

Chemistry Innovation

Driving Innovation and Value for the UK chemistry-using industries

Knowledge
Transfer
Network

Chemistry Innovation

RSC | Advancing the
Chemical Sciences

New Business Through Resource Efficiency

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Sustainability Manager

Contents

- **Why are materials scarce?**
 - How we obtain elements
 - Other resources
 - Issues influencing availability

- **How can we manage resources better?**
 - Reduce, reuse, recycle, replace
 - New business models
 - Case studies



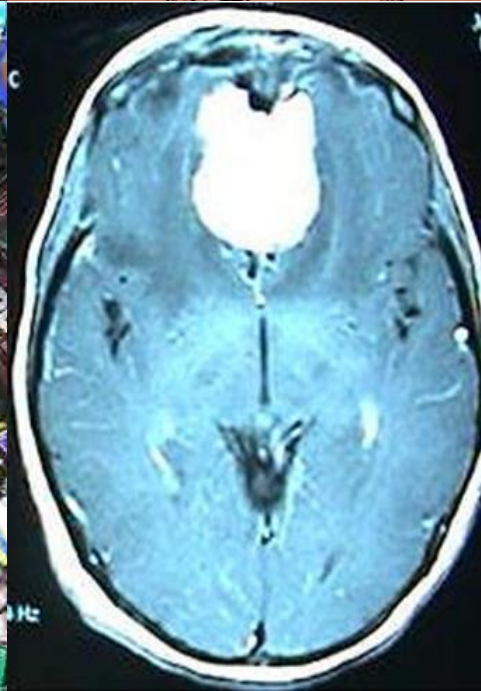
9.5bn



1 planet

3 billion new middle class by 2050





Supply Interruptions by 2015?

Forecast Supply and Demand for Selected Rare Earths in 2015

<u>Rare Earth Oxide</u>	<u>Demand @ 180,000tpa REO</u>	<u>Supply @ 208,500tpa REO</u>
Cerium	63-68,000t REO	80-85,000t REO
Neodymium	35-40,000t REO	30-35,000t REO
Europium	725-775t REO	575-625t REO
Terbium	450-500t REO	375-425t REO
Dysprosium	2,500-3,000t REO	1,600-2,000t REO

Elements in a Mobile Phone

Roughly 40 different elements

H, Li, Be, C, N, O, F, Al, Si, S, Cl, K, Ca, Ti, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, As, Br, Sr, Y, Zr, Ru, Pd, Ag, Cd, In, Sn, Sb, Ba, Ta, W, Pt, Au, Hg, Pb, Bi, Nd.

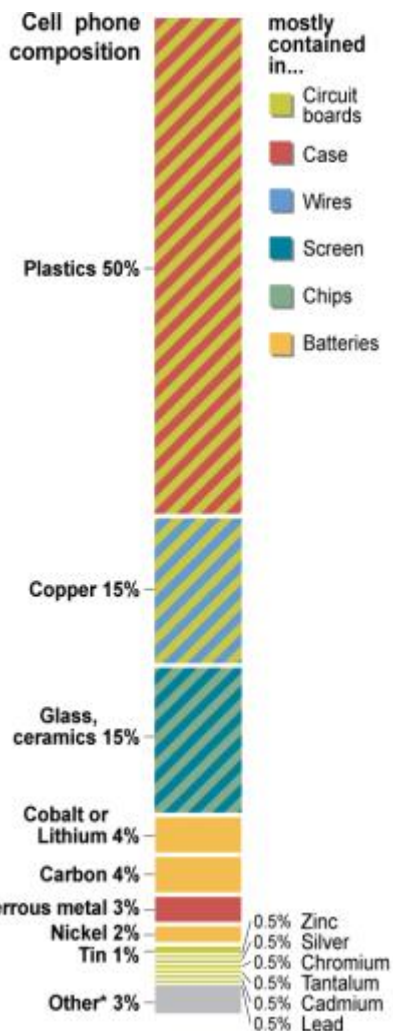
mobile phone weighing 100 grams, contains

