ASSESSING THE VALUE OF CARBON WITHIN THE ECONOMICS OF BUS OPERATION

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1. INTRODUCTION

The bus industry continues to be of vital importance to the UK. It remains central to our economy, in plans to combat climate change and to policies regarding social inclusion and accessibility. For the last twenty years, TAS has been tracking developments within the industry through the Business Monitor series; in 2007 we undertook a thorough analysis of industry costs for the Commission for Integrated Transport (CfIT) and in 2009 published *The Economics of Bus Operation* and which included an analysis of bus fares and associated influences on pricing

This paper considers the basic principles of bus economics and attempts to place an economic value on bus and other public transport journeys in relation to their carbon emissions. Our objective is to assess the correlation between price and emissions and their potential influence on transport consumers.

2. BACKGROUND

The Bus Industry is a vital part of the UK economy (Turner 2010). It is a major employer; it is a major customer itself and – as a derived demand – provides employees and customers to others. The Eddington Transport Study (2006) spelt out the importance of transport within our economy – a good transport network is vital in maintaining trade and other connections and supporting a growing economy. However, a transport network whose performance and purpose remains unchecked can have an adverse impact on the environment and our quality of life.

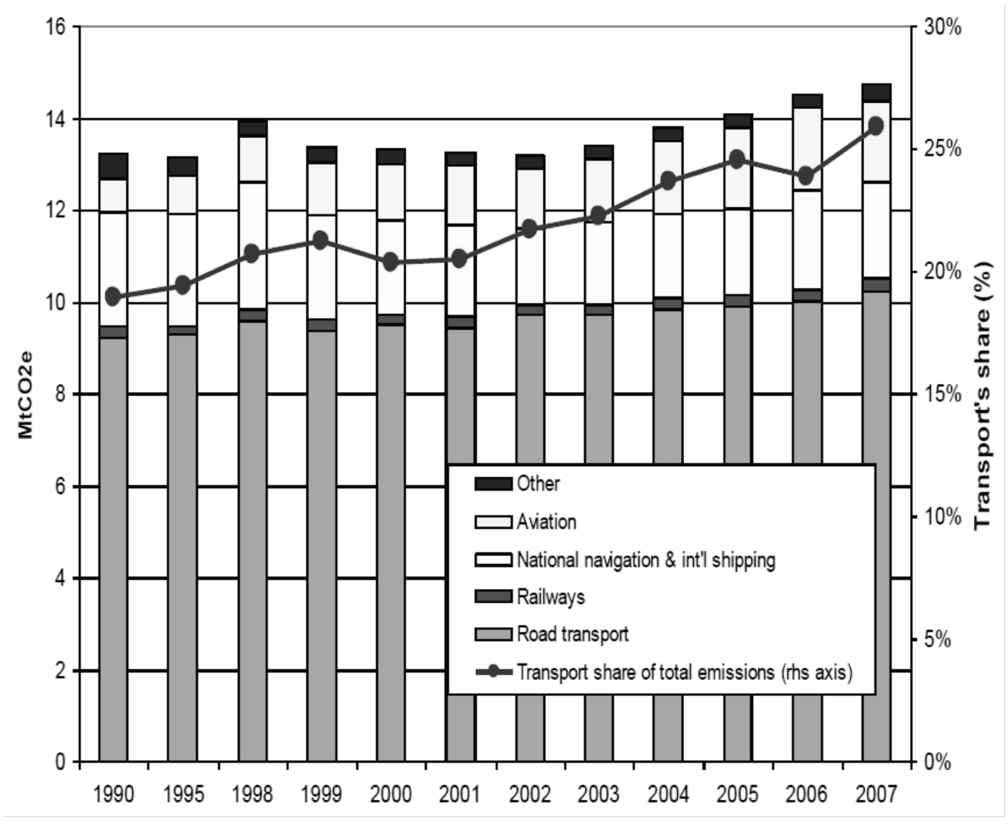
A transport system that functions well is the key to securing a long-term, sustainable response to climate change and our economic success. Our study into the value of the bus industry to the UK economy (CPT 2010) showed that the industry provides employment for over 123,000 employees and over £2.5 billion worth of business to suppliers. In Scotland alone, the industry employs over 11,000 staff with an annual average spend back into the economy of over £180 million.

As the UK has a mature economy with well-established transport connections, the focus for influencing pertinent issues such as climate change perhaps lies not with new connections but improving the performance of its current assets and reducing its liabilities. Transport-related emissions are influenced by a number of factors, including population density, levels of car ownership as well as social and personal factors such as culture and lifestyle, yet are essentially a function of four elements (CfIT 2007):

- Demand for movement – a derived need to access facilities, goods and services;
- Mode of transport used to meet that demand;
- Technical efficiency of the mode used and the chemical content (including carbon) of the fuel used; and
- Operational efficiency of the mode.

