infrastructure policies, could benefit from a better inclusion of self-selection in the models'.

More **public transport** use combined with less private car use, can help reduce traffic congestion and, more importantly, CO_2 emissions. Public transport generally causes lower CO_2 emissions per passenger kilometre than private cars. Public transport fares are subsidised in most places, which can be justified by economies of scale and by the fact that public transport can reduce total road transport externalities.

There are a number of towns and cities in the world where the share of public transport in commuting trips is very high. In London, for example, the share of trips made by public transport between 7:00 a.m. and 10:00 a.m. was 87 per cent in 2002, before the London Congestion Charging Scheme (LCCS) was introduced, and increased to over 88 per cent in 2003, after the charge had been implemented, and furthermore to over 89 per cent in 2006 (UK DfT, 2007a, Table 1.6). In Hong Kong, the share of commuters using public transport was 74 per cent in 1990 (Kenworthy and Laube, 1999, p.704).

The net revenues raised from the LCCS are used entirely to improve transport facilities in London. The focus has been mainly on bus services: of the £138 million (€153 million, $201 million) raised from the scheme in 2008, £112 million (€124 million, $163 million) was spent on the bus route network, infrastructure and safety.

Singapore is another example of excellent public transport. The rail and bus network operate entirely without government subsidies (May, 2004). Singapore has four main forms of public transport: bus, Mass Rapid Transit (MRT), Light Rapid Transit (LRT) and taxi, which account for 60 per cent of all daily trips. Most of the services are operated by two private companies, which are regulated by the Public Transport Council with regard to quality (e.g. air-conditioning and seat belts in taxis) and fares. The Council also insists on physical (e.g. MRT-bus-taxi interchanges) and fare (e.g. smart-card) integration in order to make connections in public transport as seamless as possible. Although public transport is not subsidised, the government finances over three-quarters of the price of replacing operating assets: the operator is only required to pay the historical value of assets, i.e. what they cost in 1987, so that less of an increase in fares is necessary (Santos et al., 2004; Phang, 2003). The average cost for commuting trips by public transport is less than 2 per cent of individual income, and therefore very affordable (Lam and Toan, 2006, p.186). Even Singaporean taxis are affordable and make up 11 per cent of all travel (Lam and Toan, 2006).

While North America as an area tends to be associated with cars, there are also some stories of cities that have 'overcome the dominant paradigm of automobile-based planning' (Newman and Kenworthy, 1996, p.16). Newman and Kenworthy (1996) note that the examples of Vancouver, Toronto and Portland have in common the fact that the community managed to force planners to rethink their proposals for building new major roads.

Gibson and Abbott (2002) describe the problems that Portland in Oregon faced before the crucial revitalisation plan of 1972 (the "Downtown Plan"). The city centre, and especially retail, faced a bleak future with inadequate parking facilities and a bankrupt private bus system, as well as a new super-regional shopping centre. In order to address the situation, members from throughout the community started working together with city officials to develop integrated solutions for the problems faced by the city (Gibson and Abbott, 2002). Key policies in the 1970s thus included replacing a six-lane riverside major road at the edge of the city centre with a waterfront park. Plans for the construction of the Mt Hood Expressway through the city were abandoned, instead using the federal highway funds to construct a 15-mile light rail line (Gibson and Abbott, 2002; Newman and Kenworthy, 1996). Notably, the number of passenger trips per person using public transport increased by 119 per cent between 1970 and 1980 (Newman and Kenworthy, 1996).

This rail system has since been augmented with several additional light rail lines, including the Portland Streetcar in 2001 and the Interstate MAX in 2003 (City of Portland Office of Transportation, 2004). The numerous light rail projects have been supplemented with a limitation of car access and planting of trees together with the introduction of bus priority streets with high quality bus shelters. Newman and Kenworthy (1996) also emphasise the role played by the business community in making the streets more attractive by helping to repave them and by furnishing them with seats, plants and sculptures.

Curitiba constitutes another example of public transport and land use integration. In 1964 the Preliminary Urban Plan, later to become the Curitiba Master Plan, was commissioned by the public administration of Curitiba. The integrated approach, novel at the time, viewed transport as a system linked to ‘housing, land use, the road network, commercial development and recreational investments such as parks, green spaces and the preservation of historic sites’ (Rabinovitch, 1996, p.64).