13.7 g of copper

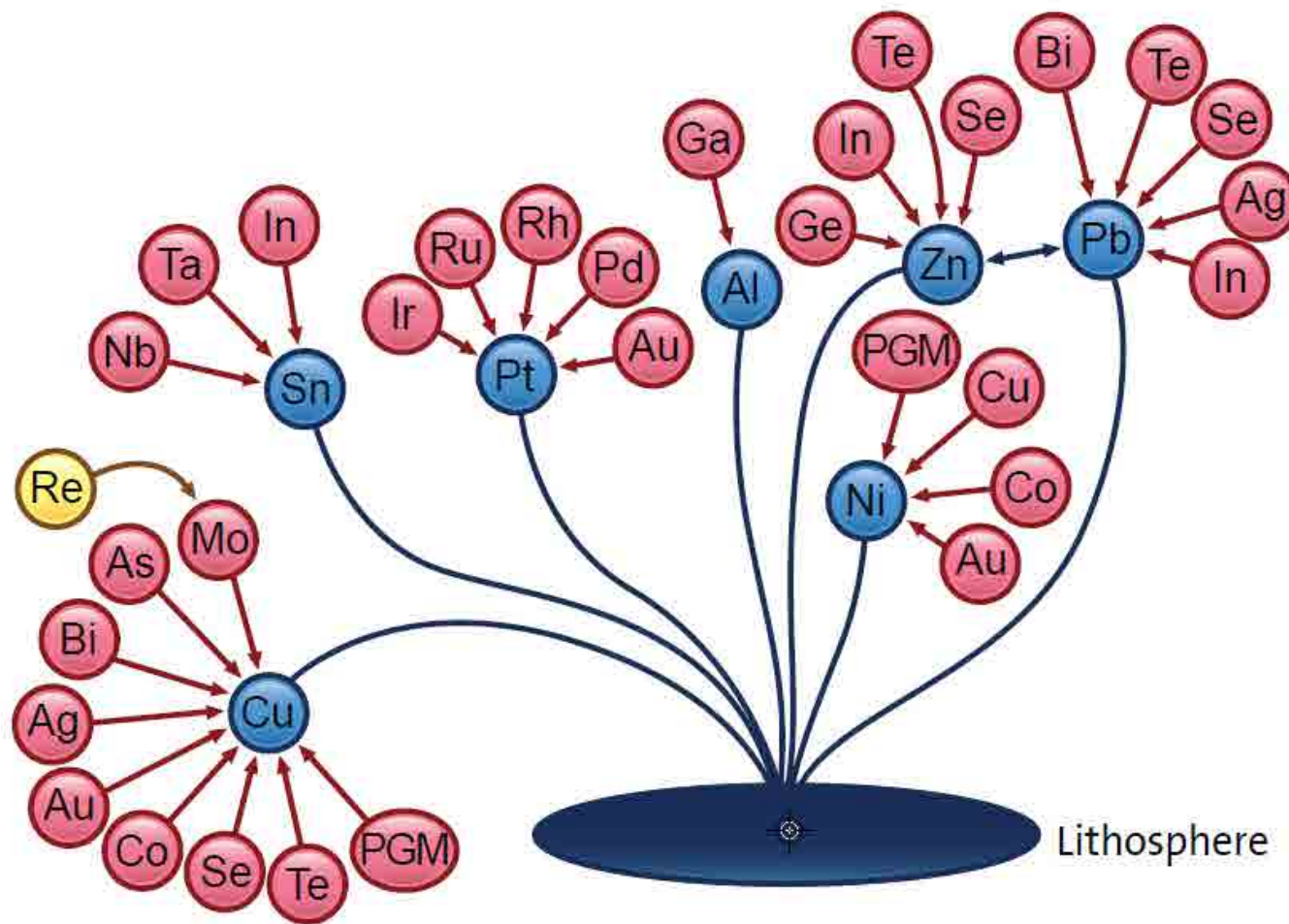
0.189 g of silver

0.028 g of gold

0.014 g of palladium



Secondary Metals



He

5.2 ppm



P



70 years?



A large coil of copper wire, showing a warm, reddish-brown glow. The wire is tightly packed and forms a dense, cylindrical shape. The lighting is dramatic, highlighting the texture and metallic sheen of the copper.

Cu

170 kg



£50 billion?

Chuquicamata mine, Chile

Criticality of the Elements

- Limited amount on the planet
- Being used in dispersive technologies
- Rapid growth in use due to technology application
- Growing global middle class (300m pa)
- Method of obtaining is disproportionately damaging to environment
- Availability a geopolitical issue (political instability)
- Lack of recycling – technical and/or infrastructure

