SUSTAINABLE PACKAGING IN THE CIRCULAR ECONOMY

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Agenda

- Problems to solve:
  - Climate emergency
  - Plastics everywhere
  - Fossil-based plastics packaging usage

- The most sustainable packaging is?

- Packaging in the circular economy

- Let’s work on solutions:
  Packaging material substitution & jobs opportunities
• At present we need 1.75 planets to support humans’ demand on Earth’s ecosystems
• Self-inflicted scarcest resource: time. We are running out of time to reverse the negative impact that humans impose on our planet’s capacity to sustain its biosphere
• We have about 10 years to bend these trends, before we hit a point of no return
• Should we give up then? No, experts like you and me and many other people, all over the world, are working with great competence, passion and determination to bring our planet back on a sustainable path
Henderson Island, uninhabited island in the South Pacific, 3100 miles away from any town or factory, highest density of debris reported anywhere in the world ("Exceptional and rapid accumulation of anthropogenic debris on one of the world’s most remote and pristine islands" by Jennifer L. Lavers and Alexander L. Bond, *Proceedings of the National Academy of Sciences*, June 6 2017)

- "The 17.6 tons of anthropogenic debris estimated to be present on Henderson Island account for only 1.98 seconds’ worth of the annual global production of plastic”
- Since the 1950s we have produced 8.3 billions tons of plastic and virtually all of it is somewhere on the planet, including human bodies
- We are trashing the planet with plastic, destroying or endangering other species, including ours, as we have started drinking/breathing microplastics
Microplastics are ubiquitous across ecosystems, yet the exposure risk to humans is unresolved. Focusing on the American diet, we evaluated the number of microplastic particles in commonly consumed foods in relation to their recommended daily intake. [...] Evaluating approximately 15% of Americans’ caloric intake, we estimate that annual microplastics consumption ranges from 39000 to 52000 particles depending on age and sex. These estimates increase to 74000 and 121000 when inhalation is considered. Additionally, individuals who meet their recommended water intake through only bottled sources may be ingesting an additional 90000 microplastics annually, compared to 4000 microplastics for those who consume only tap water.

Human Consumption of Microplastics
Kieran D. Cox, Garth A. Coventon, Hailey L. Davies, John F. Dower, Francis Juanes, and Sarah E. Dudas
Environmental Science & Technology Article ASAP
DOI: 10.1021/acs.est.9b01537

- Microplastic size between 0.05 to 5 mm (1/500 to 1/5 inch)
• Plastics are synthetic polymers
• Polymer is a chemical made of repeating units combining carbon, hydrogen, oxygen, nitrogen, chlorine, and sulfur
• Over 90% of plastics are fossil-based (feedstocks are produced by the petrochemical industry)
• Natural polymers: DNA, RNA, spider silk, keratin (horn, hair, nails, skin), rubber tree latex, cellulose
• 2015 annual production = 381 million metric tones
Forty per cent of plastic packaging waste is disposed of at sanitary landfills, 14% goes to incineration facilities and 14% is collected for recycling. Incineration creates the most CO$_2$ emissions among the plastic waste management methods.

https://www.ciel.org/news/plasticandhealth/

Fossil fuels must stay in the ground in order to stop anthropogenic climate change, therefore fossil based plastics must be abandoned.
• None as Refuse in the 5Rs (Refuse, Reduce, Reuse, Repurpose, Recycle)
• This leads to the following questions: Why does packaging exist? How much of it can be eliminated?
• We need a 350 ppm CO2 alternative economic model, urgently
• CE is one such model
• All individual and business decisions and actions, no matter how small, lead to large aggregate impacts
• CE brings human life and activities in balance with Earth’s main cycles and finitude
• CE brings human-made world in balance with the natural world where diversity, resilience, redundancy, smallness, interdependence, waste-is-food, slowness are the keys to survive and thrive
• There is no trash, no waste, no landfill in nature
• For any business adopting the circular economy model the following activities are essential, in order of priority: maintenance, reuse, remanufacture, refurbish, repurpose, recycle
  • It is the order in which entropy increases and economic value decreases
• Operates on two planes
  • Product circles within flows of natural and technical materials between producers, servicers and users
  • Growth and disposal are replaced by circles of maintenance, long-lasting value and usage
  • Local symbiosis connects market and non-market stakeholders with the shared goal of prosperity and sustainability for all

