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Zero Waste To Landfill

Carolina Recycling Association Annual Meeting

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Presented by
Frank Baldwin

Safety
Expertise
Dependability

Discussion: Zero Waste to Landfill

- **What is Zero Waste to Landfill?**
- **Methods of Diverting Waste**
  - Recycling
  - Composting
  - Anaerobic Digestion
  - Pyrolysis
  - Waste to Energy
- **Process to Achieve Zero Waste to Landfill**

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Zero Waste to Landfill Accreditation

What is Zero Waste to Landfill?

An accreditation given to a company or manufacturing facility when they have diverted 100% of their waste from going to a landfill.

How do you get accredited as Zero Waste to Landfill?

Many companies and municipalities are trying to achieve this accreditation. Typically, a 3rd party company (such as Green Circle) will audit a company's procedures and practices to ensure compliance is being achieved on all outbound waste.

Green Circle conducts audits for Zero Waste to Landfill compliance by auditing waste streams disposal methods, Waste Acceptance plans and a company's material management organization to verify compliance.

Waste Diversion Methods

Recycling

Most companies divert waste from landfill disposal by first trying to recycle.

Composting

Companies may opt for possible land applications including composting, as this method is cheaper than Waste To Energy.

Anaerobic Digestion

Digesters are a good option for certain waste streams typically food and organic waste that can be processed for use as a fertilizer.

Pyrolysis

Some companies can divert waste to pyrolysis processing. However, there are few pyrolysis facilities in the U.S., and they mainly handle specific plastic waste streams that must be pre-processed before acceptance.

Waste to Energy

Waste To Energy (WTE) is the least favorable option as there are no WTE facilities in North Carolina and it is the most expensive solution to getting 100% Zero Waste to Landfill.

Recycling

- Recycling is the preferred choice for beneficial reuse and landfill diversion.
- It is cheaper than other technologies and, depending on the market situation, many times recycling can result in a rebate on certain waste streams to the generator.
- Cardboard, steel, used oil, and certain plastic streams such as HDPE are usually paid per market conditions on a monthly basis.

Composting

- Composting is a very popular method for handling waste for "beneficial reuse".
- Some compost facilities create a compost product through the process of composting non-hazardous waste. These facilities have rigorous approval processes and look for certain nutritional value from incoming feedstock (typically food waste and organic matter such as vegetation) to produce a compost product that meets stringent specifications.
- There are several of these composting facilities in North Carolina, fewer in South Carolina.
- Other compost facilities focus more on non-hazardous waste from industrial facilities, which have low concentrations of metals and typically lower values of organic matter but still qualify for a land application.
- Most environmental companies solidify any non-hazardous liquid waste with wood flour and deliver to this type of compost facility. These facilities typically do not sell their compost but reuse it to apply to landfill and for growth of additional organic plants to add to their wind rows.
- These sites will not accept waste when there is heavy rainfall.

Anaerobic Digestion

- Anaerobic digestion is the natural process in which microorganisms break down organic materials. In this instance “organic” means coming from or made of plants or animals. The initials AD may refer to the actual process, or the system in which anaerobic digestion takes place, also known as a digester.
- AD happens in closed spaces where there is no air (or oxygen).
- Waste streams that can be processed in a digester include animal manures, food scrapes, fats, oils and greases, industrial organic residuals and sewage sludge.
- All anaerobic systems adhere to the same basic principles regardless of feedstock. Systems may vary slightly in design, but the process is largely the same.

Anaerobic Digestion

- The material left after AD is called digestate, a wet mixture usually separated into a solid and liquid.
- Digestate is rich in nutrients and can be directly land applied, used as fertilizer for crops, or made into products such as bedding for livestock, flowerpots, soil amendments and fertilizers.
- Digestate can also be further processed into products that are bagged and sold into stores.
- Some emerging technologies can be employed post-digestion to recover the nitrogen and phosphorus in digestate and create concentrated nutrient products (fertilizers).
- Biogas is generated by AD when microorganisms break down organic materials in the absence of oxygen. Biogas is mostly methane and CO_2 with tiny amounts of water vapor and other gases. The CO_2 and other gases can be removed, leaving only methane. Methane is the primary component of natural gas, therefore making biogas a renewable source that can be used in many ways.