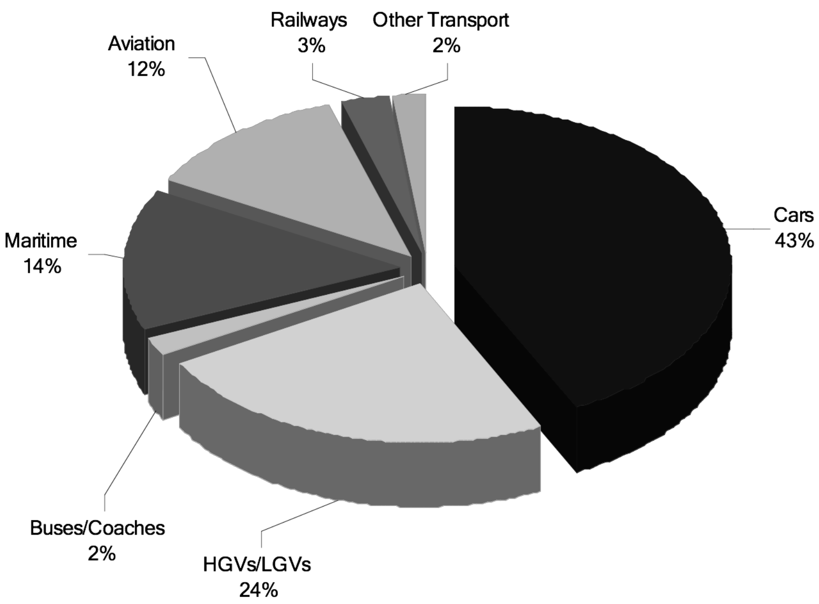
Transport-related emissions account for approximately 26% of all Scottish carbon emissions (CAT 2010). Table 1 demonstrates that whilst total Scottish carbon emissions have risen since the baseline year, transport's proportion of emissions has increased by a greater amount.

Figure A: Emissions from Scottish Transport 1990-2007[1]



The Scottish Carbon Account for Transport (CAT) states that total carbon emissions from transport in 2007 equated to 14.7 $MtCO_2e$, representing an increase in 1.3% between 2006 and 2007 and above the average of 0.6% growth between 1990 and 2007. Figure B illustrates the proportion of Scottish transport emissions by source in 2007. Road transport accounts for over two thirds of current emissions and of that cars account for almost half (43%), whilst buses and coaches account for only 2% of all emissions.

Figure B: Proportion of Scottish Transport Emissions by Source (2007)[2]



The Scottish Government's Economic Strategy states that the purpose of the Scottish Government is to *…"focus the Government and public services on creating a more successful country, with opportunities for all of Scotland to flourish, through increasing sustainable economic growth"*. The Strategy is supported by two challenging targets directly affecting transport emissions:

a) a reduction in total emissions over the period to 2011 and
b) a reduction in total emissions by 80% by 2050 (compared to a 1990 baseline)

To support the Strategy, the Climate Change (Scotland) Act 2009 creates a statutory framework for reducing greenhouse gas emissions in Scotland, confirming the 80% reduction by 2050 and an interim 42% reduction by 2020.

3. THE CARBON VALUE OF SCOTTISH PUBLIC TRANSPORT

With the imminent introduction of Carbon Budgets resulting from the Climate Change (Scotland) Act 2009, an effective means of pricing carbon has been highlighted by Stern (2006) and others as a significant policy tool for stimulating carbon reduction. Carbon pricing can take several forms:

- Market prices in the traded sectors of the EU Emissions Trading Scheme;
- Prices applied by the Government via taxation; and

- ‘Shadow’ prices used in project and appraisal in order to assess relative impact.

Whilst carbon markets are in their infancy, the Scottish Government (2009) has adopted the *Shadow Price of Carbon (SPC)* within transport policy appraisal which represents the societal cost of environmental damage and has been set at a price to ensure that the Government can meet a carbon emissions ceiling of 550 ppm as recommended by Stern. The SPC benchmark increases annually by 2% per annum with a suggested review period of five years and we have adopted the current STAG SPC value of £24.25 tCO_{2e} in our analysis. Using publicly available data and the SPC as a proxy for the price of carbon emissions, we have used SPC to estimate the inherent *carbon value* of the current Scottish public transport network as this provides a useful benchmark against developing any future transport-related policies and projects.

