



# A Comparative Life Cycle Assessment of Magnesium Front End Autoparts

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-GHG emissions

-Primary energy

45.2 kg Mg OR 61.0 kg Al front end parts

82.2 kg steel front end parts

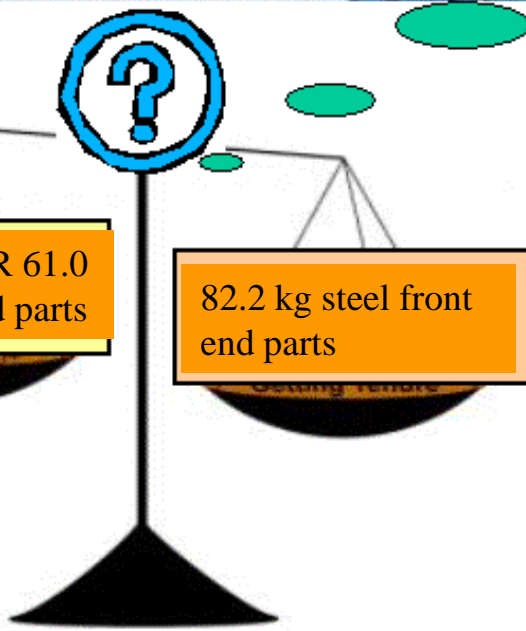


Photo: 2007 Cadillac CTS



# Introduction

## Magnesium Front End Research and Development (MFERD) Project

- Collaborative effort of Canada, China & USA
- R&D project to develop technologies and demonstrate application of magnesium autopart
- The aims are: to improve fuel economy, stimulate magnesium demand, develop value-added magnesium products
- Total cost of the Phase 1 of the MFERD Project: : \$9M

Steel, magnesium



Paper #2010-01-0275



# Introduction

## Goal of the study

The goal of this LCA study is to compare the environmental performance of the current steel design for the front end parts of a Cadillac CTS with new magnesium and aluminum designs. Magnesium and aluminum designs while maintaining the same safety performance are lighter and thus improve the fuel economy.

## Scope of the study

The scope of the study is limited to North America with the exception of the primary production of alloys who are occurring globally. The environmental aspects that are considered are the total primary energy, the greenhouse gases emissions ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$  and perfluorocarbons) and criteria air pollutants (particulates,  $\text{NO}_x$ ,  $\text{CO}$ , non-methane volatile organic compounds,  $\text{SO}_x$ ).



# Introduction

## Project Objectives

- To compare the potential environmental impacts including greenhouse gases (GHGs) emissions and the energy efficiency associated with current and advanced auto parts.
- To support policy development. LCA data will be used to model the effects of technology and material change on global and North American GHG emissions.
- To increase the environmental relevancy of decisions making by the car industry.
- To identify potential GHGs reductions and energy improvements.



# Introduction

## Functional Unit

The transportation service of front end parts equivalent to 82.2 kg front end parts made of steel, used in a GM-Cadillac CTS (including end-of-life), built and driven for 200,000 km in North America. It includes safety performance at 5-star frontal, offset and side impact crash ratings.



