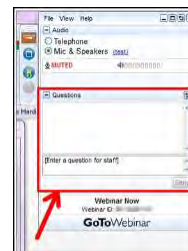
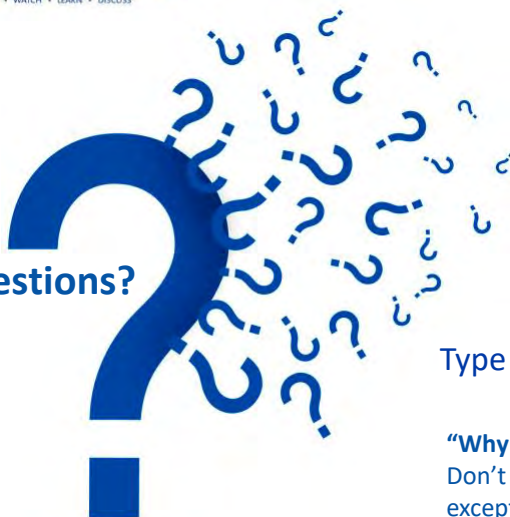




Have Questions?



Type them into questions box!

“Why am I muted?”

Don't worry. Everyone is muted except the presenter and host. Thank you and enjoy the show.

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Connect, collaborate, and stay informed about the trends leading chemical innovation

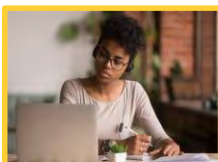
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Education



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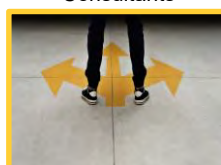
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A Career Planning Tool For Chemical Scientists



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GC&E Fridays



Workshops and technical sessions presented on Fridays leading up to the GC&E Conference week. Included in conference registration.

- **May 21:** Communications Workshop
- **May 28:** Careers in Green Chemistry & Engineering that Advance the Circular Economy
- **June 4:** Toxicology for Chemists Workshop
- **June 11:** Influencing Green Chemistry in Pharma and Beyond

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Grants for Green Chemistry Research in Pharma



Apply by May 15:

- Solvent Minimization in Flow Chemistry – (\$50k)
- Technology-Enabled Late-Stage Functionalization (LSF) of Pharmaceuticals – (\$50k)
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- Increasing the Breadth and Utility of Enzymes in Pharma Manufacturing – (\$50k)
- Ignition Grant Program for Green Chemistry and Engineering Research – (\$25k; multiple available)

<https://www.acsgcipr.org/advancing-research>

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Solving the Plastics Problem Through Chemistry

Federal Research and Technology Programs



Date: Wednesday, April 28, 2021 @ 2-3:30pm ET

Speakers: Bruce Garrett, U.S. Department of Energy / Christina Payne, National Science Foundation / Kathryn Beers, National Institute of Standards and Technology

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- Opportunities for the next generation in the chemical industry

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TAKING A LIFE CYCLE VIEW



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The Hidden Impact: Taking a Life Cycle View



RICH HELLING
Global Expertise Principal,
Dow Chemical



DAVID CONSTABLE
Science Director, Green Chemistry Institute,
American Chemical Society

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The Hidden Impacts: Taking a Life Cycle View

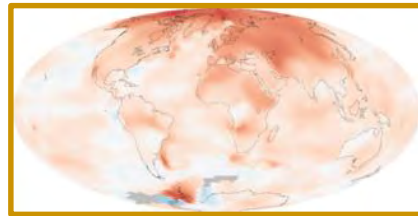
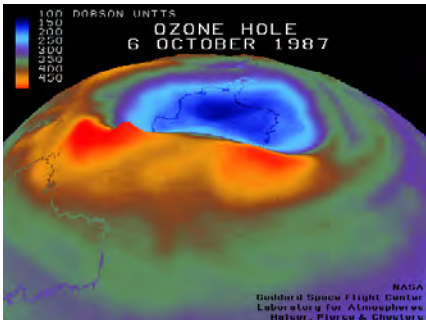
Rich Helling
22 April 2021