The transport network, designed as a trunk and branch system, started operating in 1974. . High-capacity buses serve the “trunks”, i.e. radial express routes from the city centre. Transfer stations at regular intervals along these lines allow for interchange with the “branches” of the system, i.e. the lower-demand feeder routes, as well as with the orbital inter-district routes. Interchange does not require extra payment as tickets are integrated. The system, operated by ten bus companies under the regulation of municipal authorities, is entirely self-financed (Rabinovitch, 1996).

Curitiba’s bus-based public transport system is characterised by a step-by-step approach of improvements. Thus, rather than replacing the existing bus system with an underground or rail system, the first step was to establish an express bus system with dedicated bus lanes. This system, improved and extended over the years, provides “a high-quality service comparable to an underground system at a much lower capital cost” (Rabinovitch, 1996, p.64), low costs allowing the system to be financed entirely by passenger fees.

Smith and Raemakers (1998) note that whilst Curitiba is often upheld as a developing country success story of environmentally sustainable integration of land use and transport policy, this success may not be easy to emulate. The institutional strength, policy co-ordination and in particular control over land allocation required to copy Curitiba’s success tend to be lacking in other cities.

Walking and cycling, which improve general health and produce no tailpipe emissions, constitute an excellent alternative to motorised transport on short distance trips within towns and cities. The policies which can incentivise walking and cycling include crime reduction to make streets safer, well-maintained and clean pavements, attractive street furniture, safe crossings with shorter waiting times, dedicated cycle paths, showers in offices, and lower speed limits, to name but a few.

There are a number of cities that have implemented cycling policies which have helped to increase bicycle use. The Netherlands carried out the first and probably the most successful official bicycle policy in the world (Rietveld and Daniel, 2004). A typical Dutchman cycles 2.5 km daily, which is 25 times more than does an average Spaniard, Greek or American. Almost a quarter of longer-distance trips (4.5 km-6.4 km) are made by bicycle, compared to 1 per cent in the UK.

The high cycling rates in the Netherlands are, obviously, not a result of unaffordable motorised transport (GDP per capita was over $52,000 - £35,600; €39,500 - in 2008 according to the IMF). The Netherlands is fortunate in terms of its moderate climate (although strong winds discourage cycling), high population density and compact settlements (Rietveld and Daniel, 2004); however, the high cycling rates are the result of a policy adopted by the government in 1975. This policy favoured the use of bicycles and introduced a fund for the construction of bicycle facilities in both urban and rural areas. Roughly €227 million (at 2004 prices) were spent over ten years (Rietveld and Daniel, 2004, p.536). The policy managed to reverse the fall in cycling rates and curtail a rapid expansion in car ownership (Pucher and Buehler, 2008).

Pucher and Buehler (2008) find that the Danish and German cycling programs have also increased bicycle use. Although overall Germany and Denmark have lower cycling rates, some cities, such as Copenhagen and Münster match the Dutch average. Germany, for example, tripled its cycle path network between 1976 and 1995. Like the Netherlands, many German cities invested in improving cycling safety, by separating car traffic from cyclists and integrating the cycling network to make cycling a practical mode of transport (Pucher and Dijkstra, 2000). In fact, Germany, like the Netherlands, has brought down fatality rate for cyclists by 60 per cent since 1975. The German rate (25 per billion km travelled) almost matches the Dutch rate (17) and is a long way from the US (100), which has only reduced its fatality rate by 20 per cent between 1975 and 1995 (Pucher and Dijkstra, 2000).

Bogotá in Colombia has also implemented important sustainable transport policies by building 300 km of cycle lanes (the most extensive in Latin America), connecting the lanes and pedestrian pathways to the new bus rapid transit system, building a 17 km (world's longest) pedestrian corridor, planting trees along cycling and walking lanes, restricting driving along 120 km of roads on Sundays to create a 'Cycle Way' . The total investment of $178 million on bicycle improvements increased the share of daily trips by bicycle from 0.9 per cent to 4 per cent over ten years (Cervero, 2004). The entire policy package in Bogotá reduced the capital's carbon monoxide levels by 28 per cent between 1998 and 2002 (Nair and Kumar, 2005) and reduced travel times by 11 per cent (Skinner, 2004). Interestingly, this new transport model was driven by the need to reduce poverty and promote social justice as opposed to environmental concerns (Cervero, 2004; Skinner, 2004).

