# material attributes

## what they reveal about environmental outcomes

ECOS

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David Allaway |Oregon Department of Environmental Quality

# introduction

1. History and background
2. Attributes and impacts
3. Study approach and methodology
4. Results

# project history

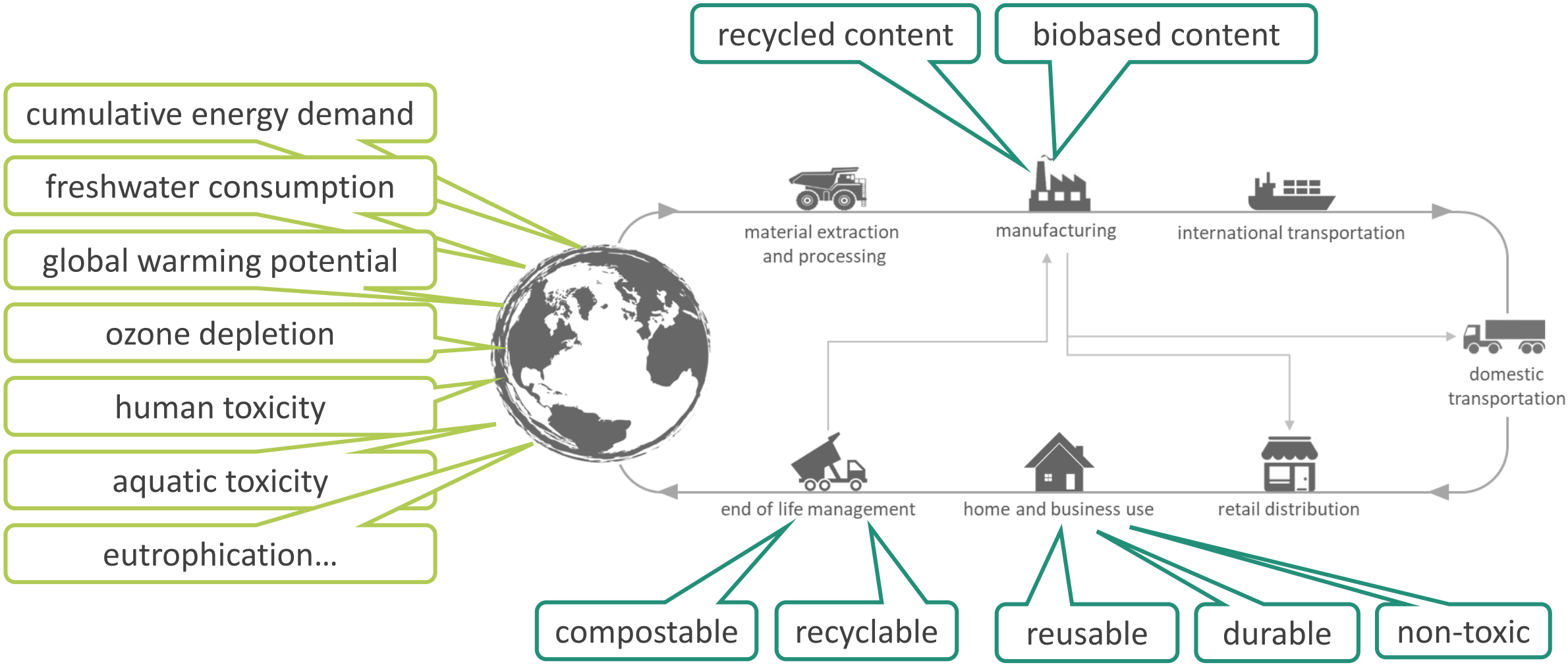
background and perspectives

# a vision for materials management

**By 2050 Oregonians produce and use materials responsibly**

- **conserving resources**
- **protecting the environment**
- **living well**

# materials attribute & life cycle impacts



# research question

How well (and when) do popular material attributes correlate with reduced environmental impacts?

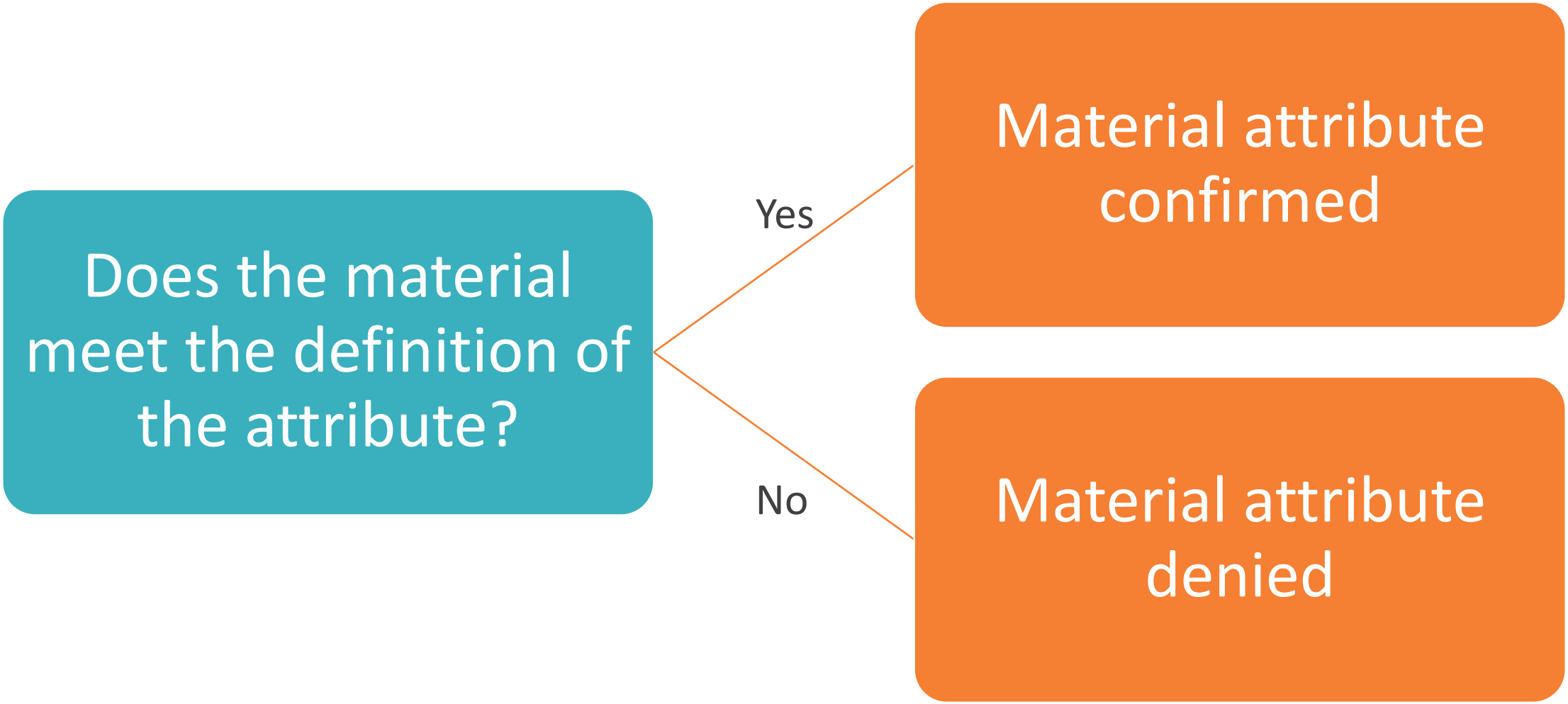
# attributes vs. impacts

an overview

**at·trib·ute** – noun /ˈatrəˌbyo͞ot/

a  quality or characteristic of a person or thing

# the process - attributes



# an example: material attributes of corrugated board

- Attribute – Biobased
- Definition – materials made from biological and renewable feedstocks that can be replenished as they are used