Concentration of critical minerals

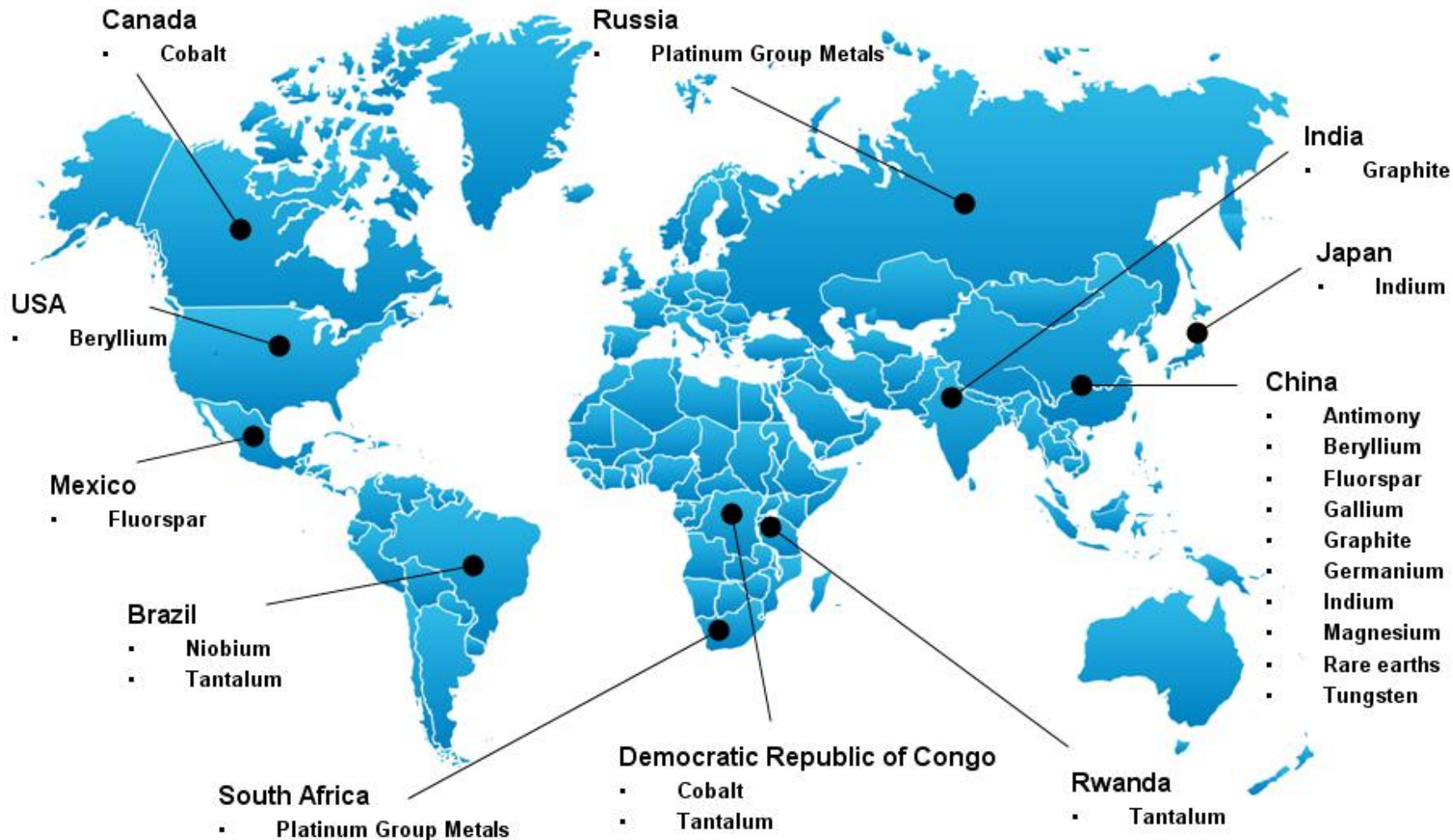




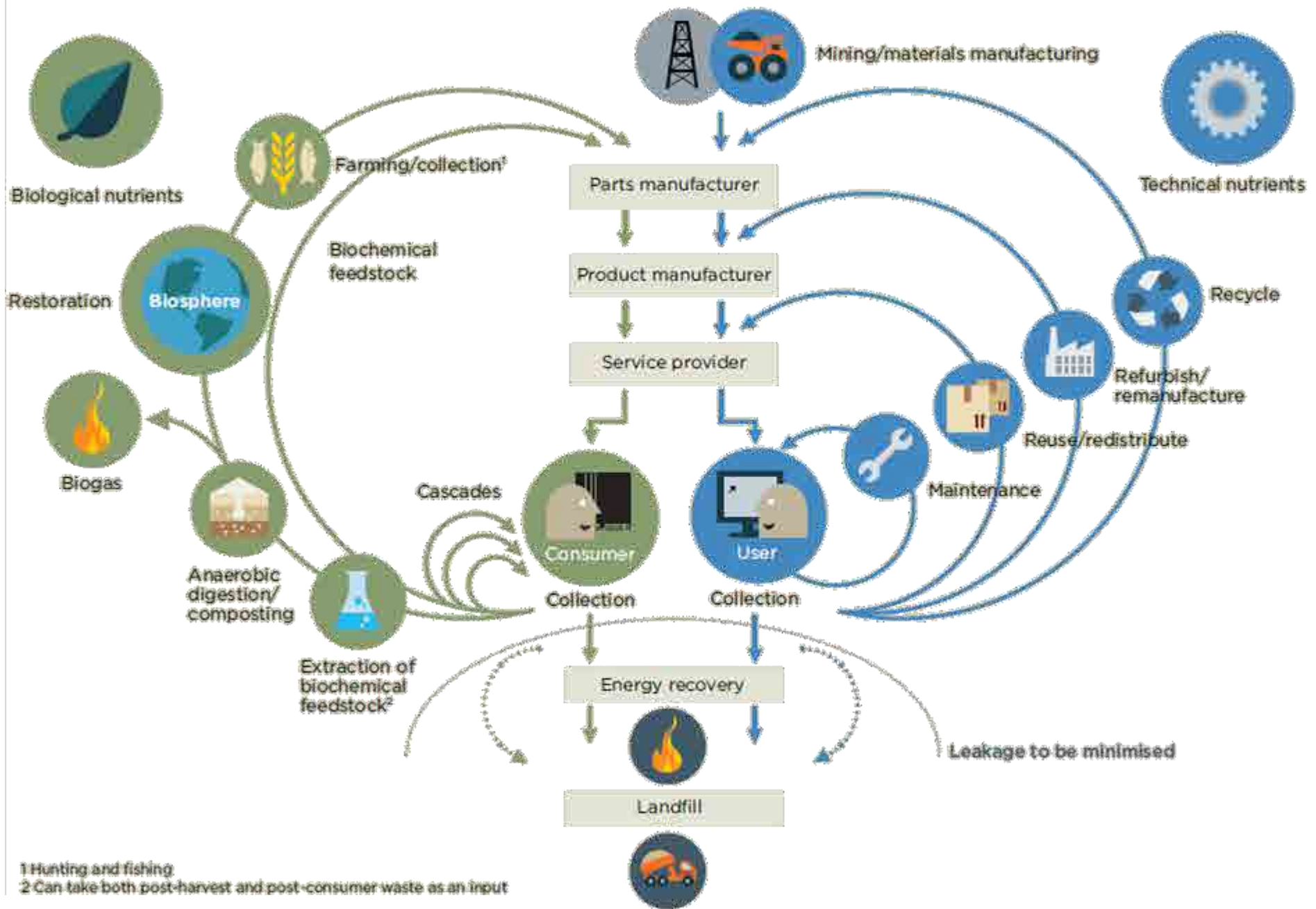
Image: Basel Action Network



What we need to do....

Reducing the overall environmental impact, whilst maintaining or improving economic, technical and social performance

- from plant/product to whole life cycle
- from process and product to service
- from unit operation to whole system