In August 2004 the Borough of Hammersmith and Fulham in London piloted a bicycle rental scheme, called OYBike. Similar small-scale schemes already existed in Stockholm, Lyon, Frankfurt, Cologne and Munich. Bicycles were located at unmanned locking stations around the borough. After completing a registration process residents could hire bicycles on a per-hour or per-day basis. Noland and Ishaque (2006) find that most trips with OYBike were made for leisure and recreation on sunnier days and weekends. Users tended to substitute short walking trips by cycling, so the environmental impact of the program was probably quite small. The reason for Londoners not taking up cycling for purposes such as commuting with OYBike is probably the lack of appropriate cycling infrastructure in London and frustrating payment facilities.

In 2007 Paris and Barcelona introduced two bicycle sharing programs, with locking stations around the entire city: *Velib* operating over 20,600 bicycles in Paris and *Bicing* operating 3,000 in Barcelona. Paris achieved a penetration of 135 citizens per bicycle (Shaheen and Rodier, 2008). The schemes are run by private companies, which introduced annual subscriptions, smart-card payment and reservation technologies. Economies of scale allowed prices to be drastically reduced to €1 (£0.90, $1.3) per day in Paris, which compares to £8 (€9, $12) per day charged by OYBike in London. *Velib*, by all accounts, has become the face of sustainable Parisian transport. Full evaluations of the schemes are yet to be done, but there are signs that commuters in Paris and Barcelona are substituting from cars into *Velib* and *Bicing* to travel to work and complement their use of public transport (Shaheen and Rodier, 2008).

Soft policies

There is no unified, agreed upon, definition of 'soft' measures in the literature (Möser and Bamberg, 2008, p.10). In this survey we define soft measures as those initiatives which attempt to bring about behavioural change by informing the public about the consequences of and alternatives to their transport choices, and providing options to the private car.

We review car sharing and car clubs, teleworking and teleshopping, eco-driving, as well as general information and advertising campaigns, highlighting their emission reduction potential.

Before we move on to these specific soft policies, a word or two should be said about the importance of understanding people's attitudes and attachments, such as the attachment to the private car. Stern (2006, p.395) remarks that 'much of public policy is actually about changing attitudes'. Car use is relatively inelastic to changes in fuel prices and other costs and although information campaigns may make drivers aware of more sustainable travel options and the negative environmental impact of car use, they may not achieve changes in actual behaviour (Dargay, 2008).

When trying to bring about change in travel behaviour through information and marketing, there is evidence indicating that personalised communication measures are more effective in changing peoples' travel behaviour, especially in breaking habitual car use, than non-personalised mass communications (Fujii and Gaerling, 2007, p.244). It is thus unsurprising that policymakers have increasingly become interested in using personalised information and marketing strategies, techniques adopted from commercial marketing (Cairns et al., 2004). Thus, individuals or households are engaged in one-on-one dialogue and provided with targeted information to enable them to choose a more sustainable pattern of transport choices. Personal Travel Planning (PTP) thus aims to overcome peoples' habitual use of the car and their psychological barriers to using sustainable transport (UK DfT, 2007b).

Cairns et al. (2004) assess the impacts of different PTP schemes. The first large-scale PTP project was undertaken in 2000 in the Australian suburb of South Perth. Amongst the sample of 35,000 people, the policy was estimated to have brought about a 14 per cent reduction in car driver trips (Cairns et al., 2004, p.103). Regarding the UK, Cairns et al. (2004) report individualised marketing projects to have reduced driver car trips by 5 and 10 per cent respectively in different areas of Bristol, and find that a pilot project in London 'reduced car driver trips by 11 per cent, with another potentially reducing them by 16 per cent' (Cairns et al., 2004, p.105). These results are found to be comparable with those reported from similar projects in Germany. Fujii and Taniguchi (2006) find evidence that such "soft" transport measures relying on personalised communication are also effective in changing travel behaviour in Japan - indicating that the effectiveness of these policies extends beyond "Western" cultures.

The UK DfT also reviews the cost-effectiveness of PTP, noting that cost-benefit analyses typically report cost-benefit ratios around 1:30 over a 10-year period. PTP programs tend to cost between £20 and £38 per household and become increasingly cost-effective as the scale of the program increases. Thus, for large-scale UK PTP projects value for money estimates in the first year of implementation are reported as being between £0.02 and £0.13 per vehicle kilometre saved (UK DfT, 2007b, p.99).

