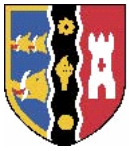

THE ROBERT GORDON UNIVERSITY ABERDEEN

Decoupling the link between economic growth, transport growth and carbon emissions in Scotland

by

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1. INTRODUCTION

1.1 Unlike most other sectors of the economy, transport energy consumption and carbon emissions are increasing. The transport sector accounted for about 17% of Scotland's 17.6 million tonnes of greenhouse gas emissions in 2003 (excluding air travel and maritime) - up 6% on 1990- levels (The Scottish Executive: 2006a). Yet, transport demand is largely derived from other economic activity. Emissions of carbon from transport derive from the amount of transport activity and the technological efficiency of these movements. The objective of a sustainable transport system, therefore, should be to improve access to goods and services without excessive or unnecessary mobility and subsequent emissions. In other words, economic growth (in the widest sense) needs to be realised with less transport (at least in terms of resource use and environmental impacts). Achieving economic development without a proportional increase in transport activity (and emissions) is known as *decoupling*. Decoupling transport demand from economic development is purported to be the only way to deliver true long-term sustainability.

1.2 This report will examine whether future economic development can occur in Scotland with significantly less mobility and carbon output than has been achieved in the past. To do this, section 2 of this paper will review the literature on decoupling and transport intensity, providing definitions and arguments for and against these objectives. Evidence on where decoupling has been achieved in other countries and sectors will also be presented. Following this, section 3 will present a selection of personal surface and freight transport measures that are most likely to satisfy accessibility and economic development objectives without proportional increases in transportation activity and emissions[1]. Section 4 will summarise the findings of this review.

2. DECOUPLING AND TRANSPORT INTENSITY

2.1 What is decoupling?

2.1.1 Traditionally, transport activity, economic activity and carbon emissions have been strongly correlated (Banister and Stead: 2002, Gilbert and Nadeau: 2001)**.** Economic activity can influence the demand for transport and simultaneously changes in the transport system can influence economic activity, while at the same time causing increases in carbon emissions (University of Leeds: 2000).

2.1.2 Indeed, the evidence on the rates of transport and economic growth strongly confirm this link. The Department for Transport (DfT) found the total volume of traffic on Scotland's roads in 2004 was about 43 billion (thousand million) vehicles kilometres, 2% more than the previous year (Scottish Executive: 2005). In parallel to this the Scottish Executive found that the value of its Gross Domestic Product (GDP) using an income approach rose by 2.1% over the past year[2].

2.1.3 However, some commentators assert there is no economic law binding transport and economic development and instead of the link being *inevitable*, traffic growth can be harmful to both the economy and the environment. For instance, Banister and Berechman (2001) acknowledge the link between transport growth and economic

[1] Note that aviation is not discussed in this report.
[2] http://www.scotland.gov.uk/Publications/2005/10/2685543/55438.

growth, but believe that there is no reason why transport growth needs to follow economic growth; *'indeed there is strong efficiency and environmental arguments for breaking the link'* (Banister and Berechman: 2001).

2.1.4 Breaking the link between transport growth and economic growth is known as *decoupling*. Although a relatively new concept, decoupling has spread throughout the transport world in response to modern day transport excesses. In Europe, *'policy makers and researchers are becoming concerned to decouple economic activity and transport activity, thereby allowing economic growth to continue with fewer adverse impacts from transport'* (Gilbert and Nadeau: 2001). Likewise, DEFRA believe that *'decoupling of economic growth and environmental degradation will help accomplish the Government's aim'* of providing sustainable transport (DEFRA: 2003).

2.1.5 Decoupling takes place *'when the growth of the environmentally bad pressure is less than that of the economic good over a given period'* (OECD: 2001; DEFRA 2005a). However, it is not at all *'straight forward'* to define what transport outputs should be decoupled from economic growth (University of Leeds: 2000). For instance, the link could be broken between transport movements (total kilometres *or* passenger kilometres *or* tonne-kilometres) *or* the energy required to achieve that level of activity. Also, the Leeds study points out: *the ability to travel easily and cheaply is essentially an economic benefit to individuals and firms. Should policy therefore be concerned to minimise travel only by private car and for leisure purposes, for example? Alternatively, perhaps it should just focus on travel at certain times of day and/or locations? These are questions that go to the heart of the 'decoupling' debate* (University of Leeds: 2000).

2.1.6 In addition, decoupling can either be *relative* or *absolute*:

- *Absolute decoupling* is the ultimate aim and occurs when the environmentally relevant variable is stable or decreasing while the economic driving force is still growing (Gilbert and Nadeau: 2001). OECD found that absolute decoupling is common in only a few OECD countries[3] (OECD: 2002).
- *Relative decoupling* on the other hand is more widespread. *'Decoupling is said to be relative when the growth rate of the environmentally relevant variable is positive, but less than the growth rate of the economic variable'* (Gilbert and Nadeau: 2001, OECD: 2002).

2.2 What is transport intensity?

2.2.1 Related to the issue of decoupling is the concept of *transport intensity*. Transport intensity is a measure of the amount of transport in relation to the size of the economy (EEA: 2006) and thus concerns the economic or energy efficiency of transport (Banister and Stead: 2002). Similarly, it has been defined as *'an aggregate measure of the resource importance of transport in the national economy, transport intensity is therefore the ratio of gross mass movement to Gross Domestic Product (GDP)'* (Peak: 1994). In this way, the intensity concept is a way of measuring whether (relative) decoupling has been achieved.

2.2.2 From an environmental perspective, transport and or energy consumption and emissions need to be reduced relative to economic growth not only in a relative sense but also in *absolute* terms. Banister and Stead (2002) note that it is probably easier in

[3] OCED countries include Australia, Belgium, Canada, Czech Republic, Denmark, Finland, Iceland, Japan, Korea, Mexico, Netherlands, New Zealand, Slovak Republic, Spain, Sweden, UK and the USA among others.

the transport sector to achieve an absolute reduction in energy and emissions, rather than an absolute reduction in transport volume. This requires indicators of decoupling/transport intensity that combine transport change with environmental factors such as energy consumption and carbon emissions.

2.2.3 Therefore, indicators of transport intensity could relate to a number of different elements of transport activity:

- *traffic* intensity: measures are defined according to economic activity as a ratio of transport volumes or distance. This can refer to the number of movements in terms of passengers or tonnes or passenger/ tonne kilometers.
- *energy* intensity: the amount of energy used to achieve a given number of passenger movements, freight movements or a combination of both). Measures of transport energy efficiency have been developed to enhance the traditional measures of transport intensity. As transport is almost entirely sourced by oil this is relatively simple to calculate, even over a ten year period where alternative fuels might be increasingly used (Banister and Stead: 2000).
- *carbon* intensity: a distinction can be made between the *transport carbon intensity of the economy* (emissions from transport movements per given unit of economic growth) and the *carbon intensity of the transport sector* (that is the amount of carbon emitted for a given number of transport movements).

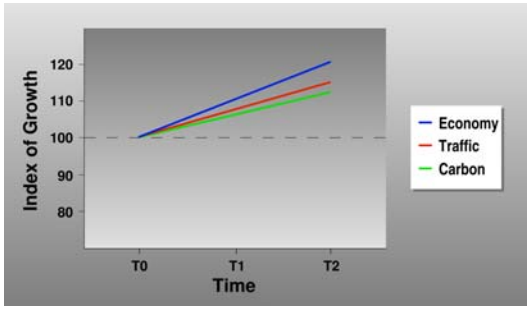
2.2.4 Transport intensity has been criticised as an inadequate indicator of sustainable transport. In particular, Banister and Stead (2002) assert that the most commonly used and most widely available measure of economic activity (GDP) has a number of limitations particularly when concerning issues of welfare or sustainability: They point out the following main criticisms of this measure:

- calculation of GDP includes spending on actions such as pollution clean-up and medical detail for road accident victims, but does not take account of unpaid activities or how economic activity is distributed across society.
- circularity is introduced by this measure as the scale of reduction in transport intensity is based on increases in GDP, which in turn influences the growth in passenger and freight travel. *Provided that GDP increases at a higher rate than travel, transport intensity will of course fall.* Thus a simple ratio of transport growth to GDP will inevitably demonstrate a decoupling effect.

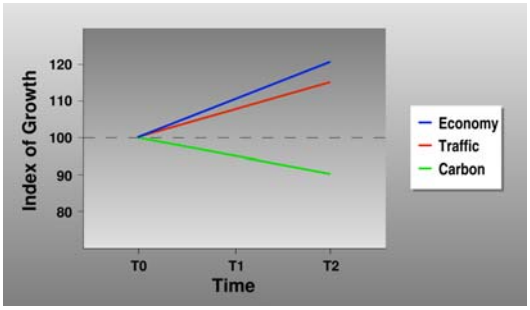
2.2.5 Similarly, Litman and Laube (2002) note: *Conventional neoclassic economic theory, which is the basis for most analysis in this paper, assumes that the benefits of economic activity are accurately reflected in market indicators such as Gross National Product (GNP), and that non-market impacts can usually be ignored in economic decision making. Sustainable economics takes a broader view. It views economic, social and environmental impacts to be equally important, and demands consideration of non-market impacts.*

2.2.6 From this it is important to note that, even if decoupling is occurring, in reality environmental damage may be increasing unsustainably. These relationships are illustrated indicatively in **Figure 1** which shows that transport intensity can fall as decoupling takes place relative to economic growth but carbon emissions may still be growing (a.). However, it is unclear whether carbon emissions can be reduced in absolute terms under this scenario (b.) or whether traffic (c.) and some commentators believe even GDP (**d**.) may also have to fall or at least stabilise in absolute terms.

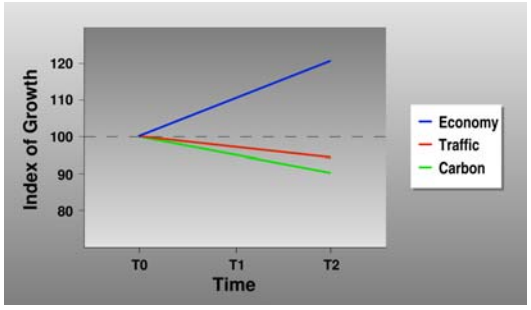
a. Current situation – some relative decoupling of traffic and carbon



b. Can *relative decoupling of traffic and the economy* achieve absolute carbon emission reductions?



c. Or is *absolute decoupling of traffic and the economy necessary* in order to achieve absolute carbon emission reductions?



d. Or *will economic growth need to be stabilised* in order to achieve absolute carbon emissions reductions?

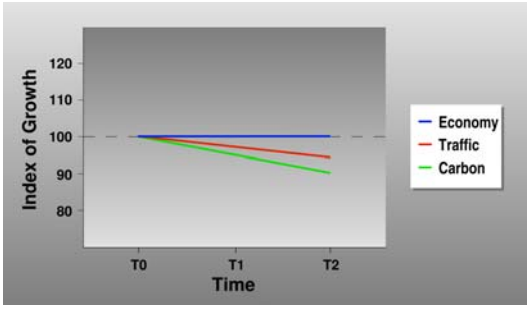


Figure 1: Relative and absolute decoupling scenarios (indicative only)

2.2.7 The ambiguous nature of decoupling acts as a significant barrier, as decisions cannot be made as to whether to attempt *'all out'* decoupling or not. (DEFRA: 2005). DEFRA sums up the complexity of the concept as follows: *The decoupling concept is a simple one to demonstrate and understand but this simplicity masks underlying complexities. One obvious complexity is the relationship between the economic driving forces and the pressures on the environment. The driving force will inevitably have multiple environmental pressures and in turn the environmental pressures are generated by multiple driving forces. These factors all interact, a fact not shown by the simple one-to-one relationship implied by the indicator* (DEFRA: 2005a). DEFRA concludes that there are therefore limitations to the use of decoupling indicators.

2.2.8 Consequently, Banister and Stead believe that additional elements need to be included, namely transport *efficiency*, which relates to: *modes, technologies, organisational structures, the use of resources and prices* (Banister and Stead: 2002). For example, in the freight sector, efficiency can be increased through the use of logistics and new forms of handling to increase efficiency and reduce volumes and distance travelled – although they can also work to increase volumes, thus working against decoupling.

2.2.9 Shipper and Marie-Lilleu (1999) developed a useful composite measure to capture these different aspects of intensity: the ASIF model. In this model, emissions are related to the *A*ctivity (in tonne or passenger kilometres), modal *S*tructure (that is share of tonne or passenger kilometres occurring on each mode), the modal energy

*I*ntensity of each mode (in energy burned per tonne or passenger kilometres) and the *F*uel to carbon ratio (carbon released per unit of energy burned). Shipper states '*the key purpose of ASIF identity is to show policy makers how the components of transport and emissions fit together and make sure that the potential – and the actual – impacts of their actions on each component are noted – it helps remind analysts of some of the linkages'* (Banister and Stead: 2002). The various components of this model will be looked at in more detail in section 3 in relation to the areas to be targeted by policy.

2.3 Is decoupling prevalent in the UK?

2.3.1 In relation to general 'decoupling' of environmental 'bads' with economic growth, the OECD (2006) found that although weak decoupling prevails, there is evidence that 'strong' decoupling, (when economic growth leads to at least no increase in environmental degradation), has taken place in some countries in the case of emissions in several areas including local air pollution, ozone depleting CFCs and lead emissions from petrol. The majority of OECD countries have experienced some level of decoupling of environmental degradation from economic growth for energy, water and resource use in recent decades. The University of Leeds, who conducted the SPRITE (Separating the Intensity of Transport from Economic Growth) project, discovered that the energy intensity of the EU economy as a whole for example has been systematically decreasing since at least the mid 1970's. This has been taking place due to:

- Sharp increases in the cost of primary energy inputs;
- Economic structuring leading to a relative decline in the economic importance of high energy using industries;
- Regulation, driven by environmental pressures (University of Leeds: 2000).

2.3.2 In relation to transport, the decoupling and intensity concepts are most commonly related to *traffic* (number of car or lorry movements). The Separating the Intensity of Transport from Economic Growth (SPRITE) project found that there had been '*little evidence'* to suggest that the growth of transport demand has been or ever can be decoupled from the rate of economic growth (University of Leeds: 2000). For instance, traffic has been growing faster than the economy as a whole. The result is that the transport intensity of the economy has been increasing i.e. each output is associated with a greater amount of movement of people or goods (SACTRA: 1999). In addition, across Europe as a whole, the measuring indicators tend to suggest that transport activity became less efficient between 1970 and 1995. This corresponds with Peak's observation that transport intensity has become less and less efficient over the last forty years (Peak: 1994). Nevertheless, more recently, the European Environment Agency (EEA: 2006) undertook a major review of transport and environment issues and concluded that relative decoupling has emerged recently in passenger transport, but absolute volumes are still increasing.

2.3.3 It is true that in the UK as a whole between 1970 and 1989, the growth in vehicle use more than doubled – outstripping economic growth (GDP grew by 56% in the same period) (DEFRA: 2004). Research has shown that people on average tend to spend a fixed share of their income and of their time on transport (at the aggregate level). Therefore greater income is a major driver of increased transport volumes and higher transport speeds boost the number of passenger kilometres. For instance, higher incomes and improved transport infrastructure has led to leisure travel becoming a significant contributor to the increased passenger transport volumes. Spatial developments are important determinants of transport volumes as well (EEA: 2005).