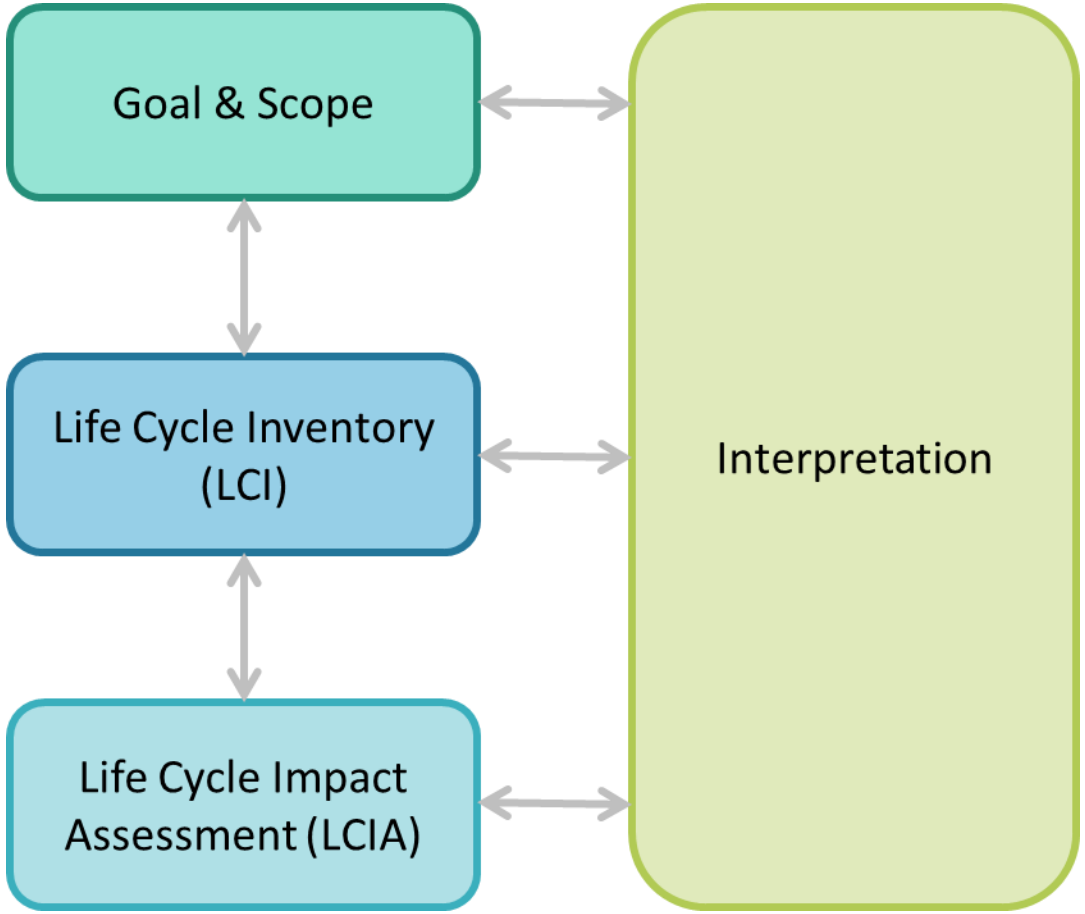
# life cycle assessment (LCA)

an overview

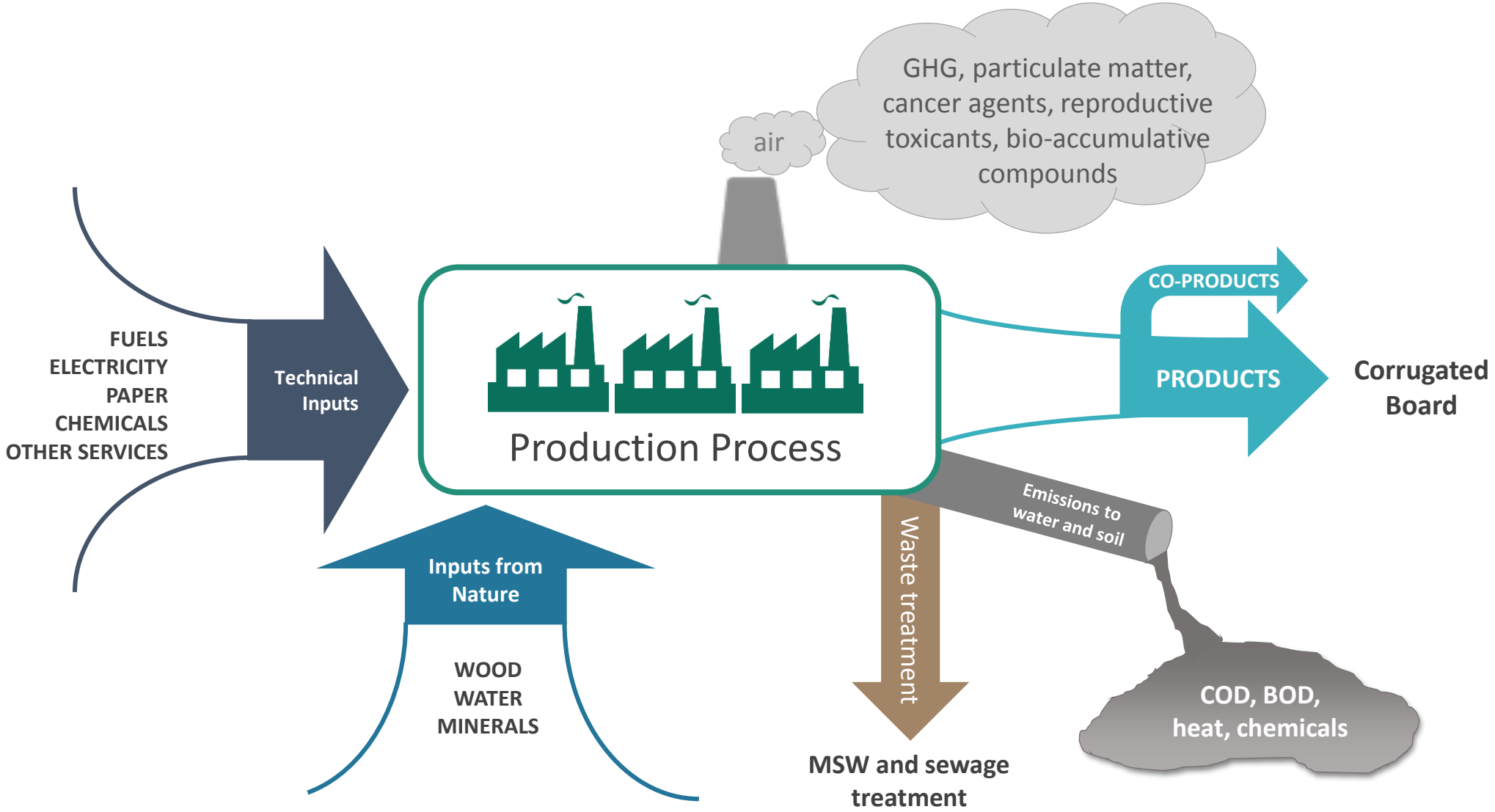
Life Cycle Assessment is

"the compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle."

# the process – LCA



# an example: basic life cycle of corrugated board



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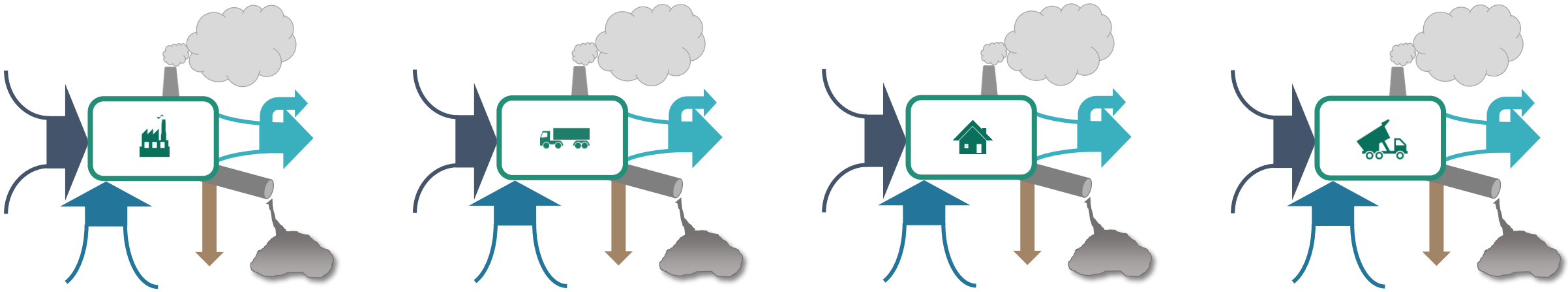


Impact Assessment

Energy consumption, raw material consumption,
climate change, smog formation acidification, over fertilization,
water depletion, toxicity, ozone depletion

# comparing attributes and life cycle impacts

| | Material Attributes | Life Cycle Impacts |
|---|---|---|
| Quantitative | Sometimes | Yes |
| Outcome-based | No | Yes |
| Methodology | No | Yes |
| Comprehensive | No | Mostly Yes* |
| Complexity | Low | High |
| Ease of Use | High | Low |

