

# PERSUADING SCOTTISH DRIVERS TO BUY LOW EMISSION CARS?: THE POTENTIAL ROLE OF GREEN TAXATION MEASURES

Sarah Borthwick  
Dr Michael Carreno  
Transport Research Institute, Edinburgh Napier University

## 1. INTRODUCTION

This paper begins by providing a brief review of the different types of 'green' policy taxation measures introduced by various governments to incentivise the purchase of lower emission vehicles (LEVs). A discussion of current understanding of individuals' vehicle purchasing decisions follows, highlighting gaps in knowledge with current explanatory models. Details of a research project are then presented which investigated the potential of 'green' taxation measures to influence vehicle purchasing decisions, via a nationally representative questionnaire survey involving 1,336 motorists living in Scotland. Results are given in 3 main areas: [1] Factors of importance in their next vehicle purchase, both psychological and situational; [2] 3 population segments identified based on their susceptibility to purchase LEVs; and [3] The potential role of future policy measures to influence future LEV purchases. Conclusions are then presented, offering recommendations to help inform future transport policy decisions and facilitate the uptake of LEVs in Scotland, and elsewhere.

## 2. POLICY REVIEW

Alongside technological innovations in the motor industry (e.g. electric/hybrid vehicles), a range of economic measures have been implemented in an attempt to influence individuals' vehicle purchasing decisions towards LEVs. In a consumer market where motorists often focus greatly on financial considerations, economic measures have the theoretical potential to change vehicle purchasing behaviour through pricing signals (Lehman *et al.*, 2003).

A system of taxation/subsidies can be introduced based on the carbon dioxide (CO<sub>2</sub>) emissions of a vehicle, with lower tax payments and/or greater subsidies for LEVs, and the opposite for higher emitting vehicles. Such measures can be implemented at 3 stages of a vehicle's lifetime: [1] At the initial purchase; [2] Periodically for the duration of ownership; and/or [3] On a pay-as-you-go basis relative to the degree of vehicle usage (Ison & Rye, 2008), namely:

- **Purchase taxes:** Present at the time of sale, these are suggested to have the greatest potential to shape vehicle purchasing decisions when it is easiest and most convenient for motorists to change between vehicle models (Potter *et al.*, 2005);
- **Circulation taxes:** Regular registration taxes on the ownership of a vehicle, typically occurring every 6/12 months. Whilst positioned away from the time of vehicle purchase, this tax generally corresponds to the

vehicle itself (e.g. CO<sub>2</sub> emissions), irrespective of the degree of usage. Hence, vehicle choice decisions at the time of purchase will impact upon future circulation tax payments, whereby acting in a secondary role to purchase taxes (Potter *et al.*, 2005). The requirement for regular payment throughout the duration of vehicle ownership amplifies the significance of circulation taxes (Ryan *et al.*, 2009);

- **Road fuel taxes:** Apply to the use of a vehicle throughout its lifetime by means of various channels including the purchase of fuel. Appearing as a regular visible expense can have a strong impact upon vehicle usage decisions (Goldberg, 1998). Purchasing a LEV will also result in reduced fuel consumption, thus raising the miles per gallon/kilometres per litre, which results in a lower tax contribution throughout a vehicle's lifetime (Potter, 2009). Recognising the estimated future running costs of a vehicle at the time of purchase may further influence vehicle choice (Giblin & McNabola, 2009; Hayashi *et al.*, 2001).

It is however unclear which of the 3 taxation types will have the greatest impact on vehicle purchasing decisions. Potter *et al.*, 2005 suggest purchase taxes to be the most effective, whereas Hayashi *et al.*, 2001 and Giblin & McNabola, 2009 advocate circulation taxes, and Ryan *et al.*, 2009 propose a combination of purchase and circulation taxes together.

The United Kingdom (UK) has a vehicle excise duty (VED) system based on CO<sub>2</sub> emissions, payable throughout a vehicle's lifetime. From 2010, payment was differentiated at the time of purchase (first year rate; FYR) to provide further financial incentives/disincentives for low and high emission vehicles respectively. Outside the UK, other tax systems are based on vehicle length, age, fuel consumption and engine size (Association of European Automobile Manufacturers, 2011).

Value added tax (VAT) is also chargeable on the purchase price of a vehicle, currently 20% in the UK. VAT has been differentiated for distinct vehicle characteristics, such as engine size in Italy. The Italian scheme saw a 14.7% improvement in car fuel economy from 1970-1998, when the rate of VAT doubled for vehicles with an engine capacity over 2000 cubic centimetres (cc) for petrol or 2,500cc for diesel engines (Potter *et al.*, 2005).

Systems of fees/taxes at the time of purchase, acting as a deterrent for higher emission vehicles, have been successfully introduced in countries such as Ireland and Germany. The Irish scheme for example, saw a reduction of 3.6% in new car CO<sub>2</sub> emissions in 2008, compared with only 0.2% prior to the revised tax structure (German & Meszler, 2010). In contrast, rebates provide financial incentives at the point of sale for LEVs to encourage their purchase. For example, a plug-in car grant (PICG) capped at £5,000 is now available in the UK for new low carbon vehicles (LCVs) emitting under 75g/km of CO<sub>2</sub> and running on e.g. electricity. However, the uptake of LCVs for the first 12 months has been slow with only 892 qualifying vehicles ordered (and 76% of these occurred in the first 6 months; Department for Transport, 2012).

The application of fees and rebates implemented simultaneously, known as *feebates*, is long established and becoming increasingly widespread (Gordon & Levenson, 1989; Davis *et al.*, 1995; Koopman, 1995). For example, the French Bonus-Malus program, with rebates of up to €5,000 and fees up to €2,600, saw an average reduction of 6% in passenger car emissions during 2008 - almost twice the European average (German & Meszler, 2010). Research into best practice for feebates advocate a continuous and linear fees/rebate tariff, providing a consistent incentive to reduce CO<sub>2</sub> emissions (German & Meszler, 2010). The pivot-point between paying fees and awarding rebates (a predetermined level of CO<sub>2</sub> emissions) should be adjusted over time as vehicle efficiency improves to maintain the incentive to purchase a LEV (German & Meszler, 2010).