2.3.4 However, since 1993, there has been some decoupling of road traffic from economic growth in the UK: motor vehicle traffic (including business use and taxis) increased by 17% to 2002 while GDP increased by 29%. ONS/DEFRA found in 'Sustainable Development Indicators in your Pocket' (2005) *'that since the early 1990's road traffic has increased at a slower rate than GDP which may indicate the beginning of relative decoupling in the UK'* (DEFRA: 2005).

2.3.5 It is unclear whether the same is true of energy and carbon intensity. **Figure 2** shows that between 1990 and 2003, there was weak decoupling of CO_2 emissions from the growth in road traffic between 1990 and 2003.

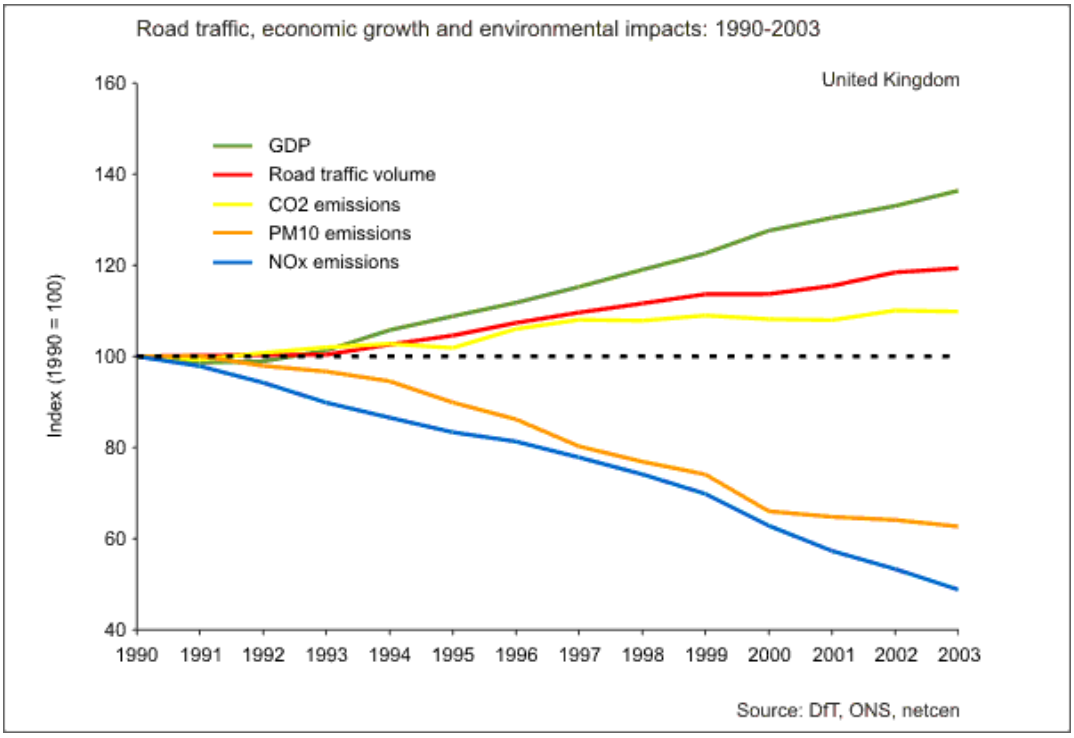


Figure 2: Road traffic, economic growth and environmental impacts 1990-2003

2.3.6 Transport *energy* consumption (and emissions of greenhouse gases) has increased steadily because transport volumes are growing faster than the energy efficiency of different means of transport. Also, car occupancy and lorry load factors have been in decline – average occupancy rates for cars are lower than a decade ago. Growing car ownership, the decreasing average size of households and disperse spatial patterns are the main causes for low occupancy rates (EEA: 2006). Indeed, DEFRA (2004) shows there was little decoupling of CO_2 emissions from growth in road traffic between 1970 and 2002. In that period, CO_2 from road emissions increased by 96%[4].

2.3.7 The recent weak relative decoupling of carbon emissions from transport related economic activity reflects changes in the average fuel efficiency of new petrol cars. Fuel consumption per car kilometre has in the past remained fairly constant but over the last decade has shown some improvement. However, progress in the UK on car fuel efficiency has not been as rapid as in many other EU member states, in part as a

[4] This is not the case with emissions of other pollutants such as NOx and PM10. Since the late 1980s, technological improvements in vehicles have allowed significant decoupling of emissions of pollutants, such as particulates and nitrogen oxides, from the growth in road traffic. NOx emissions declined by 54% between 1989 and 2002, with PM10 emissions declining by 62% over that period.

result of rising income levels which have allowed UK motorists to choose larger, less fuel-efficient vehicles (see SMMT 2006).

2.4 Is decoupling prevalent in Scotland?

2.4.1 Scotland appears to have performed rather better with respect to reducing the carbon intensity of its economy as a whole. The first Scottish Climate Change Programme, published in 2006, suggests: *Scotland's record to date shows good progress in [reducing carbon intensity]. Our GHG emissions reductions over the period 1990 to 2003 have been achieved at the same time as a 29% growth in the Scottish economy. An indicator encompassing emissions of CO_2 and economic growth is included as one of the set of Scottish Sustainable Development Indicators published in 2002*. (Scottish Executive 2006a)

2.4.2 The Climate Change Programme document compares how much CO_2 Scotland emits in relation to its wealth, providing a means of calculating the carbon intensity of our economy (The Sustainable Prosperity index). The lower the Sustainable Prosperity Index, the lower the carbon intensity of the economy. **Figure 3** compares how much Scotland's Sustainable Prosperity Index reduced between 1990 and 2003: from 100 to 71 as GHG emissions reduced at the same time as the economy grew.

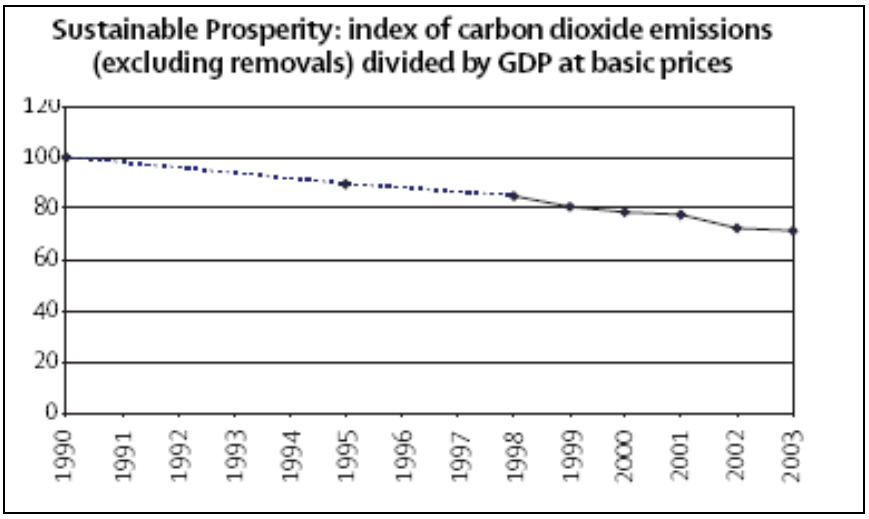


Figure 3: Scotland's Sustainable Prosperity Index
(Source: Scottish Executive 2006a)

2.4.3 Between 1990 and 2003 the major areas of Scottish emissions growth were in the energy supply (up 0.2 MtC) and the transport sector (up 0.18 MtC). (Scottish Executive 2006a). The increased use of transport, and associated GHG emissions from the sector, is projected to grow at an increasing rate, with road traffic forecast to grow by 27% by 2021 (Scottish Executive 2006a).

2.4.4 With respect to source emissions (whereby the emissions produced by the energy sector are not apportioned amongst the prospective end-users of this energy), the transport sector, excluding aviation and maritime, was the second biggest contributor (after the energy sector) with 17% of emissions during 2003 (**Figure 4**). If the emissions from the energy supply sector were apportioned among the relevant sectors of demand, transport would be the largest contributor. Indeed, the Scottish Energy Study also published in 2006 (Scottish Executive 2006b), estimated that some 29% of energy use in Scotland in 2002 was due to transport and that energy assigned to transport grew by approximately 10% between 1990 and 2003. The Energy Study

based energy for road transport on an estimate of distance travelled. It also includes estimates of energy used by air travel on the basis of aviation fuel delivered to Scottish airports.

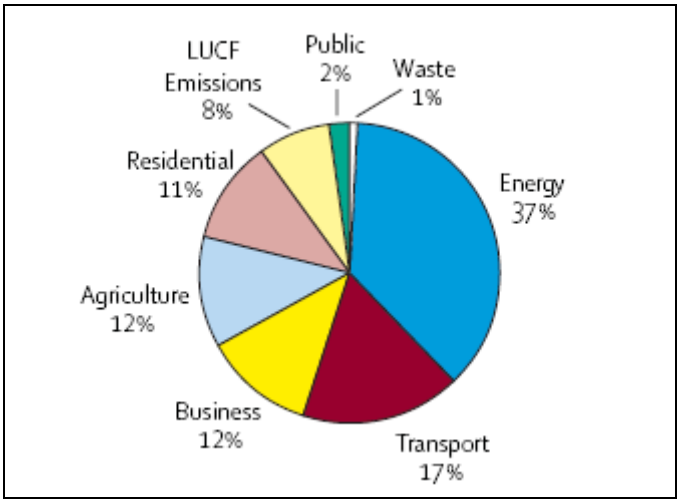


Figure 4: Contribution of each sector to Scottish GHG emissions in 2003 by GWP – the pie represents 17.6 MtC – Scotland's GHG emissions in 2003 taking account of removals.
(Source: Scottish Executive 2006)

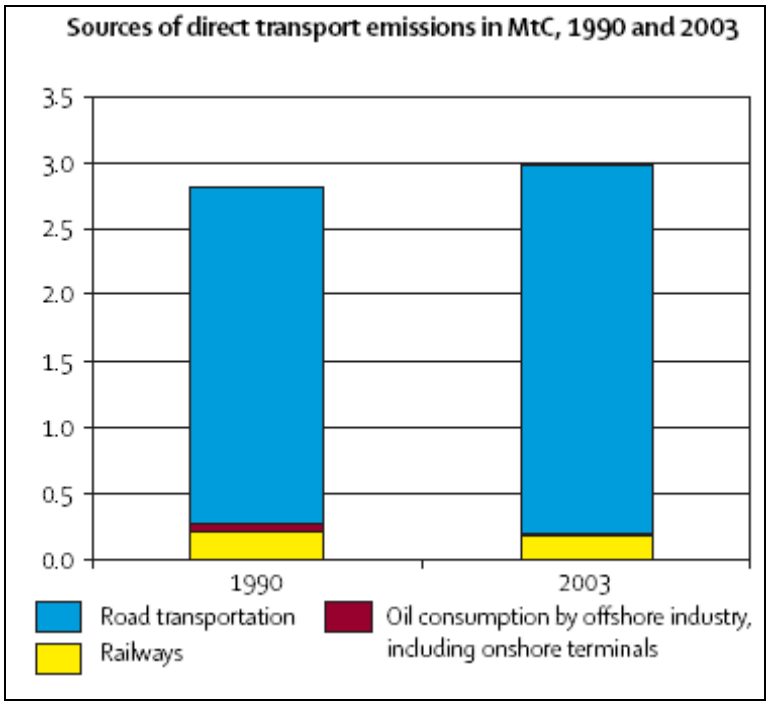


Figure 5: Breakdown of emissions between road and rail in Scotland
(Source: Scottish Executive 2006a)

2.4.5 Relating traffic and emissions from the transport sector to economic growth (expressed here as GVA (Gross Value Added)), **Figure 6** shows Scotland's GVA to have grown more slowly than the UK as a whole between 1995 and 2004. At the same time, road traffic has increased at an equivalent rate as in the rest of the UK, using 1995 as a baseline year. Carbon emissions from this sector (all transport, end user) have, fluctuated slightly, but as discussed above, the overall trend has been an increase and in the latter years, at a faster rate than the UK.

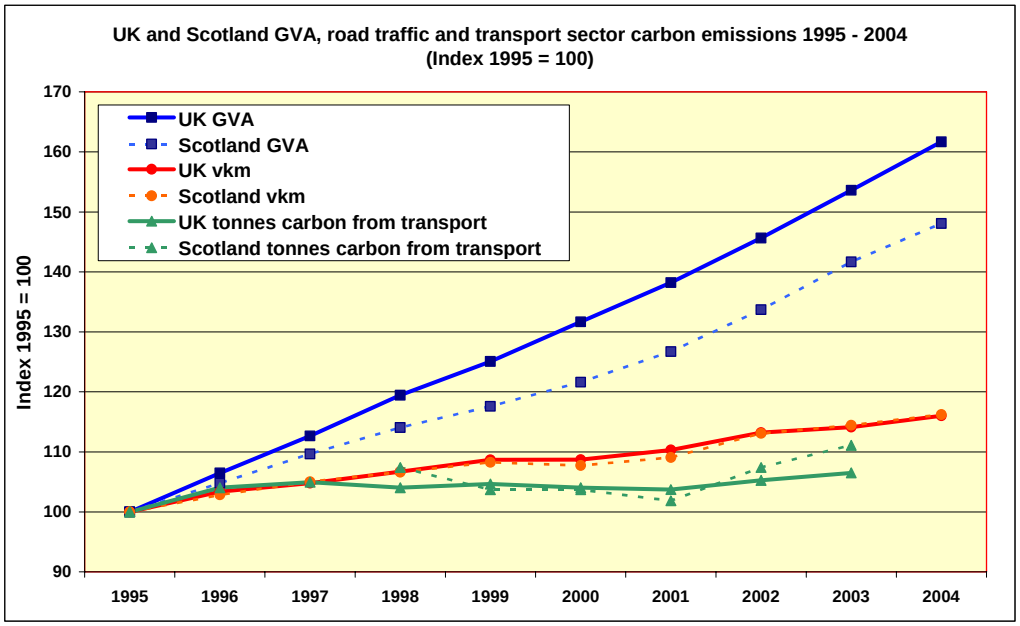


Figure 6: UK and Scotland GVA, road traffic and transport sector carbon emissions 1995 – 2004[5]

(Note: the figures used for GDP in this graph are GVA (Gross Value Added) figures. GVA is a measure of GDP at basic as opposed to market prices and are more commonly available figures at the Scotland level. However, the calculation of 'economic growth' is complex and GVA appears to have a higher year on year increase than GDP figures. Hence, traffic growth appears to be more strongly decoupled from economic growth using these figures than might actually be the case.)

2.4.6 The Scottish Climate Change Programme attributes this increase in emissions to a significant increase in travel, particularly by road. The projected increase in road traffic forecast of 27% by 2021 has worrying implications for the transport intensity of Scotland's economy. **Figure 7** shows that the traffic intensity in Scotland is already higher than the UK as a whole.