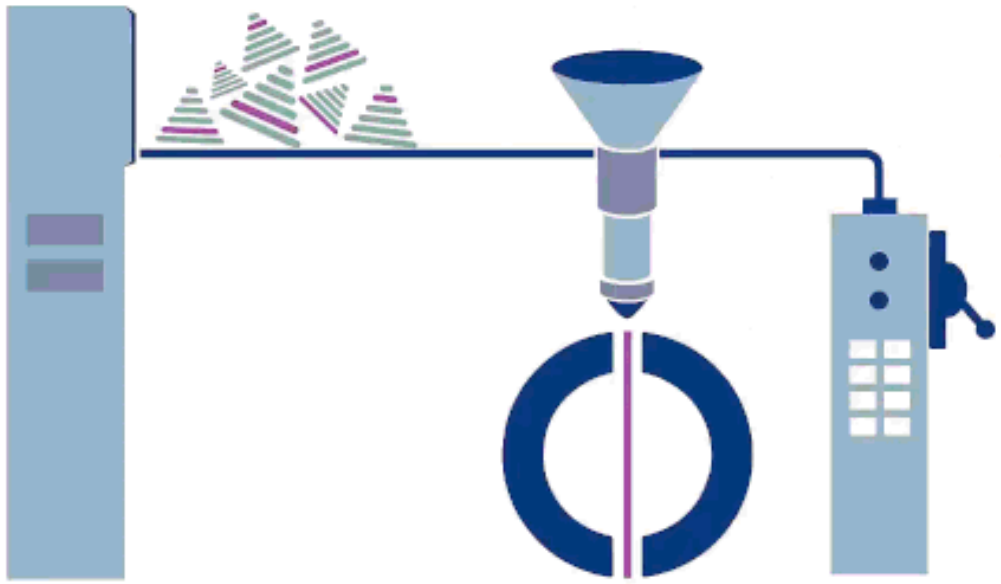
*Human toxicity (during product use) and marine debris impacts are not currently well evaluated using LCA.

# discussion pause

# study approach and methodology

## attributes in LCA literature

# Approach: systematic review of literature



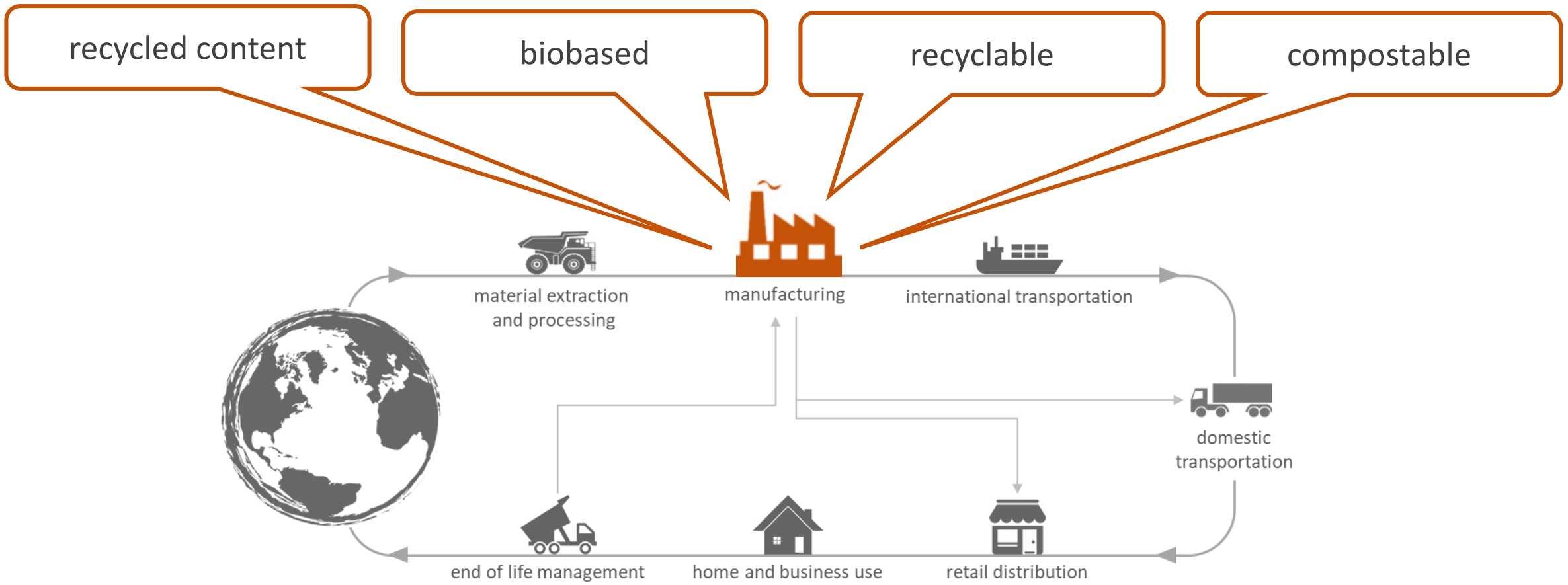
Source:*http://cccrg.cochrane.org/*

# product categories

PACKAGING

FOOD SERVICE WARE

# four materials attributes reviewed



# literature sources

- International Journal of Life Cycle Assessment (IJLCA)
- Journal of Industrial Ecology (JIE)
- Journal of Cleaner Production (JCP)
- Environmental Science & Technology (ES&T)
- Packaging Technology and Science (PT&S)
- LCA studies published by other reputable sources including: Oregon DEQ, Franklin Associates, Quantis, thinkstep, dissertations, and published technical reports.

# inclusion criteria

- Surveyed existing research between 2000-2017
- Limited to credible and publically accessible sources and journals
- Published and peer-reviewed studies that followed ISO 14040, 14044
- Must be comparative and include at least one attribute of interest

- NOTE: All comparisons reported are those found within studies, meaning that no harmonization across studies was conducted
  - Therefore all parameters remained consistent for comparisons (e.g. for system boundary, method, results, time, geography, technology)

# evaluation framework

*Ratio = Impact result with attribute A ÷ Impact result without attribute A*

| Category | Ratio | Interpretation |
|---|---|---|
| Meaningfully Lower Life Cycle Impact | <0.75 | Suggests the attribute is potentially a good indicator of environmental performance |
| Marginally Lower Life Cycle Impact | ≥0.75 and <1.0 | Marginal difference |
| No difference | 1.0 | No difference |
| Marginally Higher Life Cycle Impact | >1.0 and ≤1.25 | Marginal difference |
| Meaningfully Higher Life Cycle Impact | >1.25 | Attribute is potentially not a good indicator of environmental performance |

The lower the ratio value, the lower the environmental impact of the material(s) being evaluated (*with* the attribute) compared to the equivalent material *without* the attribute.