Anaerobic Digestion

- Biogas can be used to power engines, produce mechanical power, heat and/or electricity, fuel boilers and furnaces, run alternative fuel vehicles and supply homes and business.
- Its use and efficiency depends on its quality. It is often cleaned to remove CO_2, water vapor and other trace contaminates. Removing these compounds increases the energy value.
- Low quality biogas is typically used in tougher, less efficient engines such as internal combustion. Higher quality biogas cleaned of trace contaminants can be used in more efficient and sensitive engines.
- Biogas treated to meet pipeline quality standards can be distributed through the natural gas pipeline and used in homes and businesses. It can also be cleaned and upgraded to produce compressed natural gas or liquefied natural gas, which can be used to fuel vehicles.

Pyrolysis

<u>What is Pyrolysis?</u>

pyro • lysis

HEAT DECOMPOSITION

- Uses high temperature to rapidly decompose waste
- Breaks-down waste into its constituent "ingredients"
- The "ingredients" are extracted, processed, and re-used
- Cleanest and most thorough waste disposal solution
- Enables "zero to landfill" and "circular economy"

Source: ©2023

ENREVO PYRO

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Pyrolysis

Types of waste that can be pyrolyzed

Any waste with hydrocarbon content

- Waste plastic
- Scrap tires
- Waste oil: used motor oil, lubricants, tank bottoms, etc.
- Petrochemicals
- Oil-contaminated soil, oil sands, tar sands
- Textiles: polymer (e.g., polyester, rayon), cotton
- Biomass: food, agricultural/farm, yard, paper/cardboard, sewage

Source: ©2023
EnRevo PYRO

Pyrolysis

How does Pyrolysis work?

- Waste is fed into a high-temperature, oxygen-free chamber
- No oxygen in the chamber = the waste is not burned
  - Preserves hydrocarbon content to use for valuable outputs
  - Avoids toxic smoke pollution produced by waste incineration
- Instead of burning, the hydrocarbons break-down and vaporize
  - Heat causes the complex hydrocarbon content to rapidly decompose
  - Complex hydrocarbons → long-chain + short-chain hydrocarbon vapors
- The hydrocarbon vapors are piped from chamber to process
- Non-hydrocarbon solid residue is removed from chamber to process

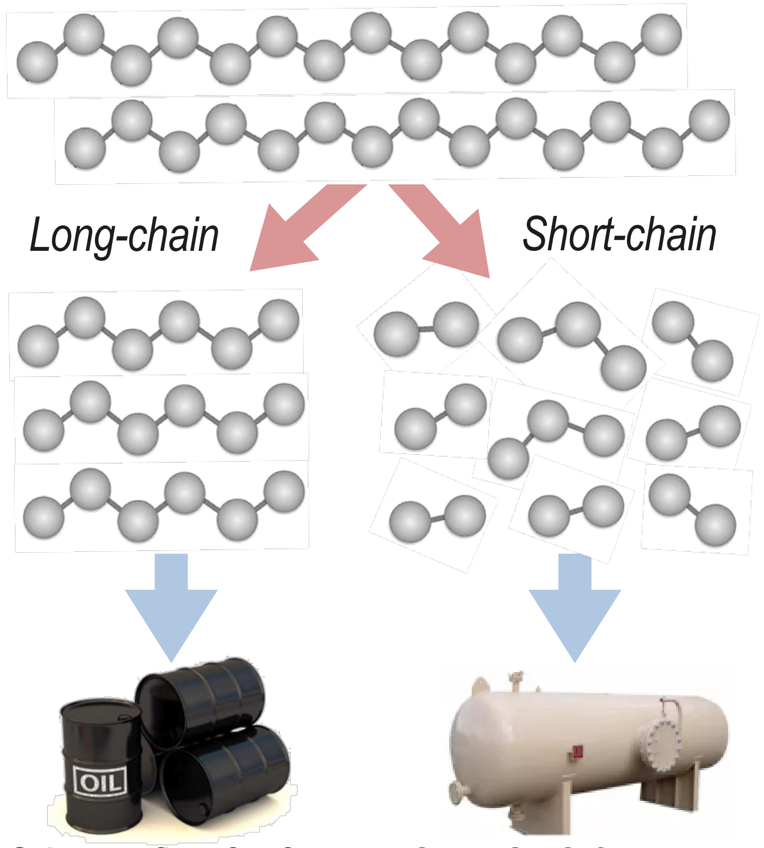
Pyrolysis

Pyrolysis processing of hydrocarbon content

Complex hydrocarbon content in waste matter

Heat breaks-down complex hydrocarbon content into simpler hydrocarbon forms (short-chain and long-chain) which quickly vaporize