[5] Source data for this graph: GVA stats from ONS:
http://www.statistics.gov.uk/downloads/theme_economy/NUTS1_Tables_1-8.xls;
UK vkm stats from TSGB 2005:
http://www.dft.gov.uk/stellent/groups/dft_transstats/documents/divisionhomepage/031571.hcsp
Scotland vkm from Scottish Transport Statistics No 24: 2005
edition:http://www.scotland.gov.uk/Publications/2005/08/25100154/03091

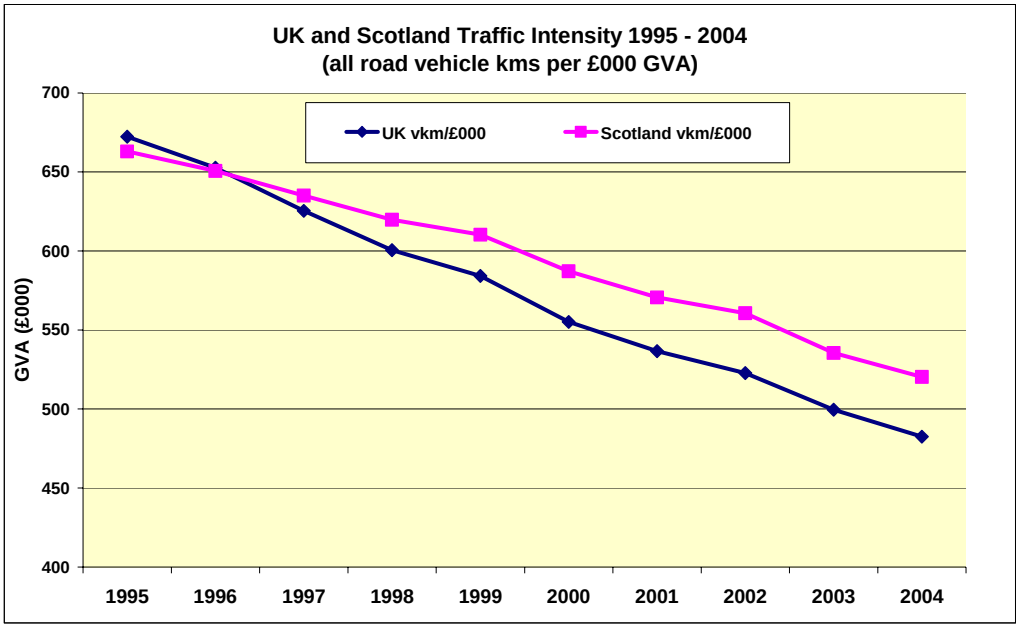


Figure 7: UK and Scotland Traffic Intensity 1995 – 2004 (all road vehicle kms per £000 GVA)[6]

2.4.7 Despite the apparent year on year reduction in the traffic intensity of both the UK and the Scottish economies, the same can not be said of the *carbon intensity of the transport sector*. **Figure 8** presents a mixed picture when the carbon emissions attributed to the transport sector are divided by the total number of vehicle kilometers on the road network. This indicator appears to show an increase in the proportional output of carbon to transport activity. However, caution must be exercised with these figures[7].

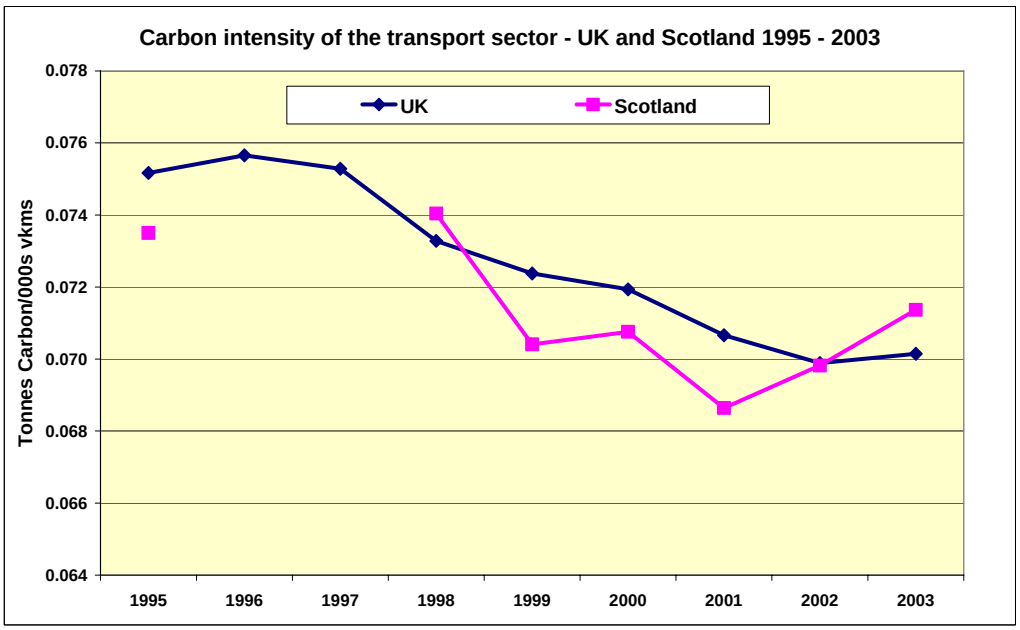


Figure 8: Carbon intensity of the transport sector – UK and Scotland 1995 – 2003

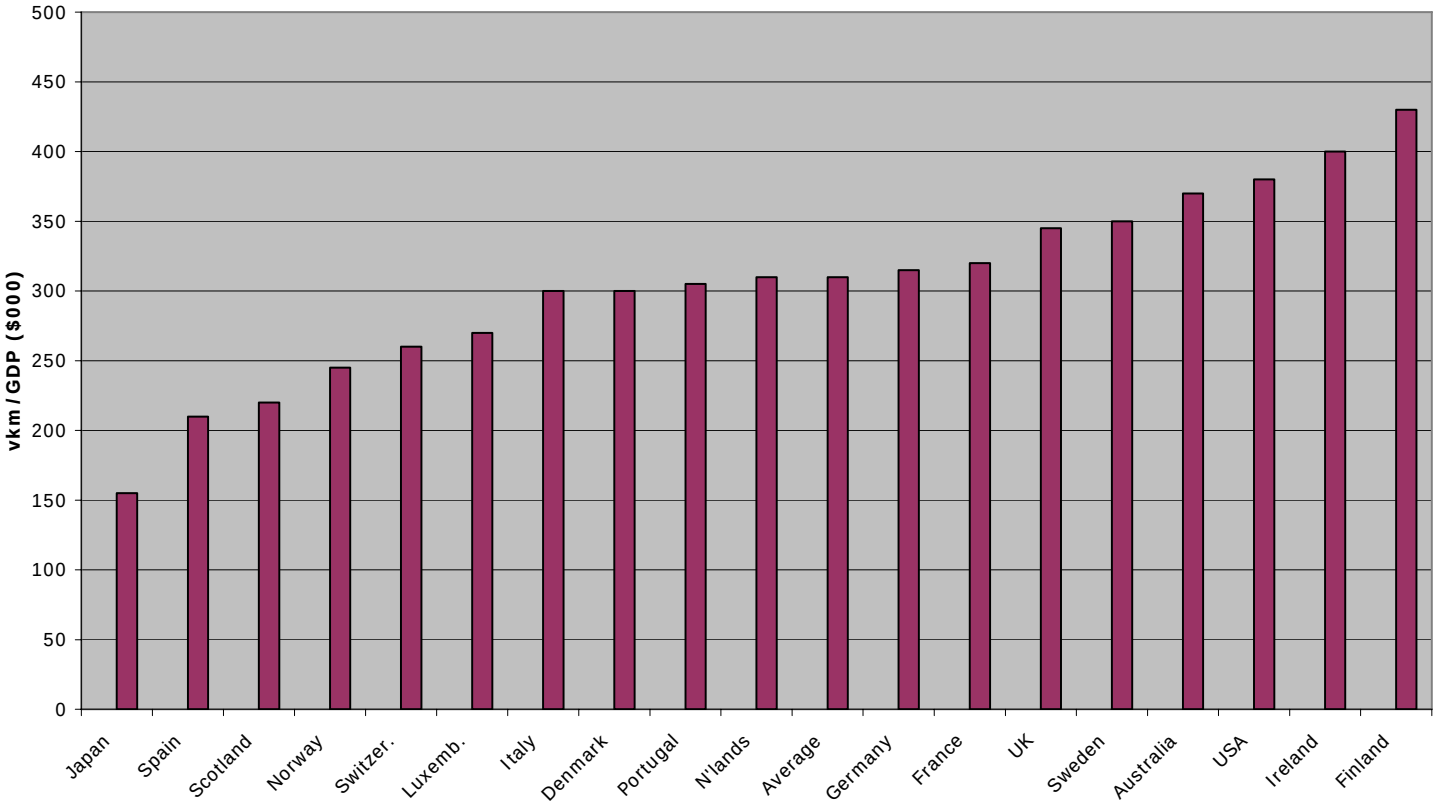
[6] Sources as for Figure 6

[7] Once again the figures used for this calculation should be treated with some caution. The carbon figures include more than just road transport emissions as figures for the whole sector are more commonly available. In addition, ideally a comparison would be carried out with passenger kilometers.

2.4.8 **Figure 9** uses a different calculation for economic growth and is therefore not necessarily comparable to the above analysis. Indeed, it would appear to show a different picture. It details the variation of transport intensity across a number of similar industrialised nations taken as a measure of *car traffic* kilometres per 1000 USD ($000) of GDP. Overall, the diagram shows that transport intensity varies across Europe. Scotland is shown to have a below average level of transport intensity in relation to other EU countries, implying a relatively efficient use of transport as a resource. In some ways this is surprising given its lower levels of population density than say, the UK and thus the need to travel farther. This would often imply higher intensity such as in countries like Finland. However, this lower intensity is more likely to be a reflection of lower incomes and lower levels of car ownership in Scotland and demographic factors such as household size and structure. In 1997 there were 39 motor vehicles per 100 people in Scotland, compared to 48 in England and Wales[8]. In other words, as car ownership levels and income levels increase, the demand for transport activity has the potential to increase disproportionately quickly in Scotland, thus making the task of decoupling more difficult. The difference with the analysis in **Figure 7** may be due to the use of GDP rather than GVA and the difference between all road traffic (including freight) and car traffic only. It may be that the Scottish transport economy is more efficient with respect to passenger car traffic (**Figure 7**) but less so when other forms of road transport is considered such as freight. Also, these figures could be different again if passenger or tonne kilometers were used.

[8] http://www.archive.official-documents.co.uk/document/cm40/4010/tc-02.htm

Figure 9: Car Traffic km per $000 of GDP



(Source: Adapted from Fielder: 2003 (figures from TSGB: 1997). Note: Statistics for Scotland have been added to Fielder's figures and were taken from Scottish Transport Statistics No.24 2005 Edition, Scottish Executive. Thus figures may not be directly comparable)

2.5 Freight

2.5.1 DEFRA (2005a) has developed a basket of decoupling indicators. In addition to economy wide indicators they are broken down according to those relating to household consumption or those relating to production. There are two indicators with particular relevance to the transport sector:

- Household vehicle use: UK household private road transport emissions, car kilometres and household fuel consumption expenditure 1990-2003 (Relative decoupling of CO_2)
- Road Transport: non domestic sector road transport emissions and GDP (Relative decoupling of CO_2)

2.5.2 Household private vehicle use amounts to around 10% of UK carbon emissions and as stated above, is showing some recent signs of possible relative decoupling. Non domestic road transport (covering road freight industry, business car use and public road transport) accounts for a further 10%. Road freight is the dominant non-domestic road transport sector in terms of CO_2 emissions, emitting around 7% of UK carbon dioxide emissions**.** The sector accounts for 18% of total vehicle kilometres, and 89% of non-car kilometres. In terms of the transport industry in Great Britain, around 85% of goods are moved by road freight, increasing from 136 billion tonne kilometres in 1990 to 159 billion tonne kilometres in 2002. As a result of this growth, carbon dioxide emissions from UK road hauliers increased by 29% between 1990 and 2003 compared to a 35% increase in GDP.

2.5.3 Freight transport intensity is defined as *'the measure of the amount of the transport activity (measured in tonne kilometres) in an economy in an output of that economy'* (Steer Davies Gleave: 2003). Pastowski believes *'reducing freight transport intensity of the economy and even more introducing restraints upon the overall volume of freight transport activity as a means to attenuate emissions of greenhouse gases and to cope with other environmental consequences of freight, have remained to be terra incognito'* (Pastowski: 1997). Pastowski points out that this could be because a reduction in freight transport activity is thought to be necessarily associated with *'losses in productivity, competitiveness and economic growth*' (Pastowski: 1997).

2.5.4 Schleicher-Tappesser et al noted that freight transport growth has historically been linked to GDP growth, but they believe that like passenger transport there is a need to develop decoupling strategies in this area, so to develop sustainably (Schleicher-Tappesser et al: 1998). They believe that decoupling can be developed by two basic strategies:

- Dematerialisation of the economy (dematerialisation can be defined as the *'reduction of material resources needed per unit of GDP'* (Schleicher-Tappesser and Hey: 1998));
- Reducing the spatial range of material flows.

2.5.5 Schleicher-Tappesser et al continue by stating that the above strategies point out that the potential for decoupling freight transport growth from economic growth could be estimated at 30-50% for the year 2020 compared to present trends. This means that instead of growing by 80% between 1995 and 2020 freight transport might remain more or less stable (98-110%) (Schleicher-Tappesser et al: 1998).

2.5.6 The European Environment Agency (2005) found that relative decoupling of growth in freight volumes from economic growth has only been achieved in the new EU accession countries (EU-10) where the growth in GDP has exceeded the high growth

in transport volumes. Hence decoupling has been achieved despite the fact that transport volumes continue to grow in these countries. The transport intensity, measured in tonne-km per euro GDP, has declined by 13% since 1995, but these countries remain very transport intensive due to the high share of bulk industries compared to the EU-15 where there is a higher share of services rather than production and manufacture. This decoupling is linked to the transition to more service oriented economies and shows that high economic growth or a more competitive economy does categorically imply higher transport intensities. For the older EU states (EU-15) there have been no clear signs of decoupling and they show growing transport intensities (EEA: 2005).

2.5.7 As growth in transport volume is a major contributing factor for most adverse effects of the environment a continuation of substantial decoupling of economic growth and freight transport would be extremely beneficial. Contrasting to the widely held view that freight transport is in general an inevitable prerequisite of economic development, there is potential for reducing freight transport intensity of the economy, '*which could be more exploited'* (Pastowski: 1997).

3. SUSTAINABLE TRANSPORT POLICY MEASURES

3.1 Issues in reducing the carbon intensity of the transport sector

3.1.1 This section will review transport measures that are most likely to satisfy accessibility and economic development objectives without unsustainable increases in transport activity and emissions.

3.1.2 Before presenting these policies, we suggest that several broad issues should be considered.

3.1.3 Firstly***, what are the main objectives of any target to reduce transport intensity of the Scottish economy?*** Targets for emissions reduction from transport need to be achieved with the minimum negative impact on other objectives and the right balance of social, economic, and environmental outcomes.Within the transport sector, there are tensions and conflicts between goals to increase accessibility, reduce congestion, speed up traffic flow and reduce the environmental impact of the movements of goods and people whilst at the same time facilitating economic development. Indeed, creating policies to introduce the most promising measures in terms of their decoupling potential may prove difficult because they need to meet the expectations and acceptance of governments and citizens (OECD: 2006). Increased promotion of the benefits of decoupling must be a priority in winning public support (Tight et al: 2003).

