The Role of Steel in Reducing Energy Use and Life Cycle Greenhouse Gas Emissions

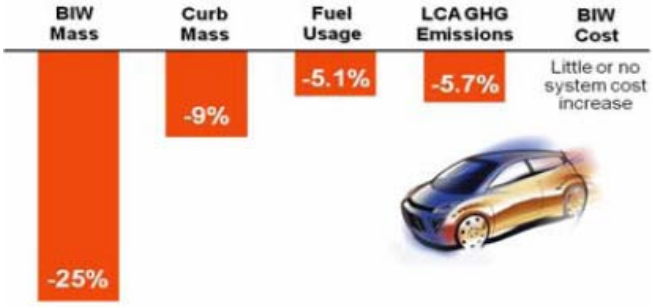
Introduction

As the consensus builds for comprehensive reductions in greenhouse gas (GHG) emissions across international boundaries and industries, there is a growing need to understand the role that materials play in achieving a low carbon society. The steel industry has made significant reductions in energy use and is committed to take positive action to achieve further reductions in CO2 emissions [1]. Through use of its products, the steel industry also helps sectors tackle the problem of rising GHG emissions.

One example is the introduction of lighter and higher strength grades of steels for various vehicle applications.

New Steel Grades in Vehicles

Most automotive structures utilize steel due to its great combination of durability, safety, weight and strength. New grades of Advanced-High-Strength-Steel (AHSS) have replaced conventional steels for a vehicle's body structure or body-in-white (BIW), resulting in typical weight savings of 25% [2]. This corresponds to an estimated total vehicle weight reduction of 9%, with an impressive reduction in fuel consumption.



Automotive GHG Emissions

Active legislation in the automotive industry has focused on the need to reduce use phase (tailpipe) emissions during the driving life of vehicles, and this is commonly achieved through weight reduction. However, tailpipe emissions don't tell the complete story, and competitive materials selected for use phase emissions reduction may not be the best choice for reducing overall energy use and the impact on the environment.

The Life Cycle Benefits of AHSS

Life Cycle Assessment (LCA) has been adopted by the steel industry as a means to comprehensively evaluate material choices, and their effect on life cycle greenhouse gases (GHGs). Major automakers such as Toyota and Daimler/Mercedes-Benz are also adopting LCA as a tool for design and material selection decisions. LCA models developed by the University of California at Santa Barbara have enabled comparisons of automotive materials and their associated GHGs across all phases of the vehicle cycle from material production, manufacturing and use phase along with recycle credits based on material recycling characteristics [3]. From these models, we've determined:

- For every 1 kg of AHSS used in the vehicle there is a total life cycle saving of 8 kg CO2 equivalents.

- If all vehicle bodies produced globally were fabricated with AHSS the annual emissions savings is estimated to be 156 million tonnes of CO2 (this is about equivalent to the amount of CO2 that is absorbed each year by 68000 square kilometers of forest [4] – an area approximately the size of The Republic of Ireland).

- Material choice becomes even more significant for vehicles using advanced powertrains and fuel sources.

Applications of LCA in vehicle design often show that steel is the lowest generator of greenhouse gases in comparison to competing materials.

LCA methodology has been sometimes overlooked by legislators/regulators concerned primarily with the use phase (i.e. vehicles' tailpipe emissions). Yet, as we move towards electric and plug-in hybrid and fuel-cell vehicles, material selection and LCA become even more essential to provide a comprehensive solution to global GHG emissions.

Other Steel Solutions

The use of AHSS in vehicles is just one example of where steel is contributing to a reduction in the use of fossil fuels. An efficient transport infrastructure is also heavily dependent on steel bridges and rail networks to reduce transport times and distances without compromising fuel consumption.

Renewable energy technologies, such as wind turbines, benefit from the strength of steel to reach heights where there are greater wind speeds and as a consequence produce more wind power [5].

- Energy used in the construction of a wind turbine is typically recovered within 6-9 months of the turbine operation.
- The weight of steel towers has been reduced by 50% over the last 10 years.

Conclusions

- Life cycle thinking needs to be applied when it comes to material selection decisions based on improving GHG's.
- The use of steel will play an important role in contributing to a low-carbon society.

References:

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[2] ULSAB research (WorldAutoSteel), automakers own body structure designs in recent years.
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[4] http://www.treesftf.org/resources/Calculating%20CO2%20Sequestration%20by%20Trees.pdf
[5] worldsteel environmental case studies, www.worldsteel.org