# external advisory group

acgov.org
County of Alameda, CA

STOPWASTE
at home • at work • at school

DEPARTMENT OF ECOLOGY
State of Washington

Metro

City of Seattle

MINNESOTA POLLUTION CONTROL AGENCY

CalRecycle

SUSTAINABLE PACKAGING COALITION®
A PROJECT OF GREENBLUE

SUSTAINABLE PURCHASING LEADERSHIP COUNCIL

Eugene

U.S. GREEN BUILDING COUNCIL USGBC

CITY OF PORTLAND, OREGON 1851

NEWMOA
NORTHEAST WASTE MANAGEMENT OFFICIALS' ASSOCIATION

# discussion pause

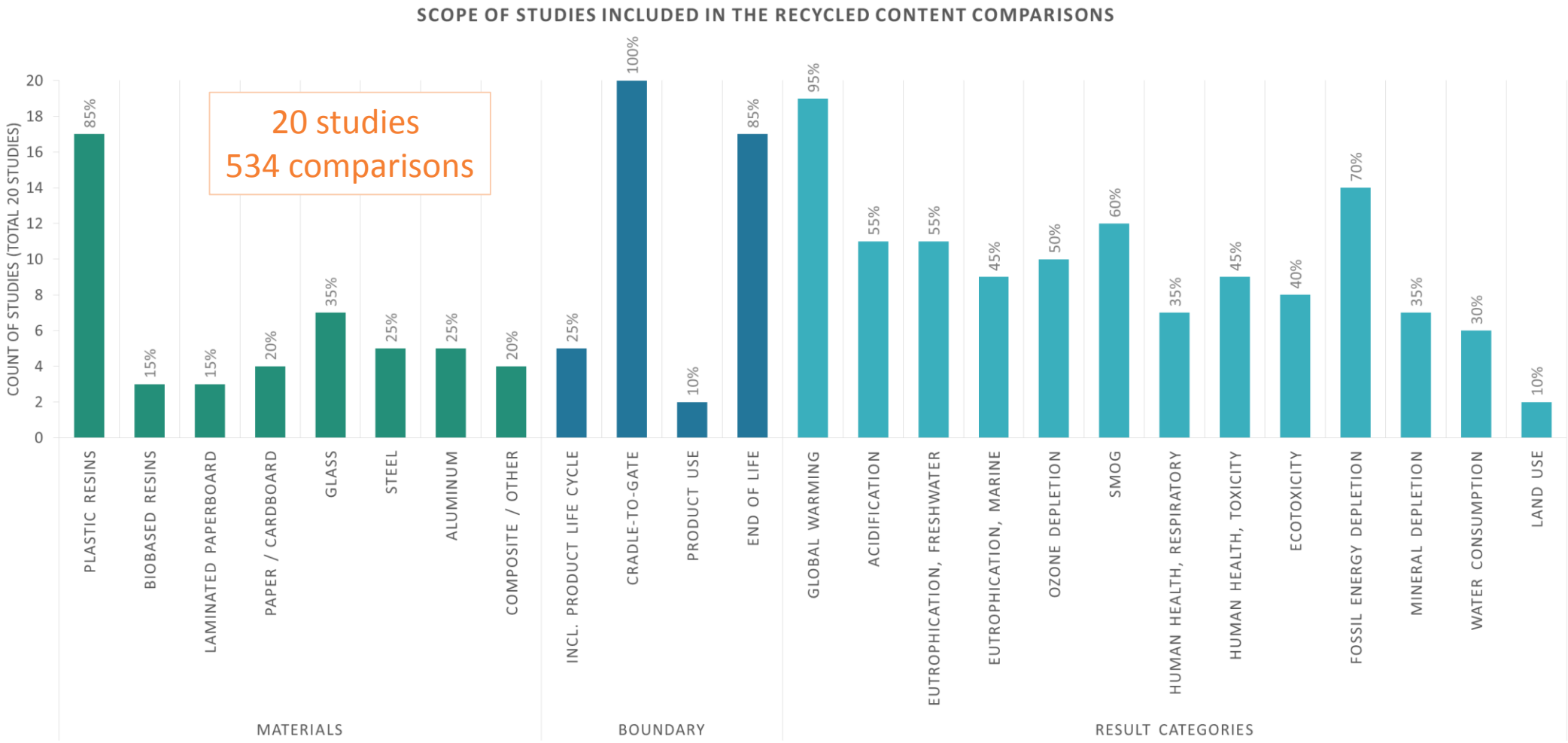
# PACKAGING

# recycled content – packaging

The portion of materials used in a product that have been diverted from the solid waste stream.