In terms of road fuel taxes, approximately 58% of UK petrol/diesel prices are taken in tax, comprising of fuel duty and VAT (Automobile Association, 2012). Research into short-term price elasticities of demand suggest that rising fuel prices have a low influence upon vehicle purchasing patterns (Giblin & McNabola, 2009); although in the long-term, Brons *et al.*, 2008 suggest they are more effective.

A need exists to understand the factors behind individuals' vehicle purchasing decisions to better inform policy decisions. A number of behavioural models have been advocated to help explain this decision-making process (see COWI, 2002). One of the more recent models suggested (Lane & Potter, 2007 - Figure 1) highlights the multifaceted nature of vehicle purchasing decisions, including situational and psychological factors influencing the decision-making process and the role of feedback in reinforcing or rejecting past decisions:

- **Situational factors:** Are concerned with the social conditions and physical structures present, including the economic and regulatory environment (including taxation), vehicle attributes and existing fuel costs and road infrastructure. Past behaviour and habits are also classed as situational;
- **Psychological factors:** Are related to individuals' attitudes, perceptions, beliefs, values and norms. These subjective factors make some individuals more predisposed or willing to purchase a LEV than others (Bamberg *et al.*, 2011).

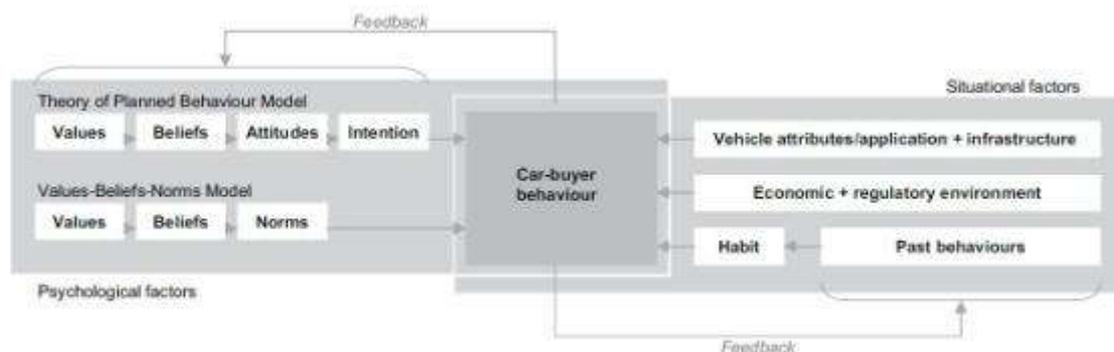


Figure 1: The Lane & Potter model of factors influencing car buyer behaviour (2007)

The model offers a straightforward distinction between the 2 types of factors, although a cause-and-effect relationship may be present where situational factors (including vehicle taxation) can indirectly alter psychological standing, i.e. changing attitudes and preferences towards LEVs.

In order to better understand individuals' vehicle purchasing decisions, this research aims to explore the relative importance and relationship between psychological and situational factors, particularly the role of 'green' taxation measures on individuals' future vehicle purchasing decisions.

### 3. METHODS

A nationally representative sample of 4,938 car drivers living in Scotland<sup>1</sup> were targeted and invited to complete a postal questionnaire. Further to the collection of basic socio-demographic data (e.g. gender and income) and information on current motoring behaviour (including annual mileage and their current vehicle's CO<sub>2</sub> emissions), the questionnaire was designed to identify<sup>2</sup>:

- The relative importance of 28 **situational factors** identified via previous research (including Lehman *et al.*, 2003; Anable *et al.*, 2008; Turrentine & Kurani, 2007) on future vehicle purchasing decisions which were measured on 7-point Likert scales (1 = 'not important' to 7 = 'very important'; Table 3);
- The strength of 11 **psychological constructs** relating to the purchase of a LEV, based on current understanding of individuals' pro-environmental decision-making behaviour (i.e. MaxSem - MAX Success, 2009; Bamberg *et al.*, 2011). The selected constructs were based upon those factors recognised to influence and lead up to the formation of a behavioural intention and adapted for the purchase of a LEV. Each construct was measured via attitude statements on 7-point Likert scales (1 = 'strongly disagree' to 7 = 'strongly agree') - see Figure 2 and Table 3;

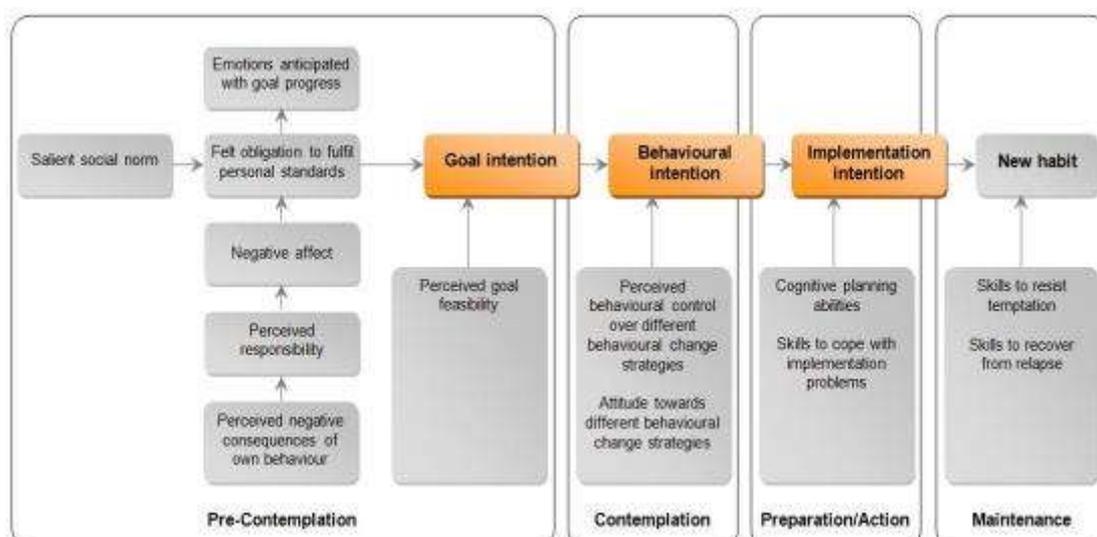


Figure 2: Overview of MaxSem

- The potential influence of 11 **policy measures** on future LEV purchasing decisions, either as a suggested modification or addition to current UK policy and measured on 7-point Likert scales (1 = 'not influential' to 7 = 'very influential'; Table 4).

