

## Abstract

Vehicle and fuel suppliers face a rapidly changing technological and socio-economic environment. Legislative pressure, emission regulations and budgetary constraints lead to a highly competitive automotive industry. These fuel type changes are evident today with the switch from conventional petrol and diesel to so-called 'greener' low-sulphur petrol and diesel, and gaseous fuels.

This study compares conventional and alternative vehicle fuels on a life cycle assessment (LCA) basis with a focus upon landfill gas (LFG) as a viable alternative, recognising that in the longer term LFG could be substituted by other methane sources associated with waste disposal.

This study differs from other LCAs in that it considers the life cycle of the fuel and, to some extent, vehicle, whereas the majority of other LCA studies only consider the fuel itself, furthermore this study is the first UK study to consider the use of landfill gas (LFG) against other fuels on a life cycle basis, inclusive of a vehicle cycle. The vehicles considered are based on typical Public Service Vehicles (PSVs) whereas the majority of other studies have concentrated on the private car.

The objectives of the study were:

- To compare conventional and alternative fuels used with the same vehicle on a like-with-like basis.
  - Identify the most critical stages in the life cycles of each fuel and vehicle combination.
  - Establish an LCA framework upon which any fuel and vehicle could be tested.
  - Assess the use of LCAs in transport related studies and comment upon the main results and conclusions.
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- Identify the key problems and availability of data in modern LCA studies.
- Identify the fuels and vehicles that contribute the least and most to global warming potential (GWP) and human toxicity (HT) through the use of the Environmental Design of Industrial Products (EDIP) methodology.

Results show that on a life cycle basis, LFG powered vehicles compare favourably with gas-powered vehicles and generally cause less pollution than the liquid-fuel powered vehicles, with electric vehicles generally producing the least pollution overall. The results are normalised and weighted to reflect the absolute impact made by each fuel and vehicle combination to Global Warming Potential (GWP) and Human Toxicity (HT).

In theory the solution is simple: it is to identify the most energy-efficient and environmentally friendly vehicle and fuel combination, today and for the future. In practice the solution is riddled with complexity. However solutions can be sought with the aid of an environmental management LCA. This thesis uses a LCA approach to give a realistic reflection of the complete environmental performance of three PSVs. The calculations are carried out with a spreadsheet, as a convenient way of modularising the process of estimating and aggregating the contributions to the emissions etc. While the objectives, noted above, have been realised in large measure, the work is on-going as technology and legislation evolves.

The LCA, as implemented herein, shows that by far the most significant stage in the life cycle of the liquid and gaseous fuels is in end-use i.e. the stage at which the fuel is combusted in an Internal Combustion Engine (ICE). An initial analysis has not indicated parameters or fuel/vehicle combinations that carry a disproportionate level of uncertainty or risk. Where appropriate comparisons could be made, the current study of public service heavy vehicles has shown the same trends as those noted in studies of the LCA for private cars.

Having presented the main conclusions from the current study, recommendations are made for the extension of the scope and depth of the LCA.

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