Seek **Together**™

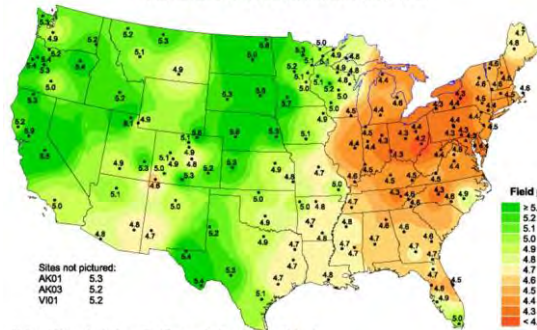
18



Environmental Challenges



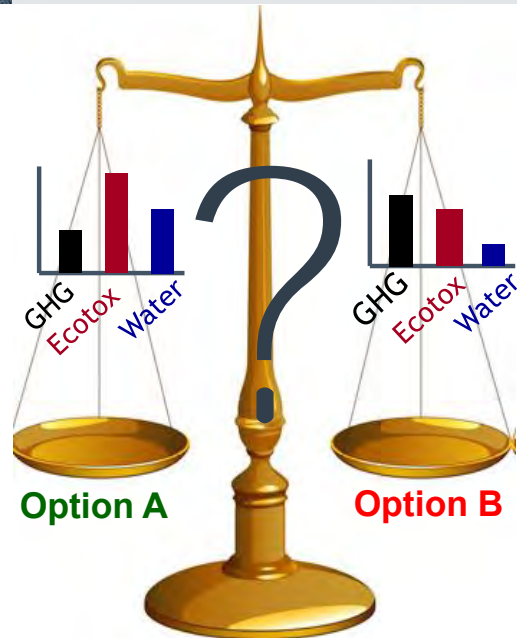
Hydrogen ion concentration as pH from measurements made at the field laboratories, 1999



National Atmospheric Deposition Program/National Trends Network
<http://nadp.sws.uiuc.edu>



Life Cycle Assessment (LCA) provides environmental insights for decisions



21

Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



The most common answer in LCA is:

- Climate change impact is the most important
- About 2 kg CO₂eq/kg
- Reusable is always better
- It depends



** If your answer differs greatly from the choices above tell us in the chat!*

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Life Cycle Assessment

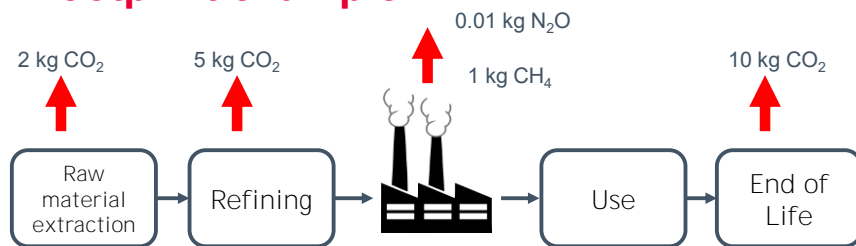


$$\text{Potential Environmental Impact} = \sum_{\substack{\text{all stages} \\ \text{all species}}} \text{Mass, energy} \times \text{Characterization Factor}$$



23

Simple carbon footprint example



Characterization Factors (Global Warming Potential)		Stage	Emissions	Characterization Factor (CF)	Emissions x CF = GWP
GHG	GWP (kg CO ₂ -eq/kg GHG)	Raw Mat's	2 kg CO ₂	1	2
CO ₂	1	Refining	5 kg CO ₂	1	5
CH ₄	30	Manu-facturing	1 kg CH ₄	30	30
N ₂ O	298		0.01 kg N ₂ O	298	3
		EOL	10	1	10
TOTAL life cycle GHG emissions (GWP)					50 kg CO ₂ -eq



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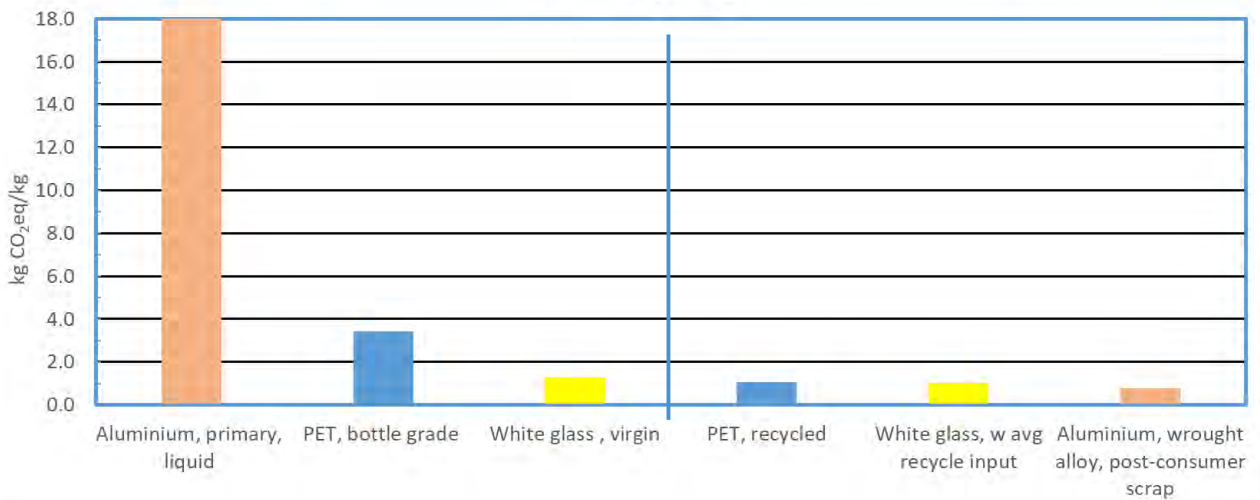
LCA started with Coke



vs.

