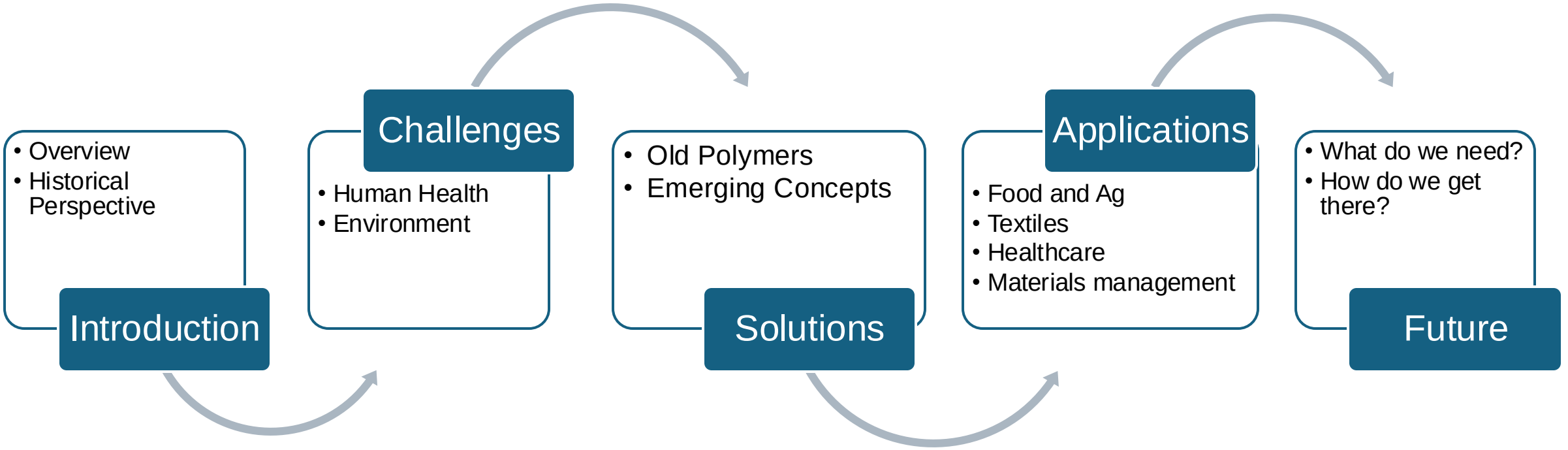
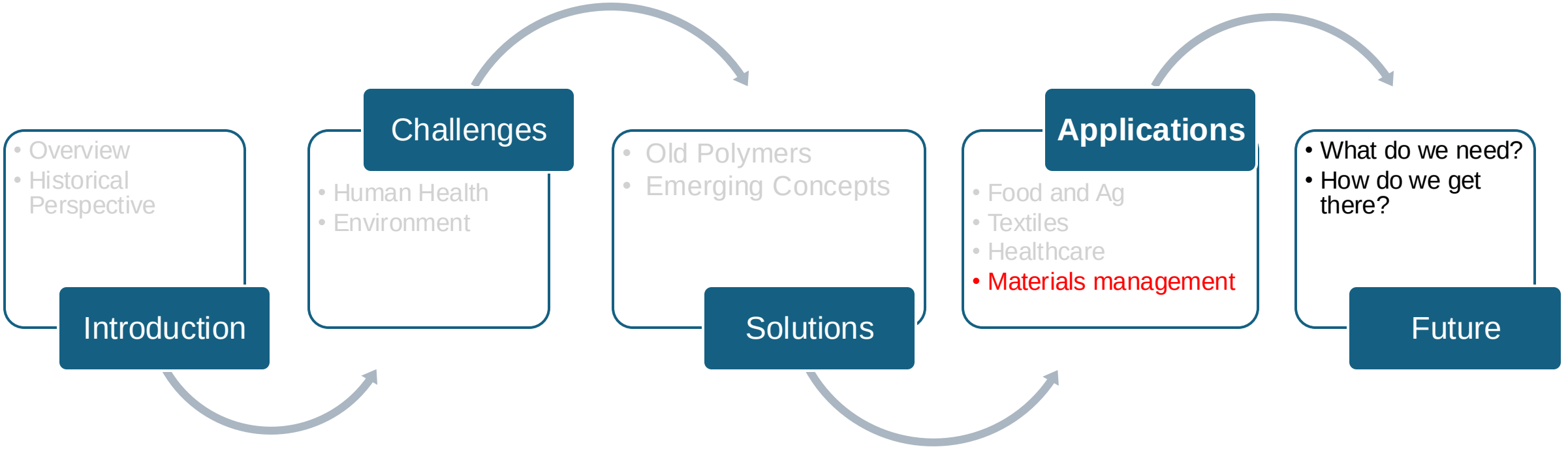
Course Overview



Lecture 16-17



Learning Objectives:

1) Sustainable Materials Management

2) Recycling

3) Sustainable production

4) Life cycle analysis

5) Final assignment

Learning Objectives:

1) Solid Waste Policy Models

- ❖ Solid Waste Policy Models in USA

2) Sustainable Materials Management

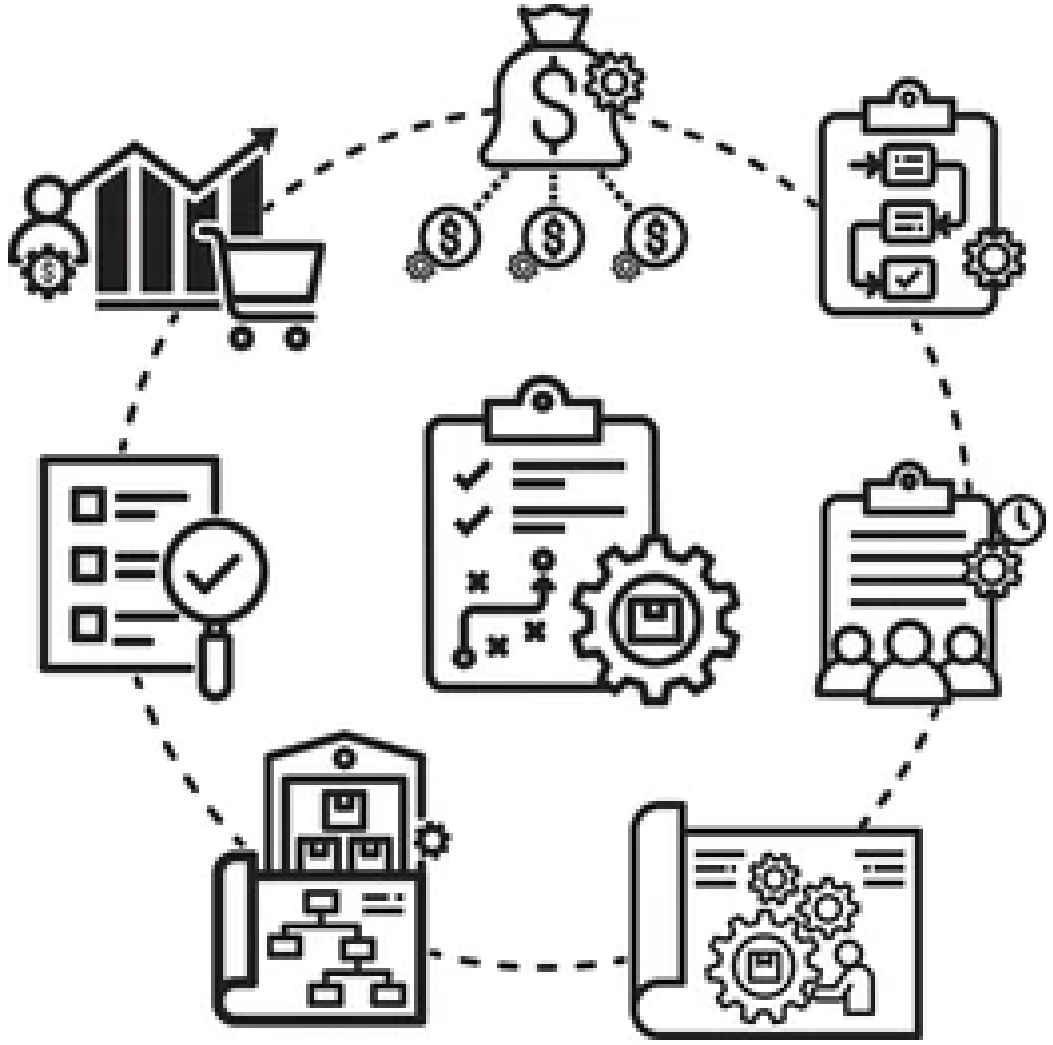
- ❖ Management Basics
- ❖ Waste materials hierarchy

3) Recycling

- ❖ Why so important?
- ❖ Environmental Benefits
- ❖ Economical Benefits

4) Sustainable Materials Management Tools

- ❖ Prioritization Tools
- ❖ Additional Tools



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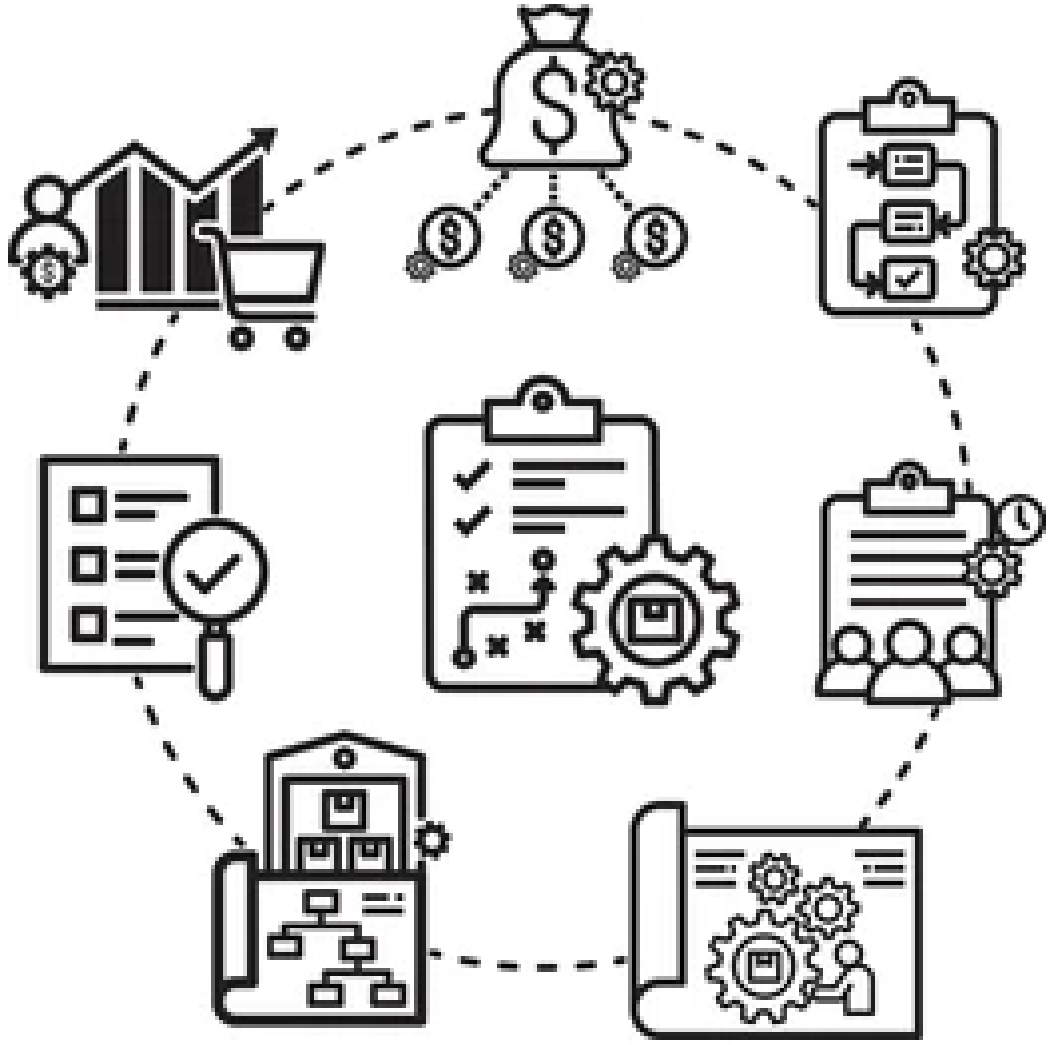


Why me talking about SMM?

