

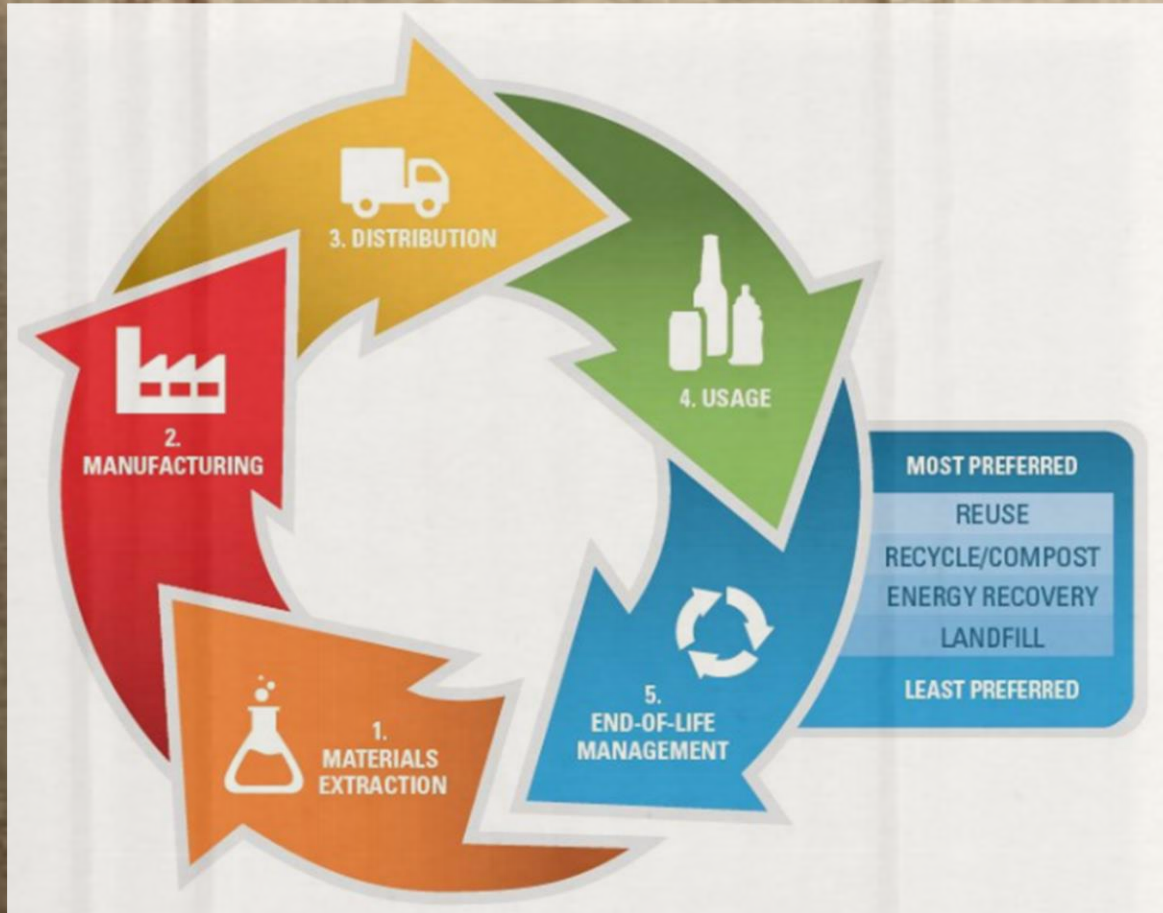


Where are the Goalposts in Sustainable Materials Management?

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What is Sustainable Materials Management?