Table 1 summarises our initial calculations of the carbon value of current Scottish transport modes. Current bus and rail trips combined operate with a carbon value of approximately £18 million per annum which is about one fifth less than the carbon value of car trips. However, putting these values into context can be achieved through a worked example of instigating a policy of modal shift. For example, a policy that advocated a 5% switch from car to bus would result in a switch of ca. 1,500 million user kilometres per annum. We recognise that additional public transport capacity would be required to accommodate capture this extra demand– such as increased services or larger vehicles - so our calculations are base on a 10% increase in public transport emissions and suggest a fall in the Carbon Value of £3.4 million per annum[3],

Table 1: Current Scottish Public Transport: SPC and Carbon Value[4]

Item	Bus Users	Rail Users	Car Users
Total trips per year (million)	493	85	2,088
Average distance per user/year (km)	777	660	5,770
Average number of trips per year	80	14	402
Average distance per trip (km)	9.72	47.13	14.35
Total user distance (million km)/year	4,790	3,983	29,967
Average emissions ($kgCO_{2e}$/pkm)	0.105	0.061	0.128
Total emissions (tCO_{2e})	502,950	242,963	3,835,776
SPC per tCO_{2e}	£24.25	£24.25	£24.25
SPC per user kilometre	£0.0025	£0.0015	£0.0031
Total SPC (Carbon Value)	**£12,197,000**	**£5,892,000**	**£93,018,000**

Public transport appears to be in an advantageous position to capitalise both on recent patronage growth and policies in favour of public transport in order to contribute to carbon emissions reduction. However, in order to encapsulate the value of carbon within transport, we need to consider the basics of public transport economics in terms of the perceived cost and the price consumers pay and how these are influenced by carbon to inform stakeholders about the value of their journeys and influence modal choice.

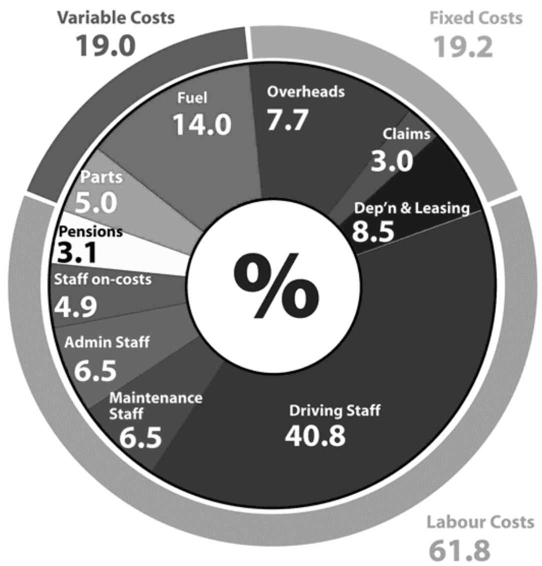
4. THE COST OF BUS OPERATION AND THE PRICE CONSUMERS PAY

Any business (whether in the public or private sector) needs to earn more money in revenue than it spends in costs for a number of reasons:

- To provide funds for the replacement and renewal of equipment needed to carry on and expand the business;
- To pay interest on borrowings and repay loans;
- To provide reserves to enable the company to survive in the bad times;
- To reward shareholders of the business for their investment and risk.

Almost uniquely in the western world, the UK bus industry (excluding London and Northern Ireland) is run on a model where bus operators determine service levels and operate services on a commercial basis. These operators need to make profits to meet financial obligations to their shareholders and asset renewal. Figure C provides an overview of a typical bus company's operating costs based on an analysis of the BIM database, together with cost indices and analysis published by the Confederation of Passenger Transport (CPT). Further analysis suggests that operating costs in Scotland account for approximately 91.8% of turnover, the remaining 8.2% attributed to operator pre-tax profits.

Figure C: Breakdown of Bus Industry Operating Costs (2009)[5]



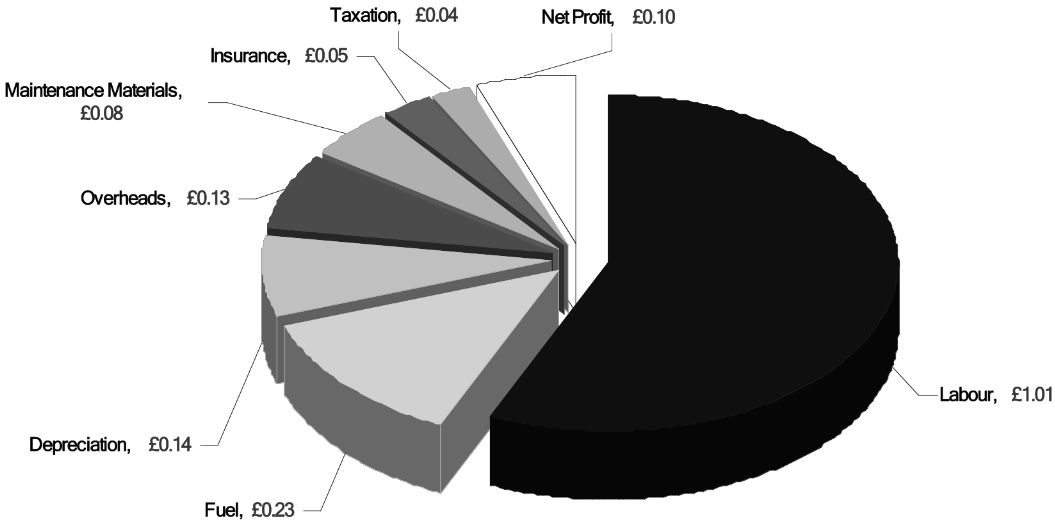
As part of our analysis of the economics of bus operation in 2009, we also undertook a comprehensive survey of bus fares to determine the level of fares currently charged by operators including single, return and period fares. Table 2 summarises our findings in terms of the average fares for a three mile journey for both urban and non-urban bus markets in Scotland compared to the UK average. In both markets, the average Scottish bus fare is lower.