3.1.4 The main purpose of monitoring the extent to which economic growth is becoming decoupled from pressures on the environment is to assess whether such levels of growth are sustainable in the longer term. However, any objective to reduce transport intensity *without a parallel objective to reduce carbon emissions from transport in absolute terms* will jeopardise national and international targets to reduce greenhouse gas emissions and contravene the goal of achieving a sustainable transport network. Indeed, as section 2.2.6 highlighted, it is possible to achieve relative decoupling whilst increasing environmental damage from transport activity.

3.1.5 Therefore, to decouple transport activity from economic activity (and vice versa) without having an adverse impact on the environment, transport intensity needs to be improved for *environmental reasons* (i.e. doing more with less as a means of reducing pollution, resource use and waste) as well as an increasing political desire to improve transport intensity (i.e. promoting economic growth without increasing transport volumes, energy use and associated social and environmental external costs) (Stead: 2000). Furthermore, it should be noted that without attempts to achieve even marginal decoupling, economic growth is likely to be '*infringed'* through increased congestion. In this light, there is therefore no other choice but to decouple (Fielder 2003).

3.1.6 Thus, in order to achieve environmental objectives, particularly those focussed on national and international obligations to reduce carbon emissions, any decoupling strategy must focus on the *carbon intensity* of the transport sector, not merely the traffic intensity of the economy. Hence, the policies presented later in this section will focus on those which have the greatest likelihood of reducing carbon whilst meeting goals of accessibility and economic growth.

3.1.7 Secondly***, what are the targets for reducing carbon from the transport sector?*** The UK has an international target (under the Kyoto agreement) to reduce its greenhouse gas emissions by 12.5% by 2008-2012. It also has two more ambitious domestic goals

to reduce carbon dioxide emissions by 20% by 2010 and to reduce them by 60% by around 2050. Through Scotland's new Climate Change Programme, the Scottish Executive has identified the 'Scottish Share' and a strategy for tackling Climate Change (Scottish Executive 2006a). The Scottish Share is the amount of carbon savings that Scotland has to deliver through its devolved policies to match savings from all devolved policies in the UKCCP on a per capita basis. The Scottish Share has been calculated at around 1.7 million tonnes of carbon (MtC) in annual savings by 2010. The Scottish Target is to exceed the Scottish Share (1.7MtC) by 1 MtC in 2010.

3.1.8 Any policy to reduce the carbon intensity of the transport sector should be designed in the light of nation-wide targets to reduce carbon emissions and tackling climate change However, neither the UK nor the Scotland Climate Change Programmes have set a sectoral target for the transport sector. As transport is one of the only sectors where emissions are set to increase, this sector could substantially erode emissions savings from other parts of the economy. To reach overall national targets, other sectors will be expected to save more than the overall national targets. The main questions are:

- ***Should transport be expected to pull its weight with respect to these targets and save an equivalent share of emissions?***
- ***Is it more difficult to save carbon from the transport sector compared to say the domestic or industrial sectors? Is this difficulty linked to cost effectiveness or political deliverability, or both (or other factors)?***

3.1.9 Secondly, analysis of the impact of policy measures on carbon emissions is relatively new. Identifying the optimum package of policies to achieve both economic and environmental goals is not only an inexact science, but suffers from being a young area of analysis and beset by potentially conflicting policy objectives. For example, the relationship between the goals of congestion reduction and carbon reduction are not well understood. The main question here is: ***Can a transport strategy which is largely focussed on reducing congestion and improving the efficiency of the network, therefore by definition speeding up traffic flow and increasing capacity, be compatible with carbon reduction?***

3.1.10 It is beyond the scope of this paper to answer these questions directly. In order to answer these questions, not only do the absolute and relative scale of emissions savings expected from transport polices need to be compared (as is partially attempted below), but the emissions savings from transport sector policies need to be set against savings that could be made in other sectors of the economy. Such a comparison would need to evaluate issues such as relative abatement costs (cost effectiveness), social impacts, political deliverability, certainty of outcomes, policy synergies and potential rebound/ takeback effects.

3.1.11 Cost effectiveness of different policies and measures is an important element of sustainable development policy at the Scottish, UK and EU levels. Transport, as in other sectors, is not capable of delivering CO_2 and other emissions reductions well beyond the point of cost effectiveness. In the UK, The Energy White Paper (2003) concluded that over the next twenty years, carbon savings are likely to be more cost effectively achieved within the energy sector than the transport sector. If this is indeed the case, it is efficient use of public money to allow the energy sector to be the main beneficiary of government support and spending on low carbon technologies. However, it is potentially misleading to simply compare the costs of mature, market ready energy technologies, like wind turbines, with some of the low carbon vehicle technologies [This needs a lot more research and development and/or may still be some way off]. Furthermore, there are many non-technological, largely behavioural

measures that have not been assessed in this way and assessed on the same basis as these 'harder' policies.

3.1.12 As far as the authors of this paper are aware, comparisons of policies to abate carbon from the transport sector or other sectors has not been undertaken in any comprehensive format that could be directly applied to the Scottish context. Unfortunately there is very little information on cost effectiveness in particular and this is especially apparent in the transport sector where policies are often less dependent on technological solutions, at least in the short term, and consequently can be more difficult to assess. As a result, the following analysis is necessarily broad-brush and incomplete, but may provide a starting point for the evaluation of solutions to the decoupling agenda in the transport sector.

3.2 Typology of policies to reduce the carbon intensity of the transport sector

3.2.1 The new UK Government Sustainable Development Strategy: *Securing the Future* highlights the need for '*a major shift to deliver new products and services with lower environmental impacts across their lifecycle, and new business models which meet this challenge while boosting competitiveness'* (DEFRA: 2005b).

3.2.2 Decoupling, absolute or relative, strong or weak, may not be thriving in the UK's transport sector at present but there are signs of it materialising relatively. With the intention of it becoming more widespread in the UK there are a number of generic factors that can be considered to encourage it. DEFRA sets out three ways to achieve this objective:

- better products and services, which reduce the environmental impacts from the use of energy, resources, or hazardous substances;
- cleaner, more efficient production processes, which strengthen competitiveness;
- shifts in consumption towards goods and services with lower impacts.

3.2.3 Similarly, the POSSUM project identified four factors that have a bearing on the degree to which freight transport volumes can be decoupled from economic growth:

- The material intensity of the economy
- The spatial structure of production and consumption
- The handling requirements of goods
- The optimisation of transport organisation (particularly the optimisation of the production chain with respect to freight movements such as shorter supply chains) (Steen et al: 1998)

3.2.4 To enhance decoupling, some technological advances may be required. However, as the above projects suggest, it is more likely that a combination of technological, land use, behavioural and logistical interventions will be necessary.

3.2.5 In Scotland the scope for policy making is a balance between devolved and reserved responsibilities. The Scottish Climate Change Programme reminds us: *Responsibility for transport policy is split between the Executive and the UK Government. The Executive has responsibility for a number of areas, including the Scottish road network; bus policy; cycling and walking policy; enforcement of vehicle emissions standards; much of rail funding and policy; financial assistance for freight facilities; and consultative arrangements in respect of public transport. We do not have responsibility for fiscal measures, including road tax and the fuel duty escalator.* It also states that: *it is clear that sectors and emissions in Scotland will be affected by*

reserved policies and that the Executive has a role in influencing the development of such policies by the UK Government. (Scottish Executive 2006a)

3.2.6 **Figure 10** shows the impact of reserved and devolved policies in the various sectors. It can be seen that in the transport sector, most savings are expected to come from reserved polices (e.g. range of fiscal measures on vehicles and fuel, voluntary agreement with car manufacturers). The Executive has responsibility for a number of areas, including the Scottish road network; bus policy; cycling and walking policy; enforcement of vehicle emissions standards; much of rail funding and policy; financial assistance for freight facilities; and consultative arrangements in respect of public transport (Scottish Executive 2006a).

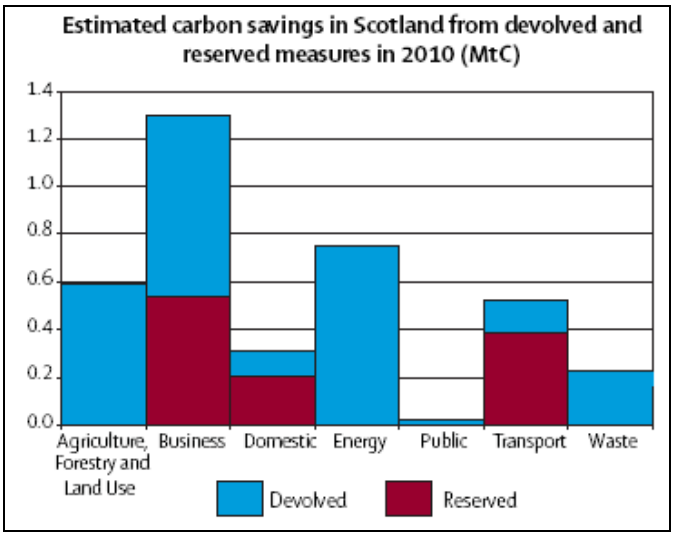


Figure 10: Estimated carbon savings in Scotland from devolved and reserved measures in 2010
(Source: Scottish Executive (2006a)

3.2.7 Whether Scotland or UK –wide, the structure of the surface transport market can be divided into two policy areas – (a) passenger and (b) freight transport. Within each of these sectors, Banister and Stead break down travel into (i) volume (ii) distance and (iii) efficiency. The first two are usually combined to give measures of performance (i.e. passenger kilometers or tonne kilometers). The third element relates to modes, travel time and price, the use of resources, technology and organisational factors. For example, in the freight sector, efficiency can be increased through the use of logistics and new forms of handling to increase efficiency and reduce volumes and distance travelled – although they can also work to increase volumes, thus working against decoupling.

3.2.8 Simplifying this somewhat, it is possible to subdivide passenger and freight transport into 3 areas which each target a way of mitigating transport's contribution to climate change. These 'routes to transport energy reduction' include:

i. *Vehicle efficiency* - reducing the carbon content of transport fuels and/ or decrease the amount of fuel used to travel a given distance
ii. *Mode choice* - encouraging the use of the least energy intensive modes of transport (including the most efficient choice of vehicle)
iii. *Travel reduction* - reducing the amount of travel whilst improving accessibility

3.2.9 Mitigating transport's contribution to climate change will require a combination of measures from each of these three routes to carbon reduction. **Table 1** outlines the

constituent polices that may be purposefully introduced to target carbon emissions from transport for (i) each of these three routes to transport energy reduction (ii) in Scotland versus the UK and (iii) in the freight versus the passenger sectors.

3.2.10 A few notes on **Table 1**:

- Smarter measures include: travel plans (workplace, schools, residential, campus, special events; personalised journey planning' car clubs; car sharing; awareness campaigns). These are discussed in more detail in section 3.5.5.
- Land use planning policies are not itemised in this table, although they potentially comprise some of the most effect policies to effect a decoupling of transport movements and associated emissions from economic development (Banister and Stead 2002). It is beyond the scope of this report to investigate these measures in terms of their carbon benefits and these have therefore been omitted from further discussion in this paper.
- In addition to the measures itemised in the table there are a couple of 'overarching measures' affecting all aspects of transforming the market for passenger and freight transport. These include:
  - Personal carbon allowances (discussed in section 3.6)
  - Measures specifically designed to galvanise public acceptability of transport policies
  - Emissions trading schemes for surface passenger transport (not discussed here).

3.2.11 The subsequent sections will examine the surface passenger measures further by ranking them in terms of their indicative potential carbon savings and over what timescale these savings will begin to materialise.

Table 1: Policies to reduce carbon from (i) surface passenger and (ii) freight transport in Scotland and the UK

	SURFACE PASSENGER		FREIGHT	
	Scotland	**UK (+EU)**	**Scotland**	**UK (+EU)**
Reduce carbon content of fuels/increase vehicle efficiency	• Fuel switching grants • Central/ local government purchase of alternatively fuelled vehicles • Subsidy for alternative fuelled buses • Bus operator fleet targets for alternative fuels • Technological developments (e.g. hydrogen fuel cells) • Speed limit enforcement • Eco-driving • Eco driving test • Vehicle idling campaigns	As Scotland + • Vehicle efficiency standards (Voluntary/ Mandatory agreements) • Fuel quality standards • Biofuels (RTFO)	• Freight dematerialisation • Logistics planning/ load sharing • Sustainable distribution centres* • Fuel switching grants* • Technological developments* • Eco-driving training	As Scotland + • Vehicle efficiency standards • Fuel quality standards
Modal switch: change to more efficient forms of transport/ using the network more efficiently	• Smart measures • Car Clubs • Car free housing • Car sharing • High Occupancy vehicle lanes • Eco-car labelling • Investment in public transport and bus lanes • Policies to encourage walking/cycling • Pedestrianisation • Road space reallocation • Controlled Parking Zones • Low emission zones • Road pricing (including urban congestion charging; motorway pricing and national road user charging) • High speed rail • Intelligent transport systems	As Scotland + • Graduated car VED • Company car tax • Fuel duty (+escalator) • Vehicle scrappage schemes	• Good distribution centres • Rail freight • Early scrappage incentives for HGVs	As Scotland + • Lorry Road User Charging • Eurovignette
Reduce the volume amount of travel	As above + • Teleshopping • Teleworking • Distance based vehicle insurance • Land use planning policies • Park & Ride Facilities	As Scotland + • Fuel duty (+ escalator) • Company car tax	As Above + • Dematerialisation - Development of less transport intensive industries • Local sourcing	As Scotland

*Although these are not devolved policies, Scotland may have some control over implementing a version of the policy.

3.3 Ranking policies to reduce carbon from the transport sector

3.3.1 In line with the policies identified in **Table 1** a qualitative exercise has been undertaken to rank the policies in relation to surface passenger transport only. This exercise has been carried out by means of a literature review and informed judgment by the authors of this report. The rationale and caveats of this analysis should be considered as follows:

3.3.2 Ranking on the basis of carbon savings

- The vast bulk of the transport literature does not address the issue of climate change and carbon emissions. Therefore, there is very little evidence as to potential carbon savings from a given policy. These have been inferred where figures for vehicle kilometre savings are given.
- Even where figures for distance, fuel or carbon savings are given, it is very difficult to compare across policies as data collection methods, scale of analysis, assumptions used etc are usually inconsistent between studies.
- Whether the potential for a policy to save carbon can be ranked as 'high' or 'low' depends on a number of factors. For example:
    - The scale and intensity of implementation assumed
    - The timescale over which outputs are considered
    - The degree to which lifecycle/net/rebound/takeback effects[9] are considered
    - Whether synergies, cumulative impacts and policy clashes are considered
- Ranking policies on one objective only – carbon reduction – does not necessarily satisfy the requirements of a sustainability appraisal given the economic and social benefits/disbenefits that may additionally result from a given policy instrument. With respect to decoupling, the effect on the economy should be considered, as well as the ranking of impact compared to policies in other sectors. Some of these issues have been addressed in **Table 4**, but more detailed analysis is beyond the scope of this report.
- Tables 2 and 3 rank the policies for surface passenger transport (minus any land use planning instruments not addressed here) in terms of their impact (high, medium or low) relative to *each other* (i.e. not relative to policies in other sectors). The ranking is also relative to the policies in the same timescales eg. Speed enforcement can have a 'high' carbon impact in the short term, but this is probably less than the 'high' impact that fuel cells could have in the longer term. In addition, the rankings assume 'moderate' levels of intensity of application.