The practice of utilizing materials in the most productive way over their life cycles by:

- ♻️ Decreasing the input of finite raw materials
- ♻️ Keeping resources in the flow of commerce
- ♻️ Reducing environmental impacts throughout the life-cycle

The Evolution of Waste Management



Throw it out the window and let the pigs eat it



Throw it in the water and let the fish eat it



Put it in the land



Integrated solid waste management, curbside recycling, composting, landfill, WTE

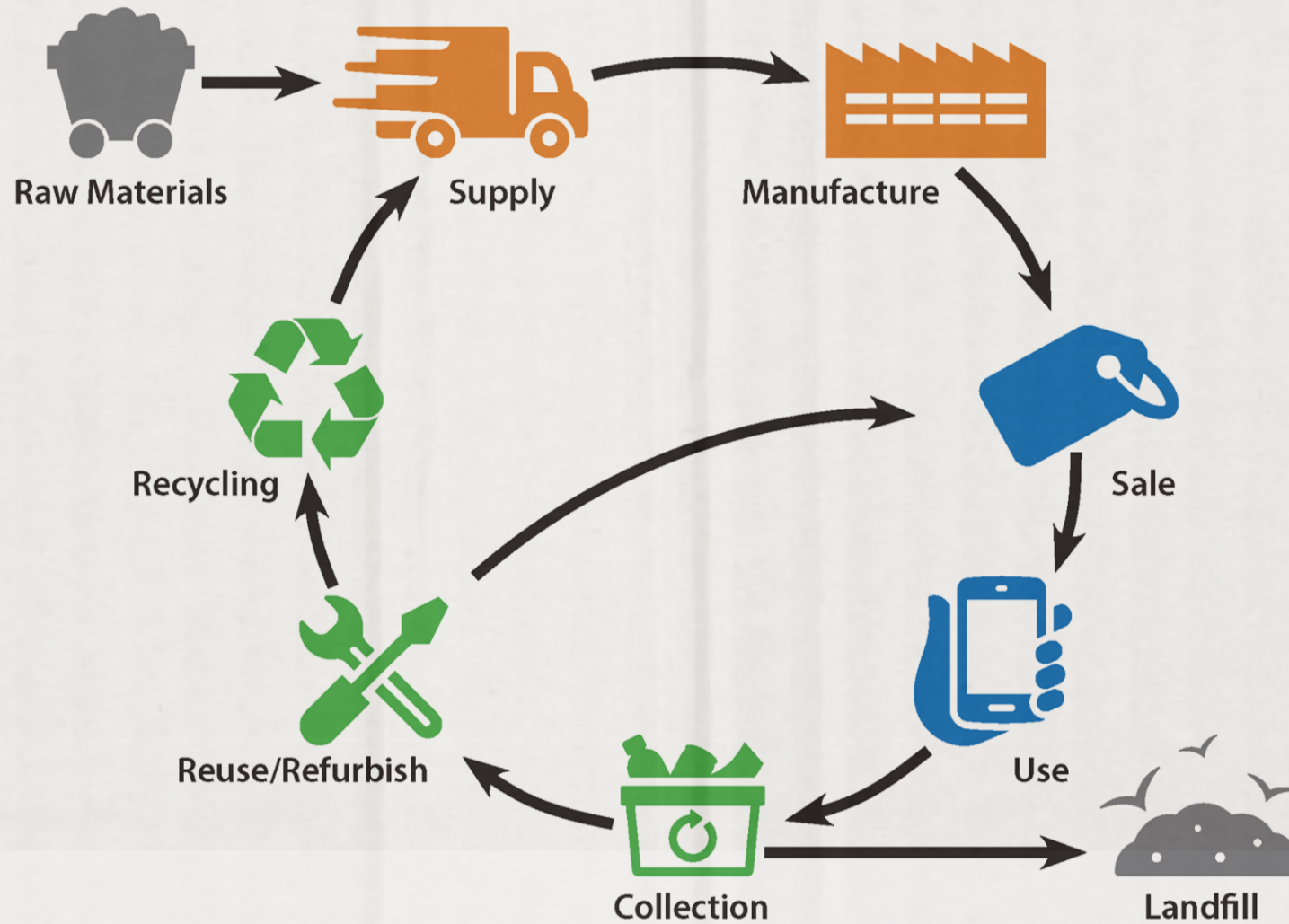


Bioreactor landfills, gas collection for direct use, pipeline sale, or electricity production

