Comparative Life Cycle Impact Analysis of Recycled Tire Products vs. Alternatives

Prepared for Brave Soles by Green Story Inc.

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Analysis Overview

Objective

- The objective of this study is to compare the impact of Brave Soles recycled tire products against conventional alternatives:
  - Recycled tire footwear soles vs. synthetic rubber footwear soles
  - Recycled tire/leather combination bags vs. pure leather bags

Intended applications

- The findings of the study are intended to be used as a basis for external communication. The primary audience for this study is Brave Soles and its customers

Study Scope and Boundaries

- This cradle-to-grave comparative life cycle inventory (LCI) encompasses entire lifecycle from raw material acquisition to product manufacture, all intermediate transportation steps and end of life. All relevant life-stages of synthetic rubber and recycled tire are analyzed to estimate the net impact across 3 key impact metrics: GHG emissions, primary energy demand, and water consumption
- Functional unit is 1 kg of outsole material used in flat sandals and 1 kg of material used in bags/wallets
- The study examined manufacturing of all recycled tire products in Dominican Republic, synthetic rubber soles in China and pure leather products in India. Usage and disposal of all products are modeled in Canada
- Impact from product use and packaging was not considered in the study

Disclosure and Declaration

- This analysis does not include impact assessment. It does not attempt to determine the fate of emissions, or the relative risk to humans or to the environment due to emissions from the systems. An exception is made in the case of global warming potential impacts
- No audit of data or third-party critical review has been performed for this study

Analysis Overview (cont.)

Common assumptions used throughout the analysis

- Use phase impact is not part of the comparative LCA. This includes transportation from distributor/retailer to consumer and any impact during the actual use of the product by consumer
- Canadian national average landfill facility is modeled with a typical landfill scenario as per data collected by Statistics Canada
- Average Canadian electricity grid 2015 is used for landfill gas to electricity and waste to electricity generation
- Average Chinese and Dominican Republic electricity grid mix from 2012 is used for all analysis
- No resource allocation has been made for equipment, machinery and buildings used for agriculture, manufacturing and production of any of the products

LCI Results (per kg of product material)

LCI results per kg of product material				
	Unit	**Recycled Tire**	**Synthetic Rubber**	**Leather**
GHG Emissions	$KgCO2_e$	1.8	4.7	14.0
Primary Energy Demand	MJ	25.7	126.7	52.3
Water Consumption	Litres	0.3	13.9	33.8

Recycled Tires vs. Synthetic Rubber

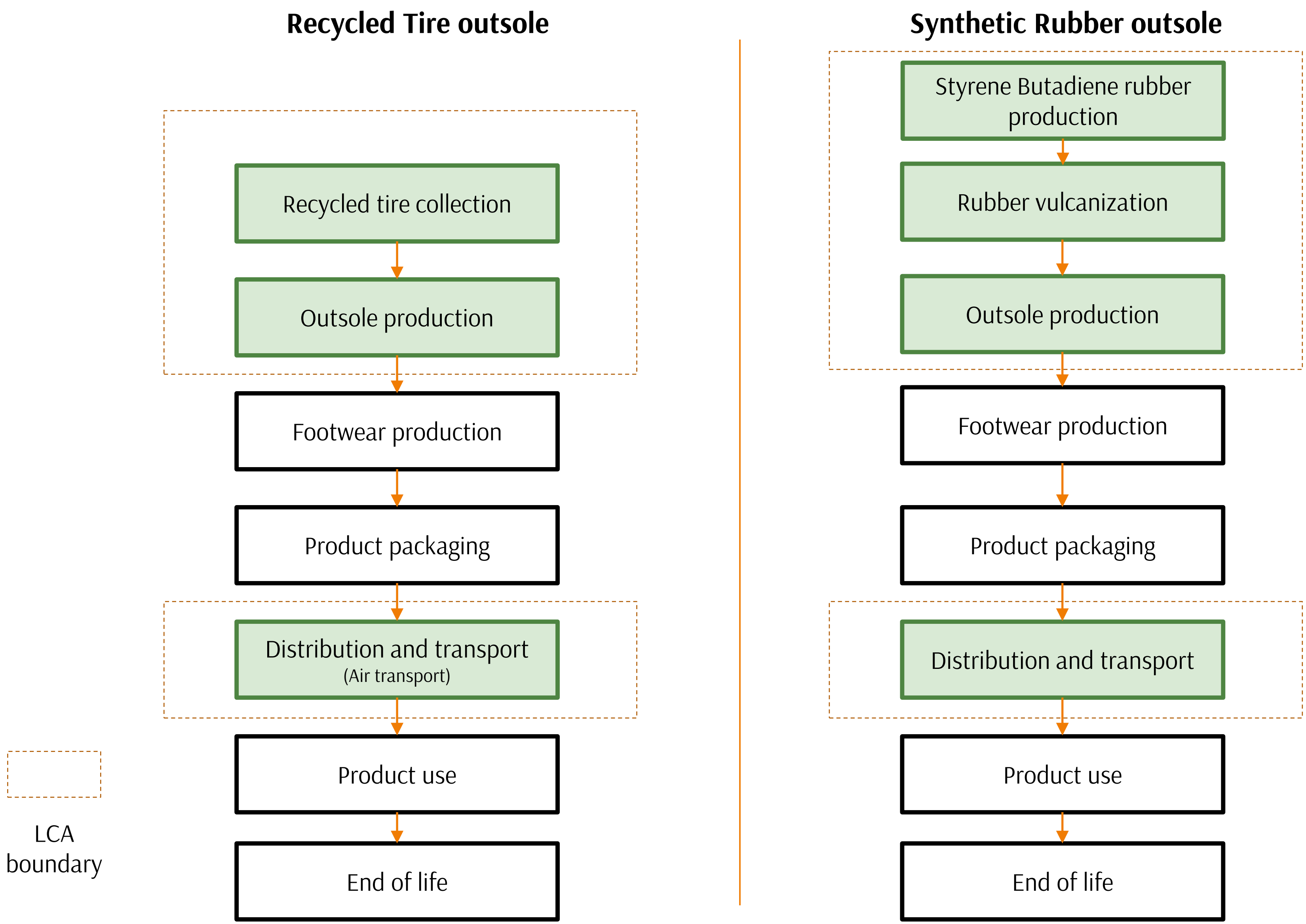
- Based on the table above, it can be seen that per kg of product, recycled tire soles have a significantly lower energy, water and emissions than synthetic rubber
- In particular, the GHG emissions for Recycled Tires are approx. a third of Synthetic Rubber. The difference would be much higher, if the transportation mode for recycled soles were switched from air cargo to ship.

