Consequential Life Cycle Greenhouse Gas Study of Automotive Lightweighting with Advanced High Strength Steel (AHSS) and Aluminum

EXECUTIVE SUMMARY

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Automakers in the U.S. have used vehicle weight reduction ("lightweighting") as one of many strategies to comply with mandated federal fuel efficiency targets. This strategy often involves substituting one material for another; for instance, replacing mild steel with aluminum or replacing mild steel with advanced high strength steel (AHSS). This lightweighting process typically results in improved fuel efficiency and a corresponding reduction in greenhouse gas (GHG) emissions from the vehicle's use phase. However, such lightweighting doesn't necessarily result in an overall GHG savings, since the production phase emissions for some lightweighting materials can counteract the improvement in the tailpipe or use phase.

Aluminum is one of the materials that is often considered for lightweighting applications, and in North America, the Aluminum Association has projected a significant increase in the use of aluminum in vehicle body and closure panels. [1] The Steel Recycling Institute (SRI) and Steel Market Development Institute (SMDI), both business units of the American Iron and Steel Institute (AISI), conducted this study to assess the GHG emissions consequences of an increase in the use of aluminum equal to that projected by the Aluminum Association, and alternately, to assess the GHG emissions consequences of using AHSS instead of aluminum to lightweight the same vehicle fleet.

These consequences were assessed using a spreadsheet model (hereinafter referred to as the Model) developed by Dr. Roland Geyer, PhD, Associate Professor, Bren School of Environmental Science and Management, University of California at Santa Barbara. The report describing the model is titled *"Consequential Life Cycle Assessment (CLCA) of Replacing Steel with Aluminum in Vehicles: User Guide and Final Project Report",* dated February 26, 2016. The Model and referenced report were independently reviewed by a three-person panel. (See Appendix A for a copy of the report and review letter.)

The CLCA was conducted according to the requirements of ISO 14044:2006. Strictly speaking, this study is a consequential life cycle greenhouse gas emissions (assessed as global warming potentials, or GWP-100) assessment. However, for simplicity the acronym "CLCA" is used in this report. It is also important to keep in mind that ISO 14044 was written with attributional life cycle assessment (ALCA) in mind and therefore some interpretation may be necessary when it is applied to CLCA.

The goal of this study is to identify and quantify the main GHG emissions consequences of a significant increase in the use of aluminum for vehicle body and closure parts, and compare these consequences to the GHG emissions consequences of the use of AHSS for the same parts, as part of an overall vehicle fleet lightweighting strategy. The study considers light-duty vehicles produced in North America between 2015 and 2053.

Four sets of consequences are modeled in the study:

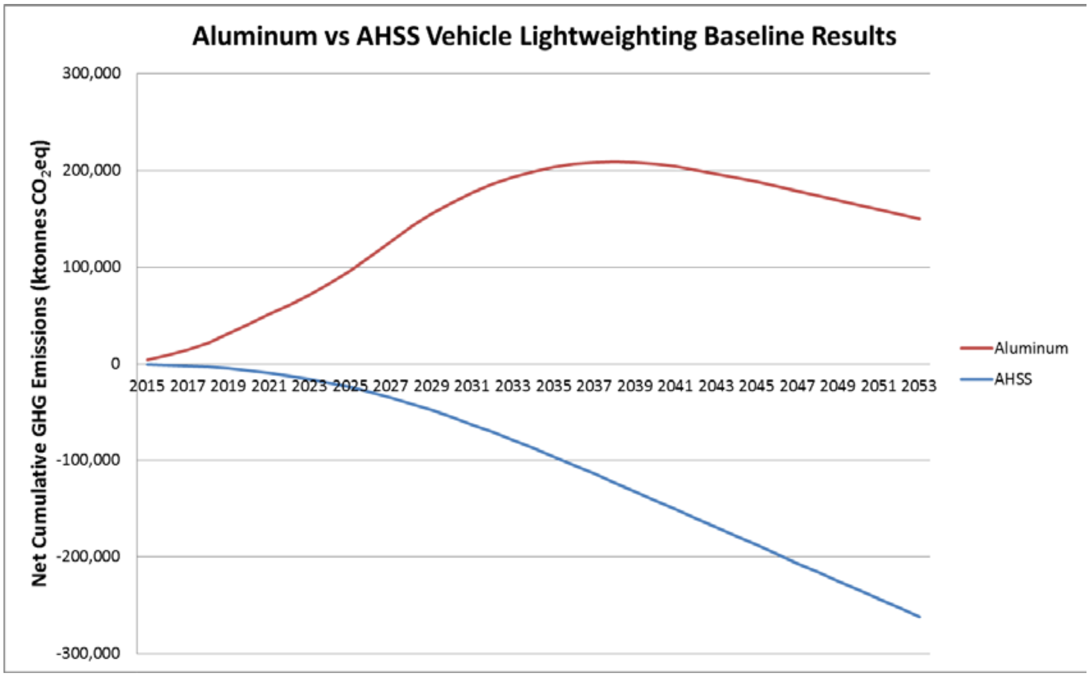
1) Changes in the production levels of the steel and aluminum used in the modeled body and closure parts, as well as secondary mass savings associated with these production level changes;
2) Changes in the fuel economy of the vehicles due to mass reduction;

[1] Ducker Worldwide. "Aluminum Content in North American Light Vehicles 2016 to 2028." Summary Report prepared for the Aluminum Association. July 2017. http://www.drivealuminum.org/research-resources/ducker2017/.

3) Changes in the generation and use of steel and aluminum scrap from material forming processes; and,
4) Changes in the generation and use of steel and aluminum scrap from vehicle end-of-life management.

In order to develop the data required for the intended comparison of an increase in the use of AHSS vs. aluminum, the Model's calculations are run separately for two different sets of assumptions. All basic input data is the same for both Model runs, except for the production levels of AHSS or aluminum.

The baseline results of the assessment can be seen in the following graph:



The graph shows the GHG consequences of the baseline comparison. In short, the projected increase in the use of aluminum for lightweighting of body and closure parts results in peak cumulative GHG emissions of approximately 209 million metric tons, while a similar increase in the use of AHSS results in an immediate and sustained decrease in overall GHG emissions. In this baseline case, at the time of the peak increase in emissions for the aluminum option (approximately Year 2038), the difference in GHG emissions between the two options is approximately 332 million metric tons. This net difference continues to grow throughout the study period until it reaches over 411 million metric tons in 2053. In other words, a significant increase in the use of aluminum for lightweighting of light-duty vehicles, as described in this report, results in an increase in overall GHG emissions of over 330 million tons in approximately 20 years time, when compared to similar lightweighting of the same vehicle fleet with AHSS.

These results are based on baseline data and inputs. This study includes numerous sensitivity scenarios which are described in Section 4.5.