Linear Economy



Circular Economy

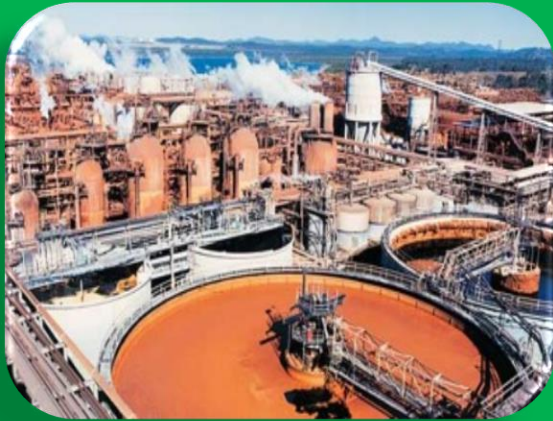


Recycling is a Major Pillar of the Circular Economy



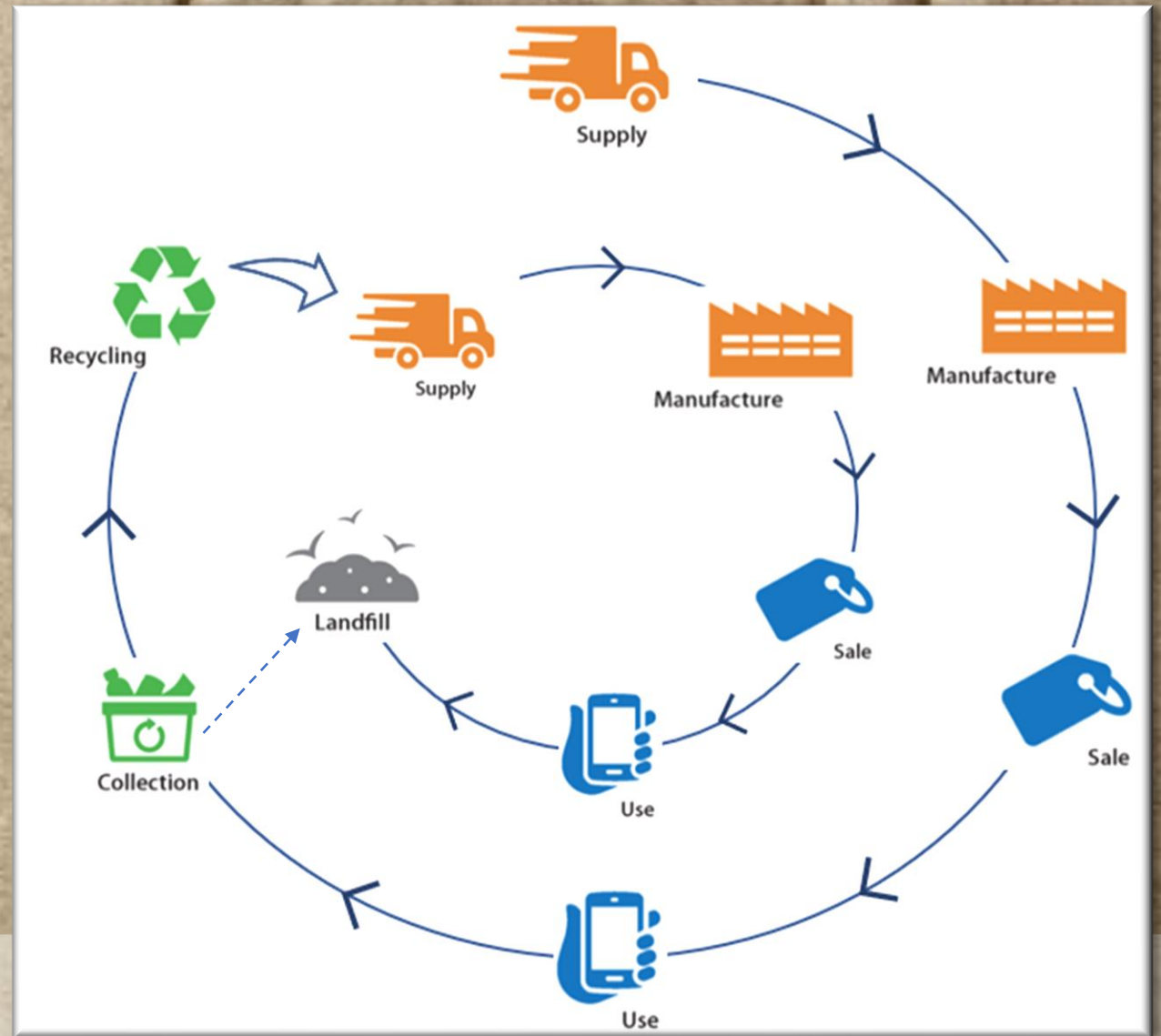
- In most cases, recycling provides environmental benefit over virgin resource procurement.
- Recycling plays a critical role in supplying raw materials for manufacturing new products and is essential to the manufacturing industry and economy.
- Recycling in the United States contributes approximately 700,000 jobs, \$37 billion in wages, and \$7 billion in tax revenues per year.
- Recycling is also an economic driver of state economies, with a 2017 study in Texas finding an overall economic benefit of more than \$3.3 billion from recycling municipal solid waste (MSW).