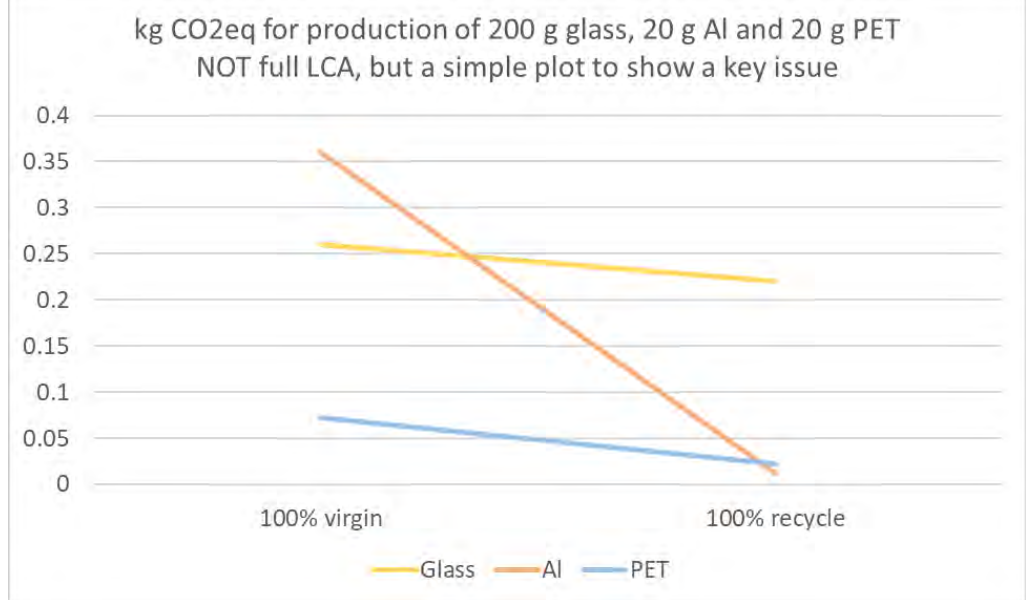


Carbon footprints of common bottle materials are lower for recycled materials, per kg



Source: ecoinvent, v 3.6

For plausible masses per bottle, the “best” material depends on recycle rate



27

Plastic Circularity



28

Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



Location of circular processes from waste depend strongly on location. **Which of these my be the least dependent on location?**

- Grid power
- Alternative fate of the waste
- Transportation modes and distances
- Process technology



** If your answer differs greatly from the choices above tell us in the chat!*

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Consider systems that do these two things:



Make plastic

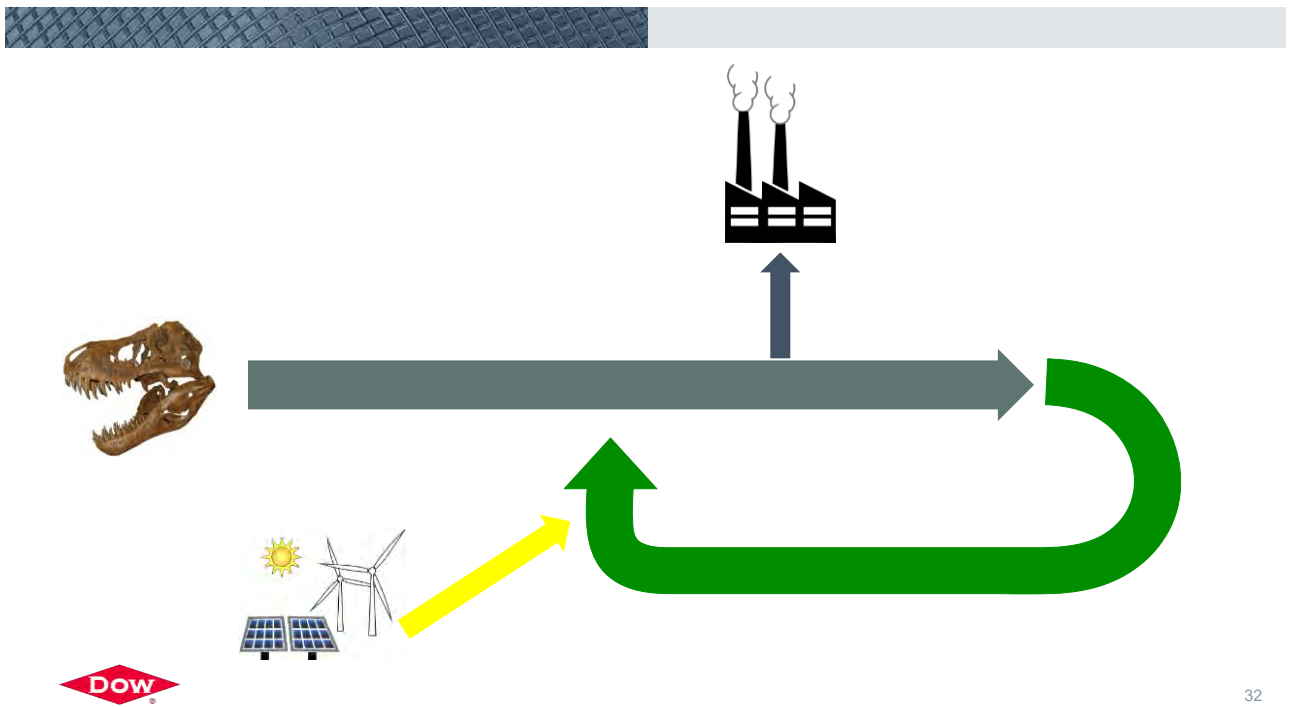
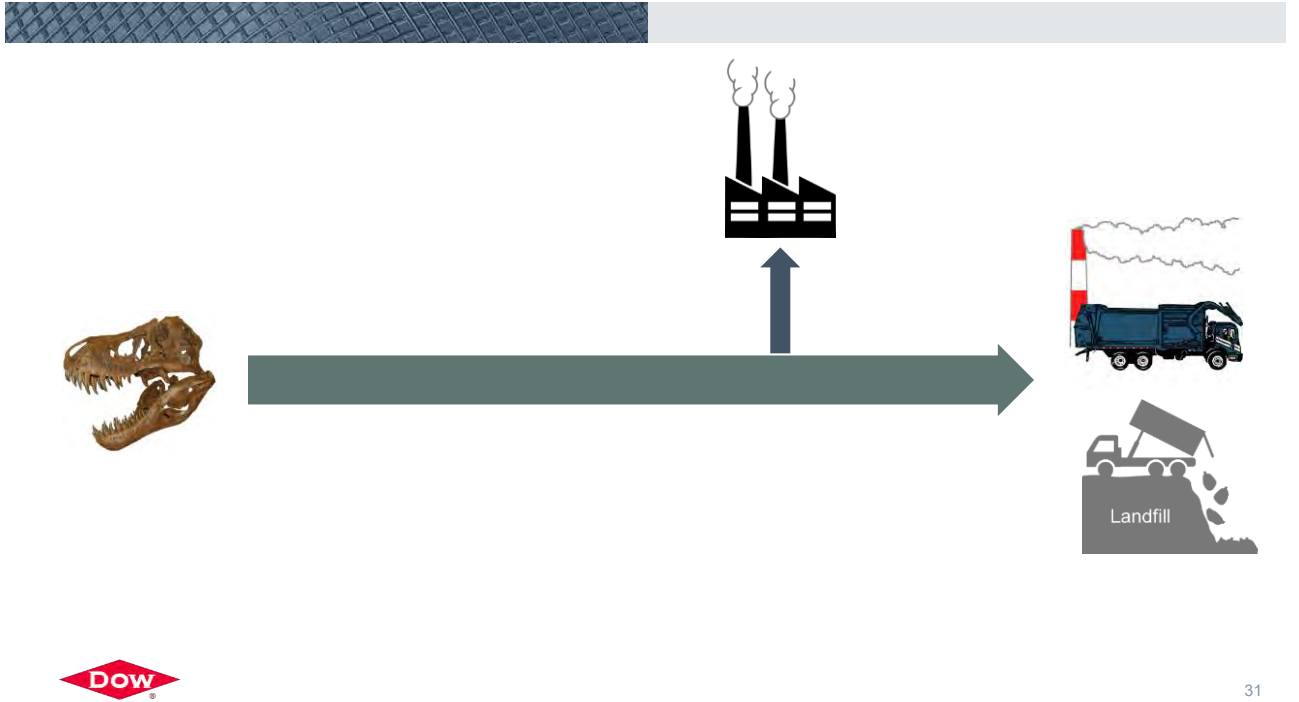
AND