Table 2: Average Bus Fares (Scotland): Urban and Non-Urban Markets

Ticket Type	Single	Day Ticket (per trip)	Weekly Ticket (per trip)
Urban Markets			
Scotland	£1.67	£1.50	£1.21
UK Average	£1.75	£1.77	£1.34
Non-Urban Markets			
Scotland	£1.39	£1.67	£1.21
UK Average	£1.96	£2.21	£1.56

Figure D provides a practical demonstration of the typical apportionment of costs and revenue to Scottish bus operators using the average single fare highlighted in the table below. The majority of the bus fare covers labour costs, followed by fuel and depreciation. Only 10p of the £1.67 fare (6%) can be considered as net profit to the bus operator which can be further subdivided amongst dividends to shareholders, interest, debt repayments and sums for reinvestment.

Figure D: Apportionment of Average Single Urban Bus Fare (£1.67) in Scotland



The costs of bus operation directly impact on the level of fares (the price) to consumers. Since history shows that labour costs, which form the majority of operating costs, almost always rise above inflation, an industry which relies so heavily on labour will see its costs rising more than inflation and this indicates why bus fares have continued to rise above inflation. Other factors contributing to fares increases include:

- Increased fuel costs;
- Increased cost of new vehicles; and
- Reduced productivity, arising from traffic congestion and increased regulation.

From our research, we concluded that the determination of fares is a complex process that is influenced by a number of factors including:

- The level of and changes to operating costs;
- The level of profits;
- The speed and reliability of bus services;
- Competition from the private car and other modes of transport;
- Competition from other bus operators; and
- Historical fare structures.

The evidence from our survey showed a high degree of variability between different local markets which, in our view, illustrates the diversity of market conditions, historical origins and service types. We believe that competition from other modes including the private car is much more important in determining operators' pricing policies than others tend to believe – and that the overwhelming case for this assertion is that current profit levels are well below levels operators would normally seek to sustain the viability of the industry in the long-term.

5. THE ENVIRONMENTAL IMPACT ON OPERATING COSTS

Our illustration of the apportionment of costs and revenue from an average single bus fare in Figure D shows how susceptible fares are to a number of factors. Whilst the demand for travel is influenced by a similarly wide range of factors, such as the location of origins and destinations, time of day, journey purpose and the mode of transport people choose to use, there is a growing underlying awareness amongst transport consumers of the environmental impact of their travel patterns and these environmental considerations are factored into their travel choices. We therefore consider how bus operating costs are susceptible to changes in the environmental agenda.

5.1 Labour Costs, Productivity and Efficiency

As the largest component of bus operating costs, any impact on labour costs is likely to have the greatest impact on the price charged to consumers. Our research has shown, however, that in terms of labour costs, scope to improve productivity through scheduling or changes to working practices is limited and has already been largely done. During the period 1991 to 2006, we estimate that staff productivity, measured as miles operated per employee, has reduced by 15%.

Bus service efficiency is largely influenced by the speed at which vehicles are able to proceed and the ability to predict and manage delay. An increase in traffic volumes increases traffic congestion which has two detrimental side effects to the bus industry demand and supply:

- **Demand side effect:** congestion creates slower bus journeys and poor service reliability, thus making bus journeys less attractive to consumers. This results in the loss of consumers over time to other more 'attractive' modes – walking, cycling, the car or even staying at home. Transfers to cars lead to higher traffic volumes, more congestion and further delay – a vicious circle of decline;

- **Supply side effect:** congestion and unreliability increase operating costs as slower journeys require additional resources (including more drivers) to maintain service levels and to achieve reliability levels determined by industry regulators (the Traffic Commissioners) whilst unpredictable delays create journey extensions.

Work undertaken by TAS using the National Bus Model developed with the DfT and CfIT (2007) shows that the cost of operating buses varies by 0.8% for each 1% change in speed. A sample analysis of scheduled bus speeds on a series of urban bus corridors showed that between 1991 and 2006, peak hour services had slowed down between 5 and 20%.