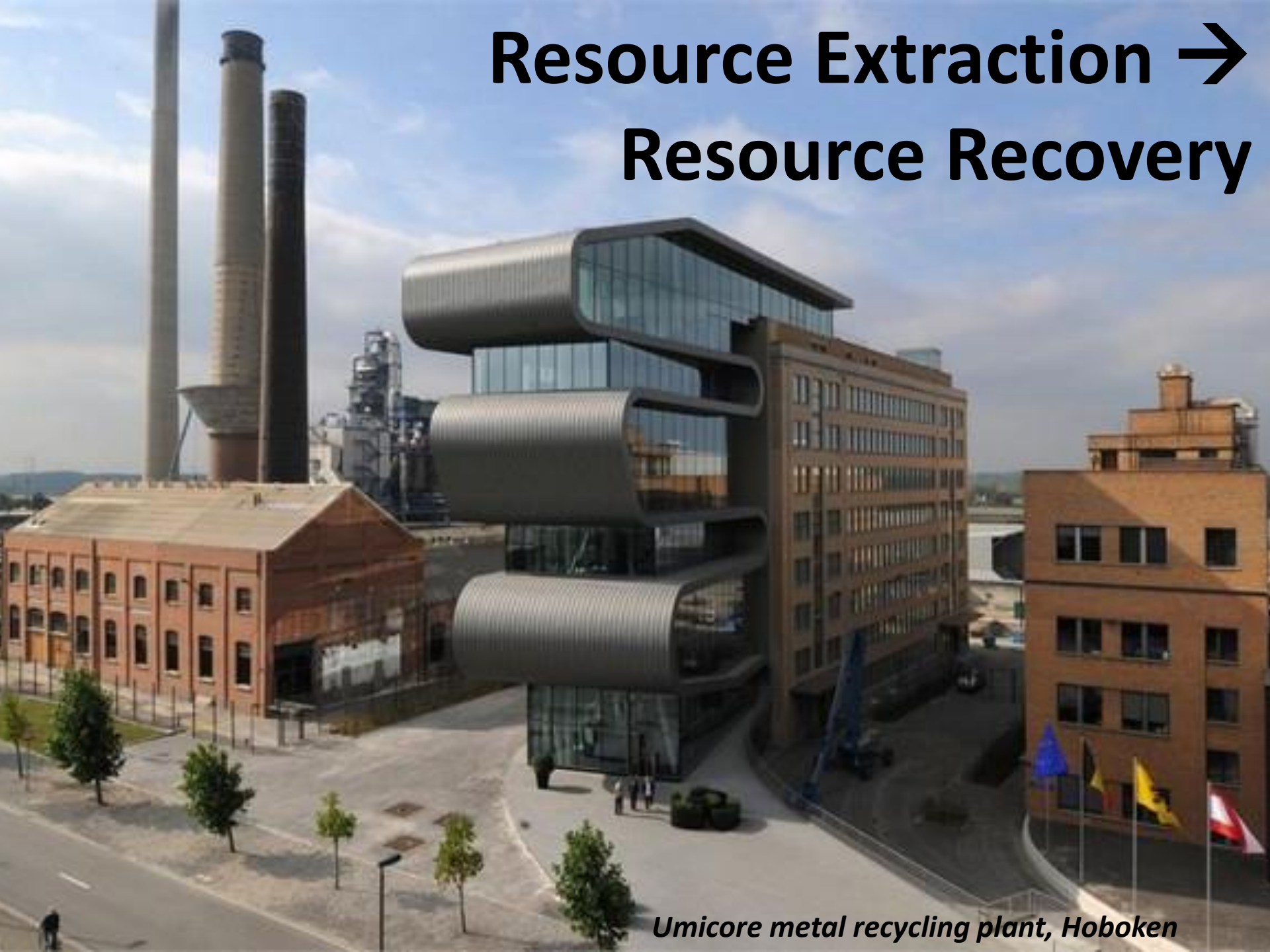


Towards The Circular Economy, Ellen MacArthur Foundation (www.thecirculareconomy.org)

Resource Extraction → Resource Recovery



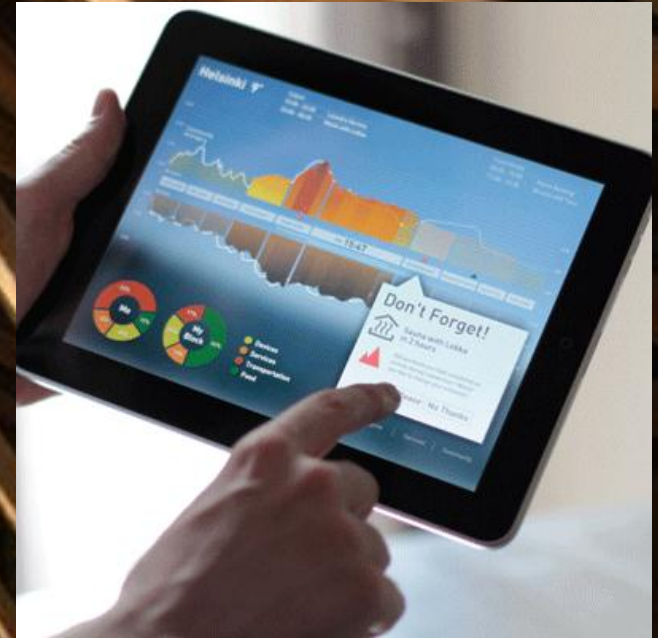
Resource Extraction → Resource Recovery



Umicore metal recycling plant, Hoboken

**Energy Generation/Supply →
Energy Efficiency**





**Energy Generation/Supply →
Energy Efficiency**



**Manufacturing Products →
Managing Cycles**

Manufacturing Products → Managing Cycles

Desso, Waalwijk, The Netherlands



Retail → Service Provision



Retail → Service Provision



Images: zipcar.co.uk



Waste Management → Material Management & Reverse Logistics

A yellow CAT bulldozer is shown operating on a large pile of waste at a landfill. The bulldozer is positioned on top of the waste pile, and its front loader is visible. The background shows a clear blue sky and a distant horizon with some hills. The text "90% of all products are waste within 6 months of purchase" is overlaid on the bottom of the image.

90% of all products are waste
within 6 months of purchase

Waste Management → Material Management & Reverse Logistics



4Rs

- **Reduce**
 - Less material or energy for the same delivered effect
- **Reuse**
 - Enable the recovery of a component or material to deliver the same effect again
- **Recycle**
 - Enable the recovery of a material to be re-processed with no loss in value
- **Replace**
 - Substitute with a material, process or business model that delivers the same effect in a better way