Car sharing and car clubs[6] can potentially reduce CO_2 emissions, although the aggregate reduction in congestion and emissions has not been measured with an adequate degree of precision in the literature.

The main benefits of **car sharing** come from decreasing fuel savings. Driving with a colleague to work every day and splitting the fuel bill would almost[7] halve one's fuel bill. Recent calculations suggest that if a passenger were added to one in ten vehicles in the US, the aggregate fuel consumption would fall by 5.4 per cent (Jacobson and King, 2009). Overall, car sharing can make a small but cost-effective contribution in reducing traffic levels and pollution (Bonsall, 2002).

Apart from increasing parking charges and road tolls, another incentive to encourage car sharing is the introduction of HOV lanes on motorways. These lanes only admit vehicles with at least 2 or 3 passengers and tend to be less congested than other lanes. Although HOV lanes are becoming quite common in the US, their effects on congestion and pollution are contested and not well understood (Johnston and Ceerla, 1996; Dahlgren, 1998; Menendez

[6] In the US 'car sharing' refers to what we call 'car clubs' in this paper (and in general, in Europe) and 'car pool' refers to 'car sharing', or in other words, to multiple occupants in one vehicle.

[7] 'Almost' because one has to travel an additional distance to pick up passengers and extra passengers increase the weight of the car.

and Daganzo, 2007). The first HOV lanes in the Netherlands, which opened in 1994, were closed after only a few weeks (Bovy, 2001). Also, despite the implementation of many HOV lane projects in the US (for example the I-395 in Virginia provides more than half an hour of time saving during peak hours), HOV lanes have not managed to stop declining vehicle occupancy (Kwon and Varaiya, 2008). Finally, HOV lanes seem to have a very small effect on CO_2 emissions. In Stockholm for example, where there are HOV lanes with a minimum occupancy requirement of three people per vehicle, the annual reduction in CO_2 emissions has only been 0.3 per cent (Lindqvist and Tegner, 1998, in Gross et al., 2009).

Most cars are unused for 23 hours a day (Shaheen et al., 1998). **Car clubs** give their members access to a car without having to bear the cost of buying and maintaining an underutilised vehicle. Car clubs can thus have a positive social impact by giving access to mobility to lower-income households. A typical car club pricing scheme makes it worthwhile to substitute away from a personal vehicle if the annual mileage is less than 6,000-10,000 miles (Shaheen et al., 2006). Annual mileage can be considerably higher, especially for higher-income groups so car club membership can often act as a supplement to an existing vehicle.

Since 1988 car club membership and fleet has grown dramatically and now there are almost 350,000 club members and 11,700 vehicles around the world (Shaheen and Cohen, 2007). Most of the growth during the 1990s was in Europe, especially in Switzerland, Austria, the Netherlands and Germany, but the phenomenon is spreading quickly to the Americas, Asia and Australia (Shaheen et al., 1998). Some car clubs are not-for-profit organisations, but recently there has been a growth in commercial enterprises (Shaheen et al., 1998), some of which, such as the Edinburgh car club, require initial public funding (Enoch and Taylor, 2006). However, governments have been happy to support car clubs because there is evidence that net economic benefits of car clubs may even be higher than those from major road schemes (Fellows and Pitfield, 2000).

Car club members tend to give up their own cars and use more public transport instead of private vehicles. Shaheen et al. (2006) report that car club membership reduces total personal vehicle miles travelled by 44 per cent on average in the US and by between 28 per cent and 45 per cent in Europe. Steininger et al. (1996) find that total net car mileage of car owners declines by 46.8 per cent mainly due to a modal switch to public transport. In Europe personal carbon emissions fall between 39 per cent and 54 per cent after joining a car club (Ryden and Morin, 2005, in Shaheen and Cohen, 2007). Ledbury (2007) estimates that if car clubs succeeded in achieving 15 per cent penetration of the UK population, they would save 7.75 million tonnes of CO_2 (or 6.4 per cent of transport emissions). On the congestion side, Steininger et al. (1996) argues that because per hour rates make car club cars unattractive for commuting, rush hour traffic would fall.

Teleworking and teleshopping can potentially reduce congestion and also CO_2 emissions. However, the evidence for this reduction is rather mixed, as it is unclear whether these measures lead to overall reductions in road transport.

