

LIFE CYCLE ASSESSMENT ROAD VEHICLE EMISSIONS MEASUREMENT

Institution of
**MECHANICAL
ENGINEERS**

The UK has a legally binding target to reduce greenhouse gas (GHG) emissions by 80% by 2050.^[1] The automotive industry contributes nearly a quarter of the UK's total emissions. Action is therefore needed to reduce this level. Current policy on vehicle emissions focuses on tailpipe emissions, but this is not the whole story and could be misleading. There is a need to measure road vehicles' overall contribution to emissions by including their manufacturing, usage and end-of-life disposal. With the advent of zero (tailpipe) emission cars and the increasing efficiency of conventional engines, a broader perspective is needed to help maintain the relevance of legislation and industry best practice. Otherwise industry could be misleading the public and potentially skewing consumer behaviour.

This policy statement looks at current measures in place to reduce vehicle emissions, and how 'Life Cycle Assessment' (LCA), by examining all the stages of a car's life, could improve upon the current methodology.

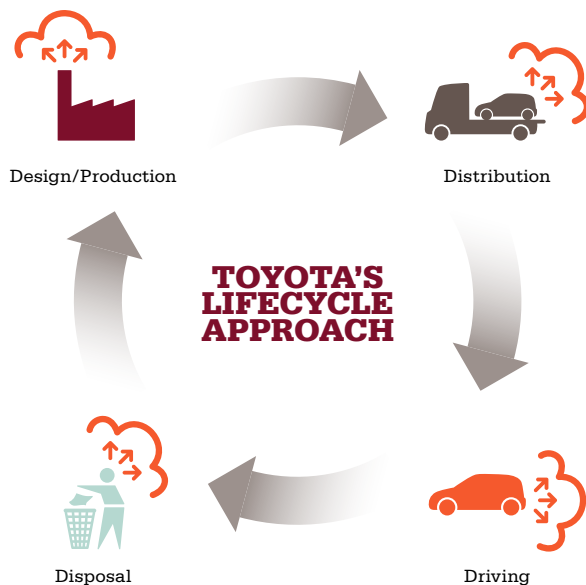
In summary, the Institution of Mechanical Engineers urges Government to adopt the following recommendations:

- **Announcement of a Technology Innovation Centre (TIC) for Transport in 2012.** This TIC would agree the agenda for a framework that defines the methodology for calculating the LCA metrics. The Institution believes that managing this metric through a TIC would encourage a holistic approach to LCA across all modes of transport.
- **Enforce the implementation of LCA legislation by 2015.** This approach will ensure that we do not move the environmental impact of vehicles from the use phase, where it is currently tightly controlled, to another part of the life cycle. Using an LCA methodology allows industry to be technology-neutral. It would have no bias towards petrol, diesel, electric, synthetic, biofuels or fuel-cell cars etc, encouraging a greater range of methods and innovation.
- **Review current vehicle taxation by 2015.** Taxation of vehicles should reflect long-term emissions targets based upon road vehicles' life cycle emissions, as opposed to their tailpipe emissions.

LIFE CYCLE ASSESSMENT

THE CONCEPT OF LIFE CYCLES

Life Cycle Assessment (LCA) is a technique that calculates the environmental impact of a product by looking at its life holistically. Environmental impacts are broadly categorised under three headings: resource depletion, effect on human health and ecological impacts. (For the purpose of this position statement we are considering only the ecological impacts for LCA.) A typical product's LCA might begin with the extraction of its raw materials and end with its eventual disposal, re-use or recycling. Inputs and outputs of energy, materials and other factors are measured and compared at every stage. This allows stages with the most potential for improvement to be identified, and can show if an attempt to improve the sustainability of one stage will inadvertently negatively affect another.^[3]