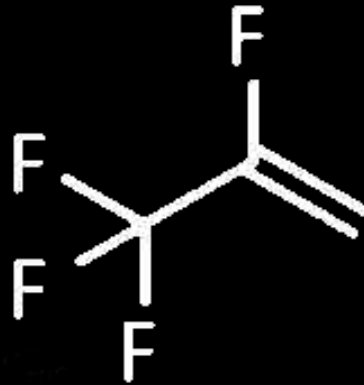
Reduce





Source: Dow – Sentricon(R) termite colony eliminator

GWP 4



1234yf

GWP 1430



R134a

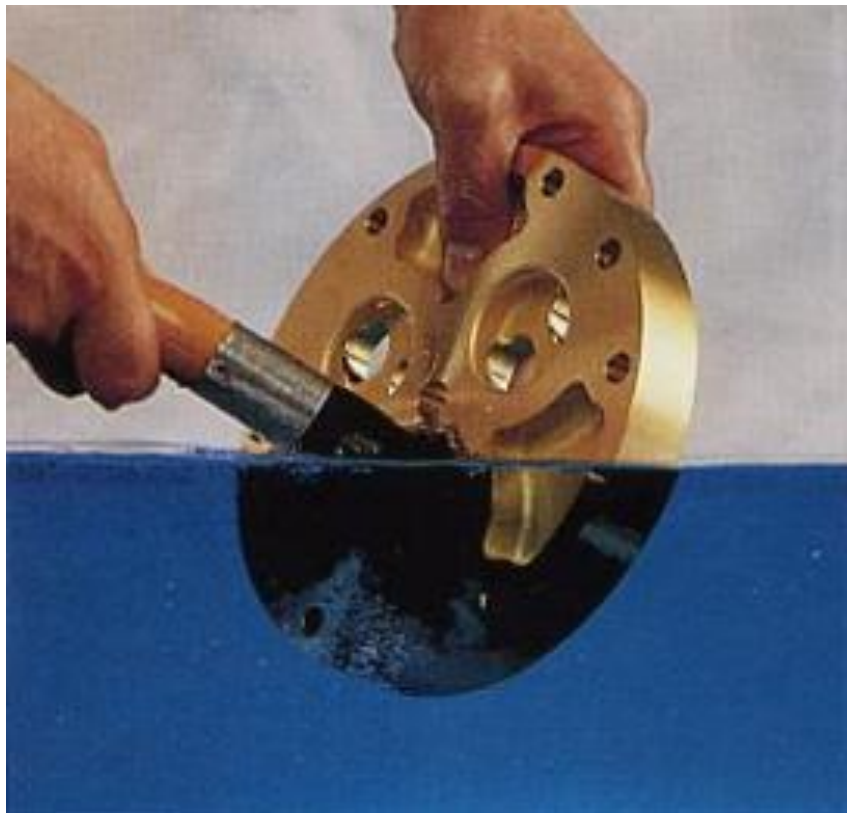
Reuse/Remanufacture



CATERPILLAR®



Recycle



Future Recycling Opportunities

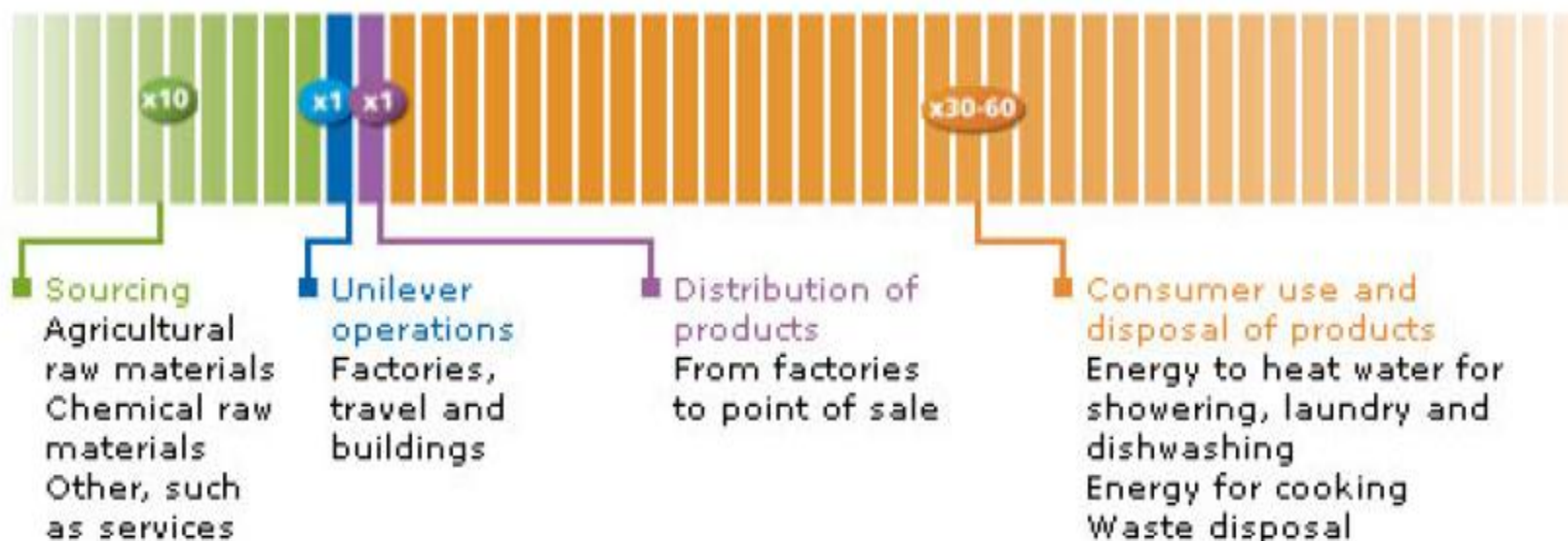






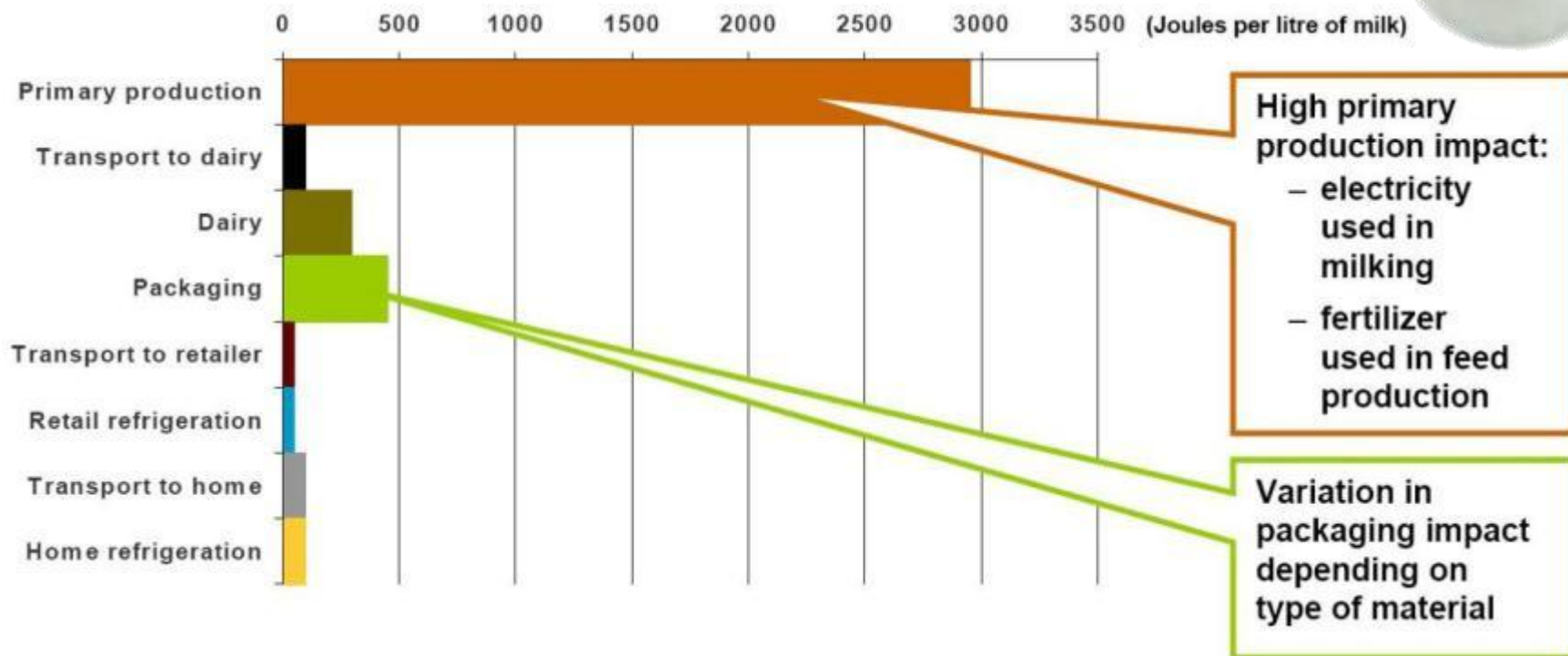
Carbon Footprint

- Unilever's carbon footprint



Lifecycle Analysis

*for each
pint of milk:*



High primary production impact:

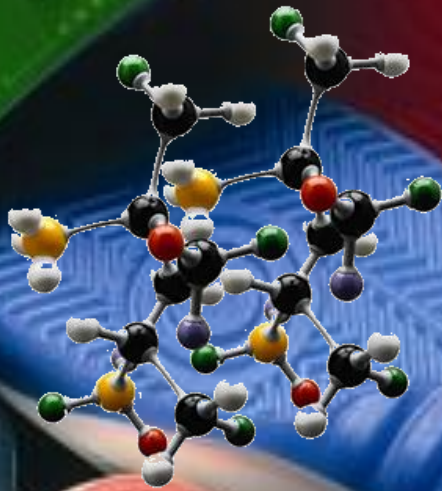
- electricity used in milking
- fertilizer used in feed production

Variation in packaging impact depending on type of material

What are we delivering?