5.2 Fuel Costs and Consumption

Perhaps the most tangible effect of the environmental influence on bus operating costs is that of fuel and related technology. Our research suggests that fuel costs have increased as a proportion of operating costs from 9 to 14% over the past five years; we note that fuel costs are perhaps the single most variable component of operating costs and are prone to sudden price hikes in a volatile market driven by:

- political instability (Middle East);
- growth in demand from the developing world;
- the environmental impact of fuel-related accidents (e.g. Deepwater Horizon in the Gulf of Mexico).

In research for CfIT (2007), we examined Government policy in relation to fuel taxation and showed that operators pay 62% of the total cost of fuel, broken down by:

- 61% Fuel Cost (actual commodity cost);
- 24% VAT; and
- 15% Fuel Duty.

The Bus Service Operators Grant (BSOG), formerly Fuel Duty Rebate, enables operators to claim back 38% of the cost of fuel purchased from the Government. As direct support to operators, it helps to reduce operating costs and prevents passing the full cost of fuel onto consumers; therefore, any reduction in BSOG will influence fares levels. Whilst BSOG payments will reduce in the UK from 2012, they currently remain unchanged in Scotland.

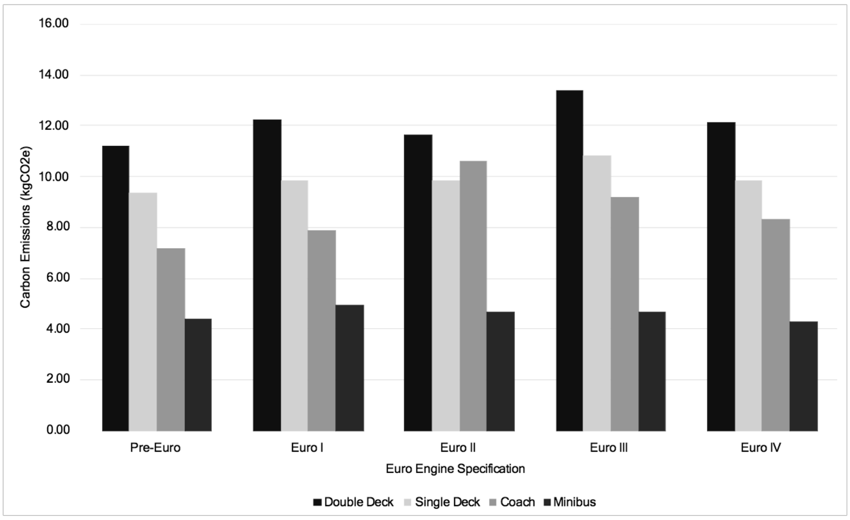
The remaining 62% is subject to significant market pressure. The commodity cost of fuel continues to rise, whilst VAT increased in January 2011. An increase in the price of fuel increases both the fuel element and VAT in proportion, whilst fuel duty applies to all fuel before BSOG. Patronage growth for operators is therefore key – a 10% increase in the commodity cost of fuel is likely to have more impact on costs that a similar increase on fuel duty and this pattern has led to what are effectively fuel surcharge fares increases in recent years on bus operations. Whilst there is evidence to suggest that an increase in the cost of fuel may influence motorists travel habits (Begg 2006; Goodwin 1992), the recent increase in the cost of fuel has been matched by a negligible increase in bus patronage, though this cannot be separated from other factors.

The Government and the bus industry are targeting fuel efficiency and alternative fuel technology as a means to both reduce fuel costs and to reduce the environmental impact of diesel carbon emissions. We have identified a number of factors influencing fuel consumption, including (but not limited to):

- Road traffic congestion (stop/start);
- Vehicle weight;
- Driving technique;
- Change to the size and scope of bus networks;
- Fuel additives; and
- Operating geography and topography (flat vs. hilly terrain).

We believe that, given other factors outlined above, the imposition of European engine emission standards has not directly led to increased fuel consumption. The standards were primarily introduced to reduce other constituents of emissions, such as Nitrous oxide and particulates and whilst these aims have been met it is arguable that Carbon dioxide emissions have increased. Figure E illustrates different bus types in each Euro standard category and their corresponding emissions over a distance of 10 miles.

Figure E: Bus Vehicle Carbon Emissions against Euro Engine Emission Standards[6]



Our research for CfIT on the comparisons of bus weight and fuel consumption from 1970 to present suggests that the issue of concern is not the poor efficiency of the engines but the vehicle weight. Buses have become longer and heavier due to regulation (reduced noise and engine emissions), different methods of construction (low floor vehicles), customer expectations (more space, reduced capacity) and manufacture using heavier components (more glass).