The practice of **teleworking** was identified in the 1970s and 1980s and it was initially thought that around 40 per cent of the workforce were potential teleworkers (Nilles, 1988). The obvious benefits for teleworkers are a better work-life balance and lower commuting stress and costs (Bailey and Kurland, 2002), whereas businesses would enjoy lower real estate costs and higher productivity (Bélanger, 1999). For this reason 37 per cent of employers in the US offered a teleworking arrangement in 2001, up from 20 per cent in 1997 (Potter, 2003). However, these results proved too optimistic (Mokhtarian, 1991) - recent surveys indicate that teleworkers constitute an impressive 25 per cent of the labour force in the US, around 15 per cent in Sweden, Finland and the Netherlands, around 5 to 8 per cent in the UK, Japan and Germany, but less than 5 per cent in Italy, Ireland and Spain (Harpaz, 2002; Hotopp, 2002; Higa and Wijanayake, 1998)[8].

Janelle (2004, p.104) notes that 'concerns over low job security, few worker benefits, and poor prospects for job advancement are at the root of labor union opposition to widespread adoption of teleworking'. Also, not all employers feel that they can monitor their teleworking employees as well as office-based employees. Nevertheless, the potential for teleworking is great in Europe - Banister and Stead (2004) estimate it at approximately 20 per cent for most EU countries.

Focusing on the role of teleworking in sustainable transport, we can argue that, in principle, if workers do not commute to work, they do not contribute to congestion and CO_2 emissions. Mokhtarian (1997) estimates that a 2 per cent increase in teleworking would cause a 1 to 2 per cent decrease in total personal vehicle travel. But recent studies in the US estimate that telecommuting reduces total vehicle miles travelled by only 0.8 per cent (Choo et al., 2005). The reason is that there are 'rebound' effects: other household members may be using the teleworker's car or the teleworker may need to make additional errand trips (Cairns et al., 2004). In effect, freed up roads may be taken up by other vehicles (Gross et al., 2009), so the impact on congestion and CO_2 emissions may be quite small. Alternatively, workers, who only telework two or three days a week and drive to the office on other days, may choose to live further away from the workplace (Janelle, 2004, p.107). Thus, although they will drive less often, they may end up driving more overall. However, there are some encouraging results from implementing teleworking, particularly in cities. In Tokyo, for example, by 2010 congestion will be reduced by as much as 11 per cent due to teleworking (Mitomo and

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[8] Teleworking is notoriously difficult to measure and so cross-country comparisons are prone to measurement error. Here we consider teleworkers to be those workers who spend some time working remotely (at least one day a month, either at home or at a satellite office). There is another category of workers, who only work from home - the so-called teleworker-homeworkers.

Jitsuzumi, 1999), which in economic terms is equivalent to a quarter of public transport spending.

The effect of teleworking on carbon emissions, pollution and energy are more ambiguous. The difference between the cost of heating and electrical equipment at home and in the office may be higher than the emissions saved from a short car or public transport commute. National energy savings in the US and Japan from teleworking are at most 0.4 per cent (Matthews and Williams, 2005).

Kitou and Horvath (2006) estimate that overall emissions (CO_2, NO_x, SO_2) from teleworking are lower than usual commuting if the commute is longer than 8 km. This also means that teleworking will mitigate the environmental impact of increasing urban sprawl, as more people living far out are choosing to telework (Ory and Mokhtarian, 2006). Overall, teleworking appears to have some potential for reducing carbon emissions in developed countries if the current trends continue - in the UK 2.4 per cent of carbon emissions from cars may be reduced due to teleworking by 2050 (Anderson, 2003, in Gross et al., 2009) and in the US the national energy savings will be at most 1 per cent in an optimistic scenario (Matthews and Williams, 2005). However, since most teleworkers are in managerial and professional occupations (Hotopp, 2002) this potential for energy saving and pollution reduction may be limited in developing countries.

Teleshopping (online shopping, e-shopping or e-commerce) allows customers to compare and purchase products online. 73 per cent of households in the UK ordered goods by internet, phone or post for delivery in 2008 (Budd, 2009). Although many more products, such as books and music, are becoming digitised and therefore do not require physical delivery, some products, such as groceries and television sets, need to be delivered to the customer.