To explore the impact of situational and psychological factors on future LEV purchasing decisions, the scores recorded for 2 items measuring individuals' behavioural intention to buy a LEV<sup>3</sup> were combined to provide a single measure of behavioural intention.

#### 4. RESULTS

1,336 usable questionnaires<sup>4</sup> were returned, representing a 28.3% response rate. The initial findings are presented below.

To facilitate data analysis, Principle Component Factor Analysis was employed to reduce the number of situational variables, resulting in 7 broad factors (Table 1):

**Table 1: Situational factors of importance in a future vehicle purchasing decision**

<b>Factors</b>	<b>Attributes</b>
<b>Financial considerations at the time of purchase</b>	<ul style="list-style-type: none"> <li>• Vehicle price</li> <li>• VAT and other purchase taxes</li> <li>• Value for money</li> </ul>
<b>Future financial considerations</b>	<ul style="list-style-type: none"> <li>• Insurance group for vehicle</li> <li>• Maintenance/repair costs</li> <li>• Warranty (length and coverage)</li> <li>• Biannual/annual VED</li> <li>• Trade-in value</li> </ul>
<b>Fuel and performance</b>	<ul style="list-style-type: none"> <li>• Fuel consumption (miles per gallon/kilometres per litre)</li> <li>• Engine type/size</li> <li>• Fuel type</li> <li>• Fuel economy</li> <li>• Performance/driveability</li> </ul>
<b>Exterior design features</b>	<ul style="list-style-type: none"> <li>• Vehicle make</li> <li>• Model of vehicle</li> <li>• Vehicle size</li> <li>• Style/appearance/colour</li> </ul>
<b>Interior design features</b>	<ul style="list-style-type: none"> <li>• Safety features</li> <li>• Security features</li> <li>• Equipment levels</li> <li>• Entertainment system</li> <li>• Acceleration time</li> </ul>
<b>Load space</b>	<ul style="list-style-type: none"> <li>• Luggage/storage space</li> <li>• Passenger capacity</li> <li>• Body shape</li> </ul>
<b>Environmental considerations</b>	<ul style="list-style-type: none"> <li>• Emissions of CO<sub>2</sub> &amp; other greenhouse gases</li> <li>• Emissions of other air pollutants</li> <li>• Vehicle noise</li> </ul>

It is increasingly recognised that any population is made up of individuals with varying levels of susceptibility towards changing their behaviour (Anable, 2005; Carreno & Welsch, 2009). The influence of taxation and other policy measures upon vehicle purchasing decisions will thus also vary and needs to be accounted for in future policy decisions. K-Means Cluster Analysis was therefore undertaken to identify population segments within the Scottish driver population, resulting in 3 distinct segments. Based on their responses to the importance of situational factors and strength of psychological constructs, the segments were subsequently named:

- **No-Greens** (27% of total sample);
- **Go-With-The-Flow-Greens** (34%);
- **Go-Greens** (39%).

To explore significant differences between the segments regarding the importance and strength of each factor/construct on future vehicle purchasing decisions, a series of one-way ANOVAs were performed, followed by post-hoc Scheffe tests.

Regarding socio-demographic factors (using Pearson Chi-Square as a test of significance):

- The No-Greens contain a significantly greater share of males (64%), compared to the other 2 segments;
- The No-Greens contain a significantly greater proportion of 'high earners' (over £30,000), compared to the other 2 segments;
- No significant differences were found in relation to age and urban-rural classification.

In terms of driver characteristics:

- A significantly greater number of Go-Greens currently drive vehicles with lower emissions relative to the other 2 segments;
- The Go-With-The-Flow-Greens have a significantly greater proportion of motorists driving the least miles annually in their current vehicle (5,000 miles or less), whilst the No-Greens drive significantly more miles (over 10,000) annually.

**Table 2: Socio-demographic factors & driver characteristics - by segment**

Socio-demographics & driver characteristics		All	No-Greens (1)	Go-With-The-Flow-Greens (2)	Go-Greens (3)
Age	16 to 34 years	14%	12%	15%	15%
	35 to 59 years	48%	54%	46%	45%
	60 years or over	38%	34%	39%	40%
Gender*	Male	54%	64%	51%	48%
	Female	46%	36%	49%	52%

<b>Income*</b>	£30,000 or less	52%	42%	55%	57%
	£30,001 or more	48%	58%	45%	43%
<b>6-fold urban/rural classification</b>	Large urban area	31%	31%	30%	32%
	Other urban area	32%	28%	33%	33%
	Accessible small town	9%	8%	10%	9%
	Remote small town	4%	4%	4%	4%
	Accessible rural area	16%	19%	15%	14%
	Remote rural area	8%	10%	8%	8%
<b>Current vehicle CO<sub>2</sub> emissions (grams per km)</b>		164	172 <sup>+2,+3</sup>	164 <sup>-1,+3</sup>	157 <sup>-1,-2</sup>
<b>Annual mileage*</b>	5,000 miles or less	28%	26%	30%	27%
	5,001 to 10,000 miles	43%	41%	40%	46%
	10,001 miles or more	29%	33%	30%	27%

*Note: Superscript items indicate those significantly greater (+) or smaller (-), relative to the other 'green' population segments ( $p < 0.05$ ) derived from Scheffe post-hoc tests. Asterisks indicate those significantly different ( $p < 0.05$ ) derived by Pearson Chi-Square.*

Table 3 presents the mean scores for the 7 factors and 11 psychological constructs for each segment, ranked in order of those items most influencing intentions for future vehicle purchasing decisions.