Most of the main bus operators have made significant investment in technology and training that monitors driving technique and to ultimately reduce fuel consumption. Whilst results from this investment are in their early stages, some major bus operators are reporting a 6% improvement in consumption (miles per gallon).

A final consideration in terms of bus services are their operating networks in light of financial pressures on local authorities from the Comprehensive Spending Review in 2010. A number of authorities have declared reductions, including absolute, on their supported networks. On paper, this will benefit the environment – less buses, less fuel consumed, less emissions. But, the supported bus network plays a much more important role in the fabric of society and accessibility and simply reducing or removing this promotes the use of private transport.

5.3 Depreciation and Fleet Investment

There has been, and remains, a clear need to invest in the re-equipment of the bus industry. That need primarily comes in the form of new vehicles, driven by the market appeal of low-floor, accessible vehicles. Decisions regarding capital investment require justification derived from a business case so that such investment can deliver an appropriate return to the operator – key factors in such decisions are:

- Contractual – e.g. as part of a Quality Bus Partnership;
- Financial – reduced maintenance costs;
- Commercial – revenue from the market potential of low-floor vehicles;
- Regulatory – older vehicles do not meet accessibility or emission standards.

Vehicle depreciation (or equivalent leasing charges) mirrors the cost of new buses and other equipment. Bus replacements are rarely like for like, tending to be more innovative and sophisticated than predecessors. Newer vehicles thus essentially cost more, particularly with quality enhancements which invariably create higher vehicle depreciation rates. The emphasis on meeting accessibility and emission standards is pushing the larger operator groups to create large fleet replacement programmes. Table 3 provides a synopsis of the Scottish Bus Fleet for BIM operators, based on the Euro engine specification by registration date.

Table 3: Scottish Bus Fleet Allocation by Euro Engine Specification (October 2010)[7]

Euro Engine Specification	Dates	No. Allocated Vehicles (Oct 2010)	%age of Total Allocation
Pre-Euro	< 1992	80	2.0%
Euro I	1992-1996	439	10.9%

Euro Engine Specification	Dates	No. Allocated Vehicles (Oct 2010)	%age of Total Allocation
Euro II(+Revised)	1996-2000	1,211	17.4%
Euro III	2000-2005	938	23.2%
Euro IV	2005-2008	1,020	25.3%
Euro V	2008-2013	439	8.6%
Totals		**4,039**	**100%**

From a fleet of around 4,000 vehicles, over a third (34%) are up to five years old although there are a substantial proportion (43%) with an average age greater than ten years. We conclude that the Scottish bus fleet has a fairly low average age and thus has seen significant capital investment in fleet replacement. Given this level of investment, we would therefore anticipate that depreciation rates will continue to increase and thus influence the cost to the consumer.

Whilst Scotland has witnessed recent investment in diesel vehicles meeting the new Euro emissions standard, it has also seen investment in fleets powered by alternative fuel technology. Glasgow and Perth are to benefit from an investment in hybrid diesel-electric vehicles at a total cost of £3.9 million (£2.4 million from the operator and £1.5m in support funding from the Scottish Government's Green Bus Fund), a cost of £230,000 per vehicle. In addition, Kilmarnock has seen two-year trials of the *BioBus* which operates on recycled cooking by-products with reports of carbon emission reductions of 80% and recycling 70 tonnes of waste oil[8]. These developments must be welcomed although with the caveat of carrying a level of innovation cost to consumers. We suggest that there is scope for further research into the business case for alternative fuelled bus services and costs to consumers.

5.4 Overheads

Utility charges form a significant part of overhead costs and utility consumption by bus operators has both direct and indirect environmental impacts. Alongside fuel costs, utility costs have risen significantly in recent years due to market supply factors similar to those for fuel. Depots naturally consume utilities such as gas and electricity for heat, power and light and water for vehicle washing. In comparison to domestic utility consumption, bus operators have a number of additional commitments which domestic (private car) users do not need to consider when choosing transport. Any increase in these costs will therefore have a direct bearing on the fares charged to consumers.

We believe that overheads are being influenced by environmental issues through:

- More efficient utility consumption on site;
- Alternative forms of power, light and heat generation (including the possibility of site wind turbines etc.); and
- Emissions trading through the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme.

The principle aim of the CRC Energy Efficiency Scheme is to focus high energy-consuming businesses (including the major bus operators) into meeting emissions reductions targets through an emissions trading scheme. Businesses would purchase emissions allowances and would either receive a bonus or penalty depending on the scale of emissions reduction. Investment by bus operators in site energy efficiency is ongoing as an overall reduction in site energy consumption places bus operators in a favourable position regarding the scheme. The trading scheme is due to start 2011 and it remains to be seen how operators pass on any bonus or penalty to consumers.