3.3.3 Ranking on the basis of timescale

- Tables 2 and 3 also group these policies according to whether their time-timetable *for implementation* (not impact) is:
    - short (0-3 years - i.e. a relatively 'quick hit')
    - mid-term (3 – 10 years)
    - long-term (> 10 years).

3.3.4 Ranking on the basis of cost effectiveness

- Some of the potential measures for the transport sector have relatively low costs, others very high at the margin. This is true for other sectors, not just transport. From the literature, a three category classification of likely policy cost was developed. The ranking, while subjective in nature (due to the sparsity of specific cost data in the

[9] For example, increasing vehicle fuel-efficiency reduces per-mile operating costs potentially causing annual vehicle mileage to increase. This is called a *rebound* or *takeback effect.*

literature), is based on evidence from the sources reviewed. The definition used in the following analysis is as follows:

- High cost — large and very large infrastructural measures or investment required in technological R&D or similar;
- Medium cost — some capital outlay and/ or administrative cost – not as large as substantive infrastructural projects;
- Low cost — minimal capital outlay; minimal revenue expenditure; may be revenue raising

- It is important to achieve the required emissions reductions at the lowest cost to reduce damage to welfare and economic growth.
- Some of the largest relatively low cost emission reductions are expected to be achieved in the power sectors (DTI) and as a result, transport is expected to contribute correspondingly less to overall emissions reductions strategies.
- Nevertheless, as the transport sector is still required to 'pull its weight' in the achievement of a low carbon society as other sectors are not necessarily able to compensate if it does not, the most cost effective measures need to be identified.
- A recent report by the European Conference of Ministers for Transport (ECMT 2006) claimed that policies tend to concentrate on some of the higher cost measures available, for example subsidies for biofuels, while some low cost measures are neglected. Lower cost measures such as regulation of fuel quality and some car components (such as tyres), support for eco-driving and labelling were identified as lower cost options in the ECMT report on CO2 abatement policies from this sector.

3.3.5 Hence the following ranking is broad brush and should be treated as indicative and a basis for further analysis and debate. It has not been possible to put figures alongside the savings or the costs for the reasons given above.

3.3.6 Firstly, **Table 2 (Qualitative impacts summary)** provides an overview of the results of this exercise. This table ranks the policies for surface passenger transport (minus any land use planning instruments not addressed here) in terms of their impact (high, medium or low) relative to each other (i.e. not relative to policies in other sectors) and assuming 'moderate' levels of intensity of application. It also groups these policies according to whether their time-timetable *for implementation* (not impact) is short (0-3 years - i.e. a relatively 'quick hit'), mid-term (3 – 10 years) or long-term (> 10 years).

3.3.7 **Table 3** (**Policy impacts – expanded summary)** provides more detail on these policies in terms of whether they are a devolved policy, the policy approach and geographical scope, an indication of the relative cost of implementation, certainty of outcomes, public acceptability and equity impacts.

3.3.8 **Table 4** (**Policy barriers and synergies**) extends this analysis to consider the barriers to implementation and necessary policy synergies of a subset of instruments – those deemed 'high impact' (short, medium and long term) and those deemed 'medium impact (short term only).

Table 2: Qualitative policy impacts summary

TIMESCALE FOR IMPLEMENTATION				
IMPACT ON CARBON REDUCTION		**Short-term**	**Mid-term**	**Long-term**
	High Impact	• **Renewable Transport Fuels** • **Speed limit enforcement** • **Hydrogen Fuel Cell R&D**	• **Voluntary Agreement**	• **Hydrogen Fuel Cell Development** • **Personal Carbon Allowances/DTQs**
	Medium Impact	• **Graduated VED** • **Company Car Tax** • **Carbon Tax** • **Fuel Duty Escalator** • **Eco Driving** • **Eco Driving Test** • **Vehicle Idling Campaigns** • **Car Clubs** • **Workplace Travel Plans** • **Personalised Travel Plans** • **Workplace Parking Levies** • **Intelligent transport systems**	• Urban Congestion Charging • Road Space Reallocation • Central/ local government purchase of alternatively fuelled vehicles	• National Road Pricing
	Low Impact	• Eco Car Labelling • Fuel Switching Grants • Bus operator fleet targets for alternative fuels • Travel Awareness Campaigns • Environmental Awareness Campaigns • Low Emission Zones • Controlled Parking zones • Teleshopping • Teleworking • Flexitime • Car sharing • High Occupancy Vehicle Lanes • Demand Responsive Transport • Vehicle Scrappage Schemes • Campus Travel Plans • School Travel Plans • Special Event Management • Distance Based Vehicle Insurance • Park and Ride Facilities	• Motorway Congestion Charging • Improvement of Cycling and Walking Facilities • Pedestrianisation • Car Free Housing	• High Speed Rail • Maglev

All policies are summarised in Table 3. All high impact policies and short term- medium impact policies (those in bold) are detailed further in Table 4.

3.3.9 As can be seen from this table, there are a number of policies to achieve high and particularly medium impact in terms of carbon emissions savings. Some of these are devolved policies (see Table 3). These comprise a combination of technological and behavioural solutions. The table shows there are some potential quick hits in the form of policies such as speed enforcement, eco-driving and many smart measures such as travel plans.

3.3.10 In addition, 'low impact' policies are disproportionately represented. These policies should not be deemed less worthy of implementation as they could prove to be particularly cost effective, particularly when their synergistic and cumulative impacts are considered. Indeed, their combined impacts could be substantial.

Table 3: Policy Impacts – expanded summary (ranked in order of carbon savings e.g. high to low)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Transport impacts	Potential Carbon Savings	Timescale of Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Renewable Transport Fuel Obligation (RTFO)	No	EU	Technical Improvement	International/ national	Decreased carbon and other greenhouse gas emissions	High	Short-term	High	Medium	Medium	None envisaged
Speed limit enforcement	Yes	EU (freight), Japan & USA	Regulatory	National	Reduced fuel consumption; reduced emissions; modal shift	High	Short-term	Low	High	Medium	None envisaged
Voluntary Agreement	No	EU, Canada & Australia	Technical Improvement	International	Increased fuel efficiency; decreased greenhouse gas emissions; decreased fossil fuel consumption	High	Mid-term	Low	Medium	Medium/High	None envisaged
Hydrogen Fuel Cell Development (& R&D)	Yes	Global, but significant in UK, USA, Canada, Germany & Japan	Technical Improvement	International/ national	Decreased carbon and other greenhouse gas emissions	High	Long-term (R&D = short term)	High	Medium	Medium	None envisaged
Personal Carbon Allowances (PCAs)/Domestic Tradeable Quotas (DTQs)	No	None	Fiscal	National	Deliver guaranteed levels of carbon savings in successive years in an equitable way; reduce carbon budget	High	Long-term	High – although cheaper than congestion charging and ID scheme	Medium	Low/Medium	Lower income households should generally benefit from an allowance scheme as they are responsible for lower than average emissions & thus should have allowances to spare.
Vehicle Excise Duty	No	UK, Ireland, Belgium, Estonia, Finland, Germany, Iceland, Japan & South Korea	Fiscal	National	Decreased fossil fuel consumption; decreased car usage; modal shift; sustainable market transformation	Medium/High	Short-term	Medium*	Low/Medium	High	May be unfair to low income households

Table 3 (continued)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Impacts	Potential Carbon Savings	Timescale of Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Company Car Tax	No	UK	Fiscal	National	Reduced fossil fuel consumption; reduced carbon consumption	Medium	Short-term	Medium*	Medium/High	High	None envisaged
Carbon Tax	No	Planned in UK, EU & New Zealand	Fiscal	National	Reduced fossil fuel consumption; modal shift	Medium	Short/Mid-term	Low*	Medium	Low	May be regressive; may be unfair on rural households in absence of efficient public transportation
Fuel Duty Escalator	No	UK (removed in 2001)	Fiscal	National	Reduced usage; modal shift to alternative transport modes; reduced carbon and fuel consumption	Medium	Mid-term	Low*	Low	Low	May be unfair on hauliers, rural households & those unable to use public transport
Eco-Driving	Yes	Planned in UK, Denmark, Finland, France, Slovakia, Spain & Sweden	Information and Education	National	Decreased carbon and fuel consumption	Medium	Short-term	Low	Low/Medium	Medium/High	None envisaged
Eco-Driving Test	(possibly)	Netherlands	Information and Education	National	Inform drivers about alternative fuels and efficient vehicle technology; raise awareness amongst drivers; influence drivers before habits are formed; reduce carbon emissions.	Medium	Short-term	Medium – not possible to quantify the costs precisely, although as a useful comparison, the Eco-drive programme introduced in the Netherlands cost in the region on 5 euros per tonne of CO2 emissions saved over a year period.	Low/Medium	Medium/High	None envisaged

Table 3 (continued)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Impacts	Potential Carbon Savings	Timescale of Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Vehicle Idling Campaigns	Yes	UK, Canada & USA	Traffic Management	National/Local	Reduced fossil fuel consumption; reduced carbon emissions.	Medium	Short-term	Low/Medium	Medium/High	Medium/High	Those idling for heat or cooling benefits in particularly for the benefit of the elderly or children, may suffer, unless common-sense is applied by wardens.
Car Clubs	Yes	UK, Ireland, Belgium, Denmark, France, Germany, Italy, Australia & Singapore	Infrastructure	Local	Reduced car ownership and use; decreased fossil fuel consumption.	Medium	Short/Mid-term	Low	Medium	High	None envisaged
Workplace Travel Plans	Yes	UK, Sweden, Brazil, Australia, & USA	Information and Education	Local	Modal shift	Medium	Short-term	Medium	Low/Medium	Medium	May disadvantage those who need their car to travel to work e.g. those with reduced mobility, If introduced on a mandatory basis it may create economic disparities if not implemented nationwide.
Personalised Travel Plans	Yes	UK, Germany, Sweden, Australia & USA	Information and Education	Local	Modal shift, reduced car usage, decreased fossil fuel consumption.	Medium	Short-term	Medium	Medium	Medium	None envisaged
Workplace Parking Levies	Yes	Plan dropped in Scotland, England, Ireland, Wales, Australia & Canada	Fiscal	National/ Local	Modal shift; reduced fossil fuel consumption; reduced car usage.	Medium	Short-term	Low*	Medium/High	Low/Medium	May be unfair on lower paid employees

Table 3 (continued)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Impacts	Potential Carbon Savings	Timescale of Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Intelligent Transport Systems	Yes	Global	Technical Improvements	National/Local	Reduced car usage; reduced carbon and fuel consumption; modal shift.	Medium	Short-term	High	Medium	Medium	None envisaged
Urban Congestion Charging	Yes	UK, Italy, Norway, Sweden & Singapore	Fiscal	National	Reduced car usage; reduced carbon and fuel consumption; modal shift.	Medium	Mid-term	High*	Medium	Low/Medium	May be unfair to low income households and centrally located businesses.
Road Space Reallocation	Yes	Global	Traffic Management	Local	Increased promotion of walking and cycling as viable means of transport; carbon savings; modal shift; decreased fossil fuel consumption.	Medium	Mid-term	High	Low/Medium	Low/Medium	None envisaged
Central/Local Government Purchase of Alternatively Fuelled Vehicles	Yes	UK (abolished in 1992), Belgium, Finland, Denmark, Austria, Japan & USA	Technical Improvement	National/Local	Decreased carbon intensity; increased fuel efficiency.	Medium	Mid-term	Medium	High	High	None envisaged
National Road Pricing	No	Planned in UK	Fiscal	National	Decreased carbon intensity; increased fuel efficiency.	Medium	Long-term	High*	Medium	Low	May be unfair on low income drivers.

Table 3 (continued)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Impacts	Potential Carbon Savings	Timescale if Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Eco-Car Labelling	Yes	UK, Australia, Europe, New Zealand, South Korea, Singapore & USA	Information and Education	National	Decreased carbon intensity; increased fuel efficiency.	Low/Medium	Short-term	Low	Medium	High	Small dealers may find costs of labelling harder to absorb than large dealers.
Fuel Switching Grants	?	UK, Japan, Bulgaria (pending), and Canada,	Technical Improvements	National	Increase fuel efficiency; decreased carbon and fuel consumption	Low	Short-term	Medium	Medium	High	None envisaged.
Bus Operator Fleet Targets for Alternative Fuels	Yes	UK,USA	Technical Improvements	National/Local	Decreased carbon intensity; increased fuel efficiency; mode shift.	Medium	Short-term	Low	Medium	High	Disadvantage those dependent on the transport if fares increase.
Travel Awareness Campaigns	Yes	EU, Austria, Japan, Singapore, Canada & USA	Information and Education	National	Decreased car usage; modal shift; decreased fossil fuel & carbon consumption	Low/Medium	Short-term	Medium	Medium	High	None envisaged
Environmental Awareness Campaigns	Yes	Global	Information and Education	Local	Modal shift; reduced fossil fuel and carbon consumption	Low	Mid/Long-term	Medium	Low	High	None envisaged.
Low Emission Zones	Yes	UK, Czech Republic, Denmark, Italy, Romania, Norway & Spain	Traffic Management	Local	Greening of fleet; reduced emissions.	Low	Short/Mid-term	Low/Medium	Low	Medium	May disproportionately impact on smaller companies.
Controlled Parking Zones	Yes	UK, EU, USA, New Zealand and Australia	Traffic Management	International	Modal shift; reduce car usage; reduce carbon emissions	Low	Short-term	Low	Low	Medium/High	None envisaged

Table 3 (continued)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Impacts	Potential Carbon Savings	Timescale if Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Teleshopping	Yes	Global	Demand Management	National	Decreased usage	Low	Short-term	Low	Low	Medium/High	None envisaged
Teleworking	Yes	Global – on an ad hoc basis. Government supported measures in Japan & USA	Demand Management	Local	Reduced travel; reduced carbon and fuel consumption	Low	Short-term	Low	Low	High	None envisaged
Flexitime	Yes	Global	Demand Management	Local	Decreased congestion; modal shift.	Low	Short-term	Low	Low	High	None envisaged
Car Sharing	Yes	Global – on a ad hoc basis	Demand Management	Local	Reduced car usage; modal shift; reduced fossil fuel consumption; reduced carbon emissions.	Low/Medium	Short-term	Low	Low/Medium	Medium	Cost of motoring;; public indifference; environmental awareness; social & cultural norms; employer commitment; personal circumstance; difficulty in judging success.
High Occupancy Vehicle Lanes	No	USA	Infrastructure Investment	National	Modal shift; reduced fossil fuel consumption; reduced carbon emissions; reduced congestion.	Low	Short/Mid-term	Medium*	Low	Medium/High	May be unfair on low income drivers.
Demand Responsive Transport	Yes	UK, Belgium, Finland, Ireland, Italy, Sweden & USA	International Investment	Local	Modal shift	Low/Medium	Short-term	Medium	Low/Medium	High	None envisaged