Early studies of book retailing in Japan argued that energy use associated with teleshopping is the same as for traditional shopping (Williams and Tagami, 2003). However, later studies, for example of DVD retailing in the US, showed the teleshopping alternative used 33 per cent less energy and up to 40 per cent less CO_2, mainly due to improved packaging (Sivaraman et al., 2007). Weltevreden and Rotem-Mindali (2008) find support for both increased and decreased travel due to teleshopping in the literature and Mokhtarian (2004) argues that although travel will increase, the magnitude of the effect is very difficult to determine in general. This underlines the fact that the impact of teleshopping is changing constantly and is responding to a variety of different factors including:

- Modal split of shopping transport - if teleshopping substitutes a shopping trip that could be made by foot, there will be a negative impact on congestion and emissions. For example, in the US 6 per cent of the shopping trips are walked or cycled and 93 per cent are made by car or motorcycle, whereas in the Netherlands the split is 48 per cent each (Weltevreden and Rotem-Mindali, 2009), therefore the impact of increased teleshopping is more likely to be more positive in the US.

- Purpose of shopping trips and types of goods - the most popular items bought online, such as books, CDs, DVDs, software, travel tickets and clothes, are usually bought together with other goods on traditional shopping trips, whereas items, such as groceries, are usually bought on purpose-specific trips (Weltevreden, 2007). Hence, buying groceries online typically leads to fewer emissions.
- Source of goods - teleshopping does not let the consumer control how and how far the goods have travelled. Improved logistics has driven down transport costs and delivery times. This has allowed firms to locate farther away from customers to reduce production costs. Many businesses now choose airline delivery over rail and road freight (Matthews et al., 2001), which causes higher carbon emissions.
- Type of buyer-seller relationship - there appear to be mobility effects of business-to-consumer (e.g. retailers, such as Amazon.com) and consumer-to-consumer (auction sites, such as Ebay.com) teleshopping. Weltevreden and Rotem-Mindali (2008, 2009) find that shopping trips and distance travelled fell by 0.3 and 0.39 per cent respectively as a result of teleshopping in the Netherlands and freight transport trips increased by 0.3 per cent (mainly because of business-to-consumer teleshopping), leading to an overall reduction in total vehicle miles travelled. However, once they break the results down, no obvious pattern emerges, which leads Weltevreden and Rotem-Mindali (2009, p.90) to conclude that 'e-shopping can have both a positive and negative effect on mobility, depending on personal characteristics, the form of e-commerce, the modal split, the level of trip chaining, and the type of products that are ordered online. Future studies should take this into account when scrutinising the relationship between e-shopping and transportation.'

Overall, the results suggest that teleshopping plays an ambiguous role in sustainable transport and its effect in the future is quite difficult to predict.

Eco-driving campaigns aim to educate drivers and give them tips to drive in a fuel-efficient and thus environmentally friendly way. Tips include maintaining a steady speed and using the highest possible gear, decelerating smoothly and checking pressure tyre frequently. Smokers et al. (2006) note that due to the multitude of circumstances which may affect the results of the policy, different studies find that eco-driving could lead to reductions in CO_2 emissions of between 5 and 25 per cent, with most concluding that reductions around 10 per cent are achievable. In addition to reducing CO_2 emissions, eco-driving, by promoting lower and more constant speeds and greater distances between cars, also has the benefit of reducing car accidents, noise pollution and wear of car components (Harmsen et al., 2003).

Information and education policies have often been advocated as instruments which may affect **behavioural change**. We find in this survey that these types of measures are necessary, but not sufficient. **Advertising and marketing** may go a long way in changing peoples' behaviour. In California, for example, Kahn (2007) finds the "Prius" effect: the

Toyota Prius is preferred by consumers relative to other similarly green vehicles, probably due to extensive marketing and celebrity endorsements. **Family life changes** are also found to trigger changes in behaviour (Goodwin, 1989, 2008). People whose lives are being changed by some important development (birth of a child, retirement, etc) tend to respond more to changes in the relative attractiveness of different transport modes. Advertising campaigns promoting a modal shift towards public transport, for instance, may thus have more impact if targeted at people in the process of important life transitions.