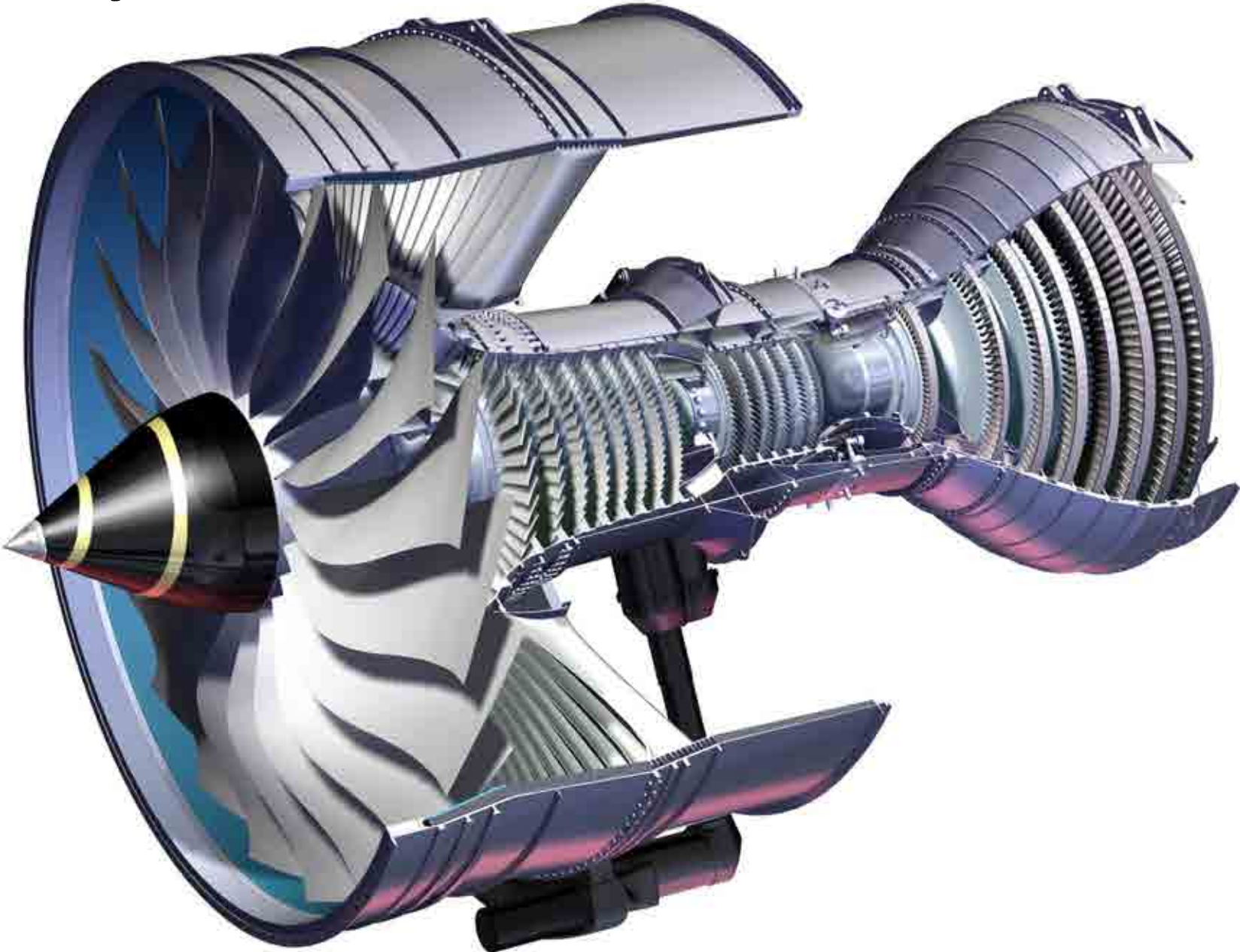


We don't sell polyurethane...