Table 3 (continued)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Impacts	Potential Carbon Savings	Timescale if Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Vehicle Scrappage Schemes	No	Denmark, France, Greece, Hungary, Spain, Ireland, Norway, Italy, Canada & USA	Fiscal	International	Targeted mode – car; impact on energy; reduced carbon emissions; reduced fossil fuel consumption	Low	Short/Mid-term	Medium	Low	Medium	May have adverse impact on low income households by significantly affecting the price of the lowest cost vehicles on the market. Cash for replacement schemes are inequitable to low income households as it is unlikely they will be able to afford to purchase a new car, even with the fee gained from participating in the scheme.
Campus Travel Plans	Yes	UK, Australia and USA	Information and Education	Local	Modal shift; reduced car usage; decreased fossil fuel consumption; decreased carbon emissions	Low	Short-Mid-term	Low/Medium	High	High	If student fees are used to fund improvements those who do not use transportation services may consider it unfair to pay for services that they do not use.
School Travel Plans	Yes	UK, most of Europe, New Zealand, Japan & USA	Information and Education	Local	Modal shift; reduced fossil fuel consumption; reduced emissions	Low	Short-term	Medium	Medium	Medium	None envisaged
Special Event Management	Yes	Global	Information and Education	Local	Decreased car usage	Low	Short-term	Medium	Medium	High	None envisaged

Table 3 (continued)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Impacts	Potential Carbon Savings	Timescale if Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Distance Based Vehicle Insurance	No	UK trial; USA	Fiscal	National	Decreased car usage; modal shift; decreased fossil fuel & carbon consumption	Low	Short-term	Low	Low/Medium	Medium/High	May be unfair on rural households & business users with no other option but to use private vehicles.
Park and Ride Facilities	Yes	Global	Infrastructure	Local	Modal Shift	Zero/Low	Short-term	High	Zero/Low	Medium/High	May increase social exclusion of those who do not have access to a private vehicle
Motorway Congestion Charging	No	UK, Austria, France, Portugal, Mexico, Brazil, Indonesia, Singapore, Australia & USA	Fiscal	National	Reduced car usage; reduced carbon & fuel consumption; modal shift	Low	Mid-term	High*	Medium	Low	May be unfair on low income drivers
Improvement of Cycling & Walking Facilities	Yes	Global	Traffic Management	Local	Increased walking & cycling; reduced car usage; decreased fossil fuel consumption; decreased carbon emissions	Low/Medium	Mid-term	Medium	Medium	High	None envisaged
Pedestrianisation	Yes	Global	Urban Planning	Local	Decreased car usage; modal shift; decreased fossil fuel consumption; carbon savings.	Low	Mid-term	High	Low	Medium	May disproportionately impact on smaller businesses; retailers & service providers located in non-pedestrianised areas of town may experience loses in revenue.

Table 3 (continued)

	Devolved Policy?	Where does policy exist?	Policy Approach	Geographical Scope	Impacts	Potential Carbon Savings	Timescale if Implementation	Cost of Implementation	Likelihood of Delivering Predicted Reductions	Public Acceptability	Equity Impacts
Car Free Housing	Yes	UK, EU	Traffic Management	International	Decreased car usage; modal shift; offers ecological lifestyle	Low	Mid-term	Medium	Low/Medium	High	None envisaged
High Speed Rail	No	UK (Channel Tunnel), Belgium, France, Germany, Netherlands, Spain, Switzerland, Japan & USA	Traffic Management; Technical Improvement	National	Reduce congestion on road network; reduce overcrowding; provide economic benefits; improve quality of rail travel; provides safety benefits	Low (Scotland)	Long-term	Initial set up costs would be high, but medium overall	Medium	High	Benefit long distance travellers, however cheaper than air travel
Maglev	Yes	UK, Germany, China, Japan & USA	Infrastructure Investment	International	Modal Shift	Low	Mid/Long-term	High*	Low	Low/Medium	May be unfair to low income households

Table 4: Policy barriers and synergies

POLICY	BARRIERS	POLICY SYNERGIES	POLICY CLASHES	NECESSARY SYNERGIES
Renewable Transport Fuel Obligation (RTFO)	Competition for resources from other industries; sustainability risk; lack of commercial incentive to invest in lowest carbon plant.	Hydrogen fuel cell vehicles; advances in biofuel technology; Enhanced Capital Allowances; Emissions trading;	**None envisaged**	Advances in biofuel technology; environmental assurance scheme is integrated with RTFO to ensure fuels supplied offer real environmental benefits; Enhanced capital allowances.
Speed limit enforcement	Political will; Enforcement funding; Public support; Social & cultural norms.	Employee travel plans; Eco-driving; National speed limiting; Public transport drives; Voluntary Agreement; EU Regulations on Vehicle Safety	None envisaged	EU speed limit harmonisation; Reinvestment of revenue from fines; Remove emphasis of speed from car advertisements; Develop an understanding of factors which influence speed; Encourage development of variable speed limiters.
Voluntary Agreement	Over-optimism; Company commitment; Political will; Social & cultural norms; opportunity for countries to free ride as target is EU average.	Biofuel Development; Company Car Tax; Corporate social responsibility reporting; Eco-Car Labelling; Eco-Driving ; Emissions trading; Fuel Duty/Fuel Duty Escalator; ISO 14001 & EMAS; Second Hand Car Tax; Vehicle End of Life Directive (2000/53/EC); Vehicle Excise Duty.	EU Regulations on Vehicle Safety	Policies need to be put in place to support the aims of the VA, such as greater vehicle excise duty differentials between clean & dirty vehicles; Development of sanctions for non-compliance; Targets for light & heavy duty commercial vehicles developed.
Hydrogen & Fuel Cell Development	Technology; Lack of funding & fragmented research; Consumer demand; Competition; Safety concerns;	Fiscal measures; Public education drives; Public transport improvements; Voluntary Agreement.	Biofuels Development.	Research and Development; Near-term policies are required in order to send signals to businesses & customers to guide them towards investments & market decisions that are beneficial to society. E.g. sustained fuel duty reductions are required on biofuels to send clear signals to steer towards alternative fuels.
Personal Carbon Allowances (PCAs)/ Domestic Tradeable Quotas (DTQs)	Must be politically removed to ensure scheme is fair; difficulties may arise enrolling 45 million plus individuals without a personal ID scheme; public acceptability. Good quality public transport alternatives must be available.	Build on existing fuel poverty policies; implementation of personal Id scheme; 'electronic verification'.	Fiscal instruments to curb car travel	Fuel poverty must be tackled; ID scheme may need to be encouraged; Investment in good quality alternatives to the car.
Vehicle Excise Duty	Consumer behaviour; Consumer awareness; Pricing; Political will.	Eco-car labelling; Fuel Duty; Road Pricing; Voluntary Agreement	None envisaged	Research & development of alternative fuel sources.
Company Car Tax	Consumer preference	Eco-car labelling; Congestion charging; Environmental Accreditation (E.g. ISO 14001 or EMAS); Fuel duty escalator; Road pricing; Second hand car tax; Vehicle Excise Duty; Voluntary Agreement.	Employee based travel plans; Teleworking	Policies & measures to limit & reduce company travel by air - i.e. air taxes.
Carbon Tax	EU Disparities; Public Acceptance; Acceptance by Industry; Political Will; Demand Elasticities	Biofuels development; Distance based vehicle insurance; Eco-car labelling; Eco-driving; Hydrogen & fuel cell development; Kyoto Protocol; Locally sourced distribution; Locally sourced retail & leisure facilities; National road pricing; Voluntary Agreement.	Fuel Duty	Other supportive soft & hard policies will need to be in place in order to lock in its benefits by further stimulating a shift in consumption & behavioural patterns, such as improvements to public transport, improvements to walking & cycling facilities, urban planning measures, national road pricing, etc.
Fuel Duty Escalator	Political will; Public acceptance; Public understanding; Lack of good public transport alternatives.	Eco-Car Labelling; Eco-Driving; Second Hand Car Tax; Vehicle Excise Duty; Voluntary Agreement.	Lorry Road User Charging; Road Pricing	Investments made in public transport.

POLICY	BARRIERS	POLICY SYNERGIES	POLICY CLASHES	NECESSARY SYNERGIES
Eco-Driving	Public apathy; Receptiveness to training	Alternative fuels; Company Car Tax; Directive 2003/59/EC on the initial qualification & training of professional drivers transporting goods or passengers by road; Eco-Car Labelling; Fuel Duty; In-car fuel saving devices; Motorway Speed Limit Enforcement; Personal Carbon Allowances.	Traffic Calming; 20 mph speed limits in built-up areas.	Review of current traffic calming measures; Encourage motor manufacturers to develop cars which are less fuel consumptive.
Eco Driving Test	Challenge to ensure new drivers remember and use the good practice that they are taught	Enforcement of the speed limit on motorways; eco-labelling for cars; promotion of alternative fuels and vehicle technology; personal carbon allowances; traffic calming measures	None envisaged	20mph speed limits, which cause cars to be driven at a speed that is sub-optimal for engine efficiency.
Vehicle Idling Campaigns	Public Acceptance; Public Knowledge; Enforcement; Funding	Eco-Driving; Fuel Duty; Voluntary Agreement; Work-Place Travel Plans.	Biofuel Development	Fuel duty increases to encourage conservative driving practices.
Car Clubs	Public Awareness; Inertia; Government Support; Personal Circumstance	Carbon Tax; Car Parking Standards for New Developments; Car Sharing; Eco driving; Employee Travel Plans; Environmental Awareness Campaigns; Fuel Duty/Fuel Duty Escalator; National road pricing; Personalised Travel Planning; Personal travel planning; Planning Policy Guidance 3 – Housing; Planning Policy Guidance 13 - Transport; Public transport improvements; Vehicle Excise Duty; Vehicle Purchase Tax.	None envisaged	Planning guidelines for new developments, both housing & commercial developments, should be enforced; Car clubs; Public transport improvements; Increases in the cost of motoring, such as through Vehicle Excise Duty, Fuel Duty, Purchase Tax, etc.
Workplace Travel Plans	Public awareness; Employer Apathy; Lack of Information; Inadequacies of the public transport sector; Personal Circumstance; Social & Cultural Norms; Lack of skills base;	Environmental Accreditation schemes e.g. ISO 140001 or EMAS; School Travel Plans; Teleworking; Transport Sector Fiscal Measures.	Company Car Tax; Personal Taxation	Travel plans need to be tied into regulatory & fiscal measures to discourage individuals from using private motor vehicles, such as a review of Vehicle Excise Duty gradients, increased fuel costs, road pricing, etc, and/or measures to discourage low occupancy motor vehicles; training and skills development; Investment in public transport alternatives; Flexibility in capital funding for revenue schemes.
Personalised Travel Plans	Disinterest; Lack of Knowledge; Personal Safety; Social & Cultural Norms; Inadequacy of Public Transport	Carbon Tax; Car Clubs; Car Sharing; Distance Based Vehicle Insurance; Environmental Awareness Campaigns; Fuel Duty; Integrated Timetable & Travel Information; National Road Pricing; Park & Ride; Pedestrianisation; School Travel Plans; Teleshopping; Teleworking; Travel Awareness Campaigns; Workplace Parking Levies; Workplace Travel Plans.	None envisaged	Widespread marketing, advertising & educational strategies; Workplace & school travel plans rigorously implemented, & developments such as teleshopping widely marketed; Improvements to public transport facilities & to walking & cycling facilities; Further development of car-sharing schemes & car-clubs; Fiscal measures, such as road pricing & workplace parking levies, combined with traffic restraint or road space reallocation methods need to be applied; Promotion of teleworking; Integrated land use planning.
Workplace Parking Levies	Shift workers; Wage Bracket; Political support; Employer Support; Employee Support; Workplace Location	Car & cycle parking standards for new developments; Car Sharing; Employee travel plans; High occupancy vehicle pricing; Improvement & expansion of public transport; Improvement of cycling & walking facilities; Integrated timetable & travel information; Park & Ride; Teleshopping; Teleworking; Urban congestion charging.	None envisaged	Introduction or strengthening of existing on-street parking restrictions; Public transport improvements; Demand responsive transport; School travel plans; Teleshopping; Workplace travel plans.

POLICY	BARRIERS	POLICY SYNERGIES	POLICY CLASHES	NECESSARY SYNERGIES
Bus Operator Fleet Targets for Alternative Fuels	Lack of commercial imperative; cost effectiveness; time lags	RTFO; Quality bus partnerships; Emissions trading for surface transport; Fuel duty differentials	Bus deregulation; Bus duty fuel rebate	Grant programmes; Bus Quality Partnerships.
Intelligent Transport Systems	System integration difficult even if bought from same supplier; may prove costly as systems are modified	Improved public transport services; public awareness campaigns.	None envisaged	Improved public transport; fiscal disincentives for car use;
Urban Congestion Charging	Public acceptance; Availability of alternatives; Political will;	Company Car Tax; Employee Travel Plans; Flexible/Condensed Working Hours; Fuel Duty Escalators; Public Transport Investments; Road Pricing; Vehicle Excise Duty; Workplace Parking Levies.	Voluntary Agreement	Fuel taxes & other costs of motoring have to be maintained; The Government must make other transport policy decisions with this potential transformation in mind, in order to have a fully integrative transport policy that supports congestion & climate change commitments.
Road Space Reallocation	Political Will; Public Acceptance; Media Support; Social & Cultural Norms	Car Sharing; Congestion Charging; Environmental Awareness Campaigns; Improvements to Cycling & Walking Facilities; Park & Ride Facilities; Parking Tariffs; Pedestrianisation; Personalised Travel Plans; Public transport improvements; Teleworking; Teleshopping; Traffic Calming; School Travel Schemes; Workplace Travel Plans.	None envisaged	RSR should give back an upgraded urban landscape, better public transport services, etc, in order to lock in the benefits of behavioural change; The take up of softer measures should be encouraged, e.g. parking restraint & congestion charging, which may motivate organisations to become involved in travel planning; & provide the space and facilities for the key aspects that will ensure the success of smarter choices, for example public transport & walking & cycling provision; RSR should be implemented alongside national and/or urban congestion charging, & other such fiscal measures.
Controlled Parking Zones	Local convenience retailers may oppose zones due to fear of loss of trade;	Cycling; walking; public transport.	None envisaged	Improved public transport in cities.
Central/Local Government Purchase of Alternatively Fuelled Vehicles	Political will; availability of technology; cost effectiveness.	Workplace travel plans; car sharing schemes; corporate social responsibility.	Company car schemes	
National Road Pricing	Public acceptance; Availability of alternatives; Political will	Car Sharing; Employee Travel Plans; Flexible/Condensed Working Hours; Public Transport Investments; Workplace Parking Levies.	Company Car Tax; Fuel Duty Escalators; Fuel Tax; Vehicle Excise Duty; Voluntary Agreement	Fuel taxes & other costs of motoring have to be maintained; The Government must make other transport policy decisions with this potential transformation in mind, in order to have a integrative transport policy that supports congestion & climate change commitments.
Eco-Car Labelling	Public understanding; Public awareness; Consumer demand; Difficulty in ensuring compliance; Prohibitive costs of clean cars	Company Car Tax; Eco-driving; EU Directive 92/75/EEC on energy efficiency labeling for appliances; Fiscal measures – e.g. Vehicle Excise Duty, Fuel Duty Escalator; Voluntary Agreement.	None envisaged	Strengthen Voluntary Agreement between car manufacturers; Monitoring regulations should be set in place for the automotive industry; Corporate Social Responsibility; Research & development into alternative fuel sources; Development of fuel-saving in car devices; Better enforced or reduced speed limits.