LIFE CYCLE CO₂

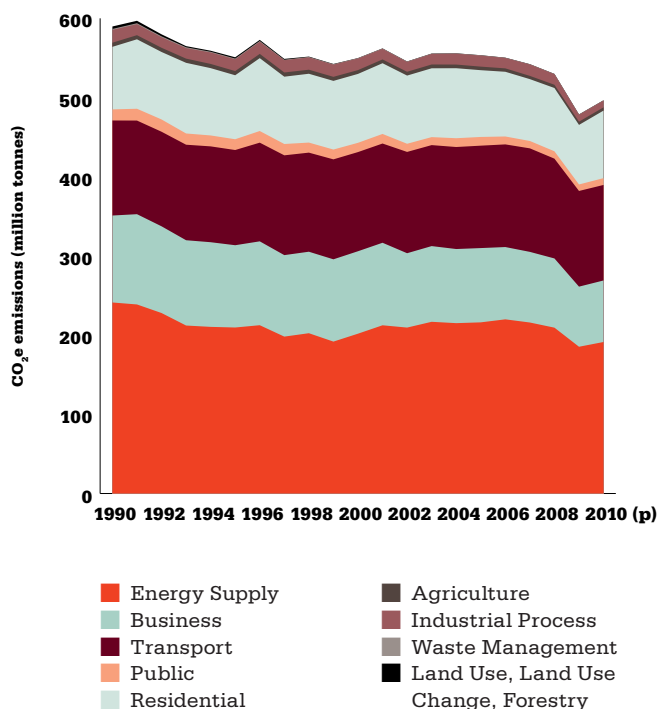
The consensus of climate scientists is that GHG emissions are one of the most critical environmental challenges. There are a variety of GHGs, including carbon dioxide (CO₂), methane and nitrous oxide. These can collectively be measured as their carbon dioxide equivalent (CO₂e). As 99% of the UK transport sector's CO₂e emissions are made up of CO₂,^[4] it is common to talk just about CO₂.

To continue reducing CO₂ emissions, the most cost-effective areas for reduction must be identified. While there are currently many methods of determining emissions, these focus on particular areas, such as the tailpipe test's measurement of local pollution. Performing an LCA can allow companies to map the emissions of their product, service or even entire business, and provide a better understanding of how these carbon emissions can be managed.^[5]

INTRODUCING LIFE CYCLE ASSESSMENT OF ROAD VEHICLES

Britain's transport sector accounted for approximately 121 million tons of CO₂e displaced into the atmosphere in 2010 when looking at the well-to-wheel of fuels used. This is about a quarter of the UK's total CO₂e emissions.^[6] About 90% of the emissions are attributed to road transport. Although a significant improvement can be seen in the actual amount emitted over the last few years, this is thought to be largely due to the recession, with no reason to suggest that this rate of decrease will be sustained once the economy rebounds. For the UK to meet ambitious targets of an 80% reduction in carbon emissions by 2050 (as compared to 1990), our methods of emissions measurement may be too simplistic. LCAs could provide a 'technology neutral' method, where a variety of powertrains are assessed on a level playing-field, without any bias towards supposedly greener technologies. Currently embedded CO₂ is not considered within the metrics and the targets that have been set. Introducing an LCA approach could help make meeting these targets more feasible. While a ubiquitous LCA methodology will be difficult to introduce before 2020–2025, work must now begin, indeed already has, for issues to be ironed out. That said, LCAs are by no means unachievable, as evidenced by the LCAs practised on biofuels, needed for the EU's Fuel Quality Directive.

UK CO₂e Emissions



TAILPIPE EMISSIONS

Currently, the main method for determining and regulating the CO₂ emissions of a vehicle is the Tailpipe CO₂ test. This measures the amount of CO₂ emitted from the exhaust during a controlled period of usage (called a drive cycle). This is translated into the average mass of CO₂ emitted per km driven. In the past this has been a reasonable estimation as the amount of fuel burned while in use has far outweighed (by about 80%) the energy use and emissions caused by manufacture and disposal. However, as cars become increasingly efficient at reducing their fuel consumption, and with the advent of fuel-cell and electric vehicles which are touted as producing 'zero-emissions at the point of use', it is clear that more holistic methods need to be implemented.

CURRENT AND PLANNED STANDARDS

One of the major problems with LCAs is comparing them with each other. The variables within the assessment comprise the boundaries, the data and the industry's allocation methods. For example in the manufacture of a car, the boundaries need to define whether to include the emissions of not only the steel factory and the other processes that go towards the production of the car but also the heating and lighting of the plant or the research and development, emissions, etc.