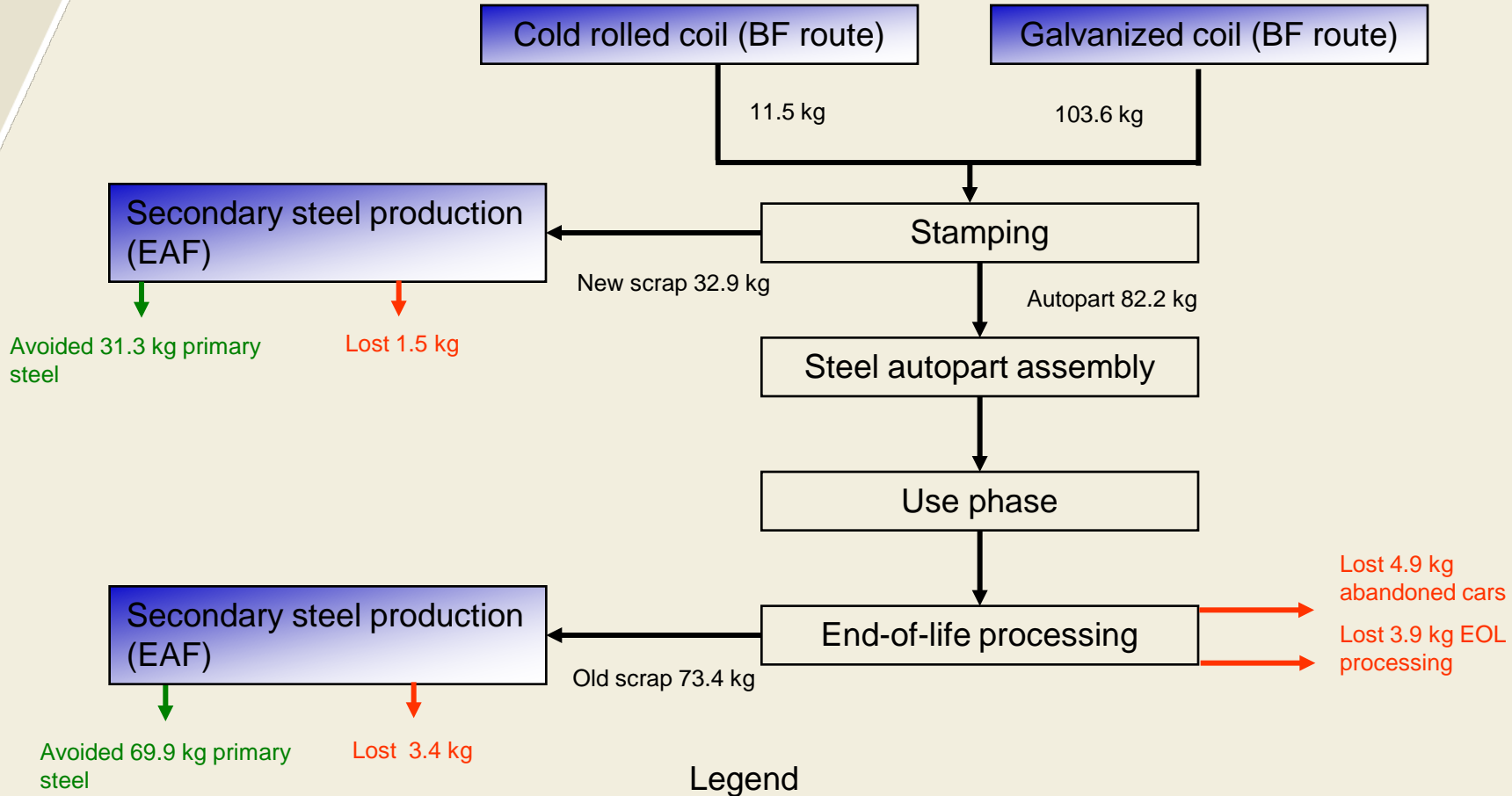
# Reference Flow

Material	Forming technology	Alloy	Weight (kg)	Comments
Steel	Stamping / Hot dip galvanized coil	n/a	74.0	
	Stamping / Finished cold rolled coil	n/a	8.2	
	<b>Total (steel)</b>		<b>82.2</b>	
Magnesium	Die-casting	AM60B	30.3	6% Al, balance Mg
	Stamping	AZ31	4.1	3% Al, 1% Zn, balance Mg
	Extrusion	AM30	10.8	3% Al, balance Mg
	<b>Total (magnesium)</b>		<b>45.2</b>	
Aluminum	Stamping	AA 5754	29.8	3.2% Mg, balance Al
	Casting	A 356	16.1	7.6% Si, 0.35Mg, balance Al
	Extrusion	AA 6061	13.4	1.6% Mg, balance Al
	Hydroforming	AA 6061	1.7	1.6% Mg, balance Al
	<b>Total (aluminum)</b>		<b>61.0</b>	





