

Critical Analysis of LCAs

Green Chemistry Change Management

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Green Rose Chemistry
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Agenda

- Reading LCAs Critically
 - Red flags
 - Relevance checks
- Analysing Real-World Examples
 - Hocking's 1994 study
 - Woods and Bakshi's 2014 study
- Conclusions and Further Reading

Red Flags

- Funding and Expertise
 - Assessment by a company of their own products
 - Funded by a corporate interest
 - Conducted by a non-expert
- Oversimplification
 - Used to draw broad or absolute conclusions
 - Simplistic comparisons between LCAs
 - Full study not publicly available
- Data Issues
 - Unsubstantiated assumptions about end-of-life, e.g. high recycling rates
 - Surprising or counter-intuitive results

Relevance Checks

- Time
 - How old is the data used in the study?
 - Is current data likely to be significantly different?
- Place
 - What geographic region is the data from?
 - Is your region of interest very similar?
- Technology
 - What technical assumptions are being made in the study?
 - Are they accurate and transferable?

Hocking's 1994 Study

<https://go.nature.com/3EmDjB3>

Take 15 minutes to read and analyse, looking for key assumptions and any red flags.

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Oxidation of phenol by aqueous hydrogen peroxide catalysed by ferric ion-catechol complexes

MB Hocking, DJ Intihar - *Journal of Chemical Technology and ...*, 1985 - Wiley Online Library

Phenol has been oxidised with aqueous hydrogen peroxide under a wide variety of conditions and yields of the catechol and hydroquinone products recorded. Catalysts tested included ...

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A refinement of the terpolymer equation and its simple extension to two-and four-component systems

MB Hocking, KA Klimchuk - *Journal of Polymer Science Part A ...*, 1996 - Wiley Online Library

Terpolymer composition estimation with an established equation has been found to give results that vary with the feed monomer ratio substitution pattern used. A new copolymer ...

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Water-soluble acrylamide copolymers. VI. Preparation and characterization of poly[N,N-dimethylacrylamide-co-acrylamide] and control polyacrylamides

MB Hocking, KA Klimchuk... - *Journal of Polymer ...*, 2000 - Wiley Online Library

This article describes the first of a new series of preparations of water-soluble acrylamide, substituted acrylamide copolymers and related homopolymers. Objectives of this work were to ...

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Water-Soluble imide-amide copolymers. I. Preparation and characterization of poly [acrylamide-co-sodium N-(4-sulfophenyl) maleimide]

MB Hocking, DT Syme, DE Axelson... - *Journal of Polymer ...*, 1990 - Wiley Online Library

Sodium N-(4-sulfophenyl) maleimide (SPMI) and its saturated succinimide counterpart were first prepared according to established methods. Hydrolysis experiments on these ...

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Acetone-induced triboluminescence of triphenylphosphine

MB Hocking, FW VandervoortMaarschalk... - *Journal of ...*, 1992 - Elsevier

The triboluminescence of triphenylphosphine has been found to be acetone-dependent and

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Disposable cups have eco merit