Based on current understanding of the behavioural change process, behavioural intention to buy a LEV was isolated (first row of Table 3) as all other psychological constructs ultimately contribute to forming this intention (Bamberg *et al.*, 2011).

For the motoring population overall, the intention to buy a LEV in the future is relatively strong, scoring 5.4 (out of a possible 7).

The 3 most important factors influencing future vehicle purchasing decisions were: financial considerations at purchase; fuel/vehicle performance; and anticipated future financial costs. Motorists also demonstrated a positive attitude towards purchasing a LEV (attitude), viewing this as a realistic option in the future (perceived goal feasibility) and feeling an apparent responsibility to actively lower their vehicle related greenhouse gas emissions (through e.g. the purchase of a LEV; perceived responsibility). A consideration of the vehicle's environmental properties was the next most influential, followed by an awareness of the negative environmental impact by driving a higher emission vehicle (perceived negative consequences).

Physical load space for passengers/luggage was of less importance, followed by internal/external design features. The remaining psychological constructs were found to be relatively weaker in terms of importance, including: a limited obligation to buy a LEV, owing to inherent principles/beliefs and particularly social pressure (personal norms/social norms); little sense of personal fulfilment if they were to purchase a LEV (affect); a lack of confidence to actually purchase a LEV (perceived behavioural control); limited plans to switch to a LEV in the future (goal intention); and above all, restrained feelings of guilt if choosing not to buy a LEV (emotions).

**Table 3: Factor scores & strength of psychological constructs - by segment**

All	No-Greens (1)	Go-With-The-Flow-Greens (2)	Go-Greens (3)
<i>Behavioural intention</i> (5.40)	<i>Behavioural intention</i> (4.32) <sup>-2,-3</sup>	<i>Behavioural intention</i> (5.28) <sup>+1,-3</sup>	<i>Behavioural intention</i> (6.22) <sup>+1,+2</sup>
↓	↓	↓	↓
Financial considerations at purchase (6.13)	Financial considerations at purchase (5.63) <sup>-2,-3</sup>	Financial considerations at purchase (6.41) <sup>+1</sup>	Attitude (6.51) <sup>+1,+2</sup>
Fuel/performance (5.71)	Fuel/performance (5.16) <sup>-2,-3</sup>	Fuel/performance (6.13) <sup>+1,+3</sup>	Perceived responsibility (6.45) <sup>+1,+2</sup>
Future financial considerations (5.59)	Load space (4.80) <sup>-2</sup>	Future financial considerations (6.10) <sup>+1,+3</sup>	Personal norms (6.30) <sup>+1,+2</sup>
Attitude (5.55)	Perceived goal Feasibility (4.79) <sup>-2,-3</sup>	Load space (5.65) <sup>+1,+3</sup>	Financial considerations at purchase (6.25) <sup>+1</sup>
Perceived goal feasibility (5.44)	Future financial considerations (4.78) <sup>-2,-3</sup>	Environmental considerations (5.52) <sup>+1,-3</sup>	Perceived goal feasibility (6.18) <sup>+1,+2</sup>
Perceived responsibility (5.34)	Attitude (4.61) <sup>-2,-3</sup>	Perceived negative consequences (5.44) <sup>+1,-3</sup>	Perceived negative consequences (6.07) <sup>+1,+2</sup>
Environmental considerations (5.26)	Perceived behavioural control (4.58) <sup>+2,-3</sup>	Exterior design features (5.41) <sup>+1,+3</sup>	Environmental considerations (5.91) <sup>+1,+2</sup>
Perceived negative consequences (5.22)	Exterior design features (4.53) <sup>-2</sup>	Interior design features (5.17) <sup>+1,+3</sup>	Affect (5.87) <sup>+1,+2</sup>
Load space (5.16)	Interior design features (4.35) <sup>-2,-3</sup>	Attitude (5.16) <sup>+1,-3</sup>	Goal intention (5.76) <sup>+1,+2</sup>
Personal norms (5.11)	Perceived responsibility (4.28) <sup>-2,-3</sup>	Perceived goal feasibility (5.08) <sup>+1,-3</sup>	Fuel/performance (5.76) <sup>+1,-2</sup>
Exterior design features (4.79)	Personal norms (4.06) <sup>-2,-3</sup>	Perceived responsibility (4.87) <sup>+1,-3</sup>	Future financial considerations (5.74) <sup>+1,-2</sup>
Affect (4.74)	Environmental considerations (4.03) <sup>-2,-3</sup>	Affect (4.61) <sup>+1,-3</sup>	Perceived behavioural control (5.31) <sup>+1,+2</sup>
Perceived behavioural control (4.74)	Perceived negative consequences (3.67) <sup>-2,-3</sup>	Goal intention (4.56) <sup>+1,-3</sup>	Social norms (5.20) <sup>+1,+2</sup>
Goal intention (4.73)	Social norms (3.44) <sup>-2,-3</sup>	Personal norms (4.53) <sup>+1,-3</sup>	Load space (5.02) <sup>-2</sup>
Interior design features (4.70)	Goal intention (3.42) <sup>-2,-3</sup>	Social norms (4.27) <sup>+1,-3</sup>	Emotions (4.89) <sup>+1,+2</sup>
Social norms (4.43)	Affect (3.21) <sup>-2,-3</sup>	Perceived behavioural control (4.17) <sup>-1,-3</sup>	Interior design features (4.56) <sup>+1,-2</sup>
Emotions (3.82)	Emotions (2.55) <sup>-2,-3</sup>	Emotions (3.59) <sup>+1,-3</sup>	Exterior design features (4.47) <sup>-2</sup>

*Note: Superscript items indicate those significantly greater (+) or smaller (-), relative to the other 'green' population segments (p<0.05) derived from Scheffe post-hoc tests.*

**Go-Greens:** Members of this segment are significantly more prepared psychologically to purchase a LEV in the future than the other 2 segments. They indicated: a significantly greatest intention to purchase a LEV in the future; hold significantly greater positive attitudes towards LEVs; indicate a significantly greater level of personal responsibility and personal/social duty to reduce their vehicle emissions; are significantly more aware of the negative effects of not reducing their environmental impact; indicate it would be significantly easier for them to purchase a LEV; would feel significantly worse about themselves if not purchasing a LEV; and would feel significantly more positive about themselves if they did purchase a LEV, compared to both other segments.