# Simplified Material Flow for Steel Front End



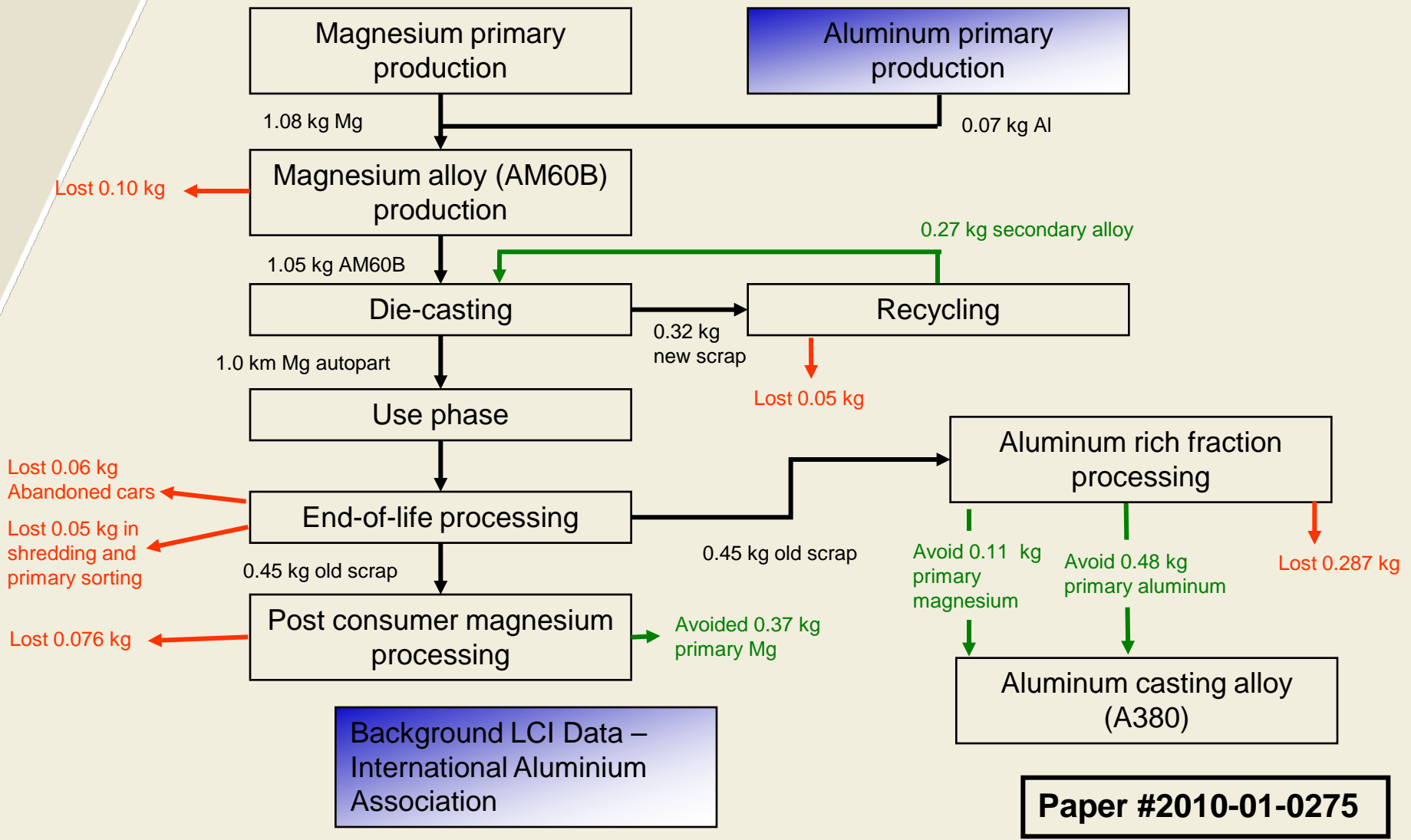
**Legend**

- Project specific LCI Data