Aluminum: A Sustainably Managed Waste Stream



Circularity doesn't always = Sustainability

- Sometimes recycling just means a longer trip to the landfill.
- PETE plastic bottle recycled into flake to make a take-home container used once and discarded.
- Need mass balance comparison of energy use, water use, and emissions generated.
- Steel cans are easy to recycle but studies have found foil packages have lower carbon footprint regardless of recycling.



Emerging Waste Streams...It Ain't Easy Being Green



Lithium-Ion
Batteries



Electric Vehicle
Batteries



Wind Turbine
Blades



Solar Panels

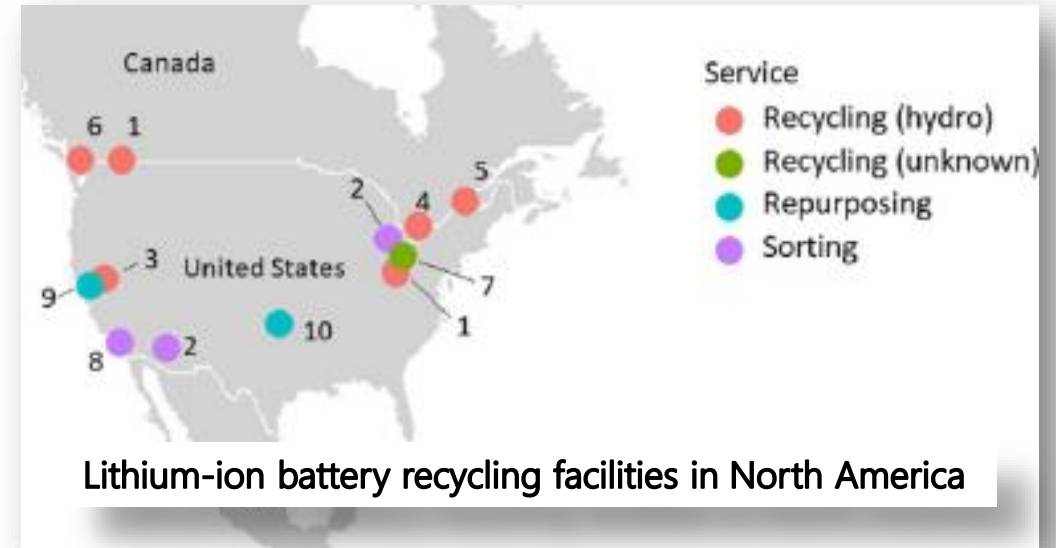
Lithium-Ion Batteries

- Proliferation of rechargeable devices and embedded batteries.
- Cause thermal events at waste and recycling facilities, damaging infrastructure.
- Need to be disposed of at household hazardous waste collection points, or at specific recycling locations.