B.Sc. Design and Technology of Electronic Devices (2012-2016)
Moscow Aviation Institute (National Research University), Moscow, Russia

M.Sc. Design and Technology of Electronic Devices (2016-2018)
Moscow Aviation Institute (National Research University), Moscow, Russia

Ph.D Materials, Mechatronics and Systems Engineering (2019-2022)
Department of Industrial Engineering, University of Trento, Trento, Italy

Courses:

- Modeling, Development and Management of High Technologies Production Manufacture Technologies and Processes (GMP, ISO 9001, pFMEA).
- Decision Making under Certainty, Risk and Uncertainty.
- Industrial Planning for Production System.

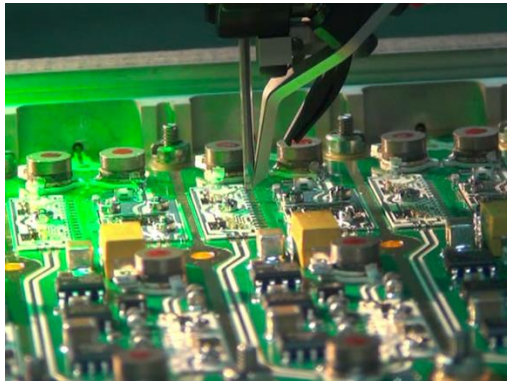
Why me talking about SMM?

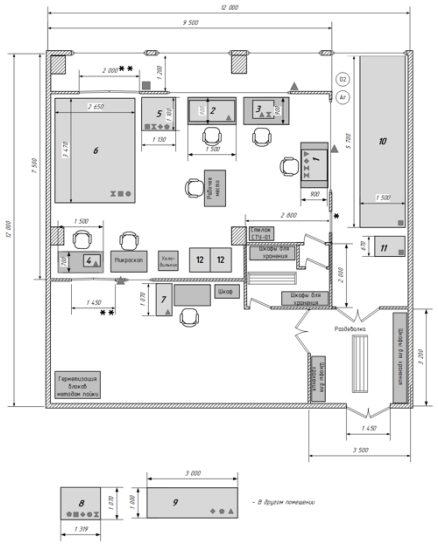
Microelectronics Manufacture Engineer
(Sep 2016 – Oct 2017)

- Launched two production lines of LTCC micromodules production and microassembly (plasma treatment, die-attachment, wire-bonding and testing).
- Developed manufacture process protocols and industrial plans for LTCC and microassembly production lines.

Leader of the Department of Microelectronics Materials
(Oct 2017 – Dec 2018)

- Technical support and production consulting.
- Production planning and control.





What skills and qualities do you need to have to be successful?

What skills and qualities do you need to have to be successful?

Communicational skills.

Managing skills (your own work, resources and other people).

LINEAR ECONOMY

Take

↓

Make

↓

Use

↓

Waste

RECYCLING ECONOMY

Take

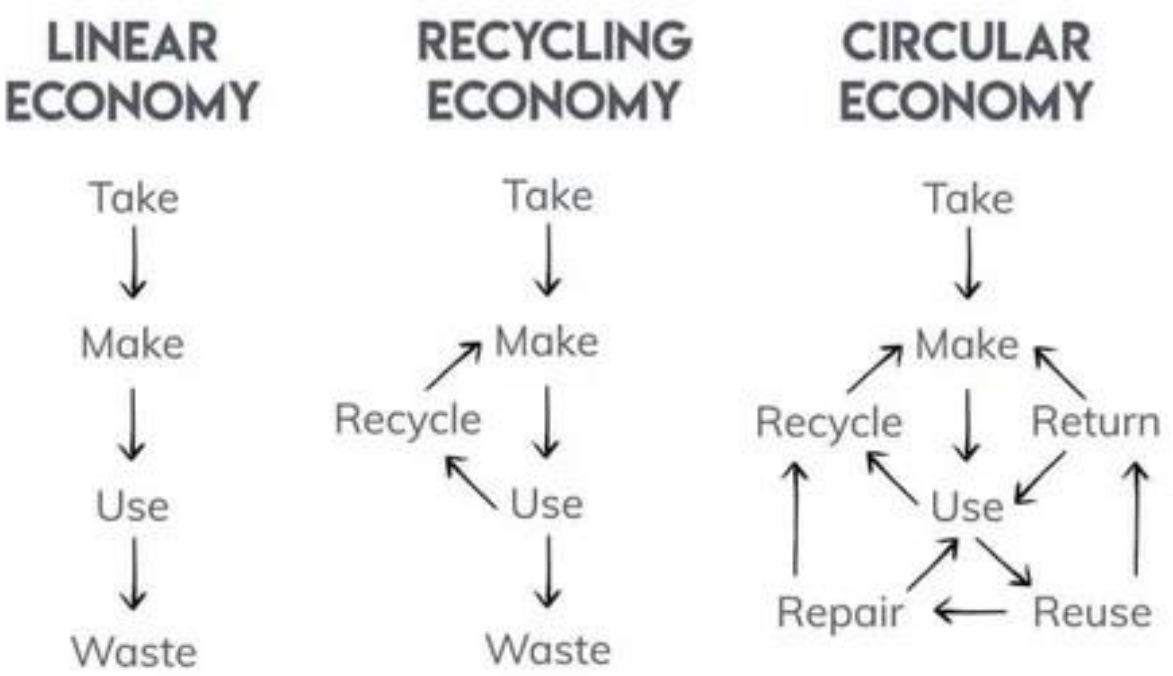
↓

CIRCULAR ECONOMY

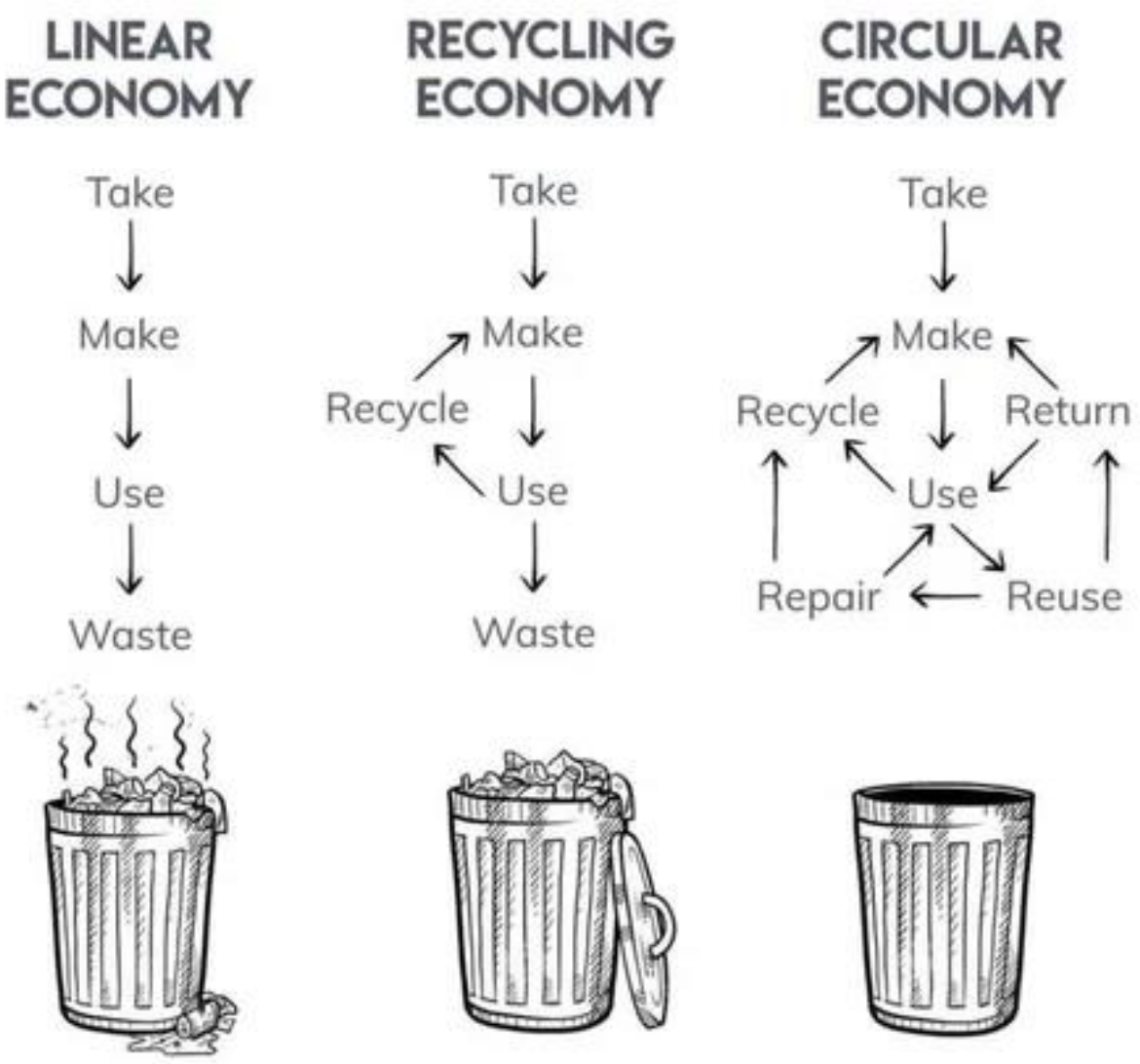
Take

↓

What is the difference?



What is the difference?


LINEAR ECONOMY
Take
Make
Use
Waste
RECYCLING ECONOMY
Take
Make
Recycle
Use
Waste
CIRCULAR ECONOMY
Take
Make
Recycle
Return
Use
Repair
Reuse

Solid Waste Policy Models:

1. Circular Economy
2. Zero Waste
3. Sustainable Materials Management (SMM)

Challenge: Application in Local Government

Case Study SMM Application

Potential SMM Approaches:

1. Use in Prioritization & Strategic Planning
   - *1.1 Best Target Materials Recycling*
   - *1.2 Prioritizing Policy and Technology*
   - *1.3 Prioritizing Stakeholders*

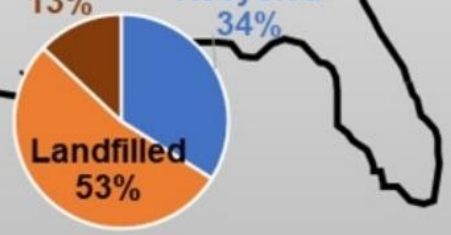
   → Prioritize materials, technologies, and polices with the greatest impact to reduce a region's environmental footprint

2. Use in Performance Metrics
   - *2.1 Effective Recycling Rates*
   - *2.2 Arbitrary Performance Outcomes*
   - *2.3 Technical Performance Outcomes*

   → Set goals using environmental footprints, such as an environmental footprint reduction goal

But Need Solid Waste Management Data…

e.g., US 2015 Generated 0.74 Tonnes/Person

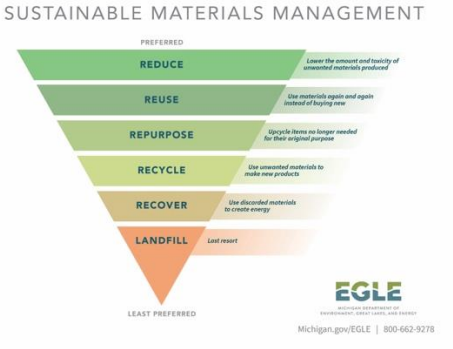


Anshassi, Malak, Steven J. Laux, and Timothy G. Townsend. "Approaches to integrate sustainable materials management into waste management planning and policy." *Resources, Conservation and Recycling* 148 (2019): 55-66.