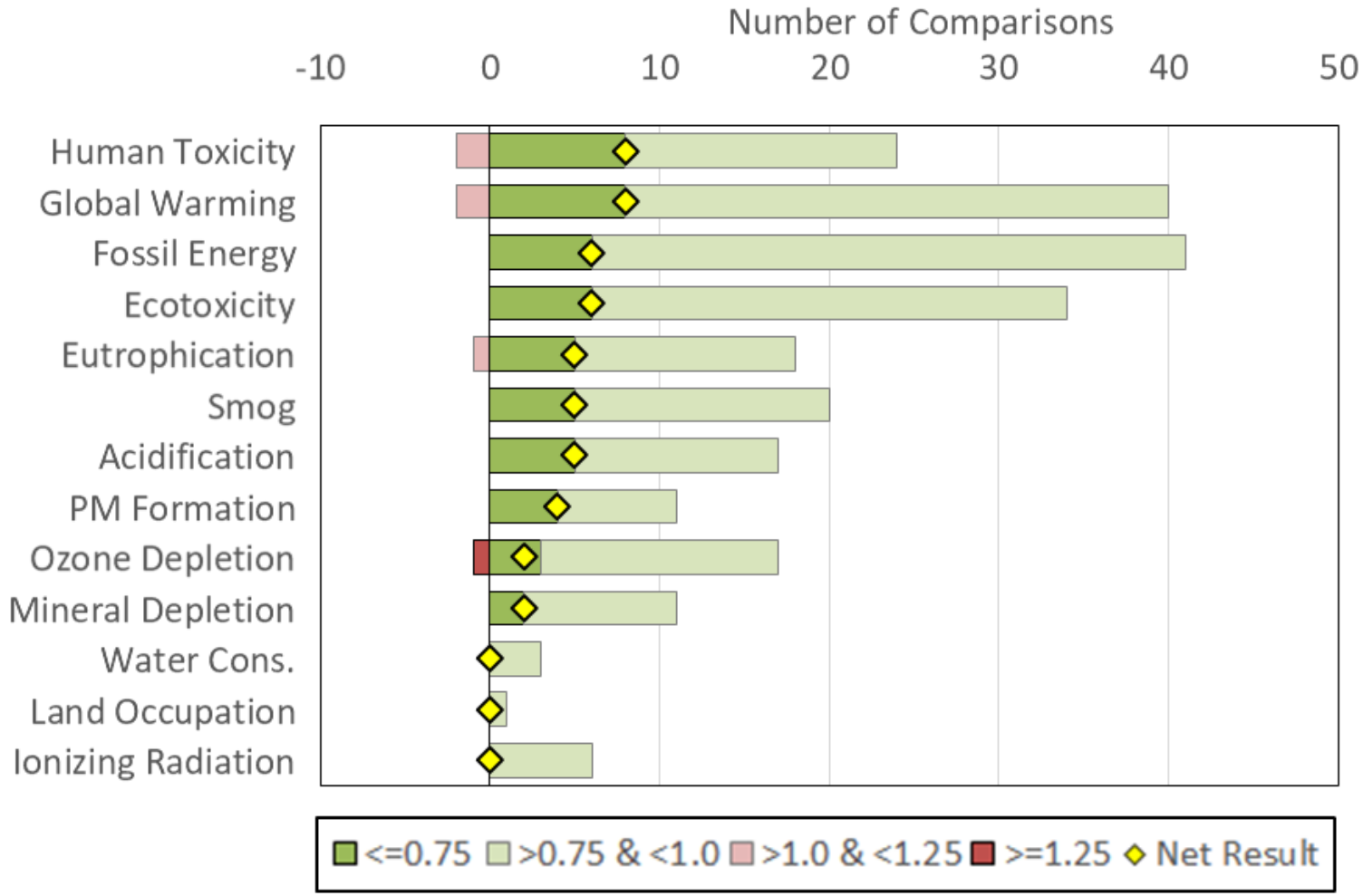
# recycled content – packaging studies

recycled content



# same material packaging with higher PCR vs. lower PCR

recycled content

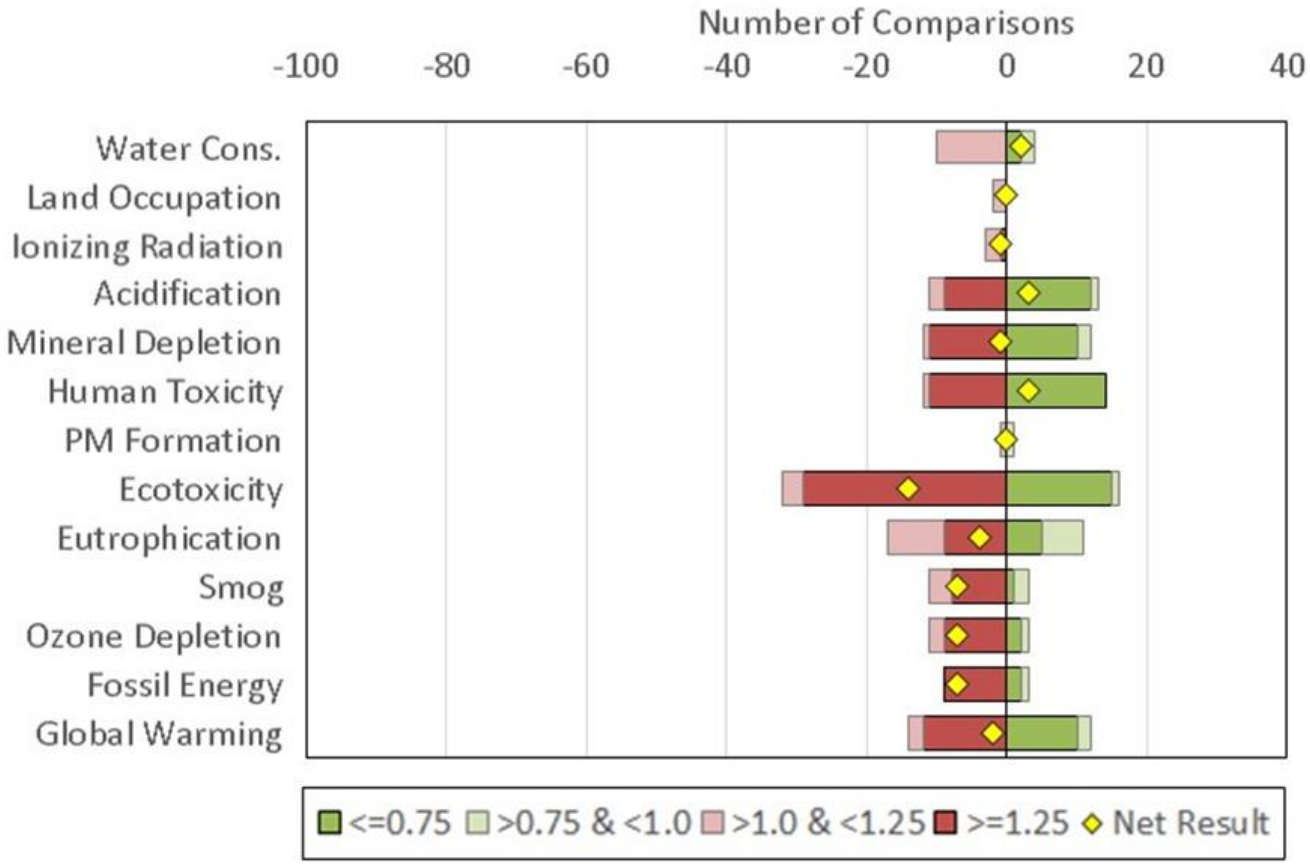


# example: recycled content across different materials

steel container
with recycled content

laminate container
without recycled content

# Comparing different packages based on PCR




When considering individual impact categories, the results comparing packaging systems made of a material with higher recycled content with a packaging system of different material with lower or no recycled content are mixed.

# summary – recycled material

recycled content

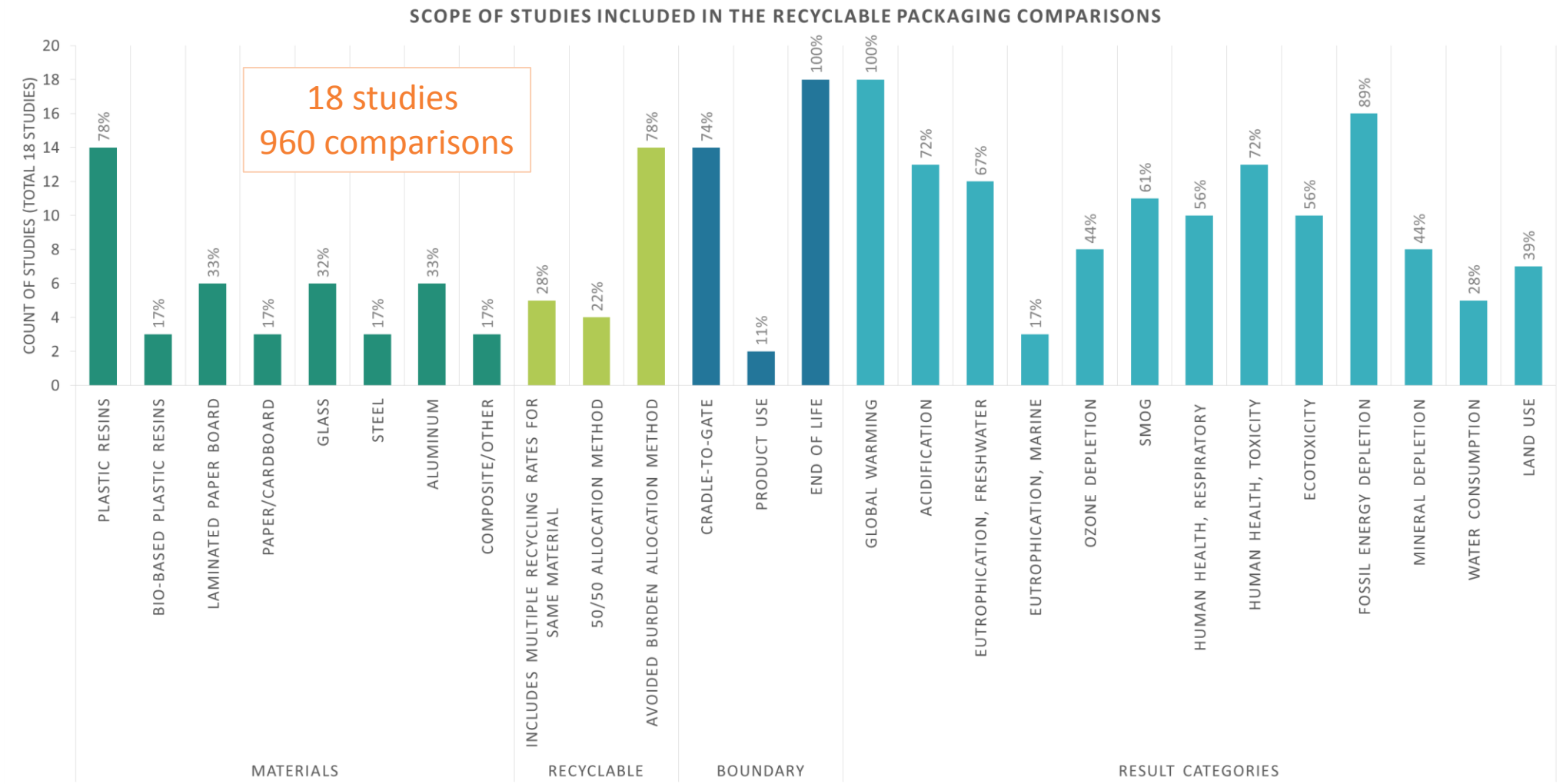
1. When comparing packaging of the same material, selecting the packaging with more recycled content is usually environmentally preferable.
2. The reductions in life cycle impacts associated with using recycled content can vary considerably in magnitude, by material type:
   - From 60-80% for aluminum packaging down to 10-15% for inkjet cartridges made of PET
3. Literature suggest that it is not possible to infer environmental preference for a packaging of one material type over another solely based on recycled content.

# recyclable – packaging

The potential for a material to be recovered from the solid waste stream to be made into a new product at the end of a prior product's useful life.