When the vapors cool-down, the long-chain hydrocarbons condense (reform) into oil and the short-chain hydrocarbons remain gaseous ("syn gas")



OIL to refine for fuel or petrochemicals

SYN GAS for process heat and industrial use

Source: ©2023 EnRevo Pyro

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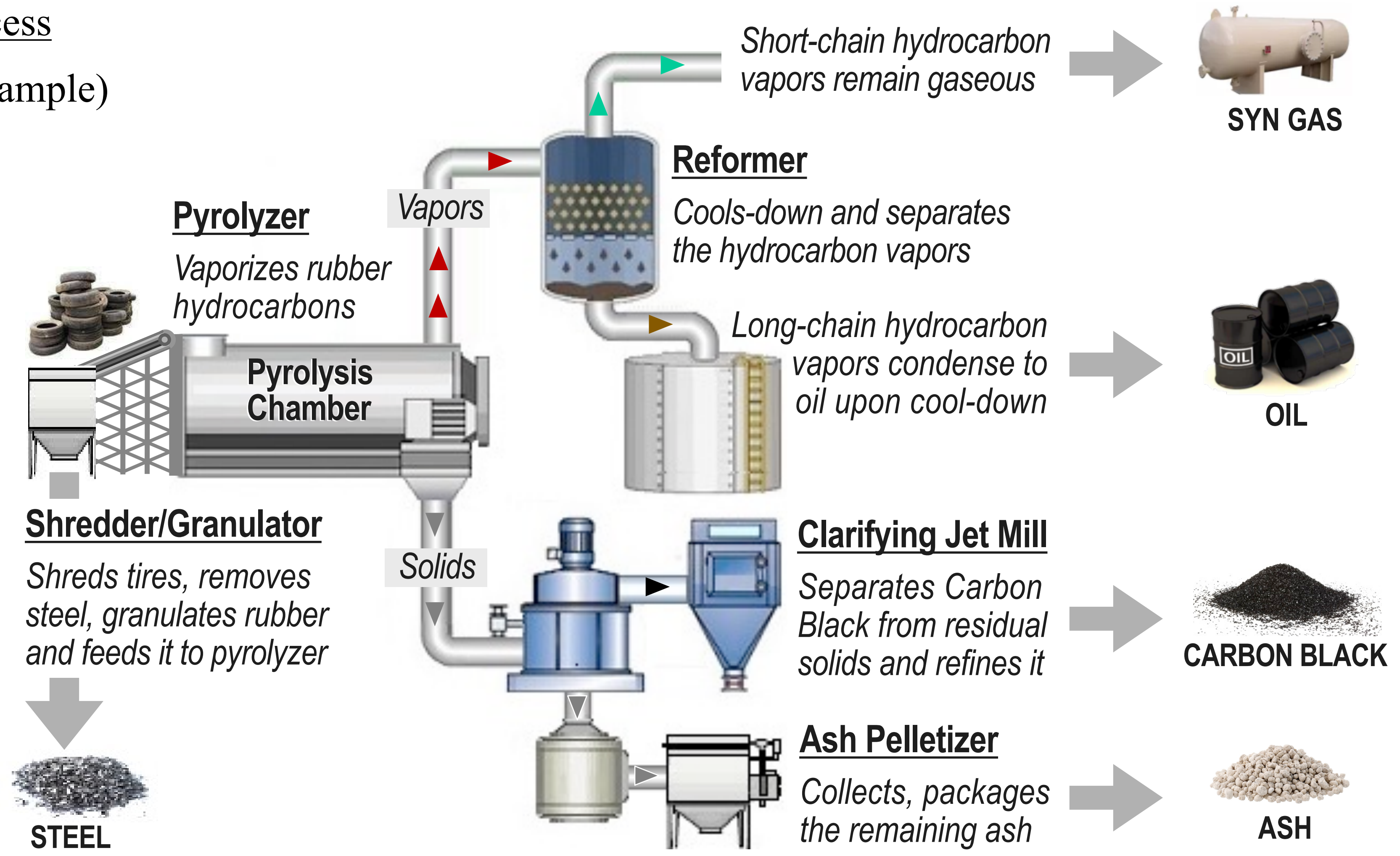
Pyrolysis