Sustainable Materials Management - an approach to serving human needs by using/reusing resources most productively and sustainably throughout their life cycles, generally minimizing the amount of materials involved and all the associated environmental impacts

Circular economy - An industrial economy that is restorative or regenerative by intention and design

Zero waste - Designing and managing products and processes to reduce the volume and toxicity of waste and materials, conserve and recover all resources, and not burn or bury them.



No explicitly described hierarchy.

Material management decisions is based on a material's impact on the environment, society, and the economy throughout its life cycle.

An alternative to the dominant economic linear model of take-make-dispose, where materials and energy flows are designed to be reduced, reused, and recycled.

Elimination of waste; end-of-life products or output waste are treated as resources and continually used as inputs, substituting the demand for the extraction of natural resources.

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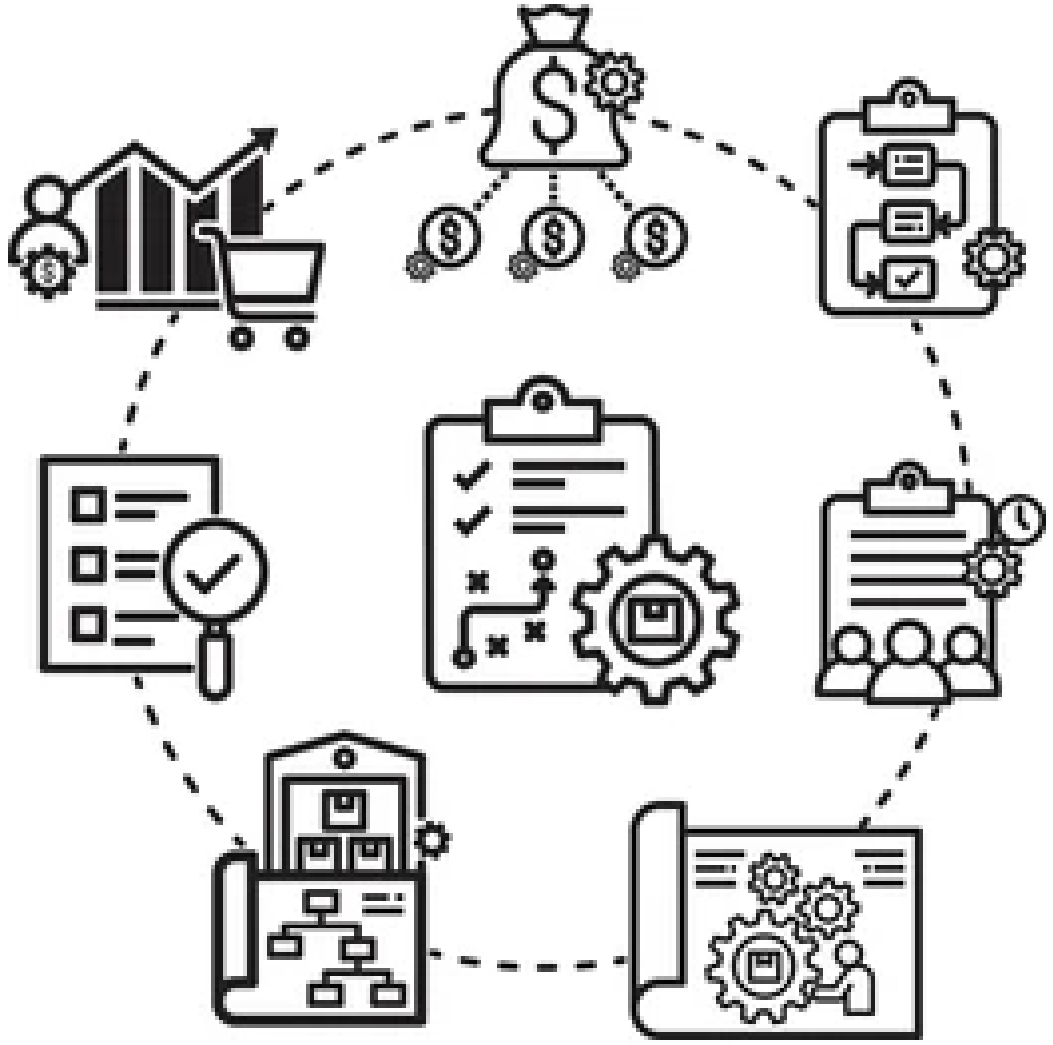
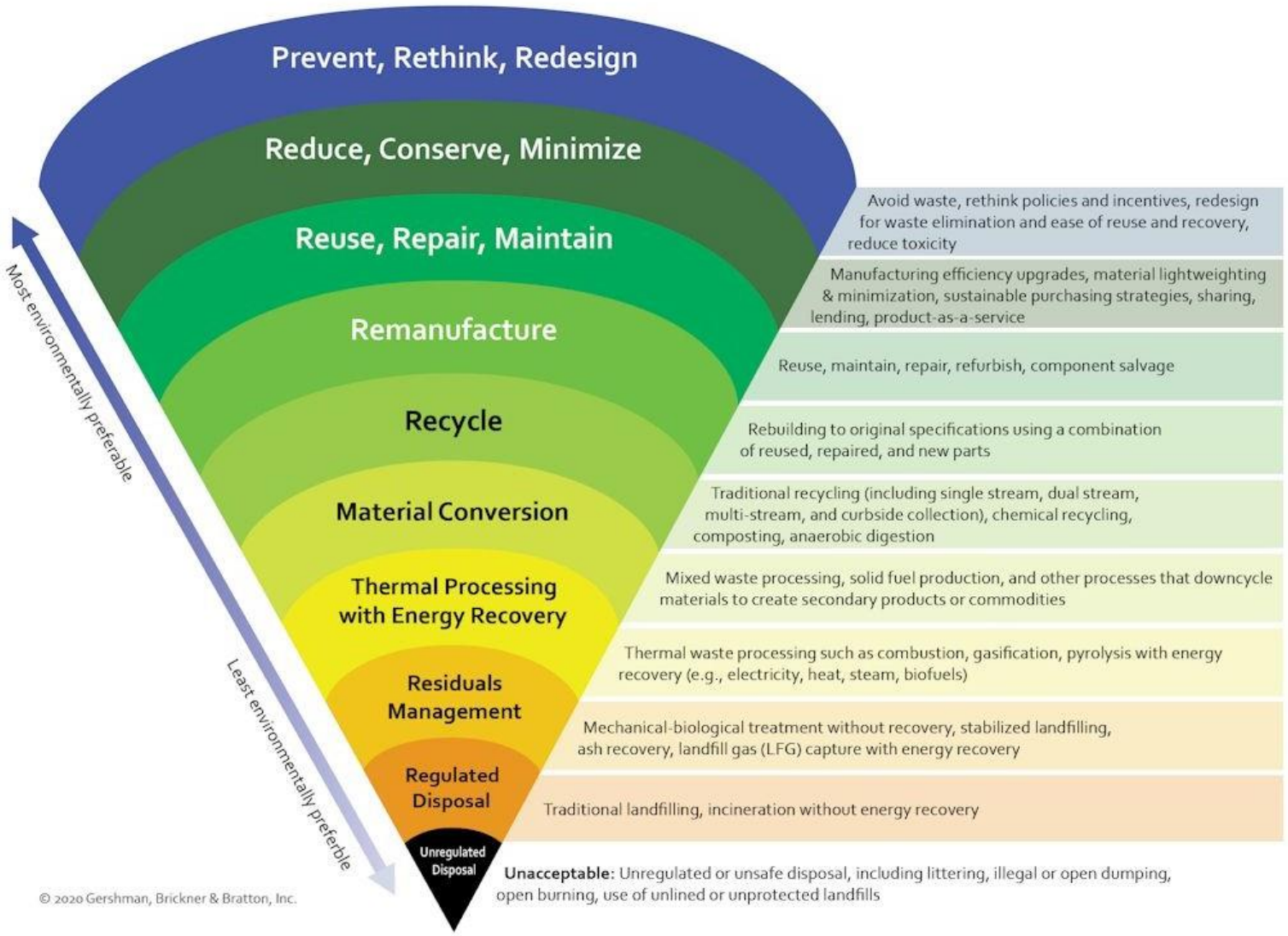


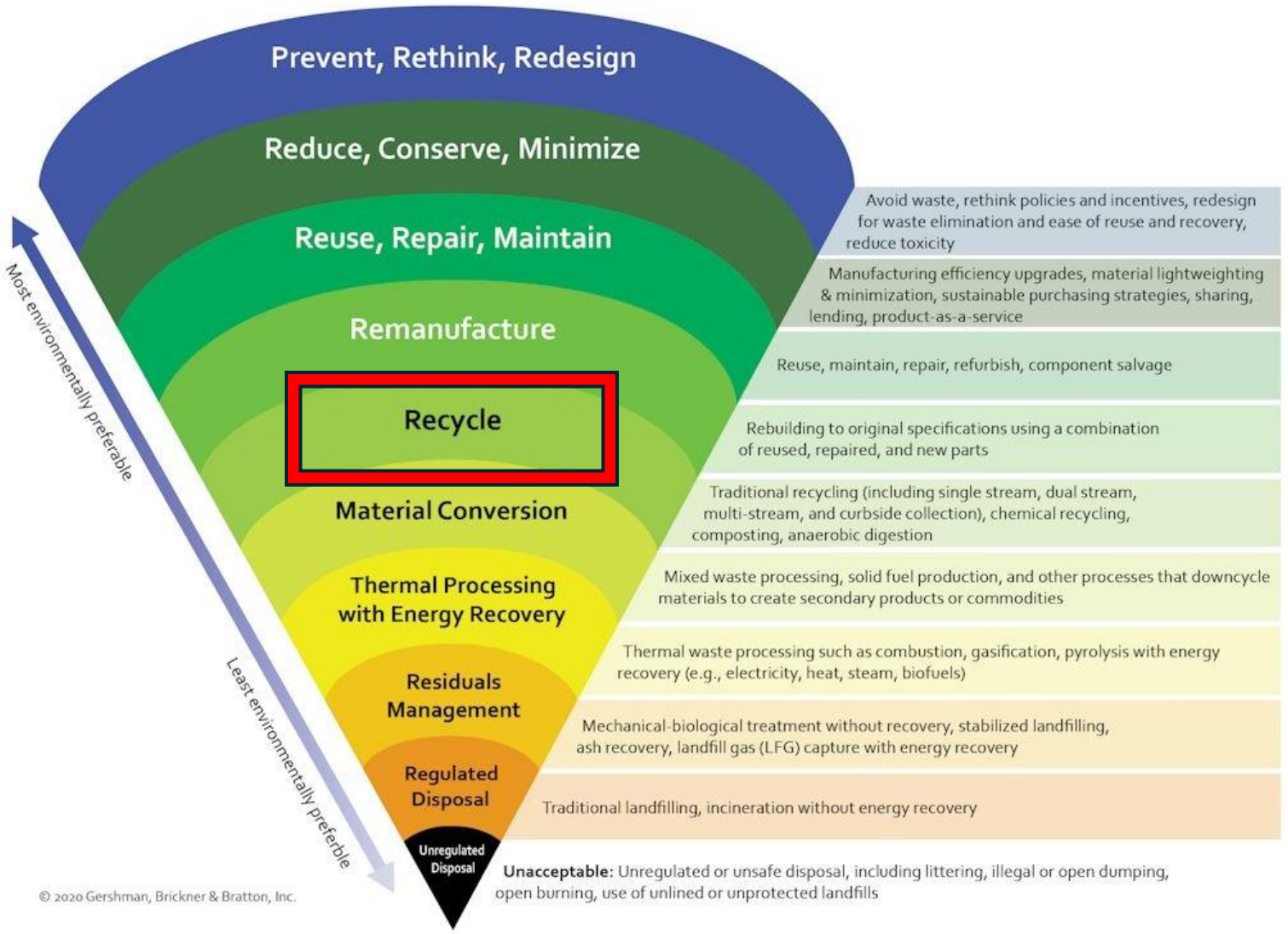
What is Sustainable Materials Management?