The Institution believes that the introduction of the Technology Innovation Centre (TIC) for Transport could oversee the consistent introduction of these standards, helping manufacturers implement them into their businesses. The Transport TIC could regulate the databases holding information on manufacturing process. This TIC could also ensure that an LCA approach is disseminated across the sector.

Two LCA approaches could demonstrate different results if not regulated. Then, if information about the carbon emissions of particular factories is not available, data from a secondary source would have to be used. There being a large number of publicly available and proprietary databases covering similar areas, it is possible to find conflicting figures for the same estimation. If, as is invariably the case, the factory serves a number of different manufacturers, how are the plant's emissions divided up? To solve problems like these, various standards exist, or are being developed. In general, these help comparison between products that have followed the same standard, but are not as yet entirely comparable with each other. Additionally, while the standards address issues such as boundaries, they still allow scope for variation in the data used, as they are not prescriptive.

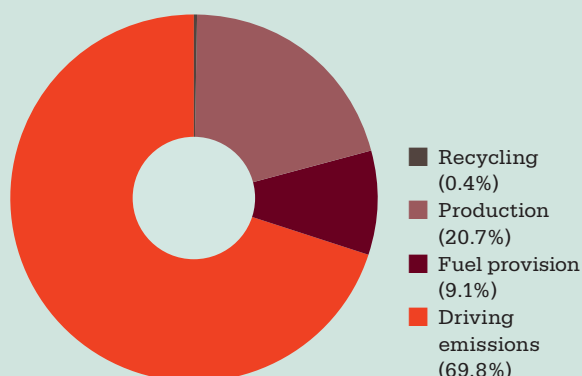
The main standards currently used or under development are:

- PAS 2050: A Publicly Available Specification released in 2008 by the British Standards Institute, and revised in 2011. This is based on LCA methodologies but considers only GHG emissions. Companies that follow its guidelines can be certified by UKAS, the UK Accreditation Service.^[8]
- ISO 14040/14044: These standards, released by the International Organization for Standards, are intended to define how a LCA can be carried out by a company. While not specifically aimed at determining the CO₂ emissions of a product, they can and have been used as a framework for assessment.^[9,10]
- ISO 14067: This standard is being developed in line with ISO 14040/44 to specifically address emissions LCA. Much like PAS 2050, it will additionally specify how to determine the emissions of an entire company.^[11]
- GHG Product Standard: Released in October 2011, this focuses on life cycle emissions and addresses the LCA boundaries.^[12]

LIFE CYCLE ASSESSMENT OF THE VOLKSWAGEN PASSAT 2009 CASE STUDY

Manufacturers are starting to introduce LCAs, but many choose to keep the results as internal documents. For several of the vehicles in their range, Volkswagen produces an 'environmental commendation'. This is an LCA that, as well as carbon emissions, measures the car's contribution to summer smog, ozone-depleting gases and eutrophication (excessive plant growth in a lake, river or ocean which can be caused by human pollution).

Volkswagen claims that the total emissions from a full life cycle of the Passat Estate 2.0 TDI are 22.2 metric tonnes. The majority of this (about 70%) is produced while the car is in use.^[7] Volkswagen is proud of the fact that it has lowered the total emissions of the car by about 10%. However, emissions caused by the car's production have slightly increased compared to the previous model, mainly due to the complexity of improving the car, as well as the improved fuel efficiency. While over its life cycle the newer model still produces fewer emissions, if current trends continue, then decreasing the production emissions is clearly going to become an issue, and one that will greatly benefit from a full LCA.



UK GOVERNMENT POLICIES

Current Government legislation focuses on specific aspects of vehicles' life cycle emissions.