- Background LCI Data - wordsteel

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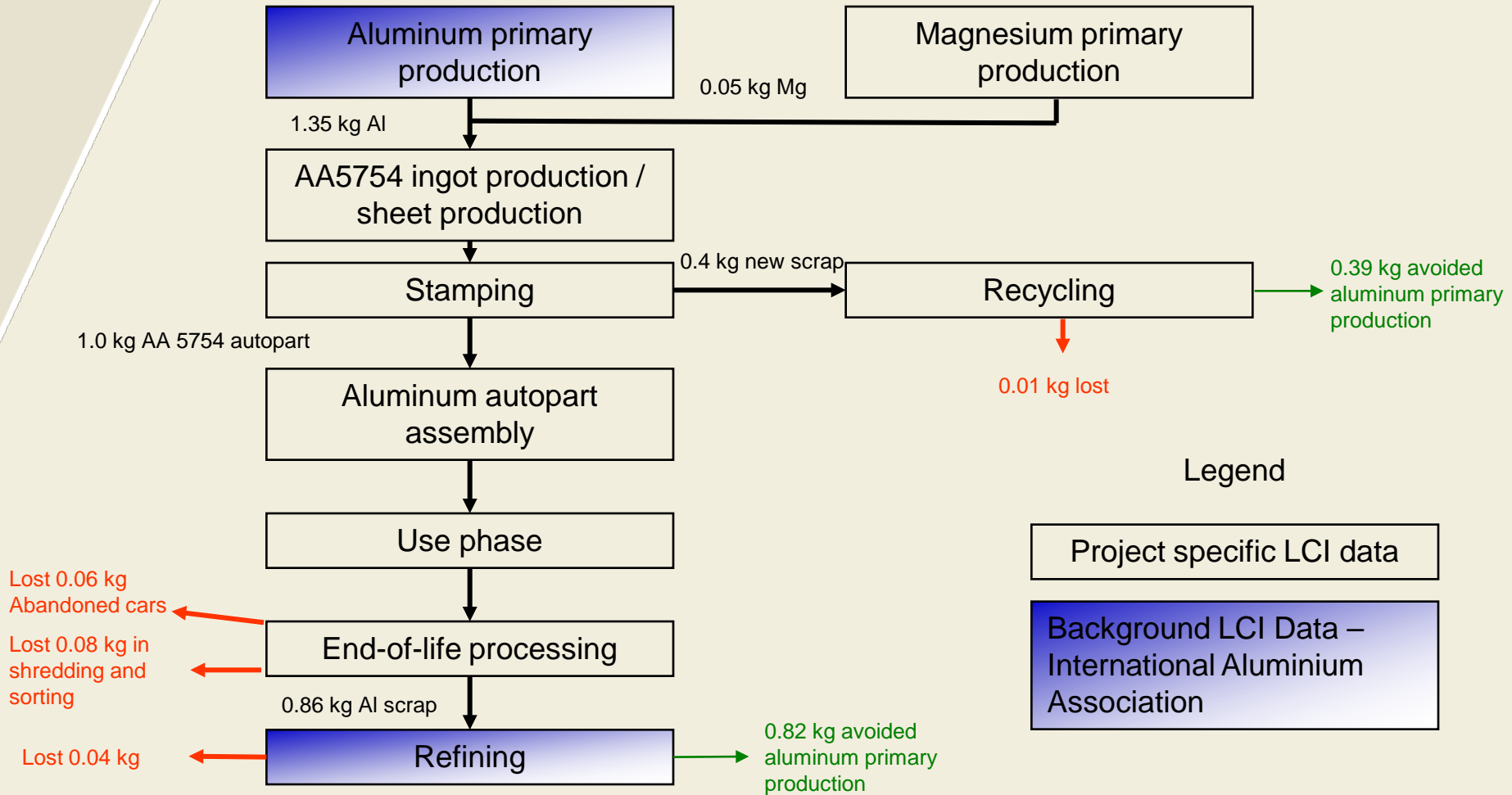