POLICY	BARRIERS	POLICY SYNERGIES	POLICY CLASHES	NECESSARY SYNERGIES
Fuel Switching Grants	Gaining public acceptability;	Low emissions zones; support for congestion charging; education programmes about low carbon vehicles.	None envisaged	Tax incentives to promote purchase of low carbon vehicles; larger fuel tax differentials to stimulate supply and demand for cleaner fuels to stimulate demand; support for the introduction of low emission zone or congestion charging schemes that discount low carbon vehicles.
Travel Awareness Campaign	Advertising from car manufacturers; Attractiveness of alternative modes; Car dependent drivers; Cultural and social norms.	Car Clubs; Employee Travel Plans; Environmental Awareness Campaigns; Improvement & Expansion of Public Transport; Improvement of Walking & Cycling Facilities; Integrated Timetable & Travel Information; National Road Pricing; Park & Ride Facilities; Parking Tariffs; Pedestrianisation; Personalised Travel Planning; Road Space Reallocation; School Travel Plans; Urban Congestion Charging; Workplace Parking Levies.	None envisaged	National campaigns should compliment local travel awareness initiatives, & vice versa; The transport sector should liaise with the health sector so as to promote similar, mutually reinforcing messages; Improvements to public transport & cycling & walking facilities are required; Rises in the cost of motoring & traffic management schemes which seek to reduce the amount of space available to cars could be implemented as a reason for drivers to reconsider their travel behaviour.
Environmental Awareness Campaigns	Lack of Funding; Lack of Political will; Lack of knowledge; Influence of mass media; Social & cultural Norms	Car Clubs; Driver Information Systems; Eco-Car Labelling; Employee Travel Plans; Personalised Travel Plans; School Travel Plans; Travel Awareness Campaigns.	None envisaged	Community-based social marketing; Guaranteed action from government & industry; National campaigns should compliment local environmental awareness initiatives, & vice versa, so as the messages conveyed to the public from the local & the national level reinforce one another.
Low Emission Zones	Cost; Consumer Demand; Agricultural Problems	Corporate Social Responsibility (CSR) Reporting; Renewable Transport Fuels; Fuel Duty; Hydrogen fuel cell technology; Public Education Drives; Public Transport Improvements; Rural Development Policy; Vehicle Excise Duty; Voluntary Agreement.	British Standard EN590; Eco-Driving; Fuel Quality Directive (Directive 98/70/EC); Speed Limiting.	Research & development should continue into second generation biofuels, such as hydrogen fuel cells; It is important to closely monitor the impact of biofuel demand.
Teleshopping	Income; Age; Attitudes to technology; Consumer confidence; Consumer preference; Computer literacy; Computer access; Social functions that shopping fulfils.	Alternative fuel usage; Direct payments of pensions & benefits: Fiscal transport polices – e.g. vehicle excise duty; Logistics management & sustainable distribution; Planning Policy Guidance Note 13; Public transport information; Social inclusion policies.	Public health drives	Comprehensive life-cycle analysis of transportation impacts of teleshopping; Implementation of policies which influence teleshopping – e.g. road pricing.
Teleworking	Job suitability; Technology Gaps; Employer Attitude	Congestion Charging; Employee travel plans; Fuel Duty Escalator; Road Pricing; School Travel Plans; VED; Workplace Parking Levies.	Company Car Tax	Development of broadband network.
Flexitime	Organisation Characteristics; Job Type	Car-Sharing; Improvement & Expansion of Public Transport; School Travel Plans; Teleworking; Travel Awareness Campaigns; Workplace Travel Plans.	Employee bus services	School travel plans; Car-sharing; Improvement & expansion of public transport services; Travel awareness campaigns
Car-Sharing	Cost of Motoring; Public Indifference; Environmental Awareness; Social & Cultural Norms; Employer Commitment; Personal Circumstance; Difficulty in Judging Success.	Congestion Charging; Fuel Duty; High Occupancy Vehicle Lanes; Road User Charging; Rural Development & Rural Social Policy; School Travel Plans; Workplace Parking Levies; Workplace Travel Plans.	Company Car Tax; Flexi-time; Travel chaining	Measures to curb car growth - such as road pricing in order to increase attractiveness of car-sharing.

POLICY	BARRIERS	POLICY SYNERGIES	POLICY CLASHES	NECESSARY SYNERGIES
High Occupancy Vehicle (HOV) Lanes	May impose costs on high income individuals; those with no access to car clubs may not benefit from HOV.	Car sharing; car clubs	None envisaged	Car sharing; car clubs; land use planning.
Demand Responsive Transport	Deregulation; Cost; Conflict with local taxi operators; Public Awareness; Vehicle Design; Technology; Legislation	Car Clubs; Car Sharing; Integrated Timetable & Travel Information; Personalised Travel Plans; Rural Development Policy; Social Inclusion Policy; Travel Awareness Campaign.	Bus Service Operator's Grant; Improvement & Expansion of Public Transport	Reform of legislation – particularly with regards to the Bus Service Operator's Grant; Enter into dialogue regarding ways to develop more integrated ticketing between different operators; Policies that increase the cost of travel by private car, such as fuel duty & road pricing, may stimulate DRT ridership levels.
Vehicle Scrappage Schemes	Income; Funding.	Eco-Car Labelling; Environmental Zones; Fuel Quality Standards; Urban Congestion Charging; Vehicle End of Life Directive; Vehicle Excise Duty; Voluntary Agreement.	None envisaged	Where urban congestion charging has been implemented, variable charges depending upon the emissions characteristics might provide incentive to participate in the scrappage scheme; sustained carbon emission reductions owing to the scheme depend upon the effective operation of the Voluntary Agreement between motor manufacturers and the government, in order to reduce emissions from new generations of vehicles; VED gradients should be widened so that drivers of the most polluting vehicles are paying the highest charges, as this may also encourage people to participate in the scrappage schemes.
Campus Travel Plans	Campus Parking Departments	Car Sharing; Corporate & Social Responsibility Reporting; Environmental Awareness Campaigns; Environmental Management Systems (EMAS); Flexitime; High Occupancy Vehicle Pricing; Improvement of Cycling & Walking Facilities; Improvement & Expansion of Public Transport; Integrated Timetable & Travel Information; ISO 140001; Parking Tariffs; Personalised Travel Plans; Road Space Reallocation; Special Event Management; Workplace Parking Levies; Workplace Travel Plans.	None envisaged	Parking prices have to be increased and/or the number of parking spaces reduced; & the cost of on-street parking in the areas surrounding the campus should also rise in line with campus costs; Compact growth patterns; Improvement & expansion of walking & cycling facilities.
School Travel Plans	Personal Circumstance; Public awareness; Inadequacies of the public transport sector	Car Sharing; Cycle lanes; Local Agenda 21; Road safety training; Road space reallocation; Traffic calming & other traffic management measures, such as installation of safe crossing points; Workplace travel plans.	None envisaged	Travel plans should be tied into regulatory & fiscal measures to discourage individuals from using private motor vehicles, such as a review of Vehicle Excise Duty gradients, increased fuel costs, road pricing, etc; Workplace travel plans have to be more widely implemented; Public transport facilities should also be improved.
Special Event Management	Funding; Ambiguity of Travel Plans; Level of Support	Car & cycle parking standards; Car sharing; Demand Responsive Transport; Improvement of cycling & walking facilities; Integrated timetable & travel information; Park & Ride; Road capacity restraint; Travel awareness campaigns.	None envisaged	Pedestrian & cycling improvements; Internet based car sharing schemes should be set up in advance, & widely marketed; Special Transit, Shuttle & Rideshare services can be part of event planning.
Distance Based Vehicle Insurance	Resistance from insurance industry; Resistance from high-mileage motorists; Public support; Public knowledge; Regulatory Framework	Carbon Tax; Car Clubs; Car Sharing Schemes; Compact Cities; Driver Information Systems; Environmental Awareness Campaigns; Improvement & Expansion of Public Transport Facilities; Improvement of Cycling & Walking Facilities; National Road Pricing; Park & Ride Schemes; Personalised Travel Plans; Teleshopping; Teleworking.	None envisaged	Campaigns to promote travel by alternative modes; Car clubs membership; Environmental awareness campaigns.

POLICY	BARRIERS	POLICY SYNERGIES	POLICY CLASHES	NECESSARY SYNERGIES
Park & Ride Facilities	Widely Available & Affordable City Centre Parking; Local Authority Structure; Political Will; Public Support	Congestion charging; Parking Tariffs; Restrictions on Parking; Workplace Travel Plans.	Planning Policy & Guidance Note 13; Rural social & economic policy; Rural transport policy.	Urban congestion charging could also be implemented in parallel to P&R schemes; Policies need to be supported that will discourage the use of the private car altogether such as national road pricing.
Motorway Congestion Charging	Public acceptance; Availability of alternative means of transport; Political will; Budgetary constraints	(Based on current M6 tolls) Car Sharing; Employee Travel Plans; Flexible/Condensed Working Hours; Lorry Load User Charging; Public Transport Investments; Workplace Parking Levies.	(Based on current M6 tolls) Company Car Tax; Fuel Duty; National Road Pricing; Vehicle Excise Duty; Voluntary Agreement.	Fuel taxes & other costs of motoring have to be maintained.
Improvement of Cycling & Walking Facilities	Political Will; Social & Cultural Norms; Personal Safety; Weather; Cost of car usage; City density; Availability of free car parking	Car & Cycling Parking Standards for new developments; Compact Cities; Employee Travel Plans; Environmental Awareness Campaigns; Health Awareness Campaigns; Land Use Planning; Parking Tariffs; Pedestrianisation; Personalised Travel Plans; School Travel Plans; Teleshopping; Traffic Calming; Traffic Management; Travel Awareness Campaigns; Urban Congestion Charging; Urban Design; Zoning Regulations.	Car Clubs; Car Sharing; Provision of Free Parking	Improvements must coincide with changes to land use & destinations - by giving priority to mixed land-use developments & brown-field developments this can support the aims of improvements to walking & cycling facilities; Improvements to public transport; School travel plans have to be implemented widely; Road user constraints should also be implemented, such as road user charging & congestion charging.
Pedestrianisation	Public Acceptance; Political Will; Local Circumstance	Car Sharing Schemes; Parking Tariffs; Personalised Travel Plans; Planning Policy & Guidance Note 13; Public Health Campaigns; Urban Congestion Charging; Zoning Regulations.	Teleshopping	Stringent application of planning policy is required to limit the construction & growth of out-of-town shopping centres; Policy should be coordinated with other development strategies, such as housing, business premises, transportation improvements, etc, so as to improve the desirability of the town/city centre, & to create an integrated, compact city; A suite of traffic management & fiscal measures, alongside improvements in the public transport infrastructure are required – e.g. fuel duty increases, increases in parking tariffs (with concessions for the disabled & those with children), improvement of cycling & walking facilities, entry restrictions, etc.
Car Free Housing	Might not work in isolated suburban locations; public acceptability.	Car sharing; Improved Pubic Transport Facilities; Improved Walking/Cycling Facilities.	None envisaged	Car sharing – allows the reduction of parking ratios; land use planning/ building regulations.
High Speed Rail	New railway tracks may have adverse effects on natural and built environment; very large public sector financial contribution;	Land use policy; road user charging; internalises the external costs of aviation.	None envisaged.	Land use planning; alternative energy supplies;
Maglev	Cost; Available Alternatives; Distance; Experience; disruption; sustainability; public acceptance	Improvement & expansion of public transport	High speed rail	None envisaged

3.4 Short term – HIGH impact policies

3.4.1 Renewable Transport Fuels

3.4.1.1 Biofuels are seen as having an increasingly important role to play in reducing carbon emissions from the road transport sector. The key instruments currently in place are the 20 pence per litre duty differentials for biodiesel and bioethanol, guaranteed until 2007-08. Biofuel market share has increased in recent years and in October 2005 stood at around 0.25% of road fuel used or 11 million litres per month. The majority of this is imported bioethanol, all or most of which is likely to have come from Brazil.

3.4.1.2 The UK has a target of 5% of all motor fuel sold in the UK must come from renewable sources by 2010-2011, and this is to be achieved through a Renewables Transport Fuels Obligation (RTFO). This is to be achieved primarily through blending small percentages of biofuels (typically 5%) with conventional petrol, which most cars can accommodate Budget 2006 also suggested that targets for renewable fuels will increase post 2010-2011. Although not yet fully in place (expected to start 2008-09), the RTFO was the main new measure for the transport sector in the UK Climate Change Programme 2006. The UK Climate Change Programme (2006) believes this policy will achieve 1.6 MtC savings by 2010-11 and given the 'Scottish Share' (8.3% based on projected population in 2010) this figure could translate directly into 0.13 MtC saving from the transport sector for Scotland. However, Scotland has pledged to exceed its 'Scottish Share' in total by 1 MtC and presumably some of this target will be met by this policy.

3.4.1.3 Nevertheless, the use of primary crops as feedstocks to meet the 5% and higher targets presents a number of challenges for government departments. The Sustainable Development Commission[10] listed the factors necessary to make full use of the potential for the RTFO to save carbon:

- new processing technologies which could become available in the short to medium term to extract the full energy value from these products;
- clarifying the relative energy use and carbon saving potential associated with different end uses of products (heat or biofuel);
- establishing markets; and,
- making sure that costs are competitive, based on whole-life costs, including social and environmental costs.

3.4.1.4 In the UK the world's largest processing plant for waste oils and fats opened in Motherwell, Scotland in 2005, with a production capacity of up to 50,000 tonnes of biodiesel a year. However, without support for biofuels plant offering a good carbon balance there is a risk of businesses failing to invest in the cleanest biofuels installations, and of some biofuels plant generally failing to find investment as smaller players in particular may struggle with cost and availability of capital. This could leave the UK relying heavily on imports, and be sub-optimal for innovation and delivery, in the longer term, of cheaper, more carbon beneficial biofuels. Consequently, the Government are considering introducing enhanced capital allowance (ECA) rate of 100% for biofuels plant that meet certain qualifying criteria will be introduced in early 2007. The ECA is essentially additional Government support for plant which incorporates environmentally beneficial equipment or uses

[10] SDC (2006) Biofuels and the Renewable Transport Fuels Obligation available at http://www.sd-commission.org.uk/publications.php?id=392

designated 'advanced processes' could help overcome the financial barrier to its take up, where such a barrier exists.

3.4.2 Speed limit enforcement

3.4.2.1 At speeds above 70 mph, vehicles produce more CO_2 as fuel consumption increases and engine efficiency decreases, thus the ramifications of speeding on motorways are severe. However, in the UK it is estimated that at least 15 million motorists exceed the 70 mph speed limit on motorways, the majority of which are never prosecuted. Speed limit enforcement works towards raising real and perceived penalty chances, using communication about enforcement practice, and primarily extending and improving both quality and quantity of police enforcement output on the road and streamlining the judicial follow-up (Anable et al: 2006).

