Life Cycle Assessment Case Study
Compact Car Reference

BACKGROUND

Life Cycle Assessment (LCA) is a methodology that considers a vehicle's entire life cycle, from material and vehicle production (manufacturing phase) through its lifetime on the road (use phase) to the end-of-life disposal (end-of-life phase), as well as the life cycle of its fuel sources.

Current regulations in discussion around the world are focused on measurement of tailpipe emissions only, which is a reflection of the use phase. However, it is not just vehicle use that generates GHG emissions, but all of its life cycle stages. Emphasis on the use phase alone ***may have the unintended consequence of increasing GHG emissions during the vehicle life.***

An LCA approach assists automakers in evaluating and reducing the total energy and lifetime GHG emissions of their products. Some manufacturers, such as Volkswagen and Mercedes, are using LCA to evaluate the contribution of materials and design decisions to total vehicle lifetime emissions. Their objective is to assess possible driving phase improvements against manufacturing phase and end-of-life disadvantages associated with GHG-intensive materials such as aluminium, magnesium and plastics.

WorldAutoSteel is actively pursuing the advancement and support of life cycle thinking in the world today because we believe it is the only way climate change can truly be addressed for meaningful impact.

To investigate the aspects of material selection on automotive LCA GHG emissions, a study entitled *The Impact of Material Choice in Vehicle Design on Life Cycle Greenhouse Gas Emissions - The Case of HSS* and *AHSS versus Aluminium for BIW applications* (see www.worldautosteel.org (click LCA Study) was conducted at the University of California Santa Barbara (UCSB) Bren School of Environmental Science and Management and a peer-reviewed LCA model for material comparisons was developed.

LIFE CYCLE ASSESSMENT PARAMETERS

Consider two case study examples based on a C-Class vehicle with a gasoline internal combustion engine. Fuel savings and driving cycles, key parameters in the The UCSB GHG Automotive Material Comparison model, are based on studies conducted by Forschungsgesellschaft Kraftfahrwesen mbH Aachen (fka), which can be downloaded at www.worldautosteel.org (click Projects/Weight Elasticity).

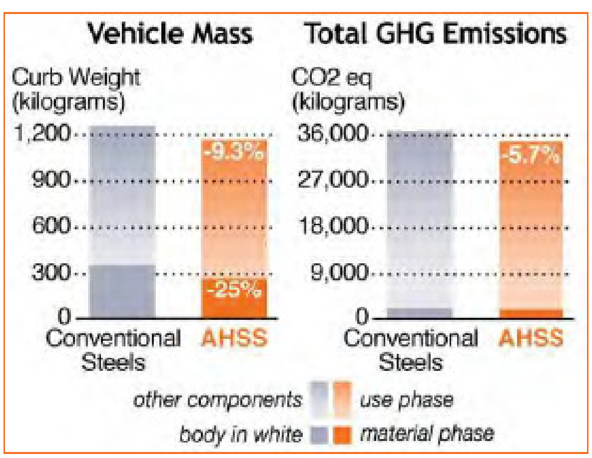

Figure 1a: Life Cycle GHG Comparisons – Conventional Steel and AHSS

Case #1: Replace Mild Steel with AHSS

Based on benchmarking studies by fka and AISI, a 25% mass reduction in the body-in-white is possible using an optimized design with AHSS. When secondary mass savings are factored, the net is a 9.3% reduction in total vehicle curb weight. Inputting this data into the UCSB model, the lighter weight AHSS body structure achieves CO_2 emissions reductions in both the material production and use phase so that the vehicle's total life cycle emissions are reduced 5.7%, compared to a vehicle with a conventional steel body structure (Figure 1a). This is accomplished at no additional cost.

Case #2: Compare AHSS to Aluminium

The UCSB model also compared an optimized aluminium design with the AHSS design (Figure 1b). In this scenario, 11% further mass reduction in the body-in-white was achieved with this GHG-intensive material. However, the additional mass savings come at a cost to the environment, as the UCSB model shows a net increase in total vehicle lifetime emissions equalling 2.6%. Furthermore, this environmental burden also comes with a significant cost penalty, estimated as high as 65%. The study concludes that when Life Cycle Assessment is used to comprehensively evaluate automotive materials impact on the environment, AHSS is an easy choice.

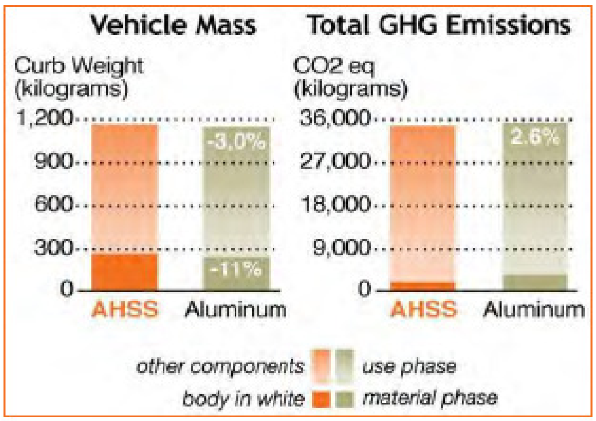

Figure 1b: Life Cycle GHG Comparisons – AHSS and Aluminium

In reality, the preferred material depends on the assumptions and inputs into the UCSB model, based on the specific application and manufacturing processes; there are sets of assumptions where the conclusion above could be reversed. The model is appealing because it is highly parameterized, user-friendly, and very transparent.

FURTHER CONCLUSIONS

The impact of material production and recycling on LCA GHG emissions are relatively small compared to total emissions; significant improvements will not be made by material substitution alone.

Using the LCA approach, comparisons can be made among other advanced automotive technologies, such as powertrain, fuel choices and driving scenarios that are emerging into mainstream automotive choices. Figure 2 compares an AHSS body to an aluminium body for a compact car, and the cumulative impact of advanced technologies on lifetime vehicle emissions (in CO2e). The use of advanced powertrains (such as hybrids), advanced fuels (such as grain and cellulose ethanols) and improved driving cycles (such as the implementation of timed lights and roundabouts) can result in a dramatic reduction in use phase emissions, making the material choice much more relevant. Thus, as other green technologies that improve vehicle GHG emissions are implemented in mainstream vehicle designs, the emissions from material production will become more important, placing greater emphasis on selecting a low GHG-intensive material, such as steel.

Figure 2: Lifetime vehicle emissions of a compact car, based on materials, fuels and powertrains.