# Material Flow for 1 kg of AM60B in Autopart





# Material Flow For 1 kg of Aluminum AA5754 Alloy



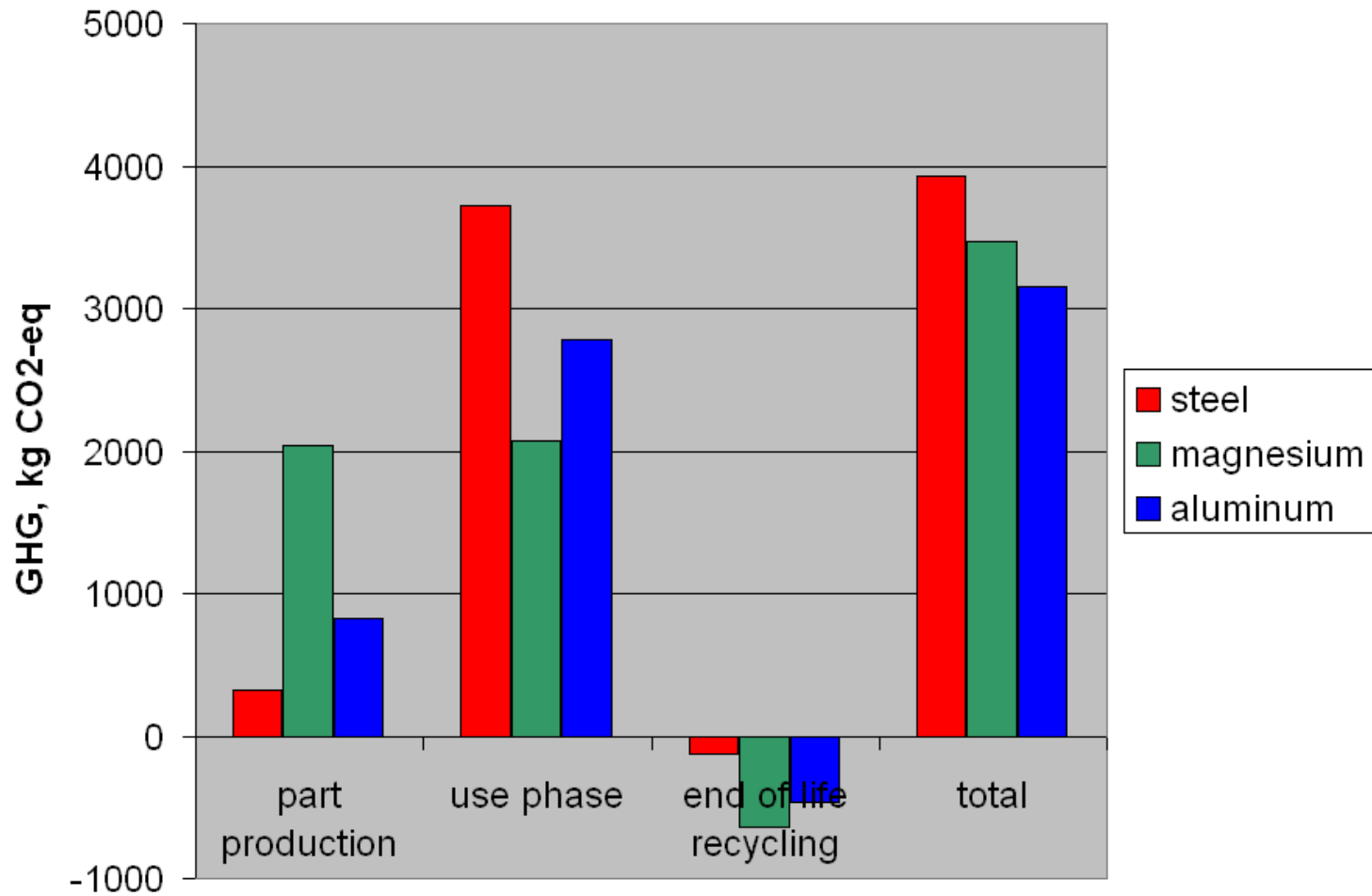


# Use Phase

- The fuel economy model considers the secondary weight savings on other part of the vehicle (transmission, power plant) in a continuous way.
- The use phase considers the energy and environmental emissions associated with the production of the fuel.
- Using the steel design as a baseline, over the life of the car (200,000 km) the fuel saving are:
  - For magnesium: 507 liters
  - For aluminum: 289 liters.