• In both planes, waste not
acceptable
• For every by-product and waste flow, feedstock demand is searched or created
LET’S WORK ON SOLUTIONS

Objectives:

- Solve the 3 problems
- Substitute fossil-based materials for six packaging plastics
- Fit the circular economy model on all criteria
- Have a neutral or positive impact on jobs
- Perform optimally on all 3 sustainability dimensions: environmental, social and economic

- Plastics & Rubber Products Manufacturing NAICS 326 is the 3rd largest manufacturing sector in the US
- Employment over 700,000
- Average hourly earnings for production & nonsupervisory employees ~ $19

https://www.bls.gov/iag/tgs/iag326.htm
• PLA = polylactic acid derived from biomass such as plant starch (e.g. corn, sugarcane)
Polyurethane PU

“Manufacturing Green Cell Foam requires 70% less energy and produces 80% less greenhouse gases than petroleum based foams. It is also backyard compostable, biodegradable and water soluble (ASTM D6400 and BPI certified). The primary raw material is U.S. grown, non-GMO cornstarch, an annually renewable resource.”

KTM Industries Inc., Holt, Michigan

Common uses: protective packaging, custom form-fitting cushioning
Composites with reinforcing fibers (glass, carbon, etc.)
https://www.bpf.co.uk/plastipedia/polymers/Unsaturated_Polyester.aspx
The resin invented for the first commercially viable plastic (Bakelite 1910)

Adhesives [for plywood bonding, my note] were prepared from konjac glucomannan, a water-soluble polysaccharide extracted from the tuber of the *Amorphophallus konjac*, or devil’s tongue plant, and from chitosan, a polysaccharide prepared through deacetylation of chitin, a compound that can be extracted from the epidermis of crustaceans such as crabs and shrimps.

*Future opportunities for bio-based adhesives – advantages beyond renewability*


Common uses: wood adhesives (plywood crates)
• Glass bottles and jars are 100% recyclable and can be recycled endlessly without any loss in purity or quality.
• One ton of carbon dioxide is reduced for every six tons of recycled container glass used in the manufacturing process.
• States with container deposit legislation have an average glass container recycling rate of just over 63%, while non-deposit states only reach about 24%, according to the Container Recycling Institute.
• Beverage container deposit systems provide 11 to 38 times more direct jobs than curbside recycling systems for beverage containers. (Source: The Container Recycling Institute, "Returning to Work: Understanding the Jobs Impacts from Different Methods of Recycling Beverage Containers").
• Recycled glass is substituted for up to 95% of raw materials.
• Recycling 1,000 tons of glass creates slightly over 8 jobs. (Source: 2011 Container Recycling Institute).
Polyvinyl Chloride

"Sustainable Design"

- Made with 100% plant-based material
- No plastic produced and discarded
- Prop 65 compliant; free of intentionally added BPA or BPA derived plastics, mercury, phthalates, and PVC
- Reduces Scope 3 GHG emissions by over 55% when compared to polystyrene foam
- Can be recycled with paper
- Biodegradable; rate dependent on disposal conditions"

NewGen Surgical

Common uses: food, shrink wrap, packing (blister), medical bags (blood bags, IV solution containers & tubing)
“The living world is in desperate condition. It is suffering steep declines in all the levels of its diversity. It will be helped out, but not saved by economic measures of its ecological services and potential products. [...] Only a major shift in moral reasoning, with greater commitment given to the rest of life, can meet this greatest challenge of the century.”


“...useful, low-entropy energy and materials are dissipated in transformations that occur in economic processes, and they return to the environment as high-entropy wastes. The economy, then, functions as a conduit for converting natural resources into goods, services, human satisfaction, and waste products. Increasing entropy in the economy sets the limit on the scale it can achieve and maintain.”

Resources

American Chemistry Council
https://plastics.americanchemistry.com/Plastics_Pages/Sustainability_and_Reycling_Pages/Recycle/
https://www.plasticpackagingfacts.org/

The Association of Plastic Recyclers
https://www.plasticsrecycling.org

Municipality-led circular economy case studies

Sustainable Packaging Coalition®
https://sustainablepackaging.org/

Packaging and Circular Economy - French Packaging Council
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https://oscedays.org/