LCA OF COMPOSITE TRAIN, BUS AND COACH PARTS

CONTEXT

As part of a project, financed by the NSERC, Bombardier, Novabus, Prevost and Composites BHS, the CIRAIG was selected by the CDCQ to support the assessment of the environmental impacts of thermosetting composite materials. The objective of the project was to establish the environmental profiles of different parts made of composite and alternatives for passenger transportation vehicles (train, bus and coach) powered by different energy sources (electricity, diesel, hybrid).

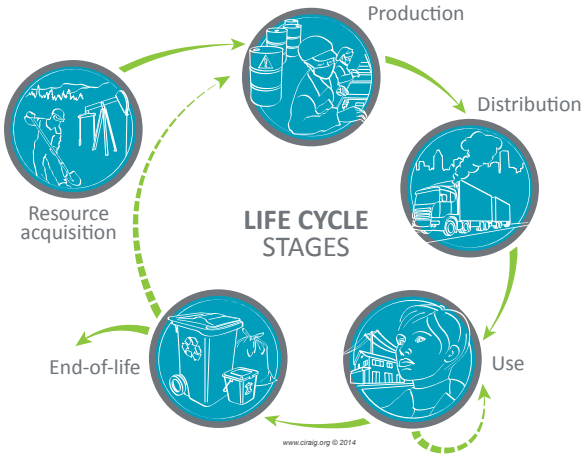
WHAT IS A LIFE CYCLE ASSESSMENT (LCA)?

Life cycle assessment (LCA) is a tool based on the life cycle approach, for the assessment of the potential impacts of a product or service throughout its life cycle, from the extraction of raw materials until end-of-life.

This analysis leads to more sustainable decision making, by avoiding moving problems across the value chain, or from one impact category to another.

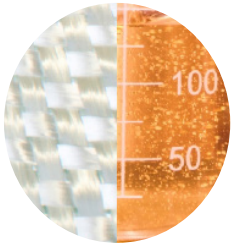
WHAT CAN WE DO WITH THE RESULTS?

- Understand the environmental profile of the parts studied: What are the impacts and where do they come from? What parameters influence the profile the most?
- Compare the alternatives to composites;
- Identify opportunities to reduce the environmental impact of a part through its life cycle.

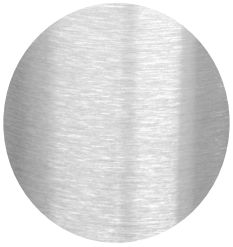


Many parts (interior liner and structural) and materials were assessed (all the combinations are not presented):

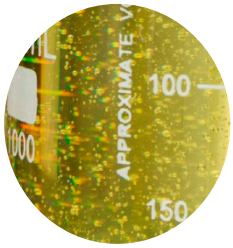
1. POLYESTER RESIN FIBERGLASS COMPOSITE



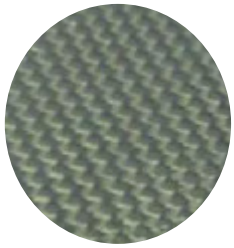
2. PHENOLIC RESIN FIBERGLASS COMPOSITE



3. ALUMINIUM



4. DICYCLOPENTADIENE RESIN (DCPD) RIM PROCESS



5. CARBON FIBER COMPOSITE

This LCA covers all the stages of the parts' life cycle, from the production of raw materials and the manufacturing process until the end-of-life, including assembly and use (operation of the vehicle).

ASSESSMENT OF THE ENVIRONMENTAL PERFORMANCE

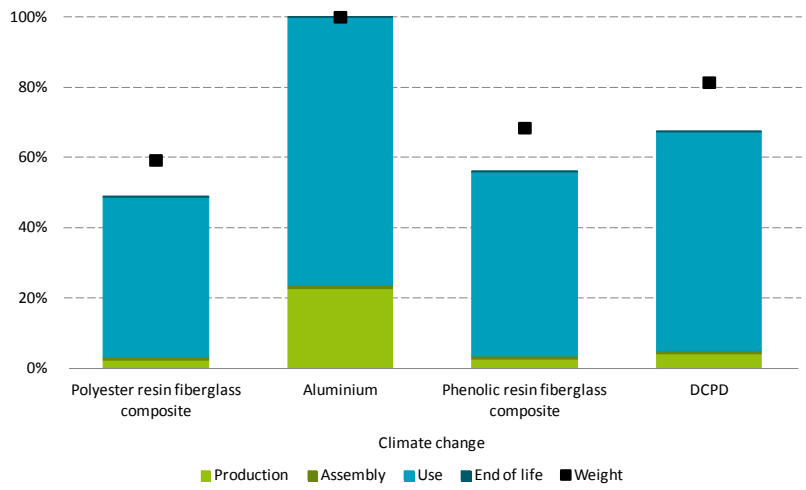
The environmental performance of the different parts is assessed according to four indicators: Climate change, Human health, Quality of the ecosystems, and Resources.

STUDY RESULTS: ENVIRONMENTAL PROFILES

For each part assessed, the life cycle stage with the greatest contribution to the indicators is the utilization phase (use stage), with over 80% of the total score for each environmental performance indicator (attributable to the consumption of energy necessary for the transit of the part during the operation of the vehicules):

- This contribution is due mainly to the extraction and combustion of fossil resources (mainly petrol, coal and natural gas) for the production and consumption of electricity or diesel;
- The weight of the parts is the parameter that has the greatest influence over the environmental profile: the heavier the part, the higher the score.

The following illustration presents the relative results for the Climate change indicator of the scenarios for one of the parts studied as well as its relative weight (100% corresponds to the higher case).



A FEW HIGHLIGHTS

- With an identical weight, aluminium presents fewer advantages than fiberglass based composites, from a life cycle assessment perspective. This is caused by the higher energy consumption required for its production;
- The environmental score of the parts is largely affected by the process used to produce the electricity needed to propel the vehicle. Thus, vehicles operated in Quebec which use hydroelectricity, an energy source with less environmental impact, will show a lower contribution score for the utilization phase and therefore will greatly reduce the overall environmental score. This gives more relative importance to the production phase, but the overall recommendations remain the same;
- The end-of-life of parts is among the less sensitive parameters. Indeed, recycling and the potential valorization of parts marginally improves their environmental profile and bear no impact on the conclusions of the LCAs.

RECOMMENDATIONS

- Whatever the material, optimize the part based on the load path to reduce its weight;
- For parts with similar weights, choose fiberglass based composites over aluminium;
- Moreover, marginal improvements over the life cycle can be obtained by:
  a) Prioritizing end-of-life management sectors that generate coproducts that can be valorized (these sectors, such as recycling can also be preferable from a societal and economic viewpoint);
  b) Increasing parts' service life.

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