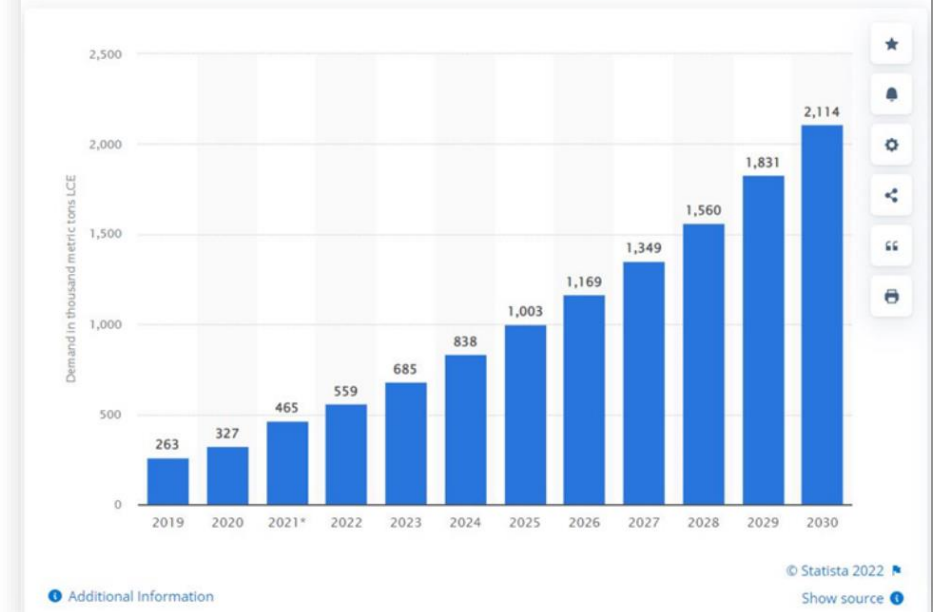


Electric Vehicle Batteries

- Same concerns as other Li-ion batteries but x5,000 (average 5k-9k cells in an EV battery pack).
- There is a worldwide demand for lithium
- End of life difficulties
 - Expensive transportation cost to reach refurbishment center.
 - No widespread knowledge of how to handle by auto recyclers.
 - Wide industry concern over safe handling and transportation.
- Lower value of scrap EV vs. ICE (fewer resalable salvage parts).
- Figure references:
 - <https://www.sciencedirect.com/science/article/pii/S0921344921003645#fig0003>
 - <https://www.weforum.org/agenda/2022/07/electric-vehicles-world-enough-lithium-resources/>



Projection of worldwide lithium demand from 2019 to 2030
(in 1,000 metric tons of lithium carbonate equivalent)



Wind Turbine Blades

- Fiberglass composite, 100-300 feet long.
- 720,000 tons of blade material to dispose of over the next 20 years.
- Difficult and expensive to transport, difficult and bulky to landfill.
- Not originally designed with recycling in mind.
- Recycling options exist (3D printing material, sound barrier insulation, decking, pallets).



Solar Panels

- 25-30 year lifespan.
- Millions of tons to dispose of in the US by 2030.
- Complicated RCRA compliance (potential toxicity).
- Recycling is possible but expensive.



UN PUEBLO SIN MEMORIA ES UN PUEBLO SIN FUTURO

Where are the Goalposts?

Can we Legislate Toward a Circular Economy?

Legislative Tools for Circular Economy

Incentives: Tax Credits, Market Development Programs	Extended Producer Responsibility (EPR)	Landfill Bans: Yard Waste, E-Waste, Food Waste	Use Bans	Recycling Goals/Mandates	Resource Exchanges
<ul style="list-style-type: none">♻ Credits for capital investment♻ Market development funding (OK tire material)♻ Tax credits for purchasing electric vehicles	<ul style="list-style-type: none">♻ 135 EPR Laws♻ 33 States♻ 1 in OK♻ 18 Products such as: paint, electronics, mattresses, batteries, tires, and medical sharps	<ul style="list-style-type: none">♻ Banned landfill items are decided by States or Cities♻ 49 states have landfill bans, but only 22 states have mandatory recycling laws	<ul style="list-style-type: none">♻ 8 states have banned single-use plastic bags	<ul style="list-style-type: none">♻ 25 states have mandatory recycling requirements♻ Most common materials: batteries, computers, newspapers, glass containers, aluminum cans, cardboard	<ul style="list-style-type: none">♻ RENEW, renewtx.org, a cooperative effort between TCEQ and Zero Waste Network

Summary: Goals