In relation to situational factors, the Go-Greens attach significantly greater importance to environmental considerations than both other segments, and significantly greater importance to financial considerations at purchase, fuel/performance, future financial considerations, and interior design features than the No-Greens, although significantly less importance to interior and exterior design features, load space and fuel/performance compared to the Go-With-The-Flow-Greens.

**Go-With-The-Flow-Greens:** Members of this segment are significantly less prepared psychologically than the Go-Greens, although significantly more than the No-Greens for all psychological constructs, except for perceived behavioural control where they score significantly less than the No-Greens.

Regarding situational factors, the Go-With-The-Flow-Greens attach significantly greater importance to 5 of the 7 factors (fuel/performance, future financial considerations, load space, exterior and interior design features) than both other segments.

**No-Greens:** Members of the No-Greens are the least psychologically prepared to purchase a LEV in the future. They score significantly lower on all psychological constructs than both other 2 segments, except for perceived behavioural control, scoring significantly higher than the Go-With-The-Flow-Greens but significantly less than the Go-Greens.

In terms of situational factors, this segment attaches significantly less importance to all factors except exterior design features which are slightly more important for the Go-Greens (although not significant), but significantly less than the Go-With-The-Flow-Greens.

To explore the effect of potential policy measures on future vehicle purchasing decisions, respondents were presented with 11 suggested policy measures that would provide either financial or time-savings for LEVs (Table 4), namely:

- **FY VRF:** First year vehicle registration fee based on CO<sub>2</sub> emissions;
- **VED:** Biannual/annual VED derived by a fixed monetary amount (£) per g/km of CO<sub>2</sub>;
- **FYR VED:** First year rate of VED derived by a fixed monetary amount (£) per g/km of CO<sub>2</sub>;

- **REB:** Rebates for vehicles below a CO<sub>2</sub> emissions threshold;
- **FEES:** Fees for vehicles above a CO<sub>2</sub> emissions threshold;
- **VAT:** VAT based on CO<sub>2</sub> emissions;
- **SCRAP:** Scrappage allowance with an emissions limit on the replacement vehicle;
- **PARK:** Parking charges partly based on CO<sub>2</sub> emissions;
- **INS:** Motor insurance premiums partly based on CO<sub>2</sub> emissions;
- **LEVL:** Designated 'low emission vehicle lane';
- **RUC:** A road user charging scheme with payment (per mile/hour or a flat rate) based on CO<sub>2</sub> emissions;

**Table 4: Influence of future policy measures - by segment**

All	No-Greens (1)	Go-With-The-Flow-Greens (2)	Go-Greens (3)
REB (5.03)	REB (4.07) <sup>-2,-3</sup>	REB (5.26) <sup>+1</sup>	REB (5.53) <sup>+1</sup>
FEES (4.89)	FEES (3.99) <sup>-2,-3</sup>	VAT (5.09) <sup>+1</sup>	FEES (5.41) <sup>+1</sup>
VAT (4.83)	INS (3.91) <sup>-2,-3</sup>	FEES (5.05) <sup>+1</sup>	VAT (5.34) <sup>+1</sup>
VED (4.75)	VAT (3.85) <sup>-2,-3</sup>	VED (4.95) <sup>+1</sup>	VED (5.27) <sup>+1</sup>
INS (4.63)	VED (3.83) <sup>-2,-3</sup>	INS (4.81) <sup>+1</sup>	INS (5.00) <sup>+1</sup>
FYR VED (4.39)	RUC (3.59) <sup>-2,-3</sup>	FYR VED (4.52) <sup>+1,-3</sup>	FYR VED (4.93) <sup>+1,+2</sup>
RUC (4.21)	FYR VED (3.56) <sup>-2,-3</sup>	SCRAP (4.37) <sup>+1</sup>	FY VRF (4.69) <sup>+1</sup>
SCRAP(4.18)	SCRAP (3.48) <sup>-2,-3</sup>	FY VRF (4.35) <sup>+1</sup>	RUC (4.60) <sup>+1</sup>
FY VRF (4.15)	FY VRF (3.22) <sup>-2,-3</sup>	RUC (4.31) <sup>+1</sup>	SCRAP (4.53) <sup>+1</sup>
PARK (3.71)	PARK (3.01) <sup>-2,-3</sup>	PARK (3.95) <sup>+1</sup>	PARK (4.01) <sup>+1</sup>
LEVL (3.48)	LEVL (2.91) <sup>-2,-3</sup>	LEVL (3.72) <sup>+1</sup>	LEVL (3.71) <sup>+1</sup>

*Note: Superscript items indicate those significantly greater (+) or smaller (-), relative to the other 'green' population segments (p<0.05) derived from Scheffe post-hoc tests.*

For the motoring population overall, a system of fees and particularly rebates were indicated to be most influential on future vehicle purchasing decisions for LEVs. VAT based on emissions was the next most influential policy instrument, followed by CO<sub>2</sub> based VED and CO<sub>2</sub> based insurance to financially reward drivers of LEVs.

Policy measures of lesser influence include: FYR of VED; a CO<sub>2</sub> based road user charging scheme; scrappage allowance; and a CO<sub>2</sub> based first year vehicle registration fee. CO<sub>2</sub> based parking charges and low emission vehicle lanes were the least influential measures on future vehicle purchasing decisions.

**Go-Greens:** Members of this segment indicated they would be significantly more influenced by all policy measures compared to the No-Greens, and significantly more influenced by the FYR of VED compared to the Go-With-The-Flow-Greens.

**Go-With-The-Flow-Greens:** Members of this segment rate the influence of all policy measures as significantly higher than the No-Greens, but less so (not significantly) than the Go-Greens (except for low emission vehicle lanes).

**No-Greens:** Members of this segment indicated they would be significantly less influenced by all policy measures compared to both other segments.