Use/treat waste plastic



30



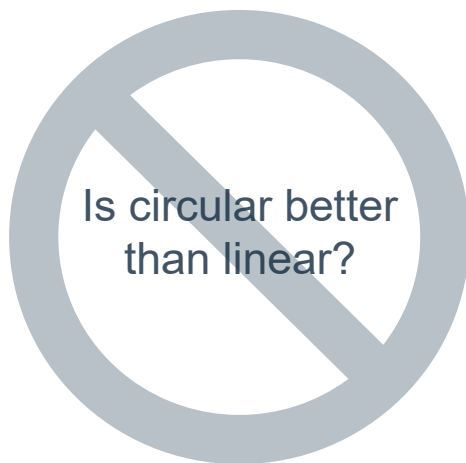
Where (or when!) in the world is the circular option better for GHG

	Use coal power	Use green power
Avoid burying waste	- -	- +
Avoid burning waste	- +	+ +



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The real question for LCA



Under what conditions is circular better than linear?

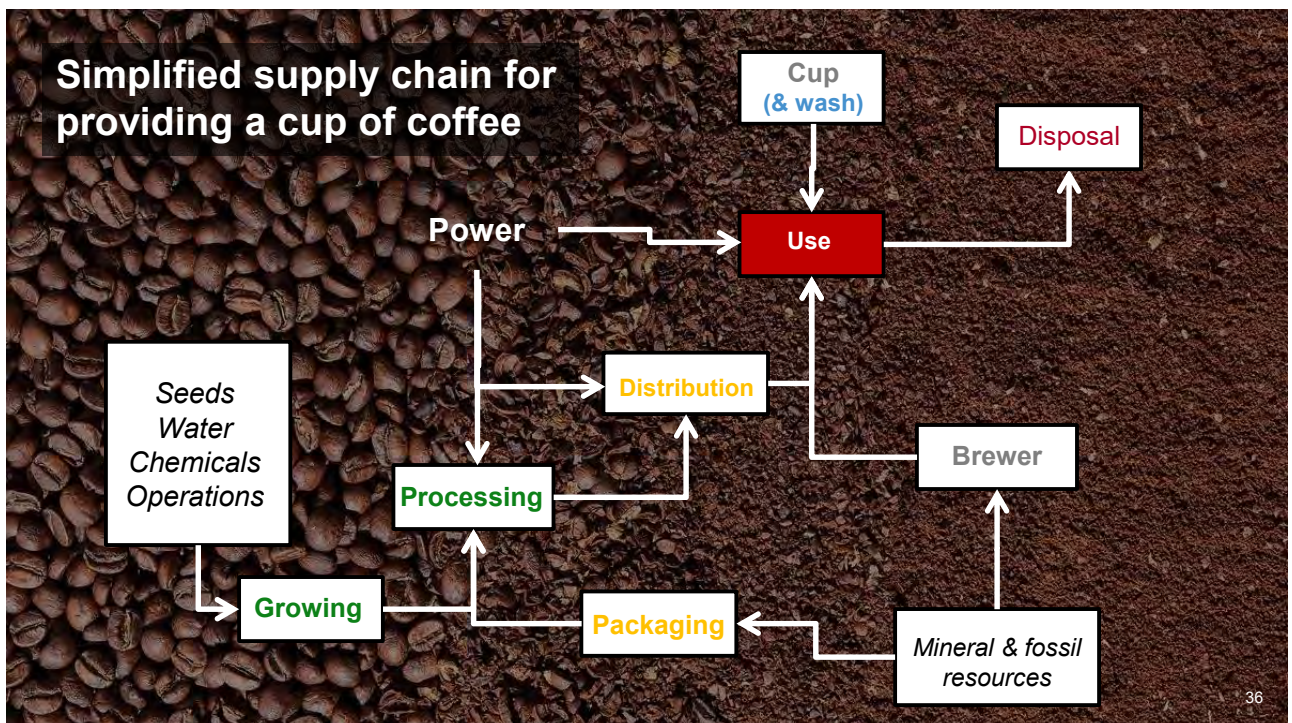


34

A short story about coffee...



35



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Audience Survey Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT



Which of these is least important in the LCA of home-brewed coffee?