- **Use** materials in the most **productive** way with an emphasis on using less.
- **Reduce** toxic chemicals and environmental impacts throughout the material life cycle.
- Assure we have **sufficient resources** to meet today's needs and those of the future.

Life Cycle Assessment (LCA) is a technique to make more informed decisions through a better understanding of the human health and environmental impacts of products, processes, and activities. This can include an evaluation of the air, water, land, and energy consequences of a product or process, and possible alternatives.



What is our goal and why?



What is our goal and why?


RECYCLING

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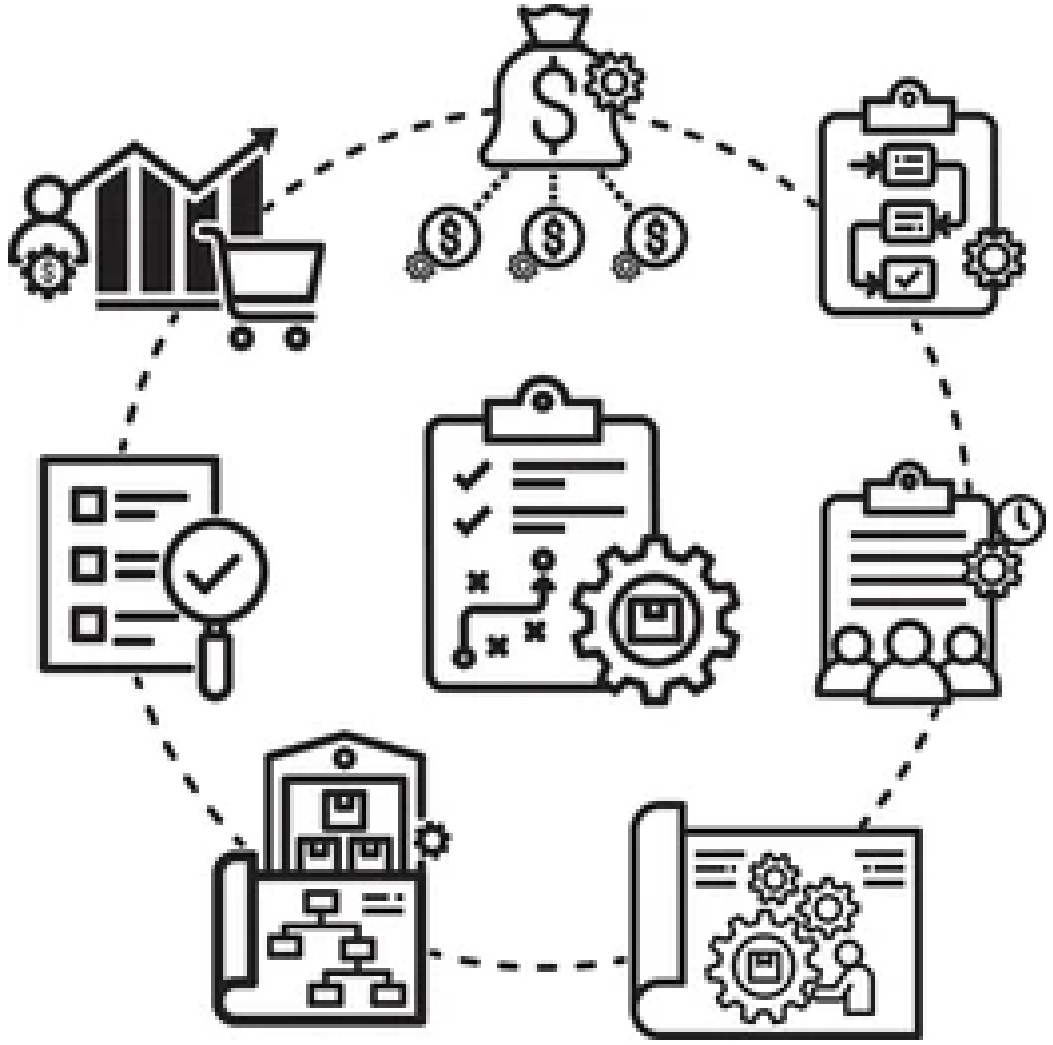


Why recycling is so important?

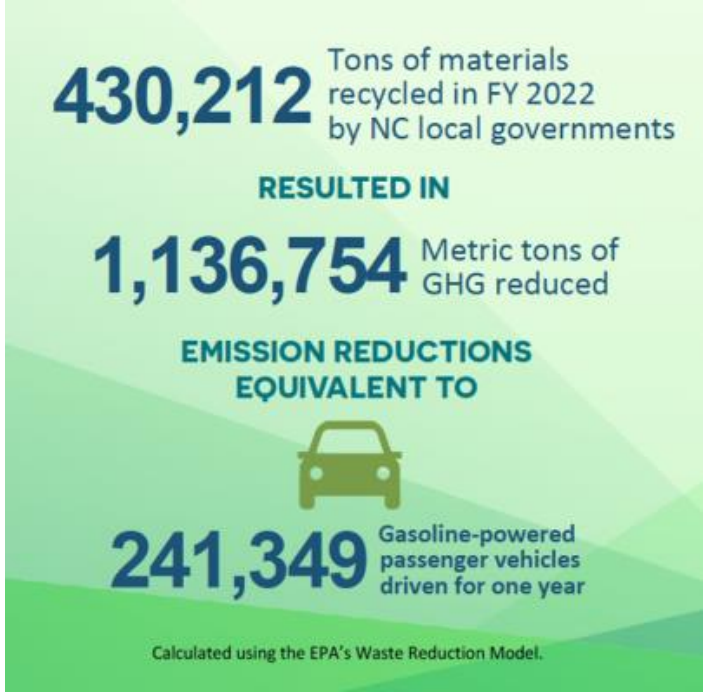
Recycling is the process of collecting and processing materials that would otherwise be thrown away as trash and turning them into new products. Products should only be recycled if they cannot be reduced or reused.

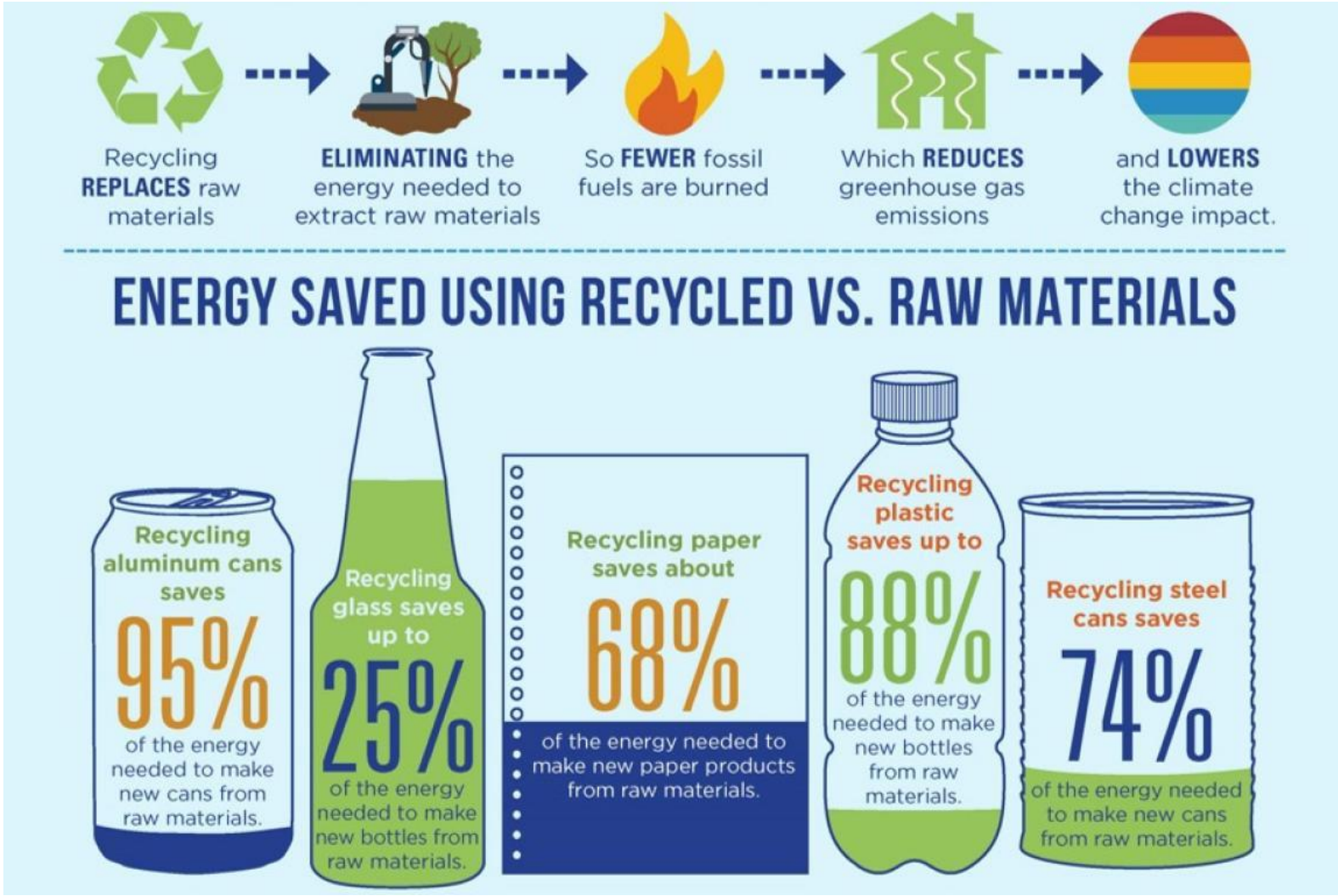
Benefits of Recycling

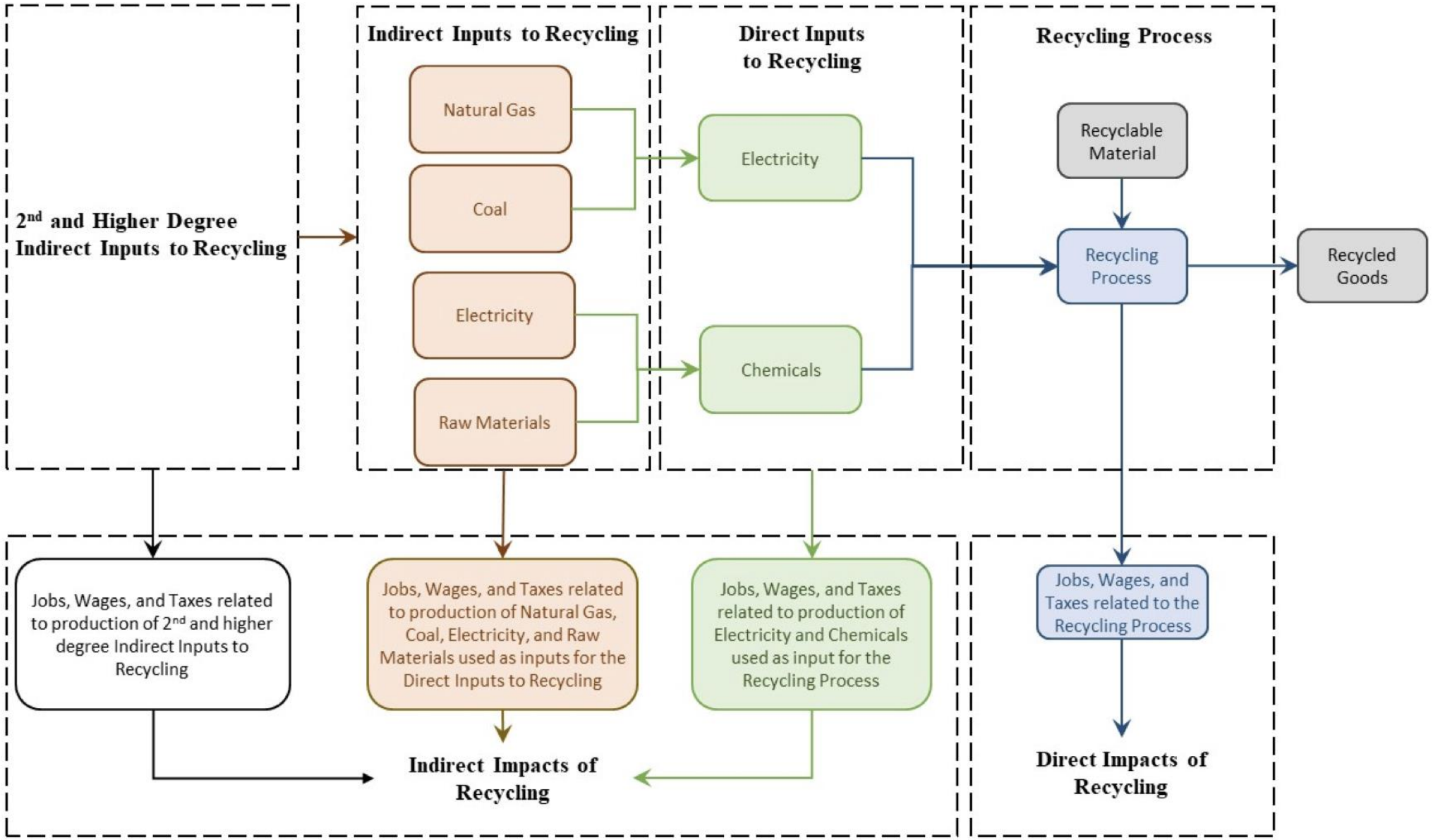
- **Environment**
- **Economy**
- **Community**