# recyclable – packaging studies

recyclable packaging

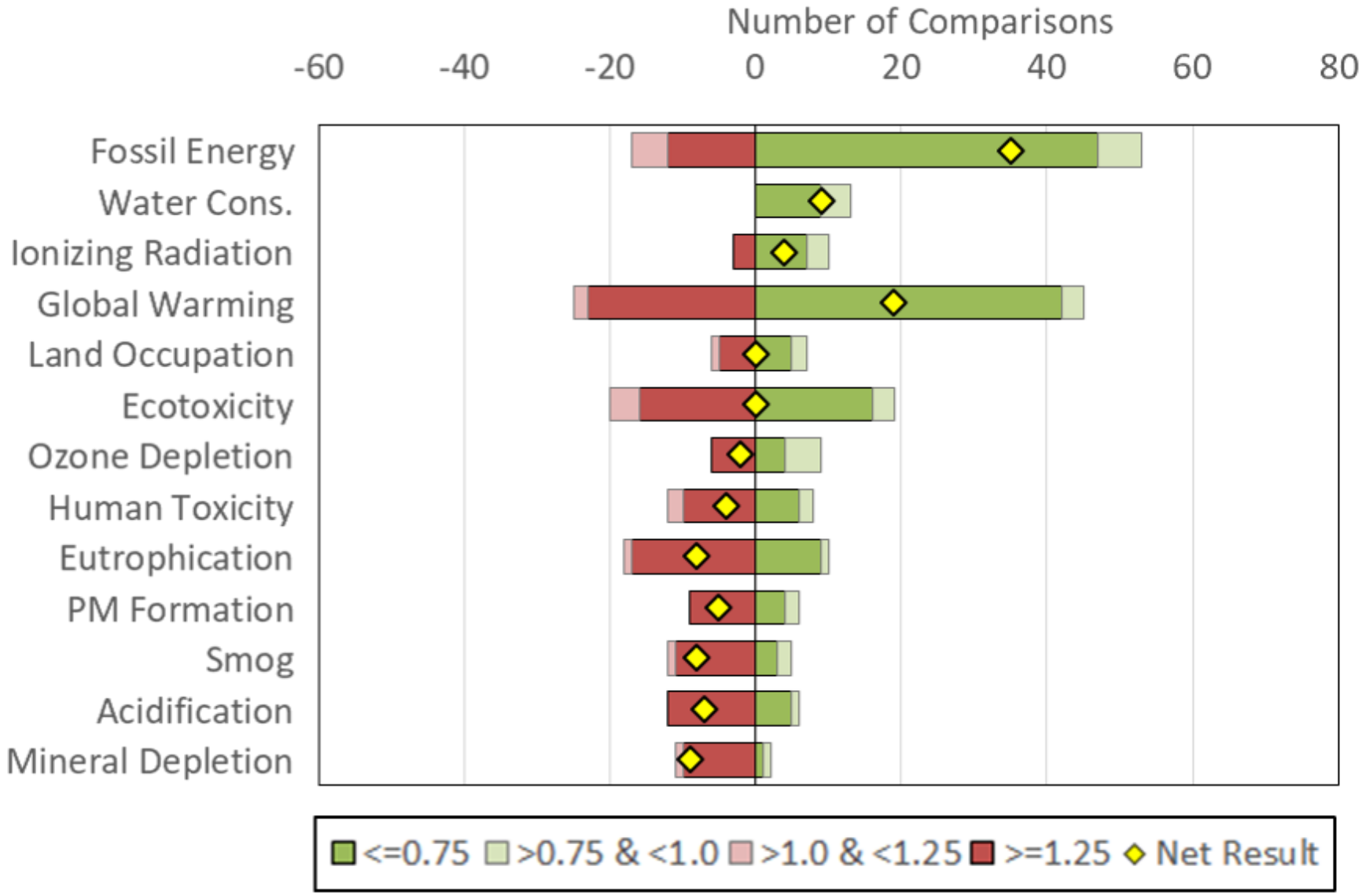


# example: recyclable packages of different materials

glass container
that is recyclable

laminated container
that is not recyclable

# Comparing different packages based on recyclability



# summary – recyclable packaging

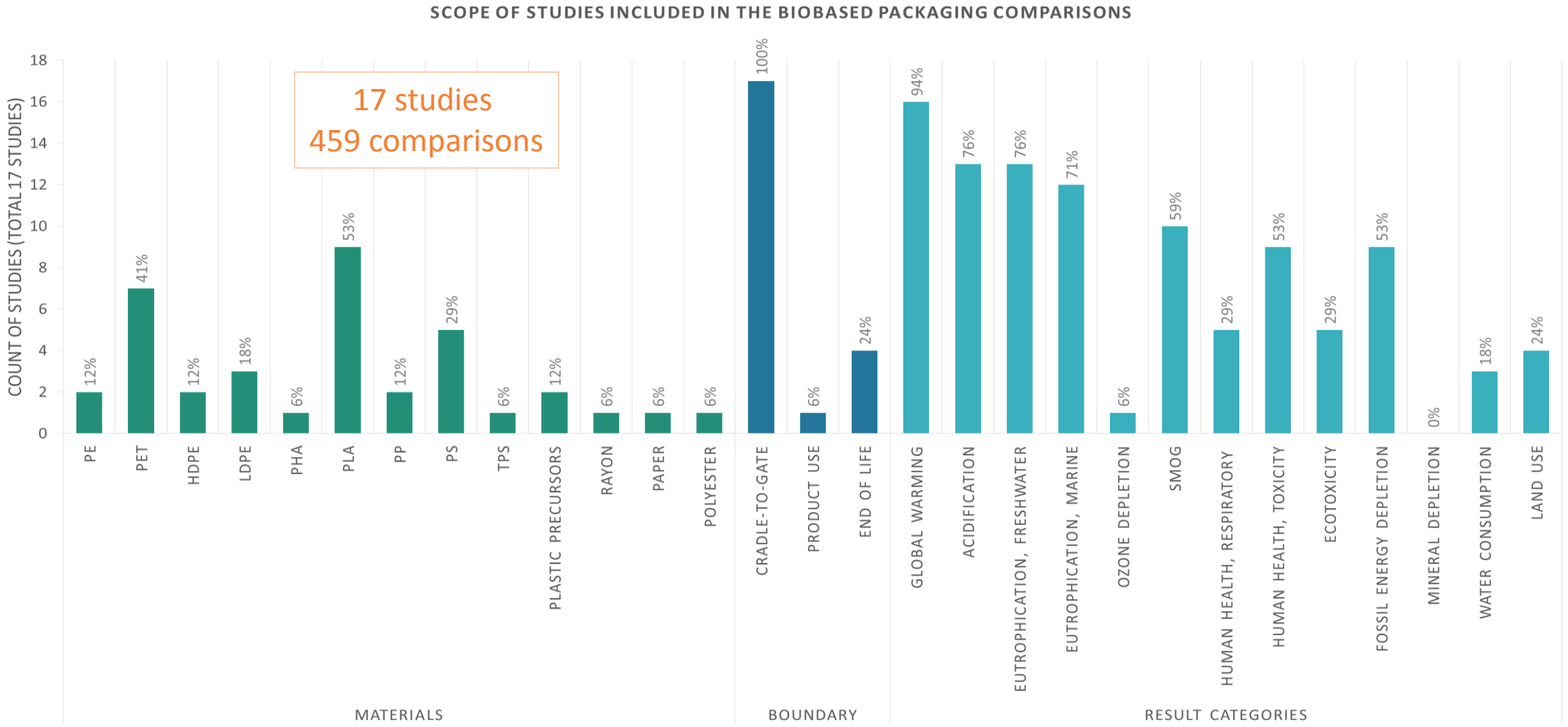

1. Generally recycling results in fewer environmental impacts than landfilling or incineration, and that higher recycling rates are generally preferable to lower recycling rates.
2. Results of comparing packaging made from different materials suggest that packaging weight and material type considerations are a better predictor of environmental impacts than the attribute of recyclability.
3. LCA literature is inconclusive regarding the benefits of recyclability given differences in upstream impacts for functionally equivalent materials, market conditions and primary material replacement rates.

# biobased – packaging

Materials are made from renewable feedstocks that can be replenished as they are used or within short- or midterm timeframes.