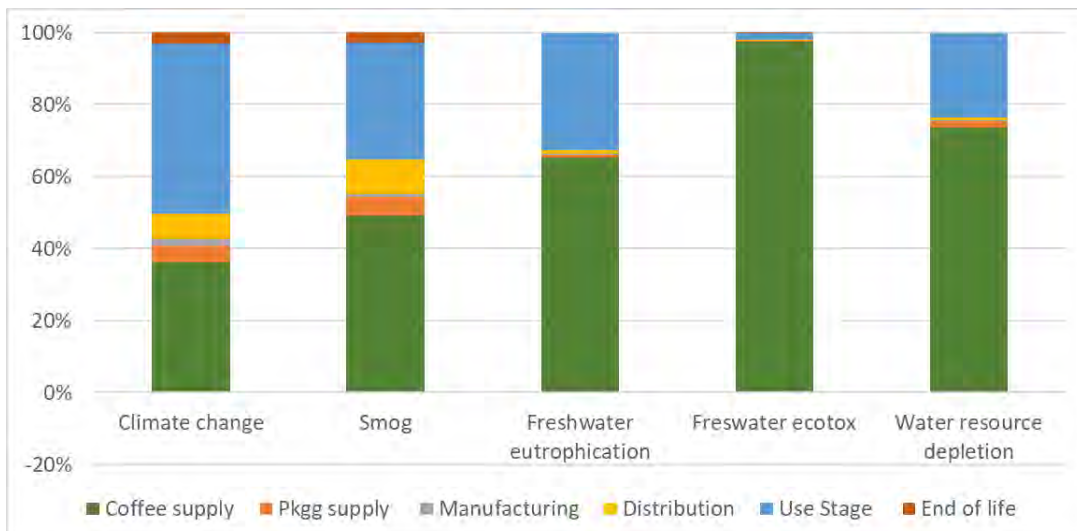
- Coffee supply chain
- Using a dishwasher
- Disposal of the filter, grounds and packaging
- Everything is important



** If your answer differs greatly from the choices above tell us in the chat!*

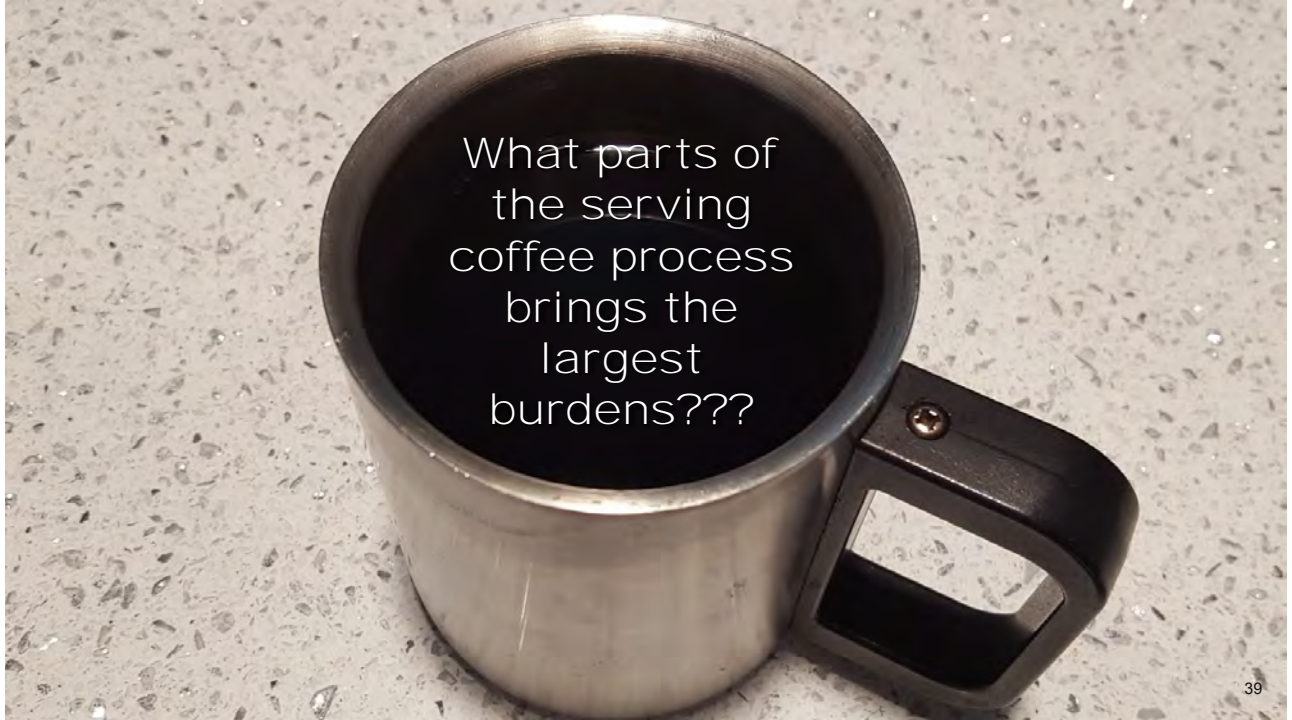
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Major impact sources for cup of coffee are supply & use