Despite these significant differences between segments, there is a consensus in the ranked order of policy measure influence on vehicle purchasing decisions. That is, the top 5 policy measures consistently include rebates, fees, VAT and insurance (based on CO<sub>2</sub>) and VED with a fixed monetary amount per gram of CO<sub>2</sub> - albeit in a slightly different ranked order of effect (although rebates consistently have the greatest influence). Similarly, agreement exists between all 3 segments that parking charges (based on CO<sub>2</sub>) and low emission vehicle lanes have the least influence upon future vehicle purchasing decisions.

## 5. Discussion

This research has revealed that the Scottish motoring population consists of 3 fundamentally different population segments based on their susceptibility for future LEV purchasing decisions, namely: The Go-Greens; Go-With-The-Flow-Greens; and No-Greens. The impact of any current and future policy interventions aimed at encouraging LEV purchases will therefore differ in this respect.

Analysis of socio-demographic factors has added insight into the basic circumstances currently facing individuals in each segment. Income, for example, was shown to be significantly lower for the Go-Greens and Go-With-The-Flow-Greens, compared to the No-Green segment (Table 2). This may suggest a greater need to be financially prudent when purchasing a new vehicle, thus raising the importance (and potential influence) of financial incentives for these 2 population segments.

Examination of current motoring behaviour allows each segment to be further profiled. For example, members of the Go-Greens currently drive the lowest emission vehicles relative to the other segments and have the greatest behavioural intention to purchase a LEV in the future. In contrast, motorists in the No-Greens currently drive the highest emitting vehicles of the segments and report the lowest behavioural intention to purchase a LEV. In both instances, future car purchasing intentions appear to be shaped by their current vehicle purchase (i.e. past behaviours/habits - Lane & Potter, 2007)

Results have confirmed the role of and relationship between situational and psychological factors in shaping vehicle purchasing decisions. Overall, it does appear that situational factors (financial considerations at purchase, fuel/performance and future financial considerations) are the main (top 3) factors driving future car purchasing decisions (Table 3). However, the segmentation exercise revealed a different pattern: where the vehicle purchasing decisions of the Go-Greens are predominantly driven by

psychological factors; whilst the No-Greens and Go-With-The-Flow-Greens are more influenced by situational factors.

Overall, this research has confirmed the potential influence of financial measures in a future vehicle purchasing decision, where pricing incentives/disincentives were found to be more influential for all 3 segments than those measures providing time-savings for LEVs (namely, low emission vehicle lanes). Results also confirm the greater influence of *pull*-measures over *push*-measures (e.g. rebates over fees; Schade & Schlag, 2003) where 'positive' messages, rewarding the purchase of a LEV were more influential than those penalising motorists who chose not to purchase a LEV.

Policy measures present at the time of **purchase** were found to have a high degree of influence upon future vehicle purchasing decisions for LEVs, specifically rebates (consistently the most influential), fees and VAT based on CO<sub>2</sub> emissions. Other measures including the scrappage allowance, first year vehicle registration fee and in particular the FYR of VED were also found to have an influence upon future purchasing decisions, although to a lesser extent.

Policy instruments based on the principle of **circulation** taxes (that is, reoccurring throughout the ownership period, e.g. VED and insurance) were also relatively influential. Motorists appear to be thinking ahead to the future financial expenditure applicable for their chosen vehicle (Ryan *et al.*, 2009).

In contrast, policy measures relating to vehicle **usage** (including road user charging, parking charges and low emission vehicle lanes) were found to be relatively less influential. This is consistent with previous impact assessments of similar usage taxes (i.e. road fuel taxes) on vehicle purchasing decisions (Giblin & McNabola, 2009 and Hayashi *et al.*, 2001).

This research confirms the suggested optimal combination of purchase and circulation taxes/measures to achieve the greatest level of CO<sub>2</sub> abatement (Ryan *et al.*, 2009).

In terms of the behaviour change process, the Go-Greens are much further in the transition to purchase a LEV in the future than both other segments. Furthermore, the policy interventions measured in this research were found to have a relatively greater impact for members of this population group.

On the other hand, the Go-With-The-Flow-Greens and No-Greens are relatively less psychologically prepared to purchase a LEV than the Go-Greens. For these segments, 'softer' interventions may be more relevant to initially raise awareness/self-focus and strengthen e.g. the obligation to purchase a LEV (personal/social norms) and stimulate feelings of guilt if choosing not to purchase a LEV (emotions/affect). Once these weaker constructs have been strengthened, interventions can then focus upon goal setting, by increasing self-confidence in individuals' ability to purchase a LEV (perceived goal feasibility), achievable through the provision of information e.g. advertising. At this stage, the policy interventions assessed in this research are likely to be more effective.

In relation to current UK/Scottish policy<sup>5</sup>, this research confirms the potential influence of rebates in encouraging the purchase of LEVs. However, as mentioned in the policy review, the current PICG has experienced limited success in the uptake of LCVs, which raises the question: What could be done to make the PICG or similar schemes more successful?

The level of incentive is perhaps the first issue, with only £5,000 to help offset vehicle purchase costs, typically costing between £25,000 and £30,000 (Department for Transport, 2012). Relative to conventional petrol/diesel vehicles with comparable features, the level of incentive appears inadequate, which confirms previous research stressing a positive relationship between the generosity of the tax incentive and the effect on consumer behaviour (e.g. Gallagher & Muehlegger, 2011).

Furthermore, the vehicle eligibility criterion for the PICG is somewhat restricted. At the launch of the scheme, only 3 vehicles qualified and 15 months later, only 3 more vehicles were eligible (Department for Transport, 2012). Based on the reported high influence of rebates on vehicle purchasing decisions, expansion of the PICG scheme to include e.g. hybrid electric vehicles is likely to result in an increased uptake of LEVs.

The PICG was designed to make the whole-life costs of qualifying LCVs more 'comparable' with petrol/diesel equivalents. However, previous research suggests that many individuals lack the fundamental knowledge to assess financial costs/benefits and payback period when evaluating the purchase of a LCV (Lane & Banks, 2010; Anable *et al.*, 2008). To counteract this information asymmetry (Kurani *et al.*, 2007), perhaps greater marketing of the scheme and provision of relevant information is required.