Environmental Benefits of Recycling:

- Conserve natural resources
- Climate change
- Energy savings
- Waste and pollution reduction



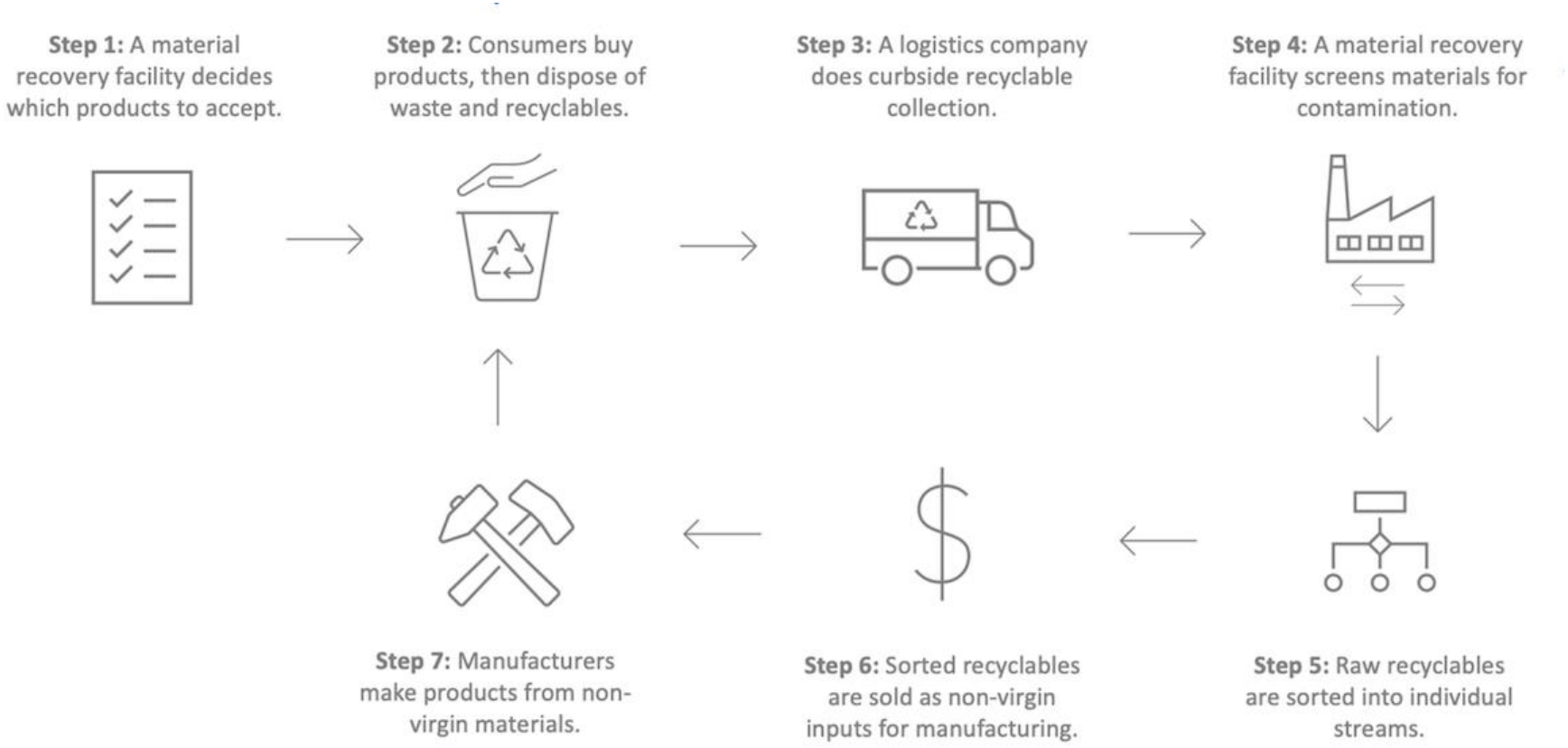



2nd and Higher Degree Indirect Inputs to Recycling
Indirect Inputs to Recycling
Natural Gas
Coal
Electricity
Raw Materials
Direct Inputs to Recycling
Electricity
Chemicals
Recycling Process
Recyclable Material
Recycling Process
Recycled Goods
Jobs, Wages, and Taxes related to production of 2nd and higher degree Indirect Inputs to Recycling
Jobs, Wages, and Taxes related to production of Natural Gas, Coal, Electricity, and Raw Materials used as inputs for the Direct Inputs to Recycling
Jobs, Wages, and Taxes related to production of Electricity and Chemicals used as input for the Recycling Process
Indirect Impacts of Recycling
Jobs, Wages, and Taxes related to the Recycling Process
Direct Impacts of Recycling

In North Carolina, more than 15,700 people are directly employed by the state's private recycling industry with a total estimated annual payroll of $759 million. Each step along the recycling process employs local workers. See the impact of plastic bottle recycling in the Carolinas.

Economic Impact	Units	US Total	Total Impacts Approach
Total Economic Impacts			
Employment	# jobs	143,739,789	681,004
Wages	$1,000	$6,568,987,567	$37,837,425
Tax Revenue	$1,000	$704,394,773	$5,460,992
Percent of Total			
Employment			0.47%
Wages			0.58%
Tax Revenue			0.78%
Primary Factors			
Employment	jobs / 1000 short tons		1.17
Wages	$ / short ton		$65.23
Tax Revenue	$ / short ton		$9.42

Problems with recycling?



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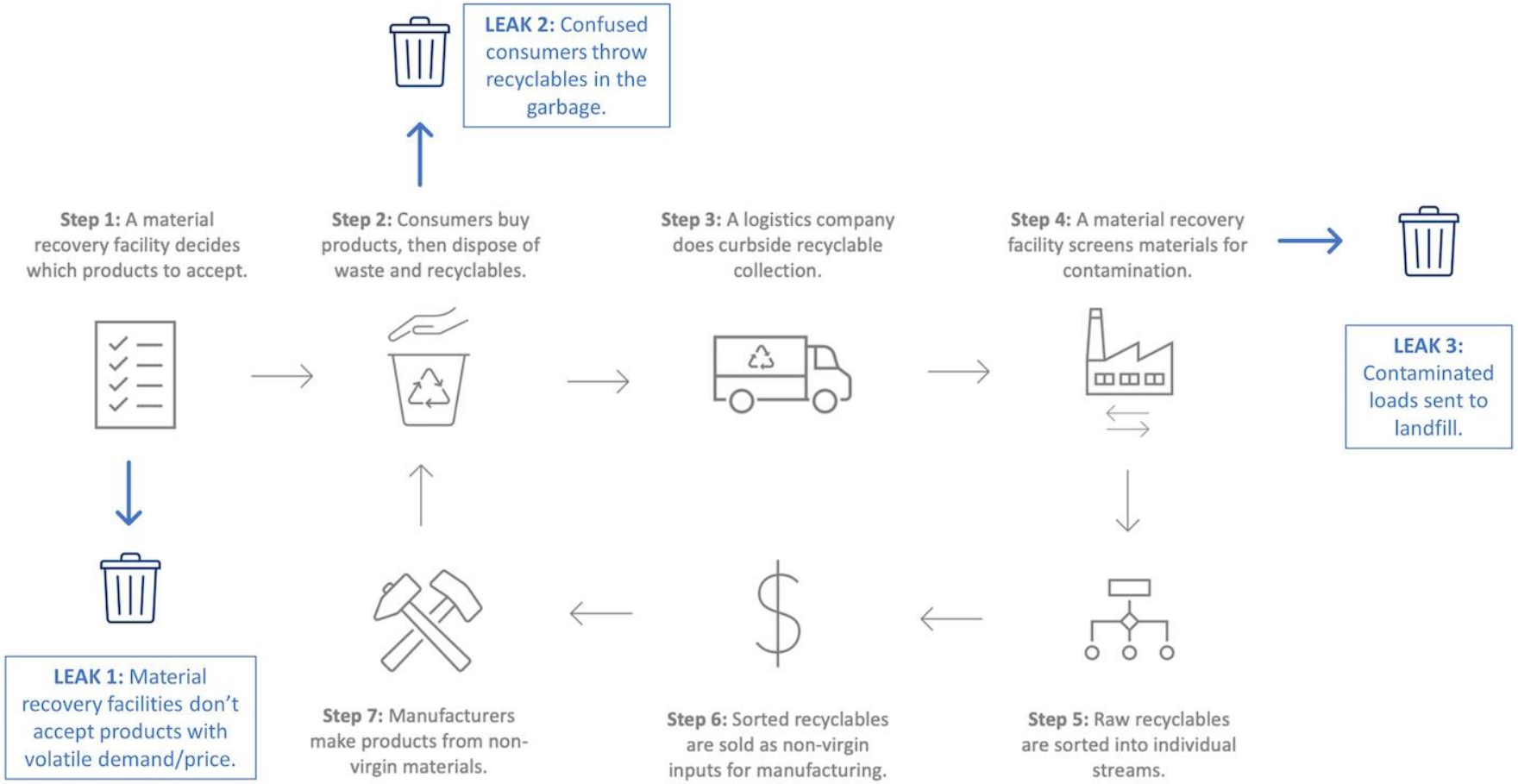