- The EU's Fuel Quality Directive sets targets for the usage of biofuels in road transport, encouraging the increase of their mix in petrol and diesel. These biofuels, 'from-well-to-wheel' typically produce 35–50% less greenhouse gas than their conventional equivalent, although variances can be so great that the production of some biofuel causes more emissions than the fuel it would replace.^[13]
- The EU's Renewable Energy Directive has set specific targets for transport. The aim is that 10% of energy for transport is produced by renewable by 2020.^[14]
- The 'Tailpipe CO₂' targets set by the EU require manufacturers to keep the average CO₂ emissions per km of their fleet below a certain amount – (130g/km for 2012). Any greater, and the manufacturer is fined according to a sliding scale. In 2012, for exceeding the target by 1g of CO₂ a fine of €5 per car made will be levied, and for exceeding the target by 3g, €45 per car.^[15] These costs are not inconsiderable, and are likely to have an increasing impact on both the manufacturer and the consumer.
- Once the vehicle reaches its end of use, it is required by the EU End-of-Life Directive to be recyclable. Currently 85% of a new car must be reusable or recyclable and this is set to increase to 95% in 2015. Curiously there is no limit set for the energy needed to achieve this recycling target, or indeed the carbon emissions produced along the way.^[16]

This legislation can have unintended consequences on areas of the car's life cycle. When engineers design more efficient cars that conform to strict CO₂ emissions limits, they sometimes have to increase the complexity of production, and by doing so, increase the emissions at the start of the life cycle. These are not currently taken into account, and therefore the actual emissions reduction cannot be known. Likewise, by encouraging the recycling of the car at its end of life, legislation may encourage the increase of more intensive production techniques to achieve overly simplistic targets.

By implementing the LCA approach, and incorporating this into vehicle emissions policies, regulations could be simplified. The displacement of emissions from one sector to another could be reduced or identified, and the export of emissions to other countries could also be identified. Government must work with manufacturers to look at how a change in legislation and introduction of LCA can help improve their businesses, creating opportunities for innovation and tax incentives. Savings of emissions in one area could be used to offset emissions in another.

COMMUNICATION

Car manufacturers must determine their life cycle emissions not only for their own benefit, but also for the consumers. A unified method of comparing cars is required to help the consumer confidently include the impact that their new vehicle will have on the environment into their purchasing criteria.

The new 'ISO 14067' specification includes in its remit a standard of communicating the carbon emissions of a product to the consumer. If followed, this could provide consistency between manufacturers, and ease consumer decision-making.

In the UK, the Vehicle Certification Authority (VCA) is responsible for maintaining a database of the fuel consumption and CO₂ emissions of virtually all car types. A voluntary scheme is in place for car dealers to print off an easily recognisable label displaying the emissions data and fuel consumption of a particular car, and which tax band this places it in.

In the next few years, vehicle taxation methods will have to move away from the current focus on tailpipe emissions. As the mix of vehicles increases, (petrol, diesel, fuel cell, hydrogen, synthetic and biofuels to name a few) a new approach in the way users are taxed will be needed to reflect the life cycle of their vehicles.

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CONCLUSIONS AND RECOMMENDATIONS

In summary, the Institution of Mechanical Engineers urges Government to adopt the following recommendations:

- **Announcement of a Technology Innovation Centre (TIC) for Transport in 2012. This TIC would agree the agenda for a framework that defines the methodology for calculating the LCA metrics.** This would include the detail of boundary conditions (what is included and what is excluded) and a common default database for manufacturing processes. The Institution believes that managing this metric through a TIC would encourage a holistic approach to LCA across all modes of transport. The TIC would work with vehicle manufacturers understanding current LCA practice. It would also provide a UK platform and set out our position to the EU and rest of the world.
- **Enforce the implementation of LCA legislation by 2015.** This approach will ensure that we do not move the environmental impact of vehicles from the use phase, where it is currently tightly controlled, to another part of the life cycle. Using an LCA methodology allows industry to be technology-neutral. It would have no bias towards petrol, diesel, electric, synthetic, biofuels or fuel-cell cars etc, encouraging a greater range of methods and innovation.
- **Review current vehicle taxation by 2015.** Taxation of vehicles should reflect long-term emissions targets based upon road vehicles' life cycle emissions as opposed to their tailpipe emissions. In 10 to 15 years' time, the ability for companies to meet targets by lowering their emissions at any stage of a vehicle's life cycle will be advantageous. With a fleet made up of a growing number of zero-emissions cars and therefore tailpipe tests becoming irrelevant, LCAs can measure the impact of their manufacture. This must therefore be reflected in the current vehicle taxation system.

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