- Unsubstantiated assumptions about end-of-life, e.g. high recycling rates
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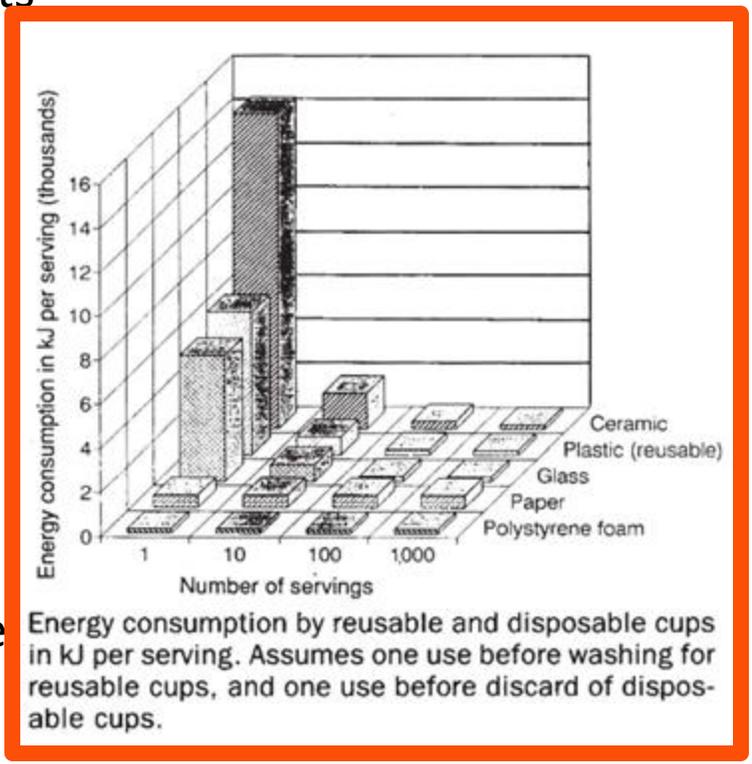
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A full version of this paper, including the databases, equations, sensitivity tests, and effects of recycle options, will be published shortly in *Environmental Management*.

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Conflicting Results

TABLE 1: Break-even points from LCA studies for two types of disposable hot cups compared with ceramic mugs.

		DISPOSABLE										
		Polystyrene Foam (EPS)						Paper				
RESUSABLE	Ceramic	Hocking 1994	Denison 1998	Ziada 2009	Carbon Clear 2012	Woods & Bakshi 2014 Calif 2004AP	Woods & Bakshi 2014 Calif 2013BAT	Hocking 1994	Denison 1998	Starbucks 2000	Ziada 2009	Carbon Clear 2012
		1000	260	127	354	110	70	39	120	70	18	31

Source: Clean Water Fund

Hocking - Relevance Check

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Hocking - Relevance Check

- Time
 - How old is the data used in the study? **1994 or older**
 - Is current data likely to be significantly different? **Yes**
- Place
 - What geographic region is the data from? **USA**
 - Is your region of interest very similar? **No**
- Technology
 - What technical assumptions are being made in the study? **Lots**
 - Are they accurate and transferable? **No**

Hocking - Discussion

<https://go.nature.com/3EmDjB3>

- Which assumptions are problematic?
- Which assumptions are likely to have changed between 1994 and 2024?
- Which assumptions are likely to differ by region?

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Woods and Bakshi's 2014 Study

<https://bit.ly/3SNn0Bq>

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 - ~~Surprising or counter-intuitive results~~

Techno-ecological synergy: A framework for sustainable engineering

[BR Bakshi](#), [G Ziv](#), [MD Lepech](#) - Environmental science & ..., 2015 - ACS Publications

Even though the importance of ecosystems in sustaining all human activities is well-known, methods for sustainable engineering fail to fully account for this role of nature. Most methods ...

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Comparative life cycle assessment of beneficial applications for scrap tires

[J Fiksel](#), [BR Bakshi](#), [A Baral](#), [E Guerra](#)... - Clean technologies and ..., 2011 - Springer

Life cycle assessment is used to determine the most environmentally beneficial alternatives for reuse of scrap tires, based on the concept of industrial ecology. Unutilized scrap tires can ...

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[HTML] Effects of a carbon price in the US on economic sectors, resource use, and emissions: An input-output approach

[JK Choi](#), [BR Bakshi](#), [T Haab](#) - Energy Policy, 2010 - Elsevier

Despite differences in their implementation, most carbon policies aim to have similar outcomes: effectively raising the price of carbon-intensive products relative to non-carbon-intensive ...

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Life cycle of titanium dioxide nanoparticle production: impact of emissions and use of resources

[GF Grubb](#), [BR Bakshi](#) - Journal of Industrial Ecology, 2011 - Wiley Online Library

Life cycle impact of emissions, energy requirements, and exergetic losses are calculated for a novel process for producing titanium dioxide nanoparticles from an ilmenite feedstock. The ...

