Hybrid Business Case

The following business case has been determined as a result of a survey of a number of delivery companies operating light commercial vehicles of around 5.5t. These companies include local courier companies to large national companies such as DHL and UPS. This data has been simplified.

The following tables give the operating costs for three types of vehicle. These are a current Diesel vehicle, an existing all electric delivery vehicle and finally the proposed e3 650cc gasoline hybrid vehicle. The individual figures are explained in the text after the table.

Table -1 Vehicle Data

Vehicle	Range km	Cost £	CO2 ECE g/km	Payload Tons	Refuel Time
Iveco Daily 50C15	480	25,000	440	2.9	5 mins
Current All electric	123	32,000	307	2.0	8 hours
e3 650cc Hybrid	320	36,000	238	2.5	5 mins

Table -2 Vehicle Operating Costs

Vehicle	Fuel cost £/km	Battery Cost £/km	Running Cost £/km	Driver Cost £/km	Total Op. Cost £/km	Typical Charge £/km	Gross Profit £/km	Annual Mileage km	Potential Profit £
Iveco Daily 50C15	0.17	0.00	0.17	0.41	0.58	0.94	0.36	110,400	19,818
All electric	0.05	0.46	0.51	0.41	0.92	0.94	0.02	28,290	350
ADAC Hybrid	0.10	0.125	0.22	0.41	0.63	0.94	0.31	73,600	11,312

Range (km) This is the approximate range for the vehicle on either 1 tank of fuel and/or 1 complete charge. It assumes the vehicle has an average 50% load (fully loaded out, empty back).

Cost The Iveco and all electric vehicle costs are taken direct from the respective manufacturers. The cost of the electric vehicle is, however, very skewed by the way the battery pack is handled (see the next paragraph). The e3 hybrid costs take into account the additional cost of the engine, generator and other associated systems. The battery pack is reduced by around 60%, although there is no capital cost reduction to the operator in this.

Battery Cost The battery packs are leased to the vehicle operator. These calculations assume that the vehicle is used to the maximum available range for each charge cycle. Li-ion batteries are assumed to be capable of 500 re-charge cycles. 1 recharge cycle assumed per day of operation.

Electric vehicle. Vehicle range at half load is 123km as per ECE R101 test carried out by the vehicle manufacturer. Therefore battery life is 500 x 123 = 61,500km. Battery pack costs £28,000 therefore cost/km = 28,000/61,500 = £0.46/km.

Hybrid vehicle. Vehicle range is 320km. The battery pack is assumed to go through 2 cycles during this time thus the range is halved for the purposes of life calculation. Following the same calculations as above, but with a reduced battery cost of £10,000 the cost per km is £0.13.

CO2 This is a calculated figure for the Iveco based on fuel consumption (there is a good direct correlation between l/100km and CO2 production for Diesels). The hybrid figure is calculated based on the mass of CO2 being equal to 3.15 times the mass of fuel burnt for gasoline. This is less accurate than the Diesel due to CO2 also being produced in the catalyst which is not included in this calculation. The electric CO2 production is a conversion factor produced by DEFRA based on the UK current grid CO2 output of 537g/kW.hr

Fuel Cost The cost per km for fuel. Based on the following data:
Diesel at 103p/lt, Iveco fuel consumption 16.6l/100km
Gasoline at 95.7p/lt. Hybrid engine fuel consumption calculated at 10.2l/100km. All battery charging carried out by the combustion engine.

Cost of Driver Data supplied by several operators. Drivers are generally self-employed. A common rate has been used throughout however the rate for short trips is generally higher to maintain income levels. Therefore the all electric rate is likely to be significantly higher.

Typical Charge Data again supplied by several operators and is for a Transit sized vehicle (based on the all-electric vehicle's payload of 2 tons). Note charge is for loaded km only. Return journey is not charged.

Annual Mileage Based on the daily range multiplied by 230 working days per year (46 weeks).

Potential Profit Using the Gross Profit/km multiplied by half the annual mileage (charge only made for loaded journeys, assumed half journey is loaded and half is return). Maintenance costs, tyres, insurance and admin costs have to come from this.

A surprising but significant value in Table 1 is that the Hybrid vehicle has a lower CO2 value than the all electric vehicle. Even allowing for catalyst effects there will still be a major CO2 benefit with the hybrid vehicle. This will change over time as the UK grid output falls towards the long term target of 430g/kW.hr. However assuming all the relationships still hold true this will only reduce the electric CO2 value to 246g/km which is still worse than the hybrid value is now. This is assuming that over the same time frame the ic engine does not improve at all.

Based on the preceding tables it is apparent that the justification for an all-electric vehicle does not exist on an economic basis. Electric vehicles have to be a purchase either out of altruism (desire to be green) or necessity (absolute need for zero emissions). In effect this means the vehicle is only going to be purchased by large fleet operators where one of the two arguments above has a commercial value that overcomes the operating and capital cost penalties.

In addition to these economic considerations is the drastically reduced range of the vehicle. Along with this range reduction is the loss of flexibility with the need to have an 8 hour re-charge period before the vehicle is ready again. In addition the reality is that with such a limited annual range the driver cost will be substantially higher to provide for a sustainable income. The vehicle therefore has no attraction to the small or independent operator. Moreover there must be considerable concern with an all electric vehicle that it will either not be available for use or it may fail in completing its daily task. For a commercial vehicle this is an unacceptable situation.

However, the use of the hybrid option has a dramatic effect on these figures. The vehicle now has an acceptable range with no loss of flexibility over the conventional Diesel as the vehicle only requires a 5 min re-fuel period. Moreover the vehicle has re-gained 0.5 ton payload which will have a direct effect on the commercial attraction of the vehicle. The hybrid retains the ability to avoid any congestion charge since it retains an all electric range of some 40km. Whilst the effect of the congestion charge has been ignored in these calculations, this can go some way to close the gap with the conventional vehicle. The congestion charge would effectively add 10p per km to the conventional vehicle costs. Whilst this is simply directly added to the charge rate it means the hybrid vehicle can offer a lower rate per km giving it a commercial advantage.

In the context of the competition scope to advance the attraction of electric and hybrid vehicles this data clearly demonstrates that the e3 hybrid concept does precisely that. It provides for an acceptable commercial return together with a major saving in CO2 emissions plus greatly enhanced range and flexibility over the existing all electric vehicle.

NOTE FROM DOCKLANDS SCIENCE PARK RELATING TO EMISSIONS WHEN LPG IS USED

USE OF LPG AS FUEL OF CHOICE

Assuming the petrol consumption at 10.2l/100km, as stated in "Fuel Cost" above, then using the liquid LPG injection the fuel usage should rise, perhaps as much as 12.5l/100 km and the cost reduce by 50%. Hence a cost for fuel of £0.05 per km and a total cost of £0.58 per km, the same as for diesel.

CO2 emissions should be reduced by 40% over petrol so that a figure approaching 150 gm/km should be achieved, say 180 gm/km at worst, so making the emissions profile markedly superior to an all electric vehicle.