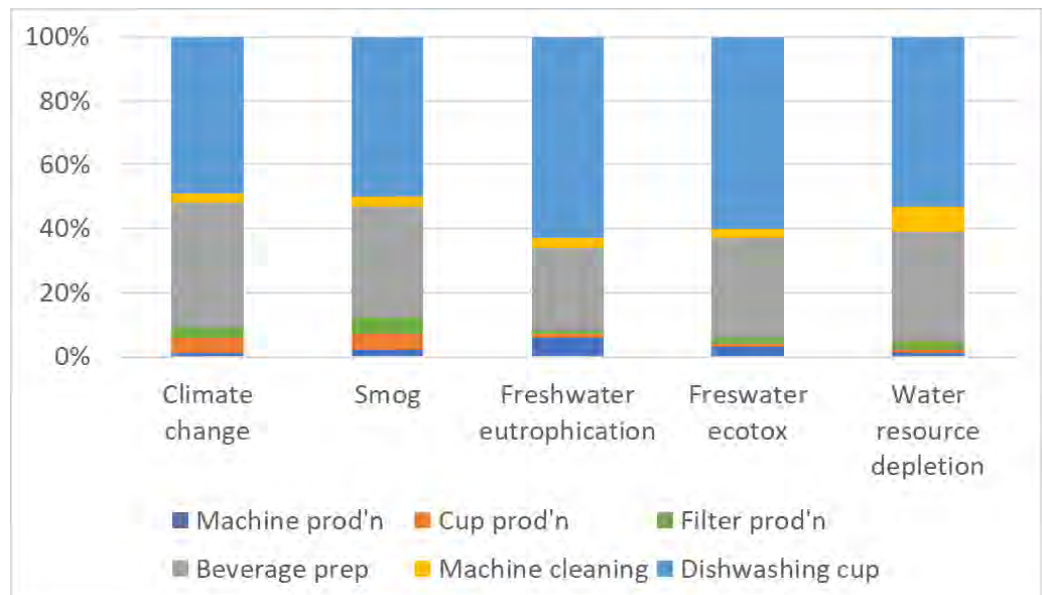
Reference: "PEF coffee screening report in the context of the EU Product Environmental Footprint Category Rules (PEFCR) Pilots", Technical Secretariat, December 10, 2015

38



39

Most of the use-phase burdens come from washing the reusable ceramic cup!



40



How about a single use cup?

“Where there is statistical difference, results almost entirely favor reusable cups in the USA.”

Number of uses required for ceramic mug to be better than single use polystyrene cup for climate change

Where & what kind of DW	2004 average DW	2013 Energy Star DW	2013 Best Available DW
California	110	90	70
Michigan	Never	360	100

What if you drive to get your coffee?



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Insights on coffee & cups

- If you make it – use it!
- Re-use your reusable cup.
- Don't go out of your way to get it



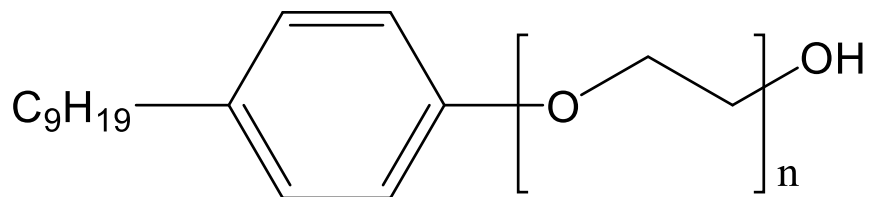
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An improved surfactant