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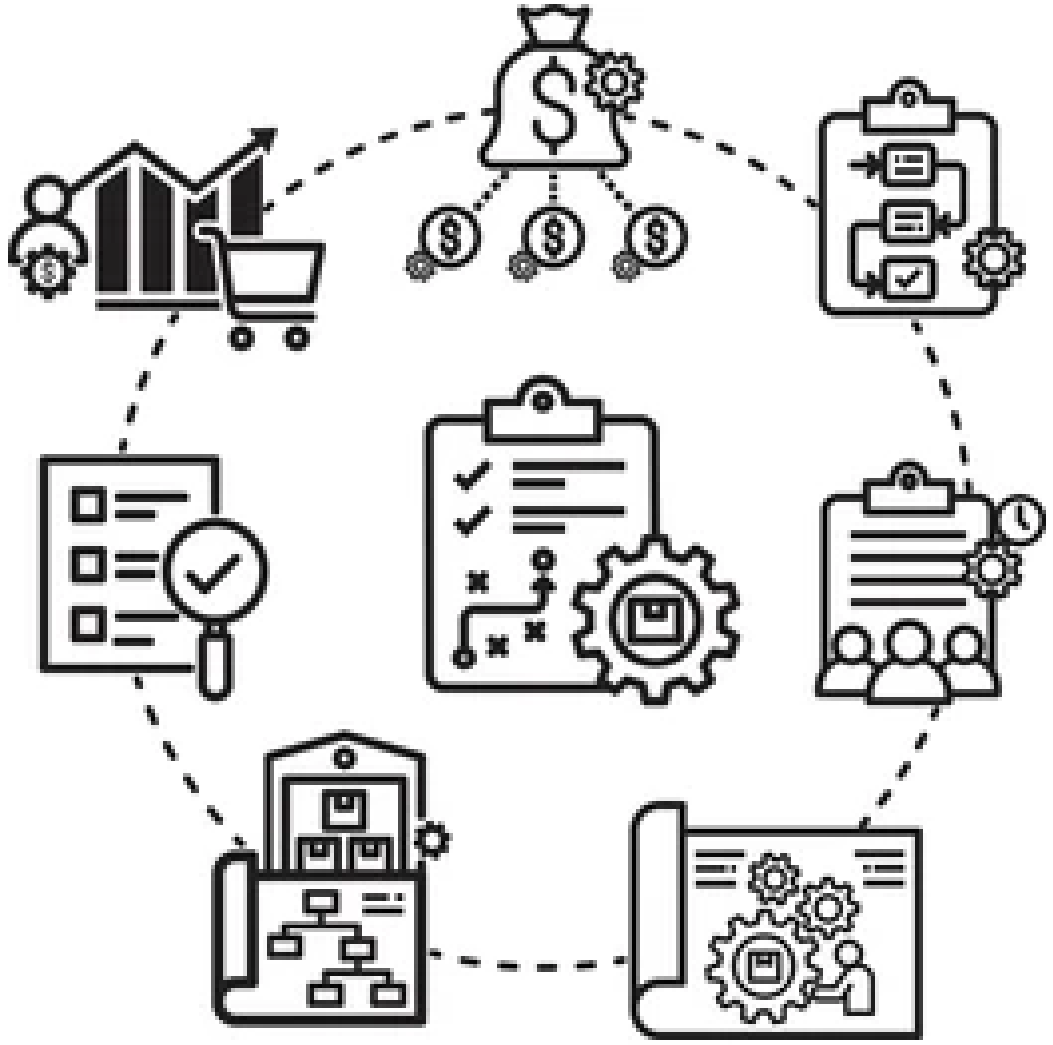
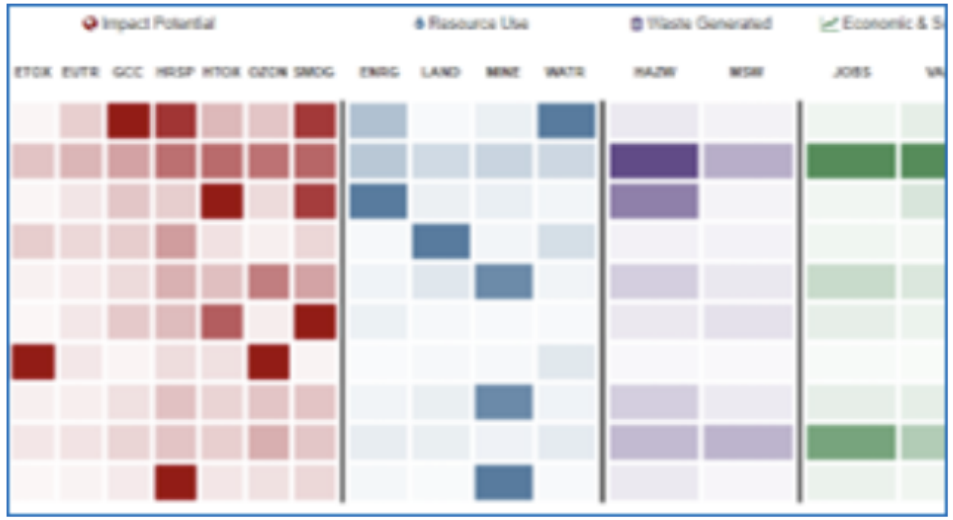


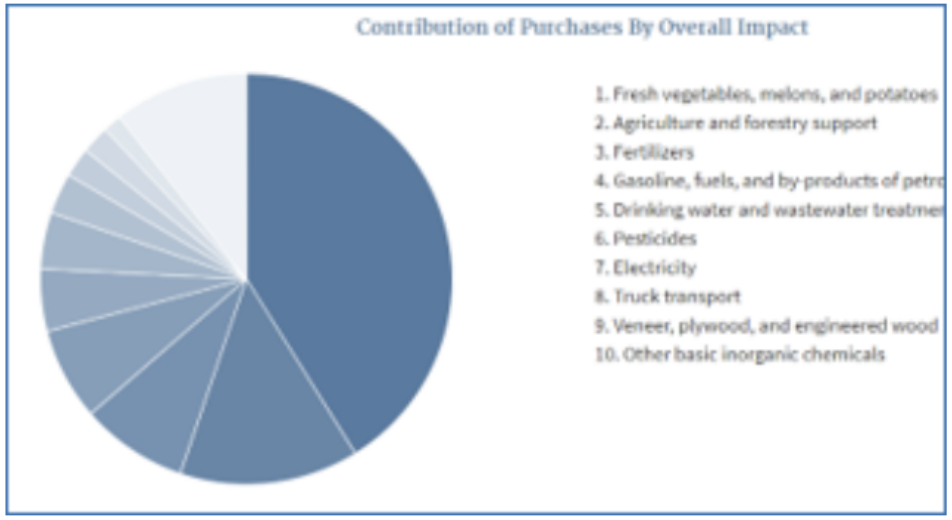
National



Big picture view for anyone with a national focus, such as government, trade associations and NGOs.

Get Started

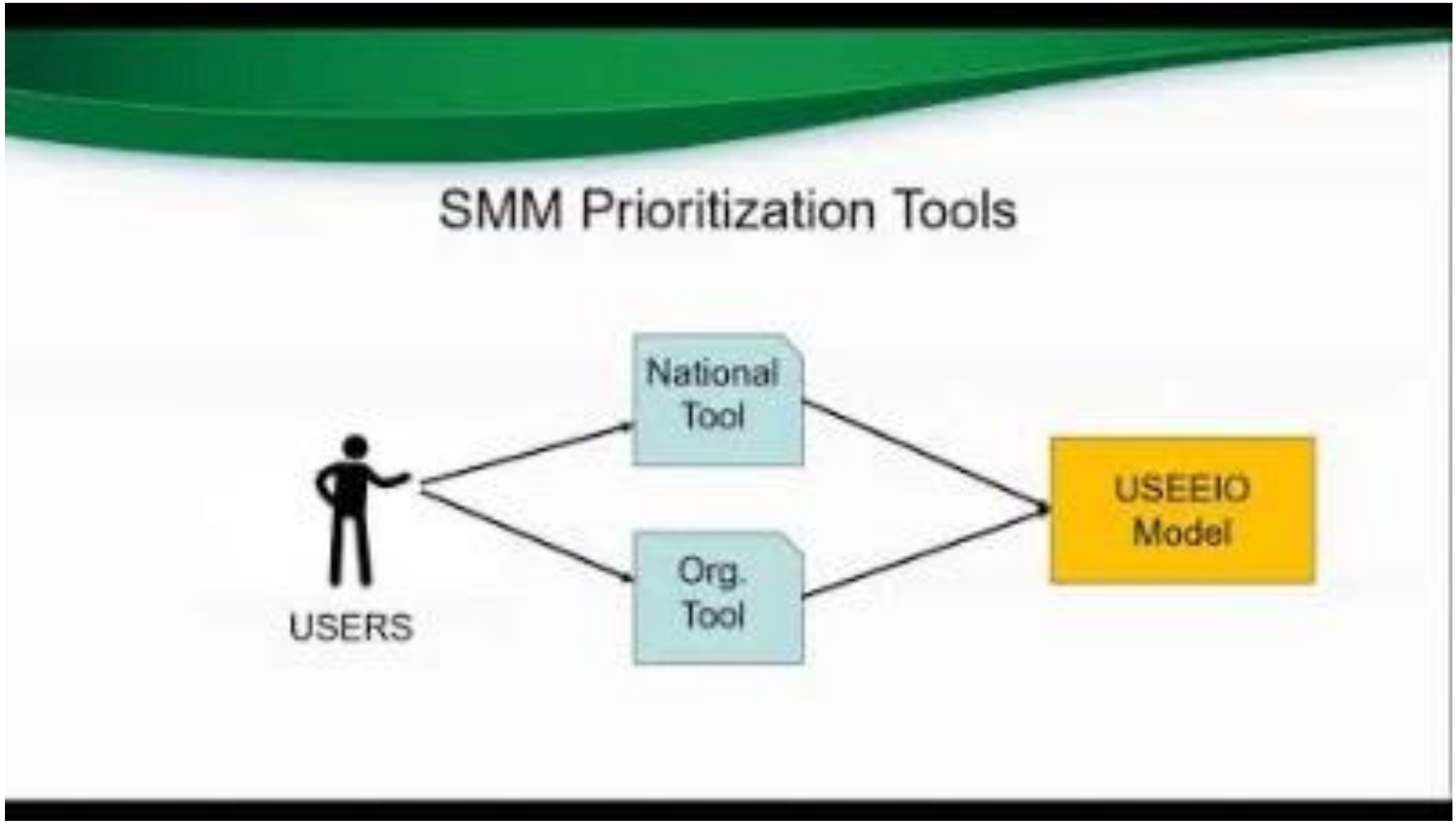
Organizational



Quick snapshots for organizations, such as companies, small enterprises and their sustainability/procurement staff.

Get Started

https://www.epa.gov/smm/smm-prioritization-tools-index



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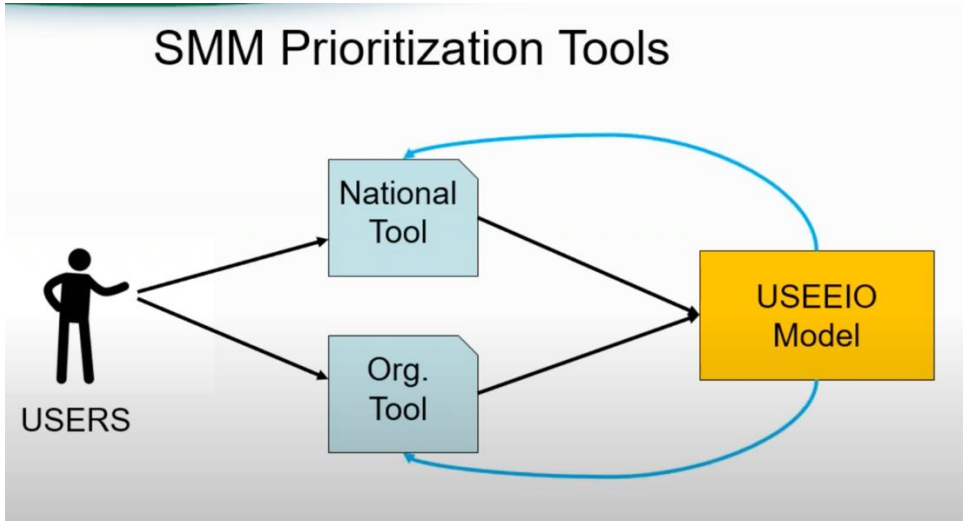
Who are the intended users?

- **SMM Prioritization Tools**: user interfaces that access, extract and display information from the United States Environmentally-Extended Input-Output (USEEIO) model.
- **USEEIO model:** fully transparent, reproducible and freely shareable life cycle assessment model that assesses over twenty indicators associated with ~386 categories of goods/services produced or consumed in the US.
- **Provides big-picture** information about potential environmental improvement opportunities in the United States and opportunities for benefits across a range of indicators.