Even though there is some uncertainty regarding the effectiveness of soft policies, given the impacts of many of them have not been quantified, their adoption is widespread. This may be explained by the fact that these policies do not encounter as much public and political opposition as traditional economic policies, such as taxes and charges do. Hickman et al (2010a,b) argue that soft measures can act on their own right and also support other policies. We think that soft measures are necessary but not sufficient to change behaviour and that incentive based instruments are essential in order to achieve significant reductions in CO_2 emissions from road transport. Cairns et al. (2008, p.597) provide estimates of the impacts of soft measures that vary greatly, with reductions in traffic levels of between 4 and 26 per cent, and conclude that 'within approximately ten years, smarter choice measures have the potential to reduce national traffic levels by about 11 per cent, with reductions of up to 21 per cent of peak period urban traffic' (p.593). McKinsey & Company (2009, exhibit 1, p.6) estimate that improving traffic flow and driving behaviour could contribute 8 per cent of the overall road transport CO_2 abatement potential by 2030. Reducing the distance driven could add a further 3 per cent.

Möser and Bamberg (2008), on the other hand, conduct a meta-analysis of 141 studies evaluating soft policies and find that 'currently available empirical evidence provides no solid basis for the claim that a broad implementation of soft transport policy measures is an effective strategy for reducing car use' (p.19). They argue that studies evaluating soft policies seem to arrive at very optimistic conclusions on the effectiveness of soft transport policies due to two factors: first, the scenarios on which the studies are built tend to be based on the results of studies that were not conducted rigorously and second, the techniques used in these studies for synthesising the trends of the empirical evidence rely on narrative techniques, such as verbal comparison and discussion, rather than on statistical methods. They conclude that the extensive use of weak quasi-experimental designs undermines the validity of the reported soft policy impact (p.19). This validity, they argue, can be further questioned because most studies do not use statistical tests for rejecting the null hypothesis of no effect and use samples that are not representative of the total population (p.19). One example they cite as having these shortcomings is Cairns et al. (2004), on which Cairns et al. (2008) is based.

The UK DfT has recently changed its view regarding the effectiveness of soft measures. Their document *Making Smarter Choices Work* (UK DfT, 2005, pp.4-5) reports that 'nationally, traffic volumes could be cut by 11 per cent'[9]. In line with these estimates the UK government committed to providing substantial funding and support to local authorities for the implementation of soft policies. However, they take a rather more cautious stand in their *Impact Assessment of the Carbon Reduction Strategy for Transport* (UK DfT, 2009). In this document they present a table which clearly reflects how their assumptions changed. The assumption that car-trips and car-km will be reduced by 11 per cent by the year 2020 is replaced by estimates of 7 per cent and 3.7 per cent reductions respectively (UK DfT, 2009, Figure A27, p.103). They argue that their analysis has been updated to be more realistic and they now assume that soft measures only have impacts in urban areas, as there are fewer alternatives to the car in rural areas (UK DfT, 2009, paragraph 4.31, p.25).

Knowledge policies

Research and Development is crucial for developing sustainable and low-carbon transport for the future. Transport stands to benefit substantially from the efficiency gains found in new technologies (Banister, 2008).

Energy efficiency will only contribute between 31 per cent and 53 per cent of CO_2 emissions reductions by 2050 (Stern, 2006, p.378). In the transport sector, technological advances have increased fuel efficiency and reduced emissions of local and regional pollutants, but they have not fully addressed the problem of decarbonisation - a permanent shift away from fossil fuels.

There are a number of promising options, at different stages of maturity. These include vehicles that run on second generation biofuels[10], hybrid internal combustion engines, plug-in hybrid and purely electric vehicles, powered by either fuel cells or batteries. Unfortunately, as of 2010, they all pose problems of one sort or another. The synthesis of second generation biofuels[11], for example, still needs to be optimised to be cost-competitive with fossil fuels, while purely electric vehicles need batteries with a higher capacity before they will be accepted by the market.

[9] UK DfT (2005) is entirely based on Cairns et al. (2004), as pointed out throughout the document and explicitly acknowledged on the last page.

[10] These improved biofuels are produced from lingo-cellulosic feedstock i.e. 'low-cost crop and forest residues, wood process wastes, and the organic fraction of municipal solid wastes… with no additional land requirements or impact on food and fibre production' (International Energy Agency, 2008).

[11] The 'synthesis' refers to 'synthesis gas' from which synthetic diesel and aviation fuels can form via a thermo-chemical reaction.