Generally speaking, a feebate system based solely on CO<sub>2</sub> emissions (thus applicable to all low emission vehicles, including but not exclusive to LCVs) would provide the greatest choice for motorists and make the scheme accessible to all individuals looking to purchase a vehicle.

Similarly, the use of fees to financially penalise motorists who choose to purchase a higher emitting vehicle would, according to this research, help shape vehicle purchasing behaviour towards LEVs. The FYR of VED follows this principle: with a £1,030 fee for vehicles in the highest CO<sub>2</sub> emissions category at the time of purchase. Although the scheme awards a payment exemption for vehicles emitting 130g/km of CO<sub>2</sub> or less, this incentive is less visible to motorists as there is no physical exchange of funds - merely a hypothetical saving by choosing to purchase a LEV over a higher emitting one. Rebates/grants can help counteract this, which are reported in this research to have a greater influence upon future vehicle purchasing decisions than fees.

Graduating the level of VAT according to CO<sub>2</sub> emissions would further strengthen the financial signal at the time of vehicle purchase; and previous schemes founded on this principle have been effective in shaping vehicle purchasing behaviour (Potter *et al.*, 2005). With VAT currently based on

vehicle price in the UK, LCVs (which are typically more expensive at their initial launch due to limited production and absence of economies of scale) will benefit substantially from reduced VAT as a further incentive.

## 6. CONCLUSIONS

This paper set out to explore the vehicle purchasing decision and the role of policy measures, including taxation, to encourage the purchase of LEVs. Analysis revealed 3 distinct population segments with varying propensities to purchase a LEV in the future. Exploration of the segments suggest that the Go-Greens, representing 39% of the driver population in Scotland are predominantly driven by psychological factors in their vehicle purchasing decisions and display the greatest behavioural intention to purchase a LEV in the future. On the other hand, the Go-With-The-Flow-Greens and No-Greens are more driven by situational factors and psychology-based interventions aimed at strengthening the weaker constructs will initially have greater success in encouraging the purchase of a LEV.

Consequently, policy measures aimed at influencing vehicle purchasing decisions are likely to be most effective for the Go-Greens and to a lesser extent the Go-With-The-Flow-Greens. Specifically, the use of policy measures particularly at the time of purchase (including fees, rebates and VAT based on CO<sub>2</sub>), supported by measures reoccurring throughout vehicle ownership (e.g. VED and vehicle insurance based on CO<sub>2</sub>) present the best opportunity for policy makers/governments in Scotland, the UK and elsewhere to shape vehicle purchasing behaviour towards LEVs across all population segments.

## ACKNOWLEDGEMENTS

Thanks are directed to the Transport Research Institute of Edinburgh Napier University for funding the PhD from which this paper arises. Thanks are also given to the Scottish Government's Scottish Household Survey administrative team for providing the contact details of motorists used in this research.

## REFERENCES

Anable, J. (2005) 'Complacent Car Addicts' or 'Aspiring Environmentalists'? Identifying Travel Behaviour Segments using Attitude Theory. *Transport Policy*. 12 (1) 65-78.

Anable, J., Lane, B. & Banks, N. (2008) *Car buyer survey: From 'mpg paradox' to 'mpg mirage' - How car purchasers are missing a trick when choosing new and used cars*. Available from: [http://www.lowcvp.org.uk/assets/reports/Car Buyer Report 2008 Final Report.pdf](http://www.lowcvp.org.uk/assets/reports/Car_Buyer_Report_2008_Final_Report.pdf) [Accessed 1 February 2012].

Association of European Automobile Manufacturers (2011) *Motor Vehicle Taxation: EU Summary*, Available from: [http://www.acea.be/images/uploads/files/20110330 TaxGuide2011Highlights update.pdf](http://www.acea.be/images/uploads/files/20110330_TaxGuide2011Highlights_update.pdf) [Accessed 18 February 2012].

Automobile Association (2012) *Fuel Price Report - March 2012*. Available from: <http://www.theaa.com/resources/Documents/pdf/motoring-advice/fuel-reports/march2012.pdf> [Accessed 30 March 2012].

Bamberg, S., Fujii, S., Friman, M. and Gärling, T. (2011) Behaviour Theory and Soft Transport Policy Measures, *Transport Policy*. **18** (1), 228-235.

Brons, M., Nijkamp, P., Pels, E. & Rietveld, P. (2008) A meta-analysis of the price elasticity of gasoline demand. A SUR approach. *Energy Economics*. **30** (5), 2105-2122.

Carreno, M. & Welsch, J. (2009) *MaxSem: Max Self Regulation Model: Applying theory to the design and evaluation of Mobility Management projects*. Available from: [http://www.epomm.eu/docs/mmttools/case\\_studies\\_TA/MaxSem\\_applying\\_theory\\_to\\_MM\\_projects.doc](http://www.epomm.eu/docs/mmttools/case_studies_TA/MaxSem_applying_theory_to_MM_projects.doc) [Accessed 11 March 2012].

COWI (2002) *European Commission's Directorate-General for Environment - Fiscal Measures to Reduce CO<sub>2</sub> Emissions from New Passenger Cars (Main Report - Final Report)*. Available from: [http://ec.europa.eu/taxation\\_customs/resources/documents/co2\\_cars\\_study\\_2\\_5-02-2002.pdf](http://ec.europa.eu/taxation_customs/resources/documents/co2_cars_study_2_5-02-2002.pdf) [Accessed 5 March 2012].

Davis, W. B., Levine, M. D., Train, K. E. & Duleep, K. G. (1995) *Effects of Feebates on Vehicle Fuel Economy, Carbon Dioxide Emissions, and Consumer Surplus*. Available from <http://eetd.lbl.gov/ea/teepa/pdf/DOE-PO-0031b.pdf> [Accessed 1 February 2012].

Department for Transport (2012) *Plug-in car grant*. Available from: <http://www.dft.gov.uk/topics/sustainable/olev/plug-in-car-grant/> [Accessed 30 March 2012].