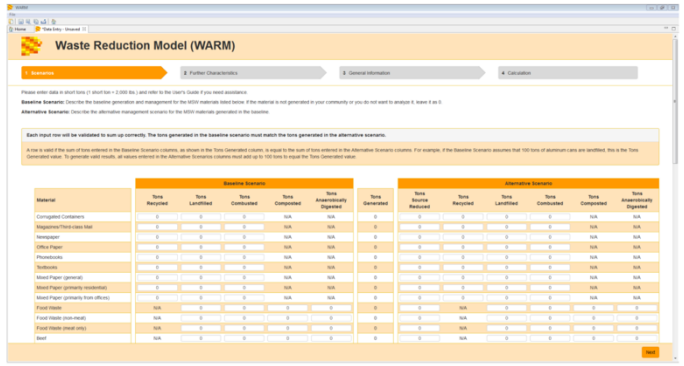
Individuals who are looking for environmental improvement opportunities or developing sustainability strategies, including:

- Individuals who are not in the field of life cycle assessment.
- Organizations who do not have the resources to hire consultants.
- CEOs, procurement and sustainability professionals.
- Government.
- Non-profits.
- Trade associations.
- Academic institutions.



Waste Reduction Model (WARM)

WARM calculates and totals GHG emissions of baseline and alternative waste management practices—source reduction, recycling, anaerobic digestion, combustion, composting and landfilling.

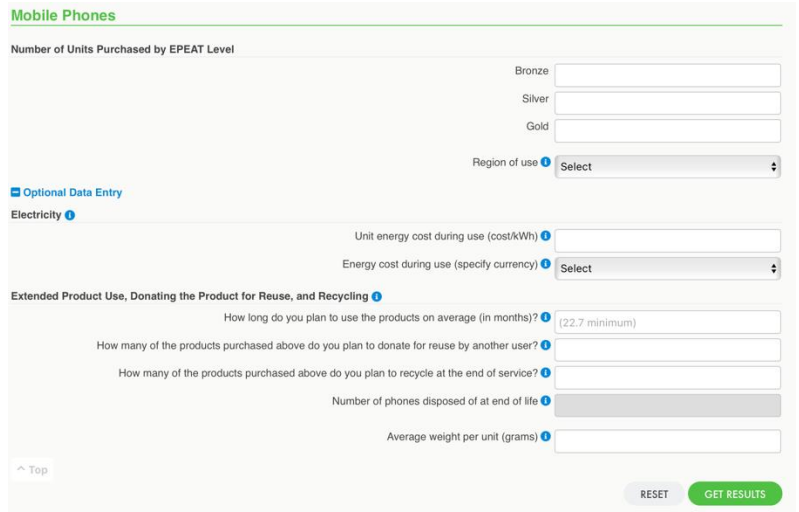


Tools for Preventing and Diverting Wasted Food

By using EPA's wasted food assessment tools, food service establishments can save money, reduce environmental impacts, support efforts to eliminate hunger, increase tax benefits, and more. EPA provides a variety of wasted food assessment tools to suit a food service establishment's unique circumstances.

EPEAT Benefits Calculators

GEC's interactive environmental benefits calculator allows purchasers to measure and report the environmental benefits gained from purchasing electronic products covered by the EPEAT ecolabel. The benefits calculator also enables purchasers to estimate how they can achieve further environmental reductions by using products longer and responsibly recycling them when taken out of service.



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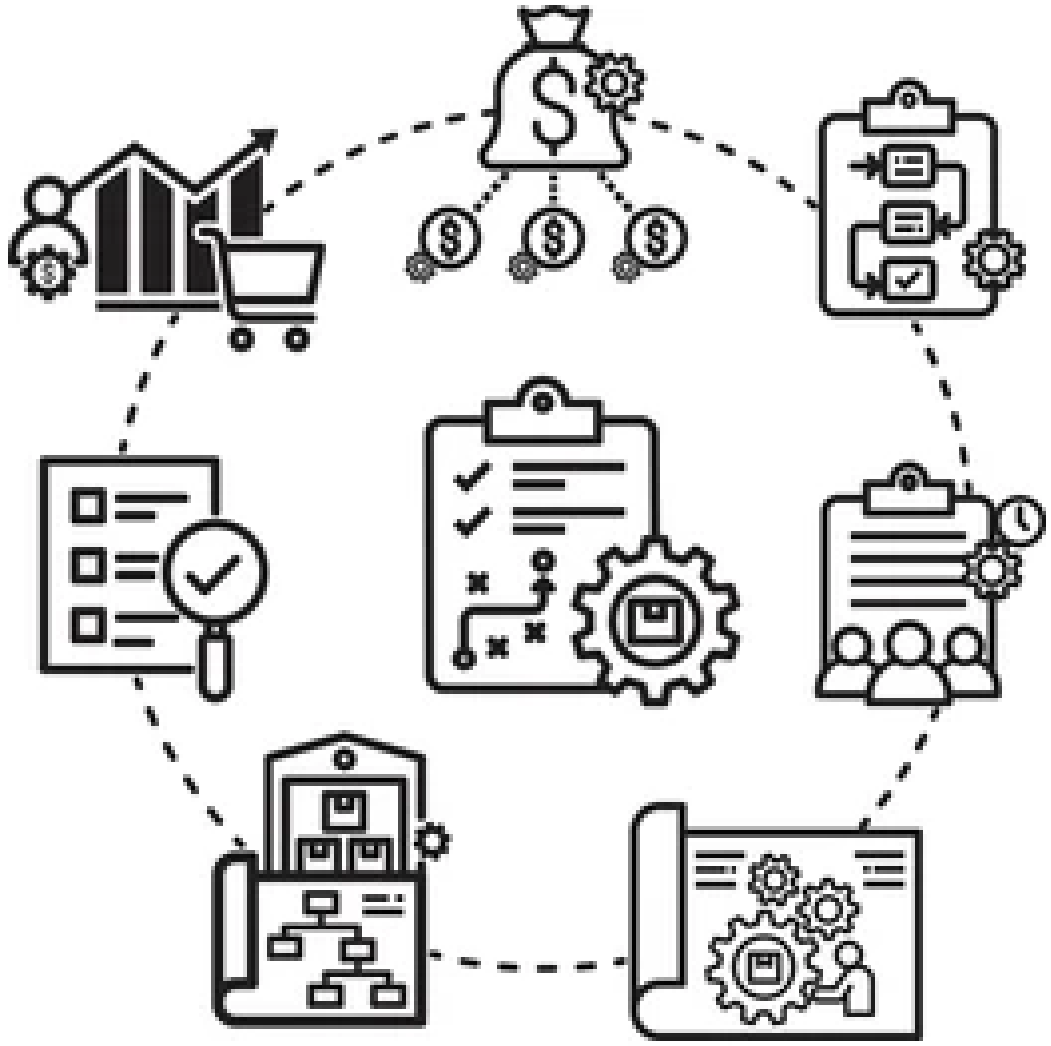


Comprehensive Procurement Guideline (CPG) Program

The Comprehensive Procurement Guideline (CPG) program is part of EPA's Sustainable Materials Management initiative that promotes a system approach to reducing materials use. A key component of the CPG program is EPA's list of designated products and the accompanying recommendations for recovered content, both post-consumer material content and/or total recovered material content.

Construction Products: Building insulation, Carpet (polyester), Carpet cushion, Cement and concrete, Consolidated and reprocessed latex paint, Floor tiles, Flowable fill, Laminated paperboard, Modular threshold ramps, Nonpressure pipe, Patio blocks, Railroad grade crossing surfaces, Roofing materials, Shower and restroom dividers/partitions, Structural fiberboard, Proposed: Nylon carpet and nylon carpet backing

Landscaping Products: Compost and fertilizer made from recovered organic materials, Garden and soaker hoses, Hydraulic mulch, Lawn and garden edging, Plastic lumber landscaping timbers and posts

Miscellaneous Products: Awards and plaques, Bike racks, Blasting grit, Industrial drums, Manual-grade strapping, Mats, Pallets, Signage, Sorbents

Nonpaper Office Products: Binders, Clipboards, File folders, Clip portfolios, Presentation folders, Office furniture, Office recycling containers, Office waste receptacles, Plastic desktop accessories, Plastic envelopes, Plastic trash bags, Printer ribbons, Toner cartridges

Paper and Paper Products: Commercial/industrial sanitary tissue products, Miscellaneous papers, Newsprint, Paperboard and packaging products, Printing and writing papers

Park and Recreation Products: Park benches and picnic tables, Plastic fencing, Playground equipment, Playground surfaces, Running tracks

Transportation Products: Channelizers, Delineators, Flexible delineators, Parking stops, Traffic barricades, Traffic cones

Vehicular Products: Engine coolants, Rebuilt vehicular parts, Re-refined lubricating oils, Retread tires

https://www.epa.gov/smm/comprehensive-procurement-guideline-cpg-program

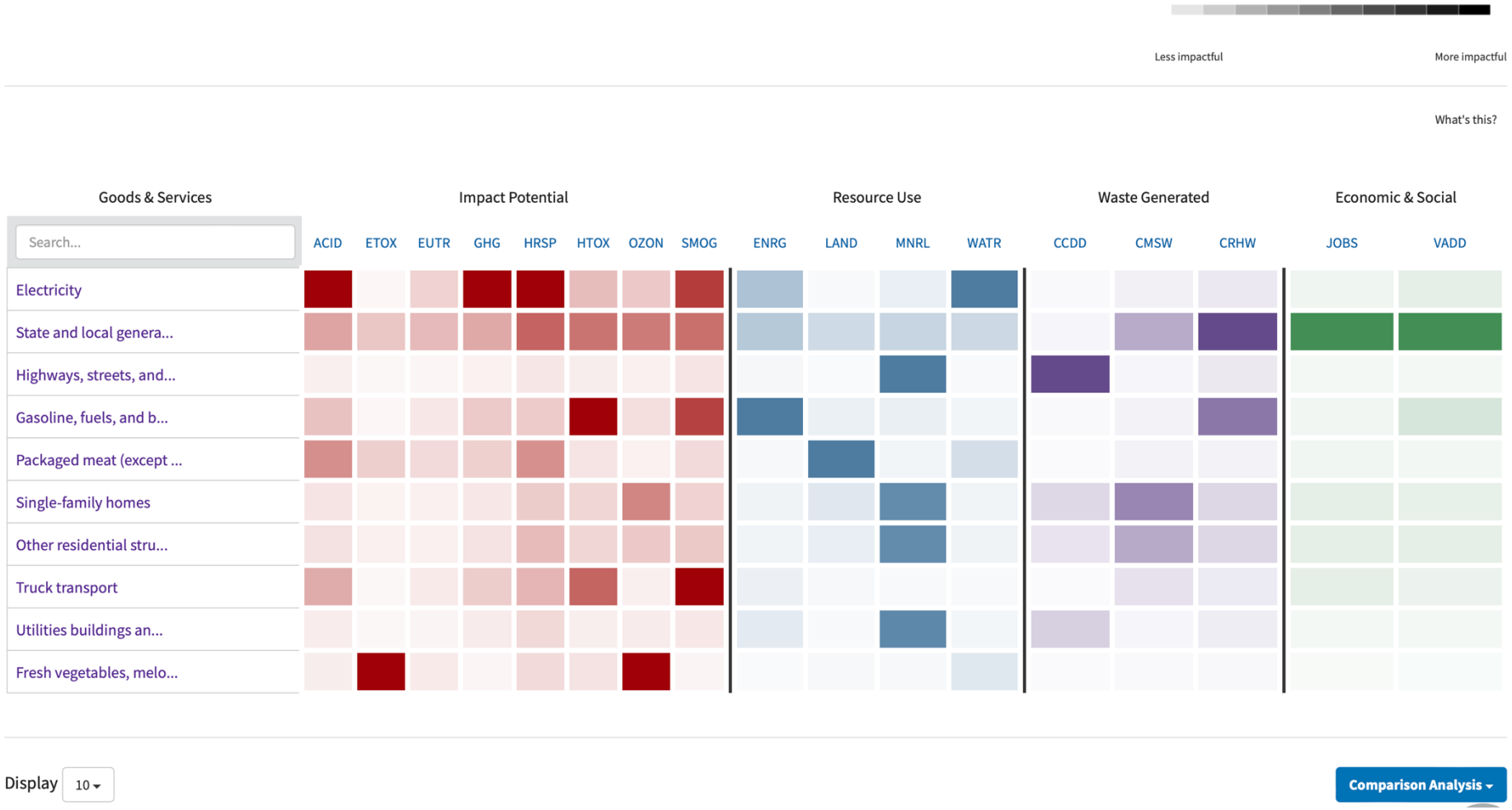
Recommended Recovered Materials Content Levels for Building Insulation [1]

Product	Material	Postconsumer Content (%)	Total Recovered Materials Content (%)
Rock Wool	Slag	--	75
Fiberglass	Glass Cullet	--	20-25
Cellulose Loose-Fill and Spray-On	Postconsumer Paper	75	75
Perlite Composite Board	Postconsumer Paper	23	23

The recommended recovered materials content levels are based on the weight (not volume) of materials in the insulating core only.