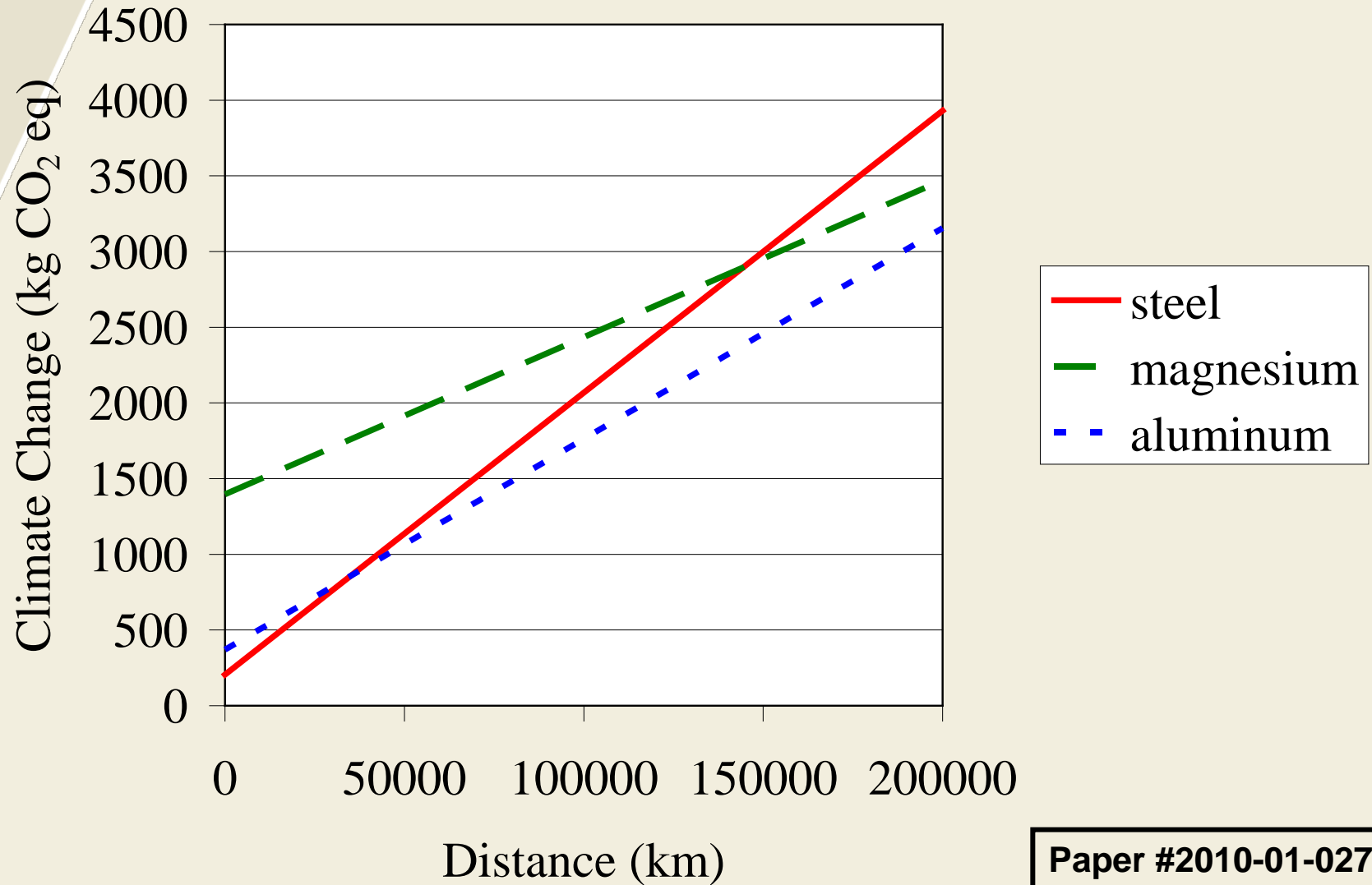


# Climate Change Emissions for Different Stages in the Life Cycle



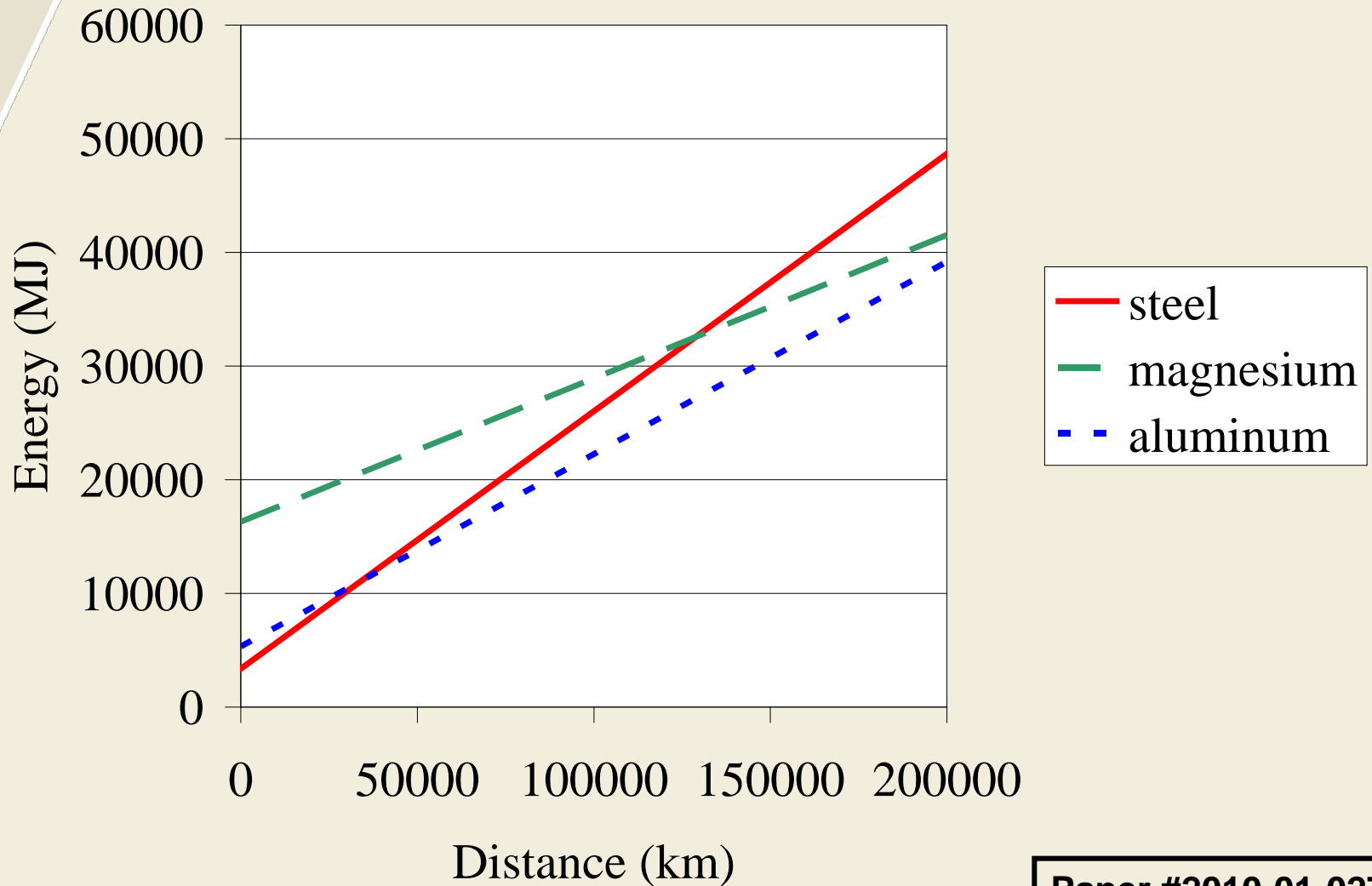


# Climate Change Emissions in Function of the Distance





# Total Primary Energy in Function of the Distance





# Conclusions

- The study is considering the current state of the technology and use world average for primary metal production.
- The impact for the use phase is directly proportional to the weight of the autopart.
- For the end-of-life, a “closed-loop” approach is used: recycling the scrap will avoid the need to produce primary metal.
- Magnesium can provide benefits in term of primary energy use and GHGs emissions vis-à-vis steel.
- Aluminum presents the best perspective in term of primary energy and GHGs emissions.
- For magnesium, in order to take a leading position, improvements are required both at the primary metal production and the end-of-life recycling processes.



# Acknowledgement

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