3.4.2.2 Although there has been no analysis of carbon emissions prior to or after speed limit reductions have been put in place, Anable et al (2006) calculated that a properly enforced 70mph speed limit (UK wide) would cut carbon emissions from transport by nearly 5 million tonnes (MtC) by 2010, averaging 0.97 MtC per annum. A new 60mph limit would double this reduction over the same period, reducing emissions by an average 1.88 MtC a year, or approximately 9.4 MtC in total by 2010, amounting to a reduction of between 2.9% and 5.6% of emissions from the road transport sector in 2010. The cumulative saving in 2010 of either 4.97 and 9.38 MtC (not including traffic restraint or knock on effects on the car market) could more than match or even double the total savings expected from the transport sector by 2010, as stated in the Energy White Paper.

3.4.2.3 Anable et al (2006) note that the enforcement of the 70 mph limit, could begin immediately, with immediate benefits. In Scotland, enforcing speed limits is straight forward as it is a fully devolved measure. However, the *setting* of speed limits is 'executively devolved' which means the Scottish Executive has the power to make exceptions to national speed limits, but the ultimate responsibilities lies in Westminster.

3.5 Short term – MEDIUM impact policies

3.5.3 Eco Driving/Eco Driving Test

3.5.3.1 Eco-driving is the application of an economically and ecologically sound driving style, adapted to modern engine technology whereby fuel consumption is reduced through better driving practice. Aspects of eco-driving include adhering to speed limits, changing gear at the optimal time, between 2,000 and 2,555rpm; limiting the use of air conditioning which is estimated to add 10 to 14 per cent to fuel consumption; reducing drag by driving with the windows closed; avoiding idling; ensuring the tyres are filled to the optimum pressure; shedding excess weight from the car; and keeping a safe distance from the car in front as sharp breaking wastes fuel (Eco-Drive 2001).

3.5.3.2 An experiment conducted in the Netherlands, as part of the Eco-Drive[11] scheme, incorporated energy efficient driving into normal driving lessons, providing training

[11] The Eco-Drive project, which started in 2001, was part-financed by the EU SAVE energy efficiency programme. The project explored the potential for reducing fuel consumption and CO_2 emissions through the promotion of energy efficient driving techniques. Six demonstration projects were conducted across Europe.

and support to help instructors incorporate the changes. People who received the training drove 4% more efficiently shortly after passing the driving test than other new drivers, even though their speeds were identical. The Eco-Drive scheme has since been rolled out, and more recent figures reveal average efficiency improvements of 10% in practice amongst drivers who received the training (Kroon 2005). Other sources[12] estimate potential efficiency gains in the region of 5 to 25% on the introduction of energy efficient driving techniques. For example, trials conducted by the Driving Standards Agency (DSA) during 2004 showed an 8.5% improvement in fuel efficiency for drivers on a set course after two hours of training (DSA 2004). The European Climate Change Programme (2001) calculated a potential reduction of eco-driving of at least 50 million tons of CO_2 emissions (12.6 MtC) in Europe by 2010[13].

3.5.3.3 There is also the potential to incorporate simple good practice on energy efficient driving into the driving test. SEA (2006) calculate the UK saving's alone would be in the region of 168 thousand tonnes of CO_2 per year by 2010 (0.05MtC). Furthermore, CO_2 emissions savings would increase each month as the total number of drivers who pass their test increases. What is more, they suggest that, allowing for the need to train driving instructors in the eco-driving techniques, and update official source materials and tests, the new driving test requirements could thus come into force in the UK at the beginning of 2008.

3.5.4 Vehicle Idling Campaigns

3.5.4.1 Vehicles left running unnecessarily at the roadside create emissions of air pollution. In vehicle idling campaigns fixed penalty notices can be given to drivers who refuse to turn off the engine of a vehicle idling unnecessarily, when requested to do so by a traffic warden or pollution enforcement officer. Campaigns also state that action should not be taken against drivers in cases where mitigating circumstances dictate that the engine needs to be running, such as defrosting a windscreen in cold weather; if the driver is elderly and is keeping warm; when the engine powers refrigeration equipment, or if the vehicle has broken down and is being fixed, etc. However, buses idling on stands and taxis with their engines running unnecessarily on taxi stands will normally be liable to fines.

3.5.4.2 Vehicle Idling Campaigns, which can be implemented promptly, can have a significant impact on carbon savings in the Scotland. For example the Department for Transport found that one car idling for 10 minutes a day can produce around a quarter tonne of CO_2 emissions each year (Energy Solutions, Alberta, 2005). If applicable to every vehicle registered in the UK (ca. 32,259,000 vehicles [DfT, 2005]) this can result in huge carbon savings if drivers comply with the policy.

3.5.5 Smart Measures (including travel plans, car clubs, personalised travel plans)

3.5.5.1 The recent assessment of smart measures for the Department for Transport evaluated a series of measures (including workplace and school travel plans; personalised travel plans, car sharing and car clubs; public transport information and marketing and travel awareness campaigns) that had been undertaken in the UK in some cases for the last 10 years (Cairns et al 2004). The main conclusions of the study were:

[12] For example, Carplus (www.carplus.org.uk); Energy Savings Trust (2005) *Ecodriving Manual*, produced as part of the EU sponsored TREATISE project (www.treatise.eu.com)

[13] To convert mass of CO2 to mass of carbon, divide mass of CO2 by 3.664, the ratio of the molecular weights of CO2 (44.010) and carbon (12.011). In this example, the eco-driving test is calculated to save at least 13.6 MtC in Europe *by* 2010 (i.e over a 9 year period).

- Taken together, smart measures could reduce traffic nationwide by about 11%, by active implementation over ten years;

- Under the 'high intensity' scenario, traffic in urban areas could be cut by 14% overall, and 21% at peak times. Traffic in non-urban areas could be cut by 8% overall, and 14% at peak times. Nationally (across both urban and non urban areas), traffic could be cut by 11% overall, and 17% at peak times;

- Under the 'low intensity' scenario, traffic in urban areas could be cut by 3% overall, and 5% at peak times. Traffic in non-urban areas could be cut by 2% overall, and 3% at peak times. Nationally, traffic could be cut by 2-3% overall, and 4% at peak times;

- On average, every £1 spent on well-designed soft measures could bring about £10 of benefit in reduced congestion alone, more in the most congested conditions.

3.5.5.2 In addition, some preliminary analysis has been carried out to attempt to quantify the carbon reduction savings over 10 years from these policies in line with the high and low intensity scenarios used in the report (Anable: 2005). This analysis found that soft factor interventions have the potential to save 2.76MtC nationally after 10 years if the high intensity scenario is realised. The majority (58%) of these savings come from policies related to the journey to work. This is a substantial saving especially given that transport (excluding aviation) is expected to account for around 43MtC in 2010. The 2.76MtC saving therefore amounts to 7% of this total.

3.5.5.3 In order to realise the benefits of smarter measures, policies such as travel plans, car clubs and even personalised marketing initiatives require a step-change in resources in order to intensify activity and mainstream them. This could take the form of smarter choices programmes in which bespoke packages of these measures are introduced simultaneously in a supportive funding and policy environment.

3.5.6 Workplace Parking Levies

3.5.6.1 A workplace parking levy (WPL) scheme involves charging employers a levy related to their provision of parking spaces for workers and business visitors in the form of a licence fee. The owners/occupiers of the premises must apply to the traffic authority for a licence stating the maximum number of vehicles that will be parked on their premises at any one time, thus offering incentive to reduce the number of parking spaces available. This levy may be passed on to employees or simply absorbed by the company. However, the availability of convenient, free or relatively cheap parking provided by employers encourages car use, particularly commuting, even when alternative modes are available, and as such the use of a WPL applicable to employees is regarded by the government in the 2000 Transport Act as one of the most important fiscal policies to reduce car dependency, with Rye & Ison (2005) similarly noting that parking policy measures are likely to be relatively more important than any other traffic management measure in terms of influencing mode choice. Similarly, Feeney (1989) suggests that the decreased availability and increased costs of parking may encourage drivers to change:

- Their parking location
- The starting time of their journey
- The mode used
- The trip destination
- Or abandon their trip

3.5.6.2 It is clear, however, that the scale of carbon savings will depend on whether employers pass the charge on to employees or not as well as the size of the area in which the levy applies; the size of the levy per parked vehicle; exemptions to the levy; and whether the levy applies to all vehicles or only above a certain threshold: Ison (2004) notes that in terms of the effectiveness of various market and non-market based transport policy options, the WPL is regarded in the policy making arena as one of the most effective policies in dealing with traffic-related pollution, and as such it could offer significant carbon savings in the future. If few employers have passed on the charge, the carbon savings are estimated to be low.

3.5.6.3 The enabling powers for local authorities to implement workplace parking levies would give a financial incentive for businesses to bring forward Green Transport Plans. The powers could include a discretionary extension of the parking levy to cover out-of-town parking. For both types of scheme, the use of the income stream will be crucial in determining the overall impact on businesses and individuals.

3.5.7 Intelligent Transport Systems

3.5.7.1 Intelligent Transportation Systems [ITS] is a *'broad range of diverse technologies applied to transport to make systems safer, more efficient, more reliable, and more environmentally friendly, without necessarily having to physically alter existing infrastructure'* (CfIT: 2005).

3.5.7.2 ITS provide information about traffic through advanced technologies and warning systems, so drivers are able to make an informed choice about when to drive, which route to take, or which transport mode to use, thus making the transport network more efficient.

3.5.7.3 There is evidence to suggest that Intelligent Transport Systems can create substantial carbon savings[14]. These are mainly indirect and result from the decrease in mileage and fuel consumption and integration of transport modes, mainly the shift from the private car to public transport.

3.6 Long term – HIGH impact policies

3.6.1 Hydrogen Fuel Cell Development (& R&D)

3.6.1.1 The carbon saving impacts of hydrogen fuel cells are still uncertain but are undoubtedly a decade or more away. However, R&D into their development is a strategy that can be implemented in the short term.

3.6.1.2 The Forum for Renewable Energy Development in Scotland (FREDS) has established the Hydrogen Energy Group (HEG) to examine and report on the potential and opportunities that hydrogen and fuel cell technology represents for Scotland in the short and long term. In a recent report, the HEG concluded that *10,000 jobs and GVA to Scotland's economy of £500 million per annum are the potential benefits available from such an approach. In order for Scotland to achieve its 40% renewable target by 2020 it will almost certainly require hydrogen and fuel cell systems to balance and integrate many diverse and intermittent sources of energy.* (Scottish Executive 2006c).

[14] http://www.dft.gov.uk/stellent/groups/dft_roads/documents/page/dft_roads_610509.pdf

3.6.2 Personal Carbon Allowances (PCAs)/Domestic Tradeable Quotas

3.6.2.1 The concept of tradable permits arose from environmental economics. The most relevant form is the tradable permit to pollute, although tradable permits have also been proposed in Mexico as an efficient way of managing road vehicle use and have been introduced in Singapore to control vehicle ownership (Goddard: 1997).

3.6.2.2 Carbon rationing is an alternative mechanism to limit carbon emissions from the domestic sector and would necessitate a radical and dramatic changing role for energy efficiency. Personal Carbon Allowances (PCAs) or Domestic Tradeable Quotas (DTQs) propose a national market in carbon units where individuals and organisations buy and sell additional units within a nation's carbon budget. The budget is set as the maximum quantity of greenhouse gases that a nation can emit in a year and is reduced annually towards achieving emissions reductions targets. These initiatives represent an electronic system of rationing as virtually all transactions would be carried out electronically using the technologies and systems already in place for direct debit systems and credit cards.

3.6.2.3 Unlike an emissions trading scheme (ETS), PCAs and DTQs are intended for application *within* an economy – not for trading between nations. However, as with an emissions trading scheme, individuals who want or need to exceed their personal annual allowance would be able to purchase carbon credits from those who have a surplus. Every individual would be allocated an equal annual allowance of carbon emissions (a carbon account). A proportion of the budget is allocated free and on an equal per capita basis to all adult citizens and the remaining units are allocated to manufacturing and other organisations. Within such a scheme, which would be implemented on a UK level, all fuels would be rated for their greenhouse gas emissions and individuals and organisations purchasing them would have to surrender carbon units accordingly.

3.6.2.4 Given the lack of research in this area it is impossible to say how effective and publicly acceptable such measures will be, but there is certainly the potential to increase the costs of driving and therefore influence vehicle kilometres. Both the transport intensity and unit environmental load impacts point towards an overall reduction in CO_2 emissions. The scale of such a reduction will depend directly upon the quantity of permits issued, if they are permits to pollute. If the permits are denominated in units of distance, the relationship may be more difficult to control. There are a number of possible unexpected effects including a move towards smaller more environmentally friendly vehicles, a long term increase in the price of vehicles given fewer cars will be sold and suppliers may see the potential for a change in the willingness to pay of the new marginal car user (Tight et al: 2004) (Goddard: 1997).

4. Discussion and conclusions

4.1 Decoupling transport demand from economic development is purported to be the only way to deliver true long term sustainability. The aim of this document has been to set out some of the arguments for a reduction in traffic and carbon intensity and to identify policies with respect to *surface passenger transport* that may mean that future economic development can occur in Scotland with significantly less mobility and carbon output than has been achieved in the past.

4.2 It is clear from this scoping study that the information needs to be gathered in a more systematic and robust way in order to assess the potential carbon savings and cost effectiveness of individual and packages of policies in this area. Furthermore, a comparison of cost effectiveness, both between policies within this sector and with carbon abatement initiatives in other sectors is required.

4.3 Scenarios to reduce the environmental impact of mobility have been constrained by political and social acceptability. As a consequence, getting the most out of the transport system requires tackling the perception of political risk within transport and energy policy. This may not so much be a quick fix. However, informing the public of the nature of the problem and of their need to change behaviour thus creating a desire to change is a critical step: this could focus on the promotion of lifestyle change linked to improve quality of life. In order to do this, more research is needed on how to gain public acceptability for more radical solutions such as congestion charging and even carbon rationing. In particular, a better understanding of how this acceptance can be encouraged and galvanised over longer time horizons is urgently required in order to develop effective transport and climate change programmes.

4.4 In the meantime, Scotland's climate change programme is bolder than the UK's. Two devolved policy areas with great potential to save carbon emissions from transport with the least economic impact are (i) speed enforcement (short term 'quick hit') and (ii) hydrogen fuel cell development (impacts felt in the long term but investment required in the short term). Many of the devolved policies such as these ones can be implemented in a similar way throughout the UK following agreement between the UK government and devolved administrations. However, the integrity of the Scotland's climate change programme could be compromised without targets for the reduction of the carbon intensity of the transport sector. Targets to reduce transport intensity could be reached while absolute levels of carbon from transport activity are increasing. In order to ensure a reduction in carbon intensity from this sector:

- Targets for the reduction of carbon from the transport sector need to be set.
- A combination of technological and behavioural interventions will be needed.
- The quickest and cheapest ways to save carbon from transport need to be identified. Transport policies have not yet been systematically assessed in terms of their value for money in relation to the cost per unit of carbon saved. If such an assessment was carried out, low tech measures such as speed management and smart measures may show the best value for money.
- An indicative value for carbon needs to be set to aid broad assessment of policies within and between sectors and policies need to be assessed according to the resources required to save an equal amount of carbon.
- The absolute and relative scale of the emissions savings expected from individual transport policy measures need to be evaluated? How much does it cost to save a gramme of carbon from various transport policies compared to other sectors?

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