Sustainable Materials Management Prioritization Tools

The heatmap below shows potential areas of significant opportunity for environmental improvement for individual goods and services. Those goods and services (down the left side) are ranked by overall environmental, human health and socioeconomic impacts (across the top) based on the selected analysis settings.



https://www.epa.gov/smm/smm-prioritization-tools-index

Sustainable Materials Management Prioritization Tools

https://www.epa.gov/smm/smm-prioritization-tools-index

Organizational SMM Prioritization Tool

If you have any questions, suggestions or feedback to help make our tools more useful, please use this contact us link.

- Select Good/Service
- Environmental Profile
- Supply Chain/Operations
- Impactful Purchases
- Supply Chain Hotspots
- Summary

What's this?

Select the primary good or service provided by your organization

Enter keywords here to describe your organization

Select an option from a list

Select the primary good or service provided by your organization

Enter keywords here to describe your organization

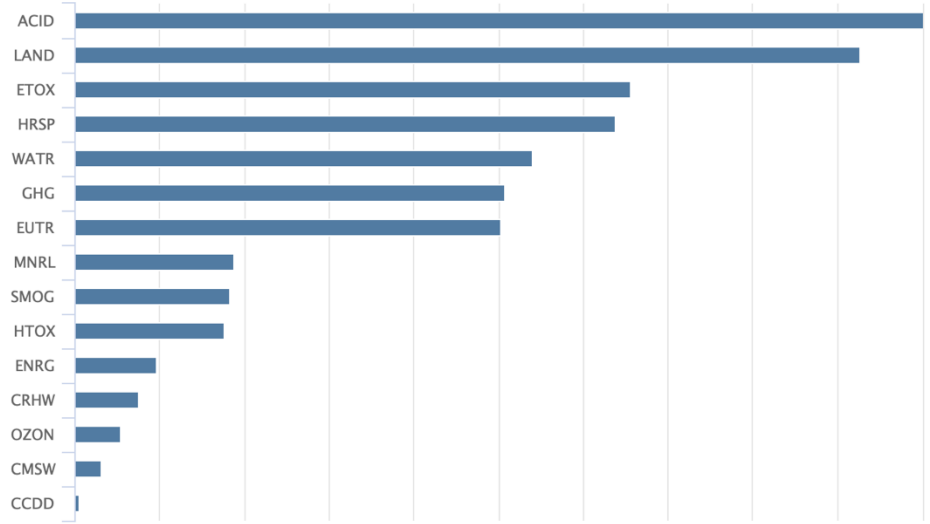
Fresh soybeans, canola, flaxseeds, and other oilseeds
Fresh wheat, corn, rice, and other grains
Fresh vegetables, melons, and potatoes
Fresh fruits and tree nuts
Greenhouse crops, mushrooms, nurseries, and flowers
Tobacco, cotton, sugarcane, peanuts, sugar beets, herbs and spices, and other crops
Cattle ranches and feedlots
Dairies
Animal farms and aquaculture ponds (except cattle and poultry)
Poultry farms

https://www.epa.gov/smm/smm-prioritization-tools-index

Sustainable Materials Management Prioritization Tools

What are the potentially significant environmental issues associated with *Dairies*?

The Environmental Profile below shows the issues potentially associated with *Dairies* from high to low significance. Level of significance is based on a good or service's contribution to the overall issues in the US.



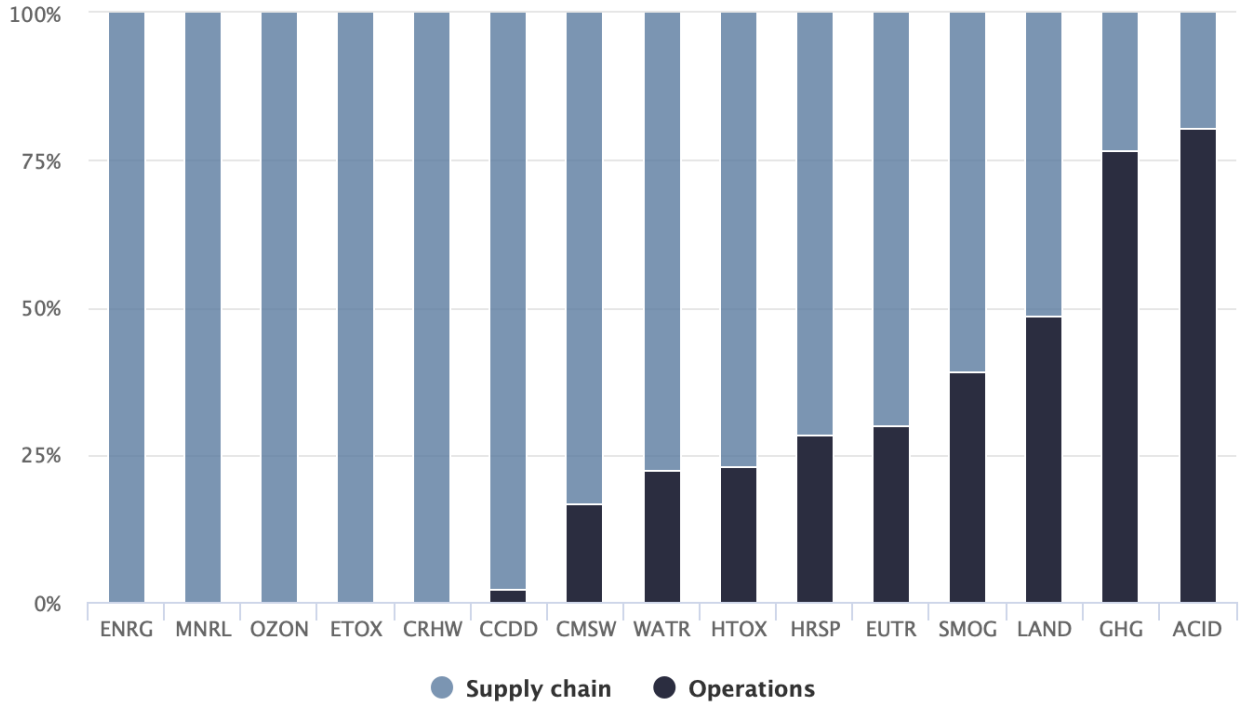
Download chart data as CSV file

The three potentially significant environmental issues for *Dairies* appear to be:

1. Acid Rain (ACID)
2. Land Use (LAND)
3. Freshwater Aquatic Ecotoxicity (ETOX)

Where are the potential issues originating from for this good or service?

The chart below shows the share of environmental issues associated with operations and the supply chain for this good or service.



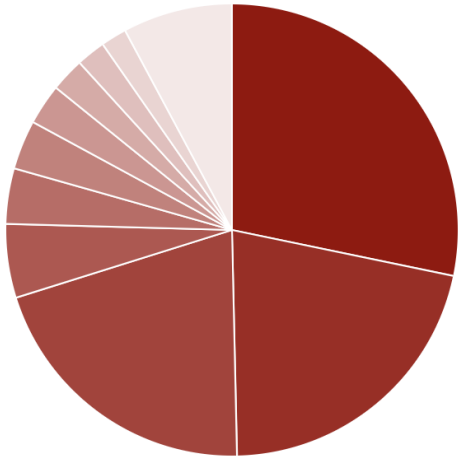
https://www.epa.gov/smm/smm-prioritization-tools-index

Sustainable Materials Management Prioritization Tools

Tufts UNIVERSITY

Contribution of Purchases By Indicator

Acid Rain (ACID)



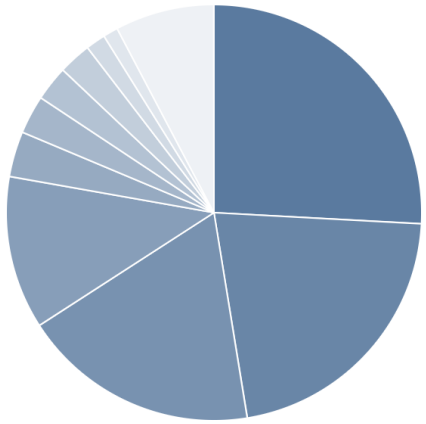
1. Other animal food
2. Fresh wheat, corn, rice, and other grains
3. Cattle ranches and feedlots
4. Tobacco, cotton, sugarcane, peanuts, sugar beet...
5. Electricity
6. Agriculture and forestry support
7. Animal farms and aquaculture ponds (except catt...
8. Truck transport
9. Water transport (boats, ships, ferries)
10. Gasoline, fuels, and by-products of petroleum r...

Download chart data as CSV file

What purchases made by providers of this good or service are potentially embedding issues in this good or service?

The charts below show the direct purchases potentially contributing to overall environmental issues (first chart) and each individual issue (second chart). Click on a good or service in the charts or lists to get more information.

Contribution of Purchases By Overall Impact



1. Other animal food
2. Tobacco, cotton, sugarcane, peanuts, sugar beet...
3. Fresh wheat, corn, rice, and other grains
4. Cattle ranches and feedlots
5. Dimensional stone
6. Vegetable oils and by-products
7. Agriculture and forestry support
8. Gasoline, fuels, and by-products of petroleum r...
9. Electricity
10. Truck transport

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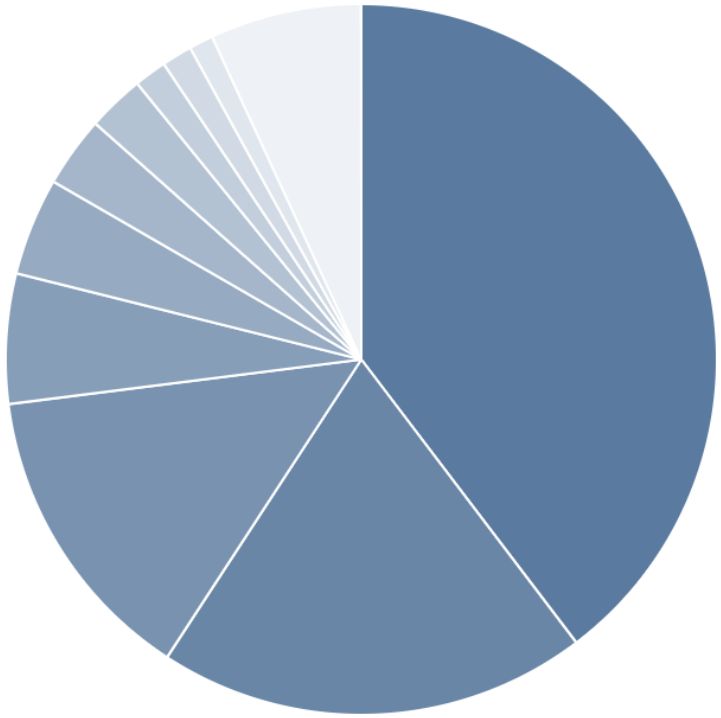
Sustainable Materials Management Prioritization Tools

Dairies, *Fresh wheat, corn, rice, and other grains* and *Tobacco, cotton, sugarcane, peanuts, sugar beets, herbs and spices, and other crops* are potentially the most significant hotspots for environmental issues in the supply chain of *Dairies*:



1. Dairies
2. Fresh wheat, corn, rice, and other grains
3. Tobacco, cotton, sugarcane, peanuts, sugar beet...
4. Cattle ranches and feedlots
5. Fresh soybeans, canola, flaxseeds, and other oi...
6. Dimensional stone
7. Unrefined oil and gas
8. Agriculture and forestry support
9. Electricity
10. Truck transport

https://www.epa.gov/smm/smm-prioritization-tools-index