...we sell a comfortable walking experience

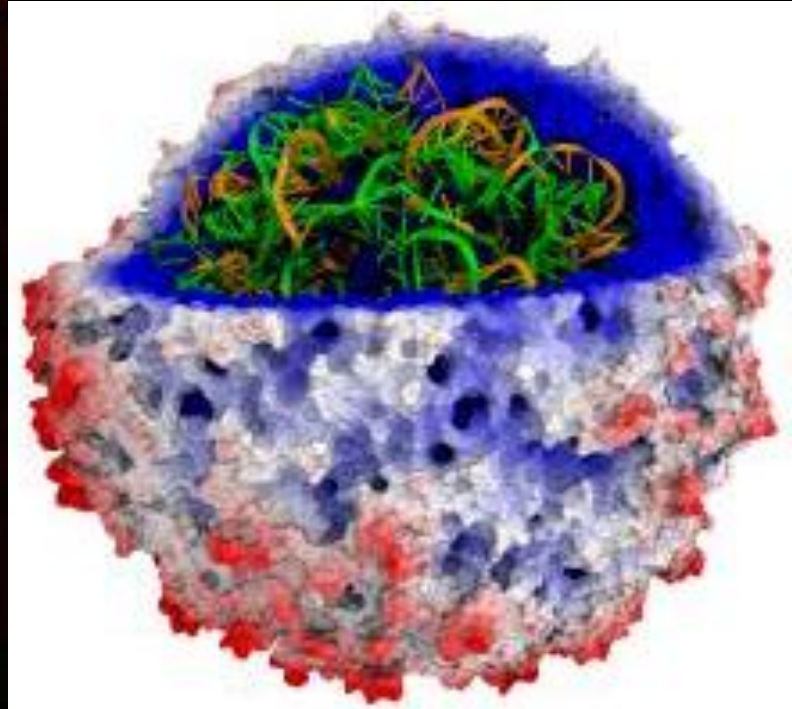
Power by the Hour

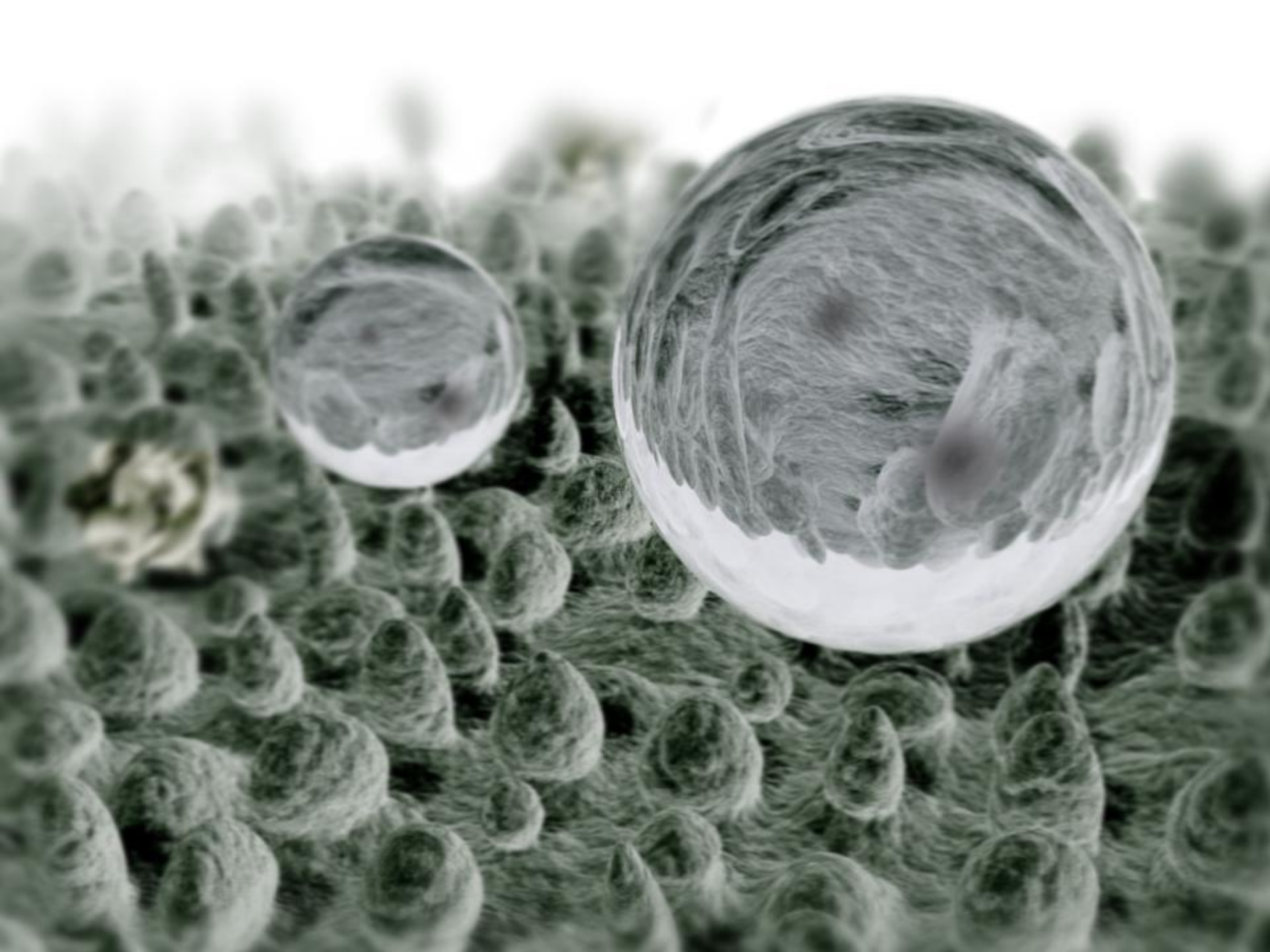


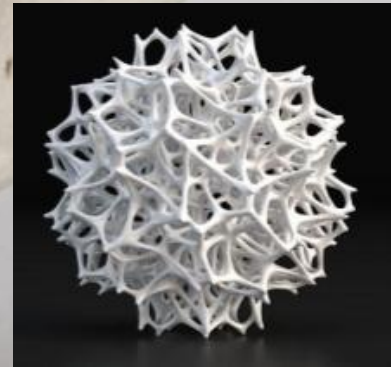
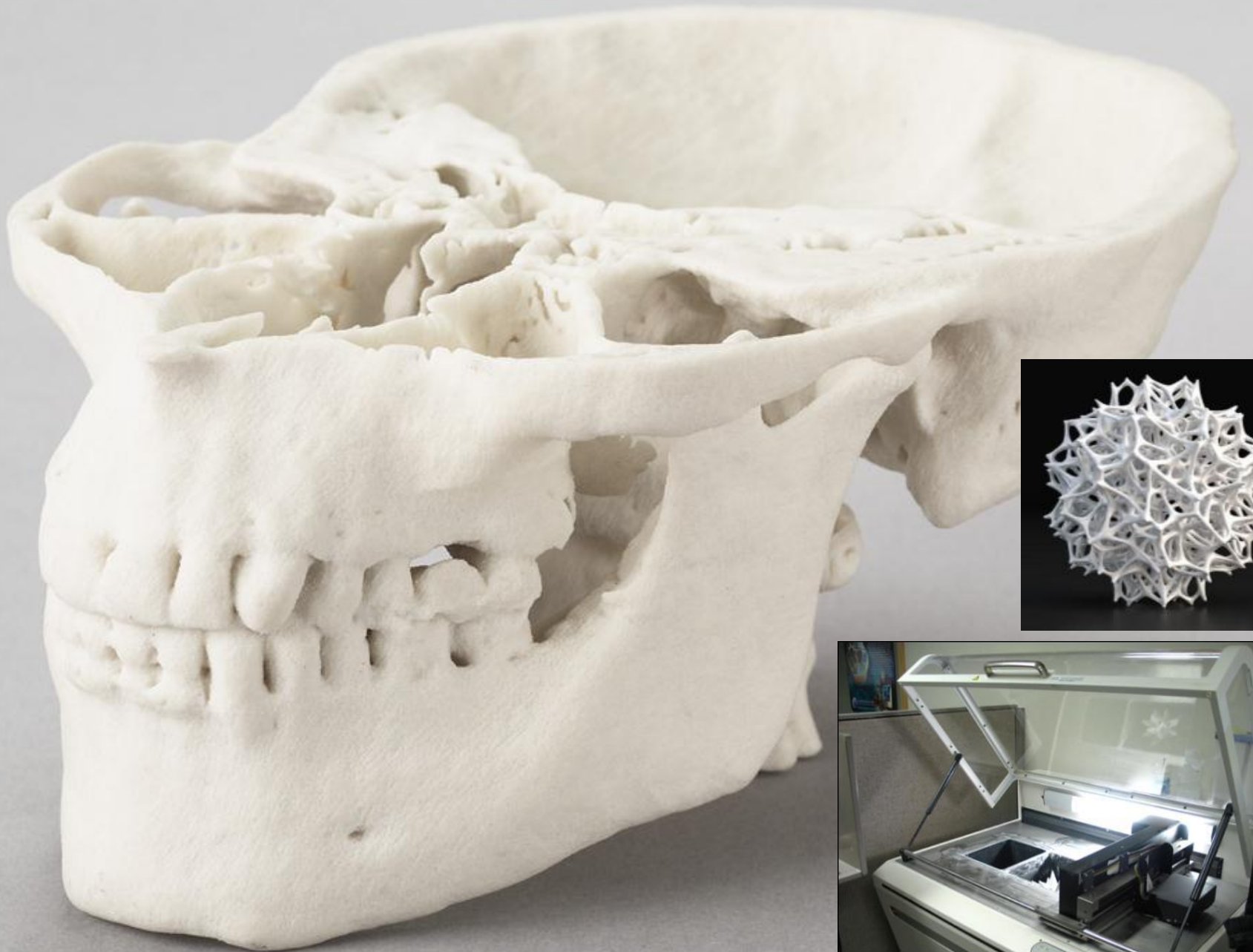
Future Business Models?

Interface **FLOR**









‘Today's problems cannot be solved if we still think the way we thought
when we created them’

Albert Einstein

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