# biobased – packaging studies

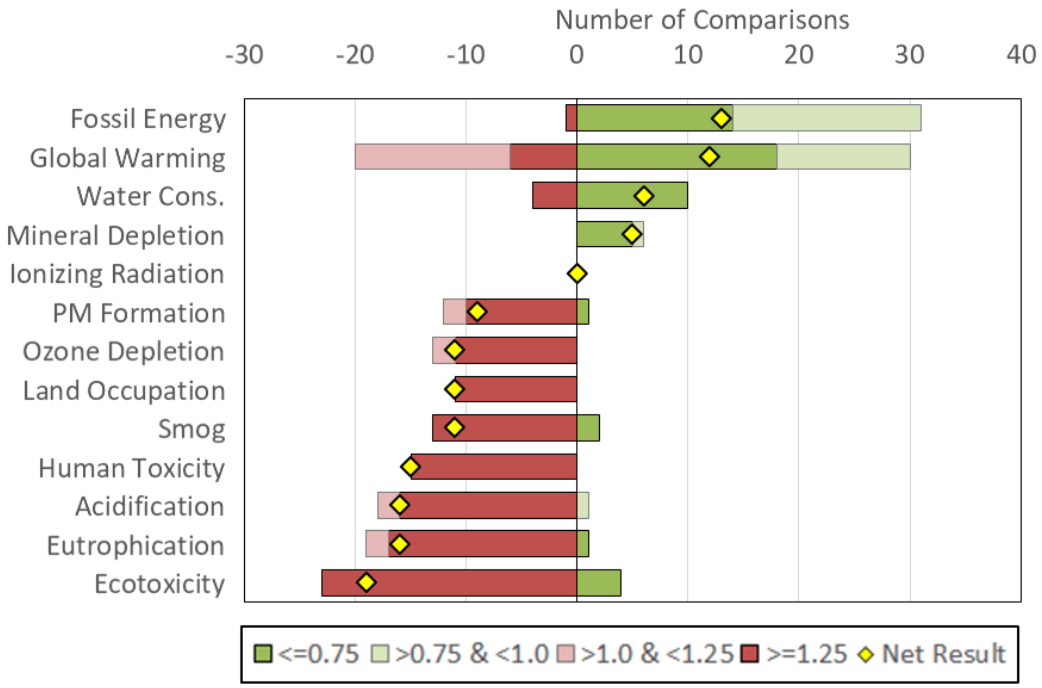
biobased content



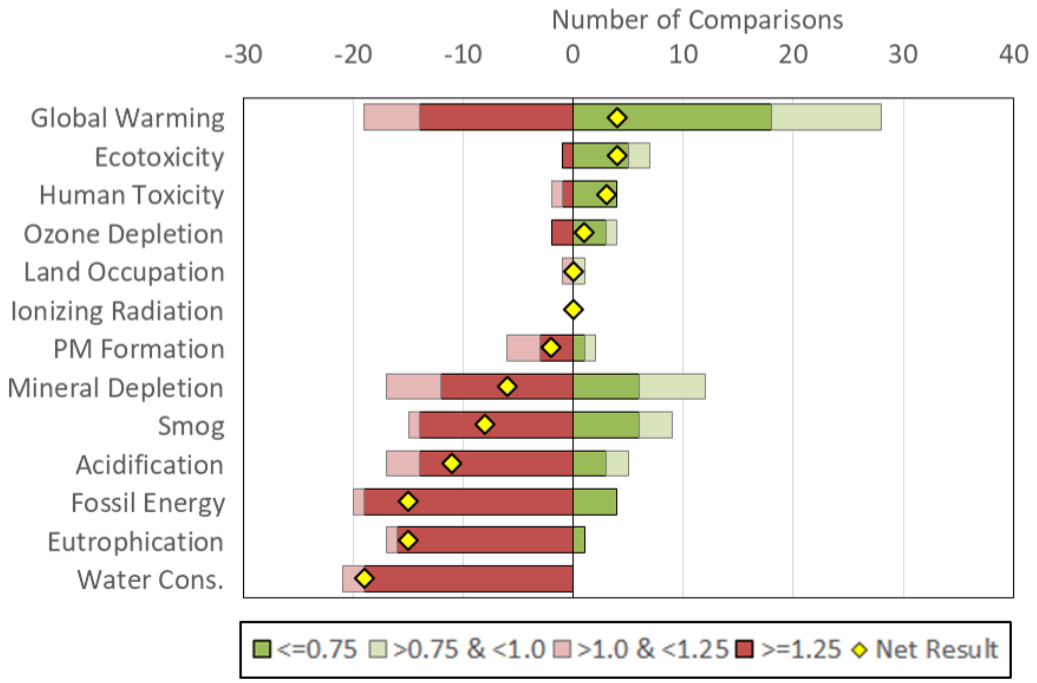
# comparing different materials, biobased vs. not

biobased content

**Same materials**
(e.g., bio-PET vs. conventional PET)




**Different materials**



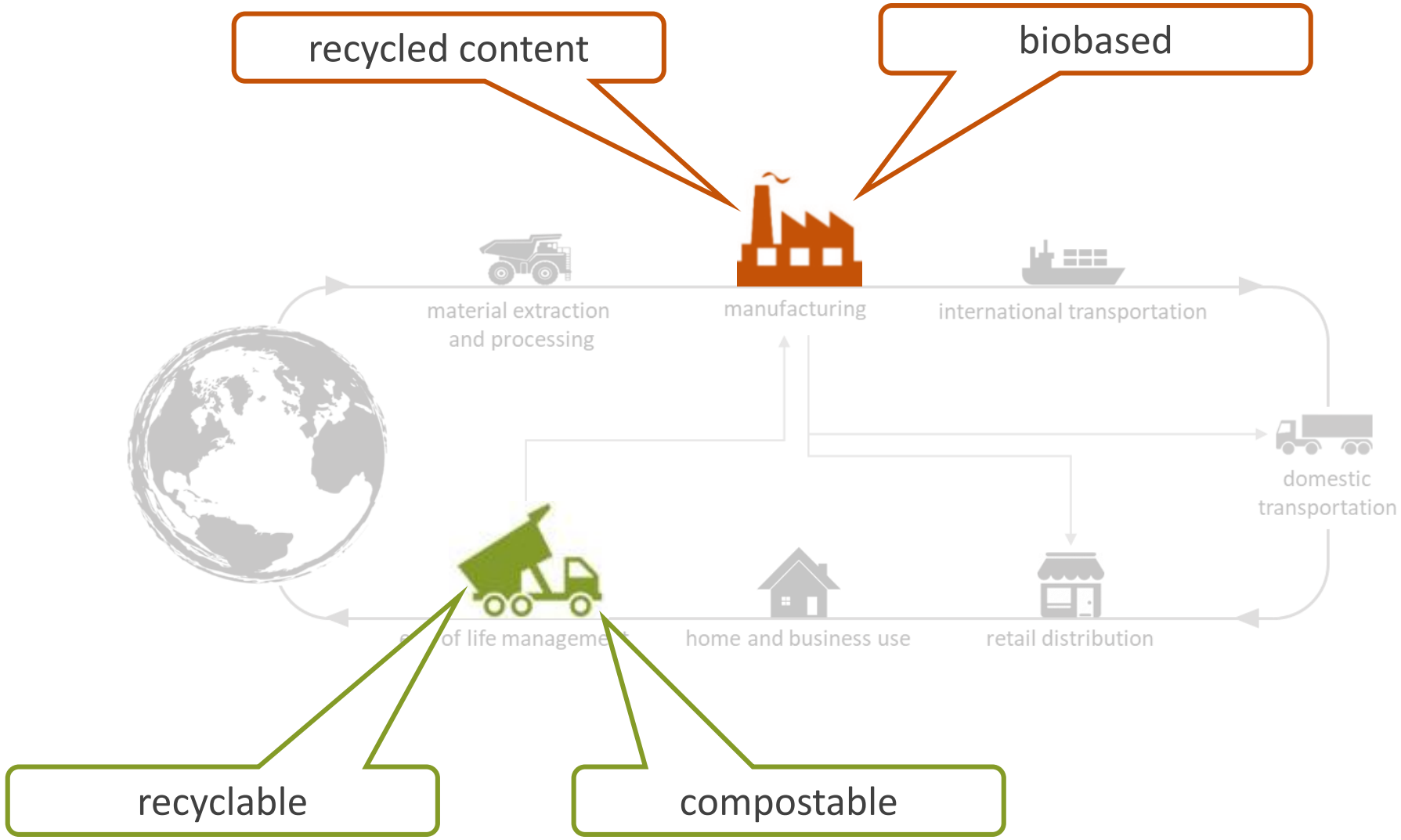
# summary – biobased packaging

biobased content

1. Most comparisons show significant environmental trade-offs between biobased and non-biobased packaging.
2. Biobased materials had their best performances in the global warming category yet these improvements are not consistent across all materials and formats studied.
3. Agricultural production drove consistently meaningful increases in the acidification and eutrophication categories.
4. Fossil-based inputs play a central role in current practices to produce biobased feedstocks.