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Thermodynamic metrics for aggregation of natural resources in life cycle analysis: insight via application to some transportation fuels

[A Baral](#), [BR Bakshi](#) - Environmental science & technology, 2010 - ACS Publications

While methods for aggregating emissions are widely used and standardized in life cycle assessment (LCA), there is little agreement about methods for aggregating natural resources for ...

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Woods and Bakshi - Relevance Check

- Time
 - How old is the data used in the study?
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Woods and Bakshi - Relevance Check

- Time
 - How old is the data used in the study? **2014 or older**
 - Is current data likely to be significantly different? **Yes**
- Place
 - What geographic region is the data from? **USA subregions**
 - Is your region of interest very similar? **No**
- Technology
 - What technical assumptions are being made in the study? **Lots**
 - Are they accurate and transferable? **Accurate, some transferable**

Discussion - Woods and Bakshi

<https://bit.ly/3SNn0Bq>

- What limitations does this LCA have?
- Could you use it to make decisions about your personal cup use?
- Could Starbucks use it to make decisions about US operations?
What about global operations?

Discussion - Woods and Bakshi

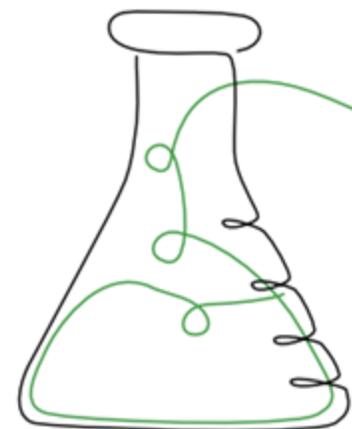
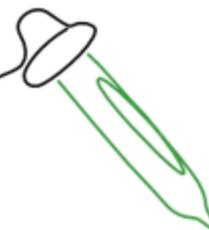
<https://bit.ly/3SNn0Bq>

- How could you adapt this to your country?
- How could Starbucks adapt it to their operations?

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Conclusions



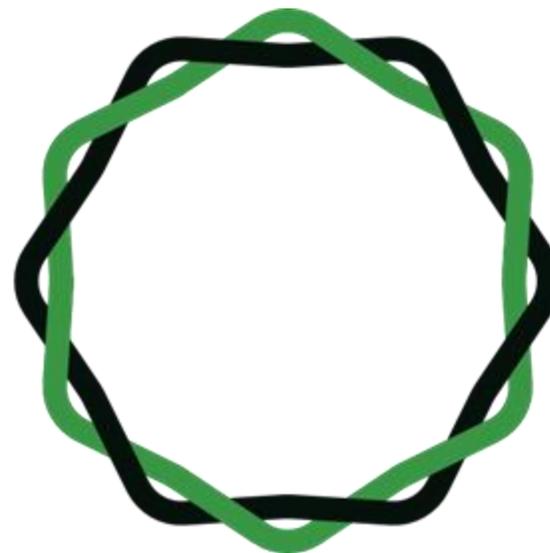
To sum up...

- LCAs are complex, demanding, and very open to bias
- Results reported in the media are usually oversimplified
- Any LCA should be read critically, especially if it is informing decision-making
- Red flags are a good place to start
- Check for relevance of time, place, and technology
- If you need an LCA, find an unbiased expert

Further Reading

- A Newcomer's Guide to LCA – Baselines and Boundaries
<https://www.gov.uk/research-for-development-outputs/a-newcomer-s-guide-to-life-cycle-assessment-baselines-and-boundaries>
- Plastics: Can LCA Rise to the Challenge?
<https://www.ecomagazin.ro/wp-content/uploads/2020/10/BBFP-Plastic-in-LCA-Final-Report-v4.0-1.pdf>
- GHG Impacts of Disposable vs. Reusable Foodservice Products
https://ec.europa.eu/environment/eussd/smgp/pdf/EF%20simple%20guide_v7_clen.pdf
- JRC Guide for Interpreting LCA Result
<https://publications.jrc.ec.europa.eu/repository/bitstream/JRC104415/lb-na-28266-en-n.pdf>

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Questions?

Contact Tabitha Petchey at tabitha.petchey@greenrosechemistry.com.