The Climate Change Levy (CCL) is a tax on non-domestic energy that currently excludes transport. It is yet to be seen, given the overall reduction in spending in other sectors of the economy, whether transport will remain excluded from the CCL given its continuing growth in emissions and as a proportion of overall emissions.

5.5 Maintenance and Insurance

It is likely that the environmental influence on maintenance and insurance costs is more an indirect result of other operating costs identified above. We do however note that real price increases in maintenance costs have been offset by reductions in fleet size, the elimination of older, more maintenance-intensive vehicles, and improved designs. However, our research suggests that early low floor designs are now showing higher maintenance costs as they reach mid-life and there are signs that tyre costs, especially, are increasing in price ahead of RPI.

Whilst the focus on reducing insurance costs has largely been on accident reduction and avoidance, the inclusion of eco-driving programmes as mentioned above has led to some appreciation of environmental impact of driving standards.

6. CASE STUDIES

To explore the relationship between the fares charged for transport journeys and their carbon values, we have chosen a number of journeys in Scotland which have a variety of modes available to the consumer. The aim of our analysis is to:

- Identify the basic generalised cost for those journeys;

- Identify the journeys' carbon footprint;
- Identify the journeys' carbon value; and
- Examine how carbon value can support the case for changes that improve the relative generalised cost of transport modes

For any given journey, the choices consumers make between car and public transport – and between different modes such as bus, rail or light rail – can be understood by comparing the total costs of the different modes, including both the consumer price and time taken – called generalised costs. Generalised cost – through the application of Generalised Journey Times (GJT) - seeks to represent consumers' likely behaviour given different travel options. It is typically expressed as time in minutes and the cost of the fare to consumers is generally converted into a number of minutes based on estimates of the value of time, derived from survey work at various UK locations.

Data have been prepared using desktop research, primarily internet-based research, using a variety of journey planning and mapping software available online in order to produce quick yet informed results for our chosen journeys. We have made a number of assumptions about the data which are available in a separate technical note (Martin 2011).

6.1 Carbon Emissions

Single journey carbon emission estimates are summarised in Table 5. At first glance, the competitive advantage that public transport offers in terms of carbon emissions over the car appears to dissipate when comparing emissions per single journey. However, public transport (including journey combinations) has a competitive advantage over the car in terms of both average occupancy rates for each mode and higher occupancy; this confirms the logic that a full 50-seat single deck has the potential to remove ten five-seat cars off the road.

6.2 Generalised Cost and Carbon Value

SPC journey calculations and their comparison to journey cost (the price consumers pay) and generalised cost (for the whole journey) are summarised in Table 4. Car journeys have much lower average generalised costs and carbon values than competing public transport journeys. However, on the basis of average vehicle occupancy, car journeys maintain their competitive advantage over public transport in terms of generalised costs, but the average journey carbon value increases. In terms of reducing the competitive imbalance between private and public transport, policies which raise the generalised cost of motoring and increase occupancy rates for public transport will make the latter more competitive.

Table 4: Case Studies: Summary of Generalised Journey Cost and Journey Carbon Values

Journey Type	Mode	Average Generalised Journey Cost	Average Vehicle Carbon Value	Average Passenger Carbon Value
Urban	Bus	73	£0.11	£0.012
	Car	31	£0.02	£0.020
	Rail	86	£0.48	£0.007
Inter-Urban	Coach	235	£1.86	£0.202
	Car	153	£0.30	£0.300
	Rail	225	£6.72	£0.108
Non-Urban	Bus	249	£1.36	£0.148
	Car	221	£0.41	£0.260
	Rail	336	£9.58	£0.155

Table 5: Case Studies: Journey Estimated Carbon Emissions and Occupancy

From	To	Distance (km)	Mode	Vehicle Journey Emissions $kgCO_{2e}$	Passenger Journey Emissions with load factors				
					$kgCO_{2e}$ Average Load	$kgCO_{2e}$ 25% Capacity	$kgCO_{2e}$ 50% Capacity	$kgCO_{2e}$ 75% Capacity	$kgCO_{2e}$ 100% Capacity
Edinburgh	Glasgow	83	Coach	76.63	6.28	6.39	3.19	2.13	1.60
		71	Rail	277.22	4.46	7.70	3.85	2.57	1.93
		74	Car	12.32	7.70	6.16	4.11	3.08	2.46
Glasgow	Partick	4	Bus	3.83	0.31	0.30	0.15	0.10	0.08
		4	Rail	15.09	0.24	0.42	0.21	0.14	0.10
		4	Car	0.67	0.42	0.34	0.22	0.17	0.13
Edinburgh	Carlisle	149	Bus	142.99	11.72	11.21	5.61	3.74	2.80
		145	Rail	938.22	15.08	19.15	9.58	6.38	4.79
		158	Car	26.29	16.43	13.14	8.76	6.57	5.26
Aberdeen	Stonehaven	27	Bus	26.00	2.13	2.04	1.02	0.68	0.51
		21	Rail	82.35	1.32	2.29	1.14	0.76	0.57
		27	Car	4.43	2.77	2.22	1.48	1.11	0.89
Dundee	St Andrews	21	Bus	20.43	1.67	1.60	0.80	0.53	0.40
		21	Car	3.57	2.23	1.79	1.19	0.89	0.71
		19	Rail+Bus	48.43	1.32	1.76	0.88	0.59	0.44