FOOD SERVICE WARE

# food service ware (FSW): same four attributes reviewed

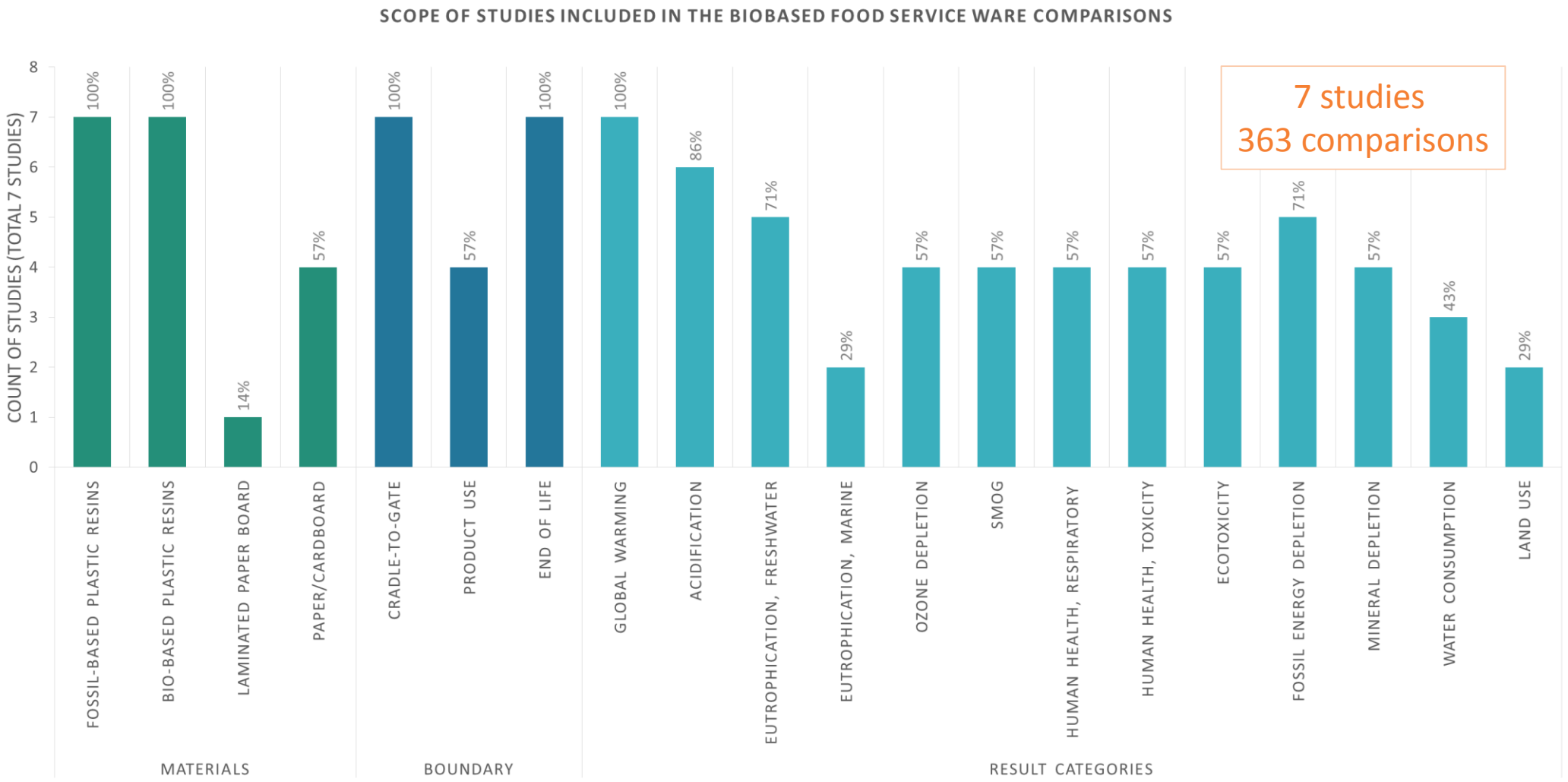


# compostable – food service ware

Materials that degrade by biological processes to yield CO2, water, inorganic compounds, and biomass at a rate consistent with biodegradation of natural waste while leaving no visually distinguishable remnants or unacceptable levels of toxic residues.

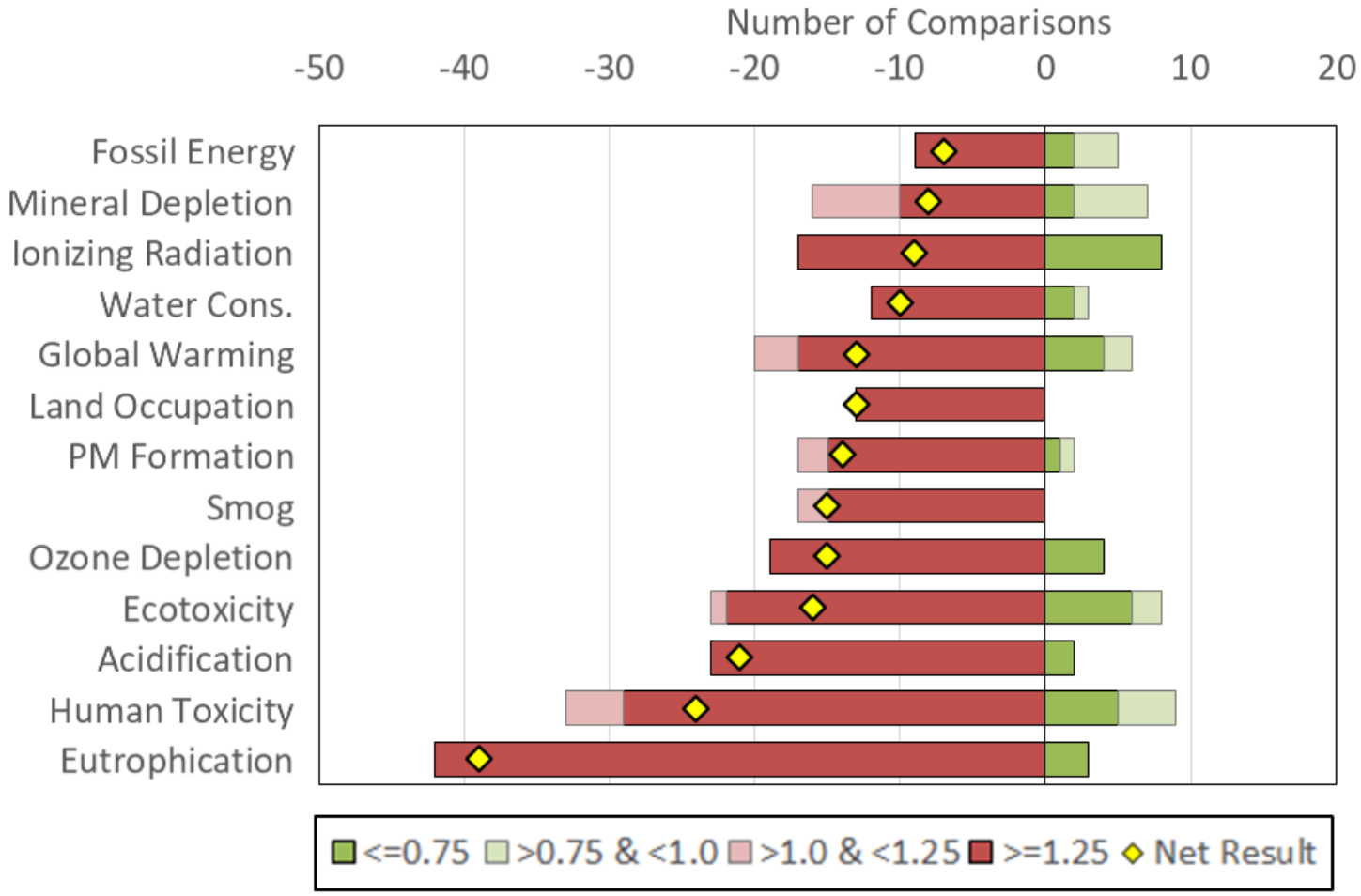
# compostability – food service ware studies

compostable
food service ware



# compostable FSW vs. non- compostable FSW

compostable
food service ware



# summary – food service ware

1. Biobased FSW is generally not preferable to fossil-based FSW. This is because production impacts for biobased materials tend to be higher than for conventional materials.
2. Compostable FSW is generally not preferable to non-compostable FSW, as it is generally biobased, resulting in higher production impacts than fossil-based materials, and there is less benefit recouped through composting than through other waste management options.

# implications and next steps

# Some high-level implications

- Design
  - Attribute-based design strategies (e.g. design for recovery) may be increasing environmental impacts across the life cycle as end of life is typically a minor portion of the overall burdens.
- Marketing
  - Sustainability programs based on attributes often present unsubstantiated claims, teetering on greenwashing.
  - Worse, they may create a demand for higher impact items and behaviors.

Purchasing:

- Institutional buying is guided by material attributes and the approach may have unintended programmatic outcomes (e.g. USDA Bio preferred).

Policy:

- A great deal of energy is devoted to material substitution (biobased), material recovery (recyclable, compostable), and secondary markets (recycled content).
- Perceived environmental benefits do not consistently match actual environmental burdens.

# next steps

- Share results
- Targeted summaries
- Workshops
- Scale through partnerships

# final thought

# materials management

*conserving resources · protecting the environment · living well*

david allaway | allaway.david@deq.state.or.us

Report at: https://www.oregon.gov/deq/mm/production/Pages/Materials-Attributes.aspx