Inderwildi et al. (2010) review alternative road vehicle technologies. They focus on hybrid-electric vehicles, battery electric vehicles, and fuel cell vehicles. Fuel cell vehicles use hydrogen and convert chemical energy into electrical energy. Battery electric vehicles run on electricity (stored on on-board batteries) and hybrid electric vehicles run both on petrol or diesel in an internal combustion engine and electricity in an electric motor (Inderwildi et al., 2010, p.8). They conclude that 'although a number of prototype fuel cell vehicles have been produced and the technology is continually improving, problems of cost, durability, and power density remain serious challenges to commercial viability' (p.7). They also point out that the current technical problems with fuel cell vehicles mean that 'the initial market uptake will be for fleet vehicles such as buses, which often use a single refuelling station and can store larger quantities of hydrogen on board' (p.11). The trials they cite include those that took place in Chicago, Vancouver, Beijing and Aichi. There is also a Fuel Cell Bus Club, which facilitated trials in ten European cities (Amsterdam, Barcelona, Hamburg, London, Luxembourg, Madrid, Porto, Reykjavik, Stockholm and Stuttgart) plus Perth in Australia.[12]

Inderwildi et al. (2010) classify hybrid electric vehicles in 'mild' and 'full'. Mild hybrid electric vehicles shut off when idling but are still propelled by an internal combustion engine, whereas full hybrid electric vehicles have a smaller internal combustion engine and run on an electric motor during most stop-and-go (typically urban) conditions (p.8). They go on to highlight that one of the crucial challenges for the growth of battery electric vehicles and hybrid electric vehicles is battery technology (p.8).

Individual governments must make permanent and credible commitments about the regulatory, economic and technological decision frameworks in order to send a clear signal to the transport industry. These decisions must be made within the structure of global governance. The transport industry will react by channelling its R&D towards the most desirable technologies to deliver low-carbon vehicles, which will meet the standards set out by governments. Only thus will the transport industry be able to meet the challenge of drastically reducing CO_2 emissions.

[12] The Fuel Cell Bus Club is funded by three projects: CUTE, ECTOS and STEP. CUTE stands for Clean Urban Transport for Europe and is mainly funded by the EU, ECTOS stands for Ecological City Transport System, and is mainly funded by Icelandic New Energy, and STEP stands for Sustainable Transport Energy for Perth, and is mainly funded by the Department of Planning and Infrastructure of the Government of Western Australia. Each of the eleven cities taking part in the trial has three hydrogen buses.

CONCLUSIONS

The 'marginal social cost equal marginal social benefit' approach to the internalisation of externalities does not seem to be enough to tackle the extremely challenging problem of climate change. It is important that road users pay the full costs of their actions, but this traditional economic approach can be combined with complementary policies, designed to change motorists' behaviour.

Command-and-control policies, fuel and vehicle taxes and other road user charges, and potentially, cap-and-trade schemes, still have an essential role to play. Although standards and regulations do not ensure economic efficiency, they trigger less public and political opposition and tend to be easier to introduce. Taxes and permits, on the other hand, ensure that the target is achieved at minimum cost, at least in theory. We admit though that in real world situations, lack of information may lead to inefficient outcomes.

On top of these economic instruments, an integrated transport policy is key to moving towards a more sustainable design of urban mobility. Providing safe and pleasant interchange facilities together with integrated ticketing and real-time passenger information can help make public transport more attractive and reduce some of its perceived disadvantages relative to the car. In order to meet urban mobility needs, a sustainable urban mobility concept must be multi-modal, integrating different modes of public transport, private cars, and walking and cycling. For example, building cycling lanes to railway stations encourages people to make multi-modal commutes. Park-and-ride facilities can be effective at reducing congestion and pollution in the city centre. Mixed-use neighbourhood design can reduce travel demand by locating facilities near people's homes.

Car use in the city can be further discouraged by parking restrictions and establishing car clubs, together with congestion charges. Combining these policies with information and advertising campaigns that promote more sustainable transport choices can help to bring about behavioural change and discourage unnecessary car use. Changing driving behaviour by informing people about eco-driving can also reduce CO_2 emissions in a very cost-effective way.

Commuting traffic is central to the urban mobility challenge, and thus teleworking could play a role in alleviating congestion. Establishing satellite offices, in particular, could be feasible for companies operating in very congested cities. Cities also offer an excellent testing ground for innovative transport technologies, such as fuel cell buses.

Given the severity, complexity, persistence and uncertainty and risk related to climate change, policymakers cannot afford to ignore the problem. Road transport is a challenging sector to decarbonise but at the same time the number and variety of policies is wide and promising. There is thus no excuse not to do anything, except fear of facing public opposition, and thus not being re-elected.

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