From	To	Distance (km)	Mode	Vehicle Journey Emissions kgCO_{2e}	Passenger Journey Emissions with load factors				
					kgCO_{2e} Average Load	kgCO_{2e} 25% Capacity	kgCO_{2e} 50% Capacity	kgCO_{2e} 75% Capacity	kgCO_{2e} 100% Capacity
Inverness	Portree (Skye)	148	Coach	136.89	11.22	11.41	5.70	3.80	2.85
		157	Rail+Coach	491.36	10.37	15.73	7.87	5.24	3.93
		183	Car	30.58	19.11	15.29	10.19	7.65	6.12
Inverness	Fort William	114	Coach	105.05	8.61	8.75	4.38	2.92	2.19
		413	Rail+Rail	1613.05	25.93	44.81	22.40	14.94	11.20
		106	Car	17.75	11.09	8.87	5.92	4.44	3.55
Inverness	Wick	158	Bus	151.65	12.43	11.89	5.95	3.96	2.97
		261	Rail	1020.89	16.41	28.36	14.18	9.45	7.09
		174	Car	29.11	18.19	14.55	9.70	7.28	5.82
Glasgow	Wick	383	Coach+Bus	359.52	29.47	29.22	14.61	9.74	7.30
		444	Car	74.08	46.30	37.04	24.69	18.52	14.82
Edinburgh	Kingsknowe	7	Bus	6.25	0.51	0.49	0.25	0.17	0.12
		6	Rail	24.61	0.40	0.68	0.34	0.23	0.17
		7	Car	1.10	0.69	0.55	0.37	0.28	0.22
Aberdeen	Bridge of Don	4	Bus	3.99	0.33	0.31	0.16	0.11	0.08
		5	Car	0.75	0.47	0.38	0.25	0.19	0.15

7. CONCLUSIONS

We have shown that the Scottish bus industry is of critical importance in both supporting a buoyant economy as employer and facilitator for travel demand, but also in helping to reduce carbon emissions from transport which continue to grow above the 1990 baseline and as a proportion of total Scottish carbon emissions. We have used the *Shadow Price of Carbon* (SPC) as a basis for establishing the carbon value of different Scottish transport behaviour and it is clear that in pursuing policies or strategies that encourage modal switch from private (cars) to public transport, the relative carbon value of transport will decrease.

In our assessment of the cost of bus operation and the price that people pay for bus journeys, through our demonstration of cost allocation we have shown that operating costs are subject to significant pressures from the market and that profit levels sustaining the viability of the industry long-term are insufficient. Environmental pressures on labour (productivity), fuel (price volatility and consumption), depreciation (investment) and overheads (utility costs) all have the potential to increase and thus increase the fare charged to consumers. We briefly discussed the role of Government in terms of support (BSOG) and taxation (Fuel Duty and CRC) and the potential increase in costs as a result of current policy.

Through our journey case studies in Scotland, public transport has the potential to reduce the carbon value of journeys and has a significant advantage over private transport in terms of emissions per passenger. Efforts should focus on rebalancing the generalised costs between public and private transport to establish the business case for modal switch.

There are a number of potential opportunities going forward. Government and local authorities need to enable the rebalancing of generalised cost and reduction of the carbon value of current transport through policies and strategies encouraging modal switch. For operators and consumers, this approach provides an opportunity to establish the full carbon costs and price of transport to allow consumers to make a more sustainable travel choice.

NOTES

1. Carbon Account for Scotland (2010), Figure 1, page 9.
2. Derived from analysis of Tables 1 to 3, Carbon Account for Scotland (2010, pages 11-12.
3. A worst case scenario would be that bus emissions rise in direct proportion to the increase in bus trips, however this would still result in a reduction in the Carbon Value of the transport network by approximately £900k.
4. Data derived from Scottish Transport Statistics, STAG (Monetisation) and AEA (2010).

5. Cheek, C. et al (2009) *The Economics of Bus Operation*, Figure A
6. Data derived from fuel consumption data supplied by operators
7. Data derived from analysis of our analysis of *Bus Industry Monitor* operators and their fleet allocations as of October 2010.
8. Stagecoach plc Press Release (2 October 2010) *Stagecoach to invest £2.3 million in new greener hybrid buses for Scotland*

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