Scrap tire process

(Simplified example)



Source: ©2023 EnRevo Pyro

Pyrolysis

<u>Zero-to-Landfill solution</u>

(Scrap tires example)

100% of the content is:

- Recovered
- Recycled
- Reused

= 0% to Landfill

	OIL	Industrial input: • Plastics manufacturing • Petrochemicals manufacturing • Refined fuels: diesel, gasoline, jet	46.8%
	CARBON BLACK	Industrial input: • Tires • Electronics • Rubber products • Ink toner • Paints / pigments • Steel	18.7%
	SYN GAS	Applications: • Pyrolysis + cement kiln (heat) • Power generation (fuel) • Industrial input (methanol, graphene)	15.3%
	SCRAP STEEL	Industrial input: • Steel components • Metal products	15%
	ASH	Industrial input: • Concrete (aggregate)	4.2%
	TOTAL	Recovered + Recycled + Reused	100%

Source: ©2023 EnRevo PYRO

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Pyrolysis

Not all Pyrolysis technology is the same

Results depend on many specific, nuanced parameters
… most Pyrolysis systems fail to perform as advertised

- Pyrolysis system design: chamber size/dimensions, heat source
- Feedstock selection: more monolithic = better output yield and quality
- Feedstock preparation
- Heat parameters
  - Temperature level, consistency, uniformity
  - Heating rate
- Process/retention time
- Other process details

Source: ©2023 EnRevo Pyro

Waste To Energy

- Waste To Energy (WTE) plants burn Municipal Solid Waste (MSW), often called garbage or trash, to produce steam in a boiler to generate electricity or steam.
- MSW is a mixture of energy-rich materials such as paper, plastics, yard waste, and products made from wood.
- In the U.S., for every 100 lbs. of MSW, about 85 lbs. can be burned as fuel to generate electricity.
- WTE plants reduce 2,000 lbs. of garbage to ash weighing about 300-600 lbs. and reduce the volume of waste by 87%.
- There are different types of WTE systems and technologies. The most common type used in the U.S. is the mass-burn system, where unprocessed MSW is burned in a large incinerator with a boiler and a generator for producing electricity.
- A less common type of system processes MSW to remove most of incombustible materials to produce refuse derived fuel.

Global Waste Challenge

Global Waste Challenge

Waste handling can be time consuming and costly, exposing industries to environmental and reputational risk

Complex waste management operations compete for funding with other priorities such as clean water and general utilities

Municipalities struggle with lack of infrastructure and budgets to manage waste

Improper waste management puts a strain on the health of urban dwellers and the environment

Landfill and Incineration

Traditional options for management of non-recyclable waste streams pose serious challenges

- Large waste footprint and liability
- Produce harmful gases & leachates
- Doesn't capture inherent value of waste
- Contribute to high GHG emissions
- Require additional infrastructure
- High cost opportunity

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What is Co-Processing?

A globally recognized pathway through which alternative raw materials and fuels are processed in energy-intensive industries

- The technology allows to efficiently recover energy and to recycle the mineral components from materials that otherwise would be disposed
- High temperatures and long residence time in cement kilns allow for the safe destruction of organic compounds and leave no residues

What is Co-Processing?

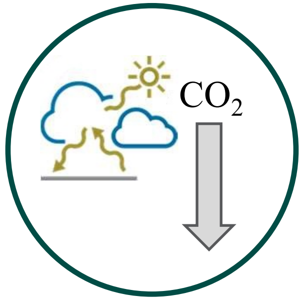
Co-Processing in cement kiln…

Completely decomposes waste through high temperatures and long residence time

Recovers energy and recycles mineral value of waste, if any

Leaves no residue

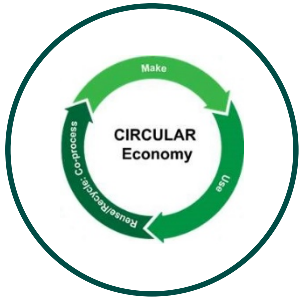
Leads to conservation of natural resources



Reduces greenhouse gas emission

Offers local waste management solution

Saves public funds