45

Nonylphenol has known ecotoxicity

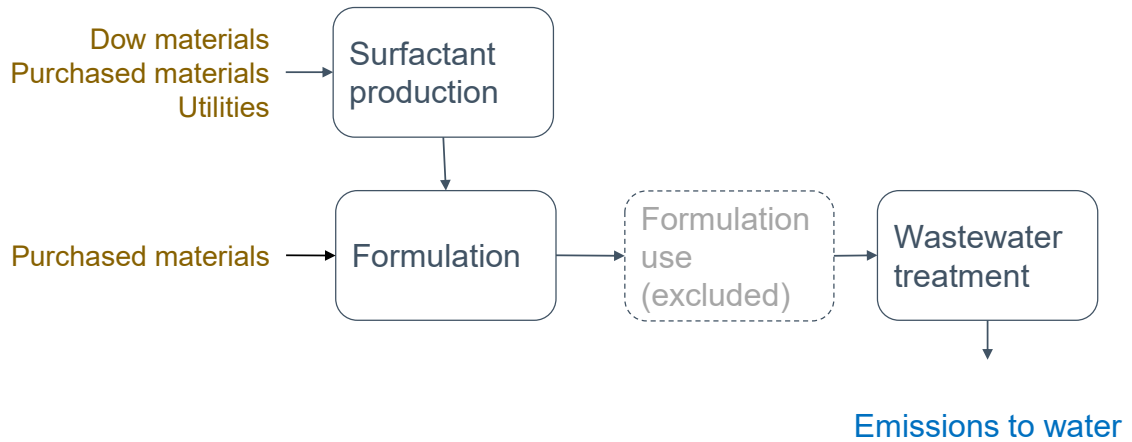


TERGITOL™ NP-9 Surfactant



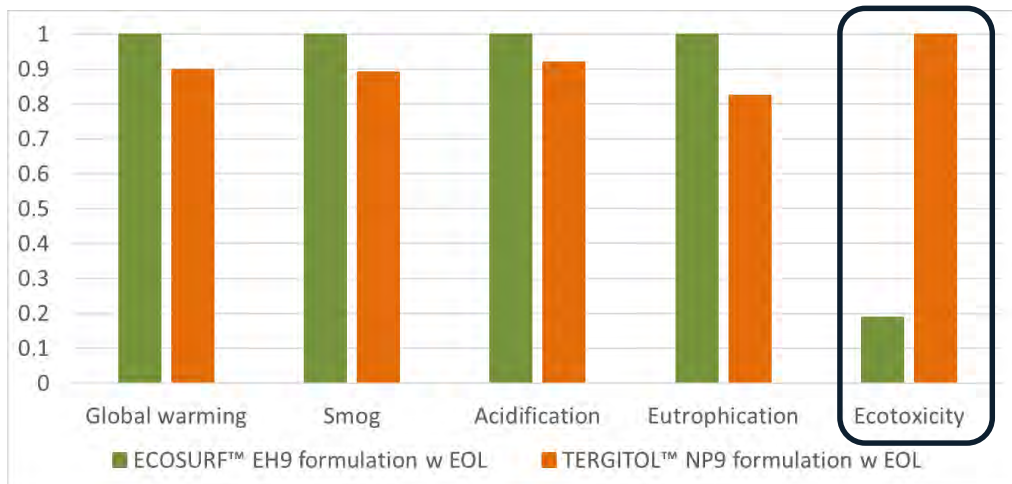
46

Analysis boundaries



49

**TERGITOL™ NP-9 formulation has largest ecotox impact;
all other TRACI categories higher for ECOSURF™ EH-9**



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LCA results are part of making an informed choice

PRICE

PERFORMANCE

SOCIAL ISSUES

**QUANTIFICATION
OF RISK**



51



<https://epic.gsfc.nasa.gov/>



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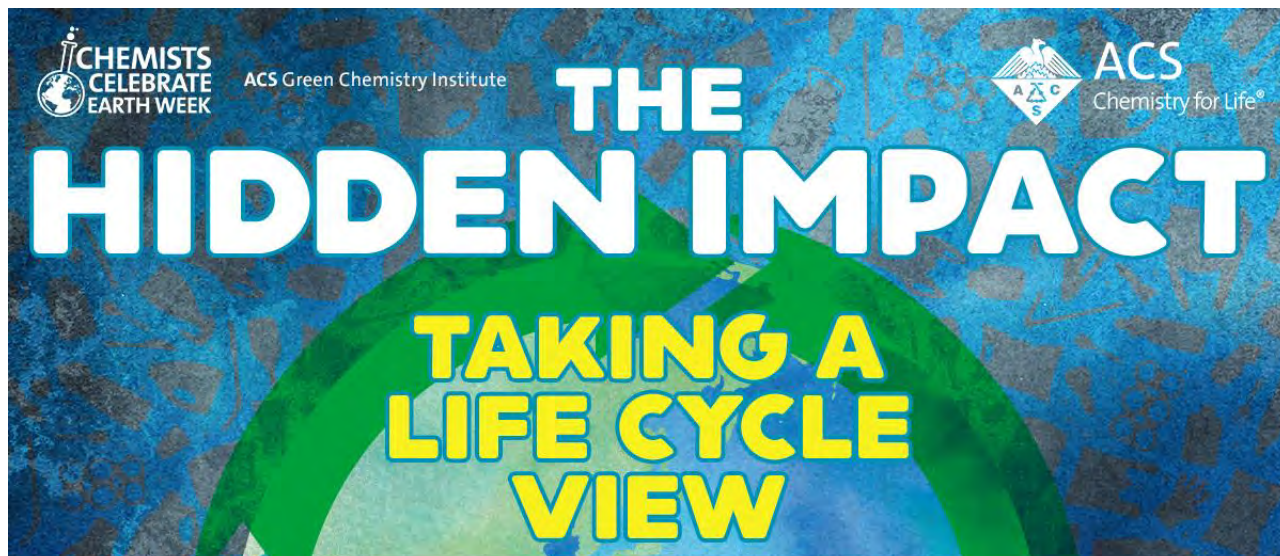
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