Gallagher, K. S. & Muehlegger, E. (2011) Giving green to get green? Incentives and consumer adoption of hybrid vehicle technology. *Journal of Environmental Economics and Management*. **61** (1) 1-15.

German, J. and Meszler, D. (2010) *Best Practices for Feebate Program Design and Implementation*, Available from: [http://www.theicct.org/pubs/feebate\\_may10.pdf](http://www.theicct.org/pubs/feebate_may10.pdf) [Accessed 4 April 2012].

Giblin, S., and McNabola, A. (2009) Modelling the Impacts of a Carbon-Emission Differentiated Vehicle Tax System on CO<sub>2</sub> Emissions Intensity from New Vehicle Purchases in Ireland, *Energy Policy*, **37** (4) 1404-1411.

Goldberg, P. K. (1998) The Effects of the Corporate Average Fuel Efficiency Standards in the US, *The Journal of Industrial Economics*, **46** (1) 1-33.

Gordon, D. & Levenson, L. (1989) *Drive+: A proposal for California to use consumer fees and rebates to reduce new motor vehicle emissions and fuel consumption*. Berkeley, Applied Science Division.

- Hayashi, Y., Kato, H., and Teodoro, R. V. R. (2001) A Model System for the Assessment of the Effects of Car and Fuel Green Taxes on CO<sub>2</sub> Emissions, *Transportation Research Part D: Transport and Environment*, 6 (2) 123-139.
- Ison, S., and Rye, T. (2008) *The Implementation and Effectiveness of Transport Demand Management Measures - An International Perspective*. Ashgate Publishing Limited, England and United States of America.
- Koopman, G. J. (1995) Policies to reduce CO<sub>2</sub> emissions from cars in Europe: a partial equilibrium analysis. *Journal of Transport Economics & Policy*. 30 (1), 53-70.
- Kurani, K. S., Heffner, R. R. & Turrentine, T. S. (2007) *Driving Plug-In Hybrid Electric Vehicles: Reports from U.S. Drivers of HEVs converted to PHEVs, circa 2006-07*. Available from: [http://pubs.its.ucdavis.edu/publication\\_detail.php?id=1193](http://pubs.its.ucdavis.edu/publication_detail.php?id=1193) [Accessed 1 April 2012].
- Lane, B. & Banks, N. (2010) *LowCVP Car Buyer Survey: Improved Environmental Information for Consumers*. Available from: <http://www.lowcvp.org.uk/assets/reports/LowCVP-Car-Buyer-Survey-2010-Final-Report-03-06-10-vFINAL.pdf> [Accessed 30 March 2012].
- Lane, B., and Potter, S. (2007) The Adoption of Cleaner Vehicles in the UK: Exploring the Consumer Attitude-Action Gap, *Journal of Cleaner Production*, 15 (11-12) 1095-1092.
- Lehman, C., McLoughlin, K., and Dewhurst, M. (2003) *Assessing the Impact of Graduated Vehicle Excise Duty - Quantitative Research*, Available from: <http://www.dft.gov.uk/pgr/roads/environment/research/consumerbehaviour/assessingtheimpactofgraduate3817> [Accessed 2 February 2012].
- MAX Success (2009) *Final Report Deliverable D 0.6*. Available from: [http://www.max-success.eu/downloads/MAX\\_FinalReport.pdf](http://www.max-success.eu/downloads/MAX_FinalReport.pdf) [Accessed 3 April 2012].
- Potter, S. (2009) *Using Environmental Taxation for Transport Demand Management*, In: Lye, L., Milne, J. Ashiabor, H., Deketelaere, K., and Kreiser, L. (eds.) *Critical Issues in Environmental Taxation: International and Comparative Perspectives*, Oxford University Press, Oxford pp. 39-54.
- Potter, S., Parkhurst, G. and Lane, B. (2005) *European Perspectives on a New Fiscal Framework for Transport*. In: Reggiani, A. and Schintler, L. A. (eds.) *Methods and Models in Transport and Telecommunications: Cross-Atlantic Perspectives (Advances in Spatial Science)*. Springer, New York pp.319-333.
- Ryan, L., Ferreira, S. and Convery, F. (2009) The Impact of Fiscal and Other Measures on New Passenger Car Sales and CO<sub>2</sub> Emissions Intensity: Evidence from Europe, *Energy Economics*, 31 (3) 365-374.

Schade, J. & Schlag, B. (2003) Acceptability of urban transport pricing strategies. *Transportation Research Part D: Transport and Environment*. **6** (1) 45-61.

Turrentine, T. S. & Kurani, K. S. (2007) Car Buyers and Fuel Economy? *Energy Policy*. **35** (2) 1213-1223.

## NOTES

<sup>1</sup> The contact details of motorists was provided by the Scottish Government's Scottish Household Survey administrative team, based on individuals who had previously indicated their willingness to be recontacted for further research. A precondition was also in place for respondents to have a full driving licence and regularly drive a vehicle.

<sup>2</sup> The questionnaire was also designed to measure the different levels of current taxation measures (namely VED, VAT, PICG and fuel duty) that would act as either an incentive or disincentive on individuals' purchasing decisions towards LEVs - although the results are not presented in this paper.

<sup>3</sup> "I intend to buy a lower emission vehicle in the future" and "Nothing would persuade me to buy a lower emission vehicle in the future" - scores for the second statement was reversed before averaging the two into a single measure.

<sup>4</sup> A copy of the questionnaire can be made available from Sarah Borthwick ([s.borthwick@napier.ac.uk](mailto:s.borthwick@napier.ac.uk)).

<sup>5</sup> Scotland has a devolved Government, where national taxation measures (including VED (and the FYR), VAT, fees/rebates) are 'reserved' for the UK Parliament to legislate. Scotland does have the power to deal with some aspects of transport but within set boundaries. See <http://www.scotland.gov.uk/About/18060/11552> (Scottish responsibilities) and <http://www.scotland.gov.uk/About/18060/11555> (UK responsibilities) for further information.