Recycled Tires vs. Leather

- Similar to the results as against Synthetic Rubber were obtained. Leather has significantly higher emissions and water consumption due to the raising of cattle.

Recycled Tire VS. Synthetic Rubber Comparative Impact

Recycled Tire vs. Synthetic Rubber Study Boundary



Recycled Tire vs. Synthetic Rubber Comparative LCI

Net impact difference (per kg of outsole)

LCI results per kg of outsole				
	Unit	**Recycled Tire outsole**	**Synthetic rubber outsole**	**Difference**
GHG Emissions	$KgCO2_e$	1.8	4.7	2.9
Primary Energy Demand	MJ	25.7	126.7	101.1
Water Consumption	Litres	0.3	13.9	13.6

Net Impact Equivalence

468 hours
of light bulb energy saved

11 km
of car driving emissions avoided

7 days
of drinking water conserved

Key Assumptions

- Recycled tire outsole is compared with S-Styrene-butadiene Rubber (SBR). SBR is the most popular synthetic rubber used in outsoles for flat sandals. The same rubber is also used in car and truck tire treads. In terms of performance and functional features both rubbers are similar
- Only the outer sole of the footwear is considered for comparative LCA. It is assumed that all other parts of the footwear (midsole, insole and upper including bonding agents) are identical between both synthetic rubber and recycled tire outsole footwear.
- Impact of transporting scrap tire from waste management facility to Brave soles facility is extremely small and not part of the model. The average transportation distance is 2 km and uses mopeds to transport.
- The cutting of soles from tire treads is done manually by hand in an open facility. No resource utilization is considered for this process
- **End of Life:** End of life for both recycled tire soles and synthetic tire soles is identical as the material is very similar and end-of-life pathway is exactly same. It is not modeled as the impact will cancel out in a comparative analysis
- **Key Transportation distances**

Synthetic rubber outsole

Transportation process	Distance (km)
Rubber to Shoe factory	600
Shoe Factory to China port	1,610
China port to Toronto port	22,492
Port to Toronto warehouse	100

Recycled tire outsole

Transportation process	Distance (km)
Tire landfill to shoe factory	2
Shoe Factory to Punta Cana airport	20
Punta Cana to Pearson airport	5,205
Toronto airport to warehouse	100

List of Sources

Secondary sources

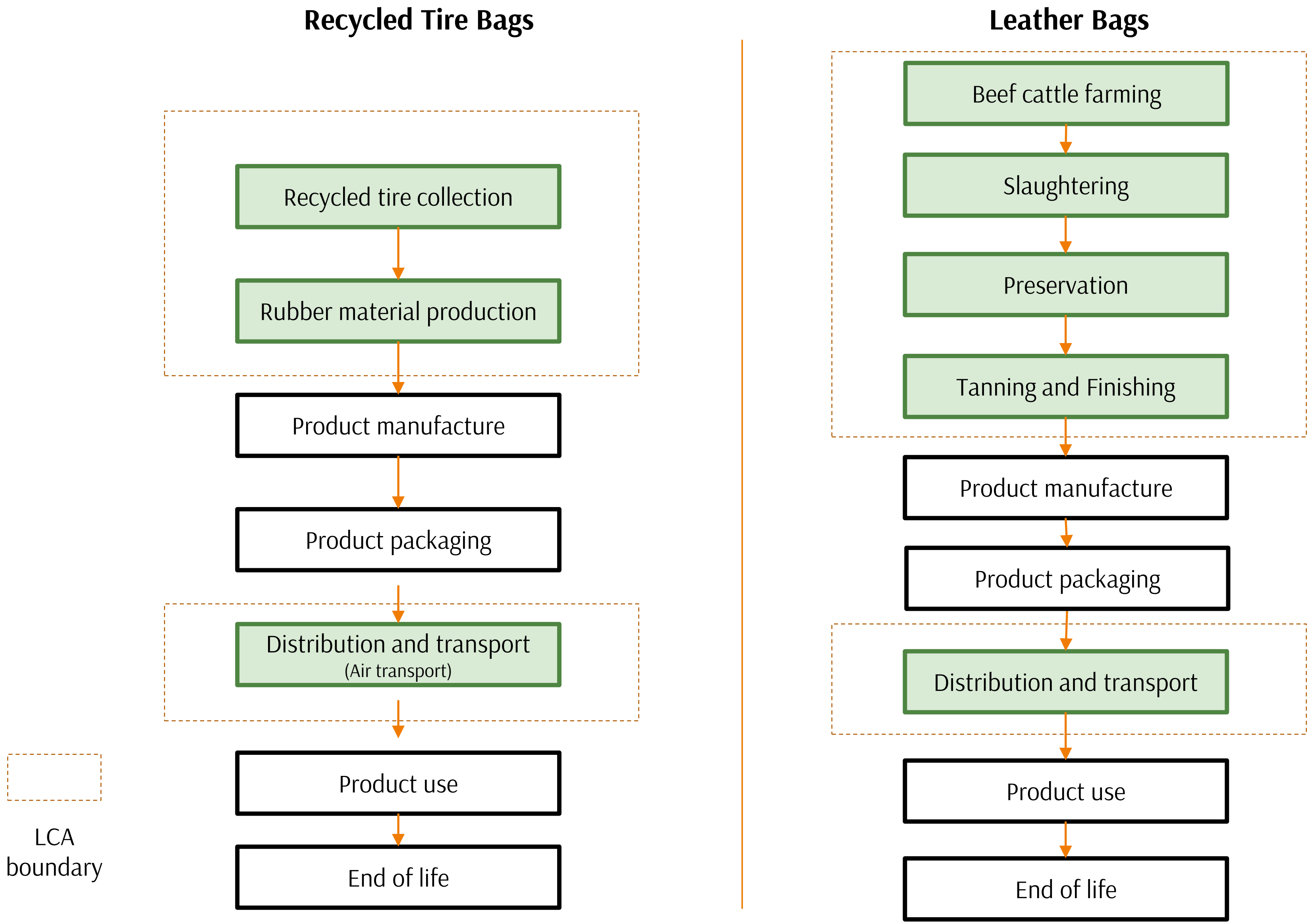
- Energy Efficiency Index in Rubber Industry, Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand, 2007 → Ratio of Electricity to Thermal energy in vulcanization
- Abi Santhosh Aprem* and Sabu Thomas, Sulphur Vulcanisation of Styrene Butadiene Rubber using New Binary Accelerator Systems, Journal of elastomers and plastics vol. 35–january 2003 → Other chemicals required in vulcanization
- Anatomy of a Tire http://infohouse.p2ric.org/ref/11/10504/html/intro/tire.htm (Accessed 19th Jan 2018)
- Randolph Kirchain, Elsa Olivetti, T Reed Miller and Suzanne Greene, Sustainable Apparel Materials - An overview of what we know and what could be done about the impact of four major apparel materials: Cotton, Polyester, Leather, & Rubber, October 2015
- Rania Abouglil, Life cycle analysis and recycling of tires, The Business and Management Review, Volume 8 Number → Energy use in vulcanization
- Lynette Cheah, Manufacturing-focused emissions reductions in footwear production, Journal of Cleaner Production 44 (2013) 18-29 → General information
- EPA equivalences: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references (Accessed Jan 10th, 2018)

GaBi Datasets

- GLO: Truck, Euro 4, more than 32t gross weight / 24,7t payload capacity ts <u-so>
- GLO: Container ship, 27500 dwt payload capacity, ocean going ts <u-so>
- DE: Styrene-Butadiene Rubber (SBR) Mix ts
- CN: Electricity grid mix (production mix) <LC>
- DR: Electricity grid mix (production mix) <LC>
- IN: Thermal energy from hard coal ts
- IN: Sulphur (elemental) at refinery ts
- US: Diesel mix at filling station ts
- IN: Heavy fuel oil at refinery (1.0 wt.% S) ts
- GLO: Cargo plane, 65 t payload ts <u-so>
- US: Kerosene / Jet A1 at refinery ts

Recycled Tire Vs. Leather Comparative Impact

Recycled Tire vs. Leather Study Boundary



Recycled Tire vs. Leather Comparative LCI

Net impact difference (per kg of bag material)

LCI results per kg of wheat straw product				
	Unit	**Recycled Tire**	**Leather**	**Difference**
GHG Emissions	$KgCO2_e$	1.8	14.0	12.2
Primary Energy Demand	MJ	25.7	52.3	26.6
Water Consumption	Litres	0.3	33.8	33.5

Net Impact Equivalence

123 hours
of light bulb energy saved

47 km
of car driving emissions avoided

18 days
of drinking water conserved

Main Assumptions

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Leather

- Leather manufacturing is modeled based out of India. Thailand data for cattle raising is used as proxy for India
- Economic allocation is used to allocate resource among beef byproducts and co-products (hide, meat, waste, offal and rendering product)

Recycled Tire

- Impact of transporting scrap tire from waste management facility to Brave Soles facility is extremely small and not part of the model. The average transportation distance is 2 km and uses mopeds to transport.
- The extracting and cutting of inner tube from tire is done manually by hand in an open facility. No resource utilization is considered for this process

End of Life

- Product disposal is not part of the system boundary for this analysis

Key Transportation distances:

Synthetic rubber outsole

Transportation process	Distance (km)
Farm to Pellet factory	20
Pellet factory to product factory	600
Product factory to port	400
China port to USA port	11080
Consumer to waste management facility	32

Recycled tire material

Transportation process	Distance (km)
Tire landfill to shoe factory	2
Shoe Factory to Punta Cana airport	20
Punta Cana to Pearson airport	5,205
Toronto airport to warehouse	100

List of Sources

Secondary sources

- Kurian Joseph*, N. Nithya; Material flows in the life cycle of leather, Journal of Cleaner Production 17 (2009) 676–682
- Akifumi Ogino, Environmental impacts of extensive and intensive beef production systems in Thailand evaluated by life cycle assessment, Journal of Cleaner Production 112 (2016) 22-31
- Zayetzi Rivera Muñoz, Water, energy and carbon footprints of a pair of leather shoes, ITM School of Industrial Engineering and Management, Stockholm, Sweden.
- Mass balance in leather processing, regional programme for pollution control in the tanning industry in south-east asia, US/RAS/92/120, United nations industrial development organization, august 2000
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- EPA equivalences: https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references (Accessed Jan 10th, 2018)
- Carbon Footprint of Beef Cattle, Sustainability 2012, 4, 3279-3301; doi:10.3390/su4123279,www.mdpi.com/journal/sustainability

Datasets

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About Green Story

The Green Story team is led by Akhil Sivanandan and Navodit Babel. Both members received their sustainability reporting training from the Global Reporting Initiative and LCA training from ThinkStep

- Navodit has 10+ years of experience in consulting and product management with global corporations. He has successfully overseen the launch of national card strategies in Canada. During his MBA at the University of Toronto, he developed a sustainability ranking algorithm for mining projects for Sustainalytics which used in the company's global operations

- Akhil has worked on sustainability projects for companies such as Philips Lighting and given presentations and interviews on the topic for multiple publications including the New York Times. He was also intimately involved in the Ontario Cap and Trade and Offsets programs as part of the Government. Akhil received his MBA from the University of Toronto.

Green Story's mission is help companies communicate environmental and social impact to stakeholders in a clear, credible and relatable manner

We work with a range of companies from waste management firms to one of North America's largest bottled water manufacturers to engage stakeholders and measure and communicate impact

Green Story is a Ministry of Environment Agent of Change, Social Capital Markets scholarship recipient, a member of the MaRS Centre for Impact Investing and of Ryerson University's Social Venture Zone

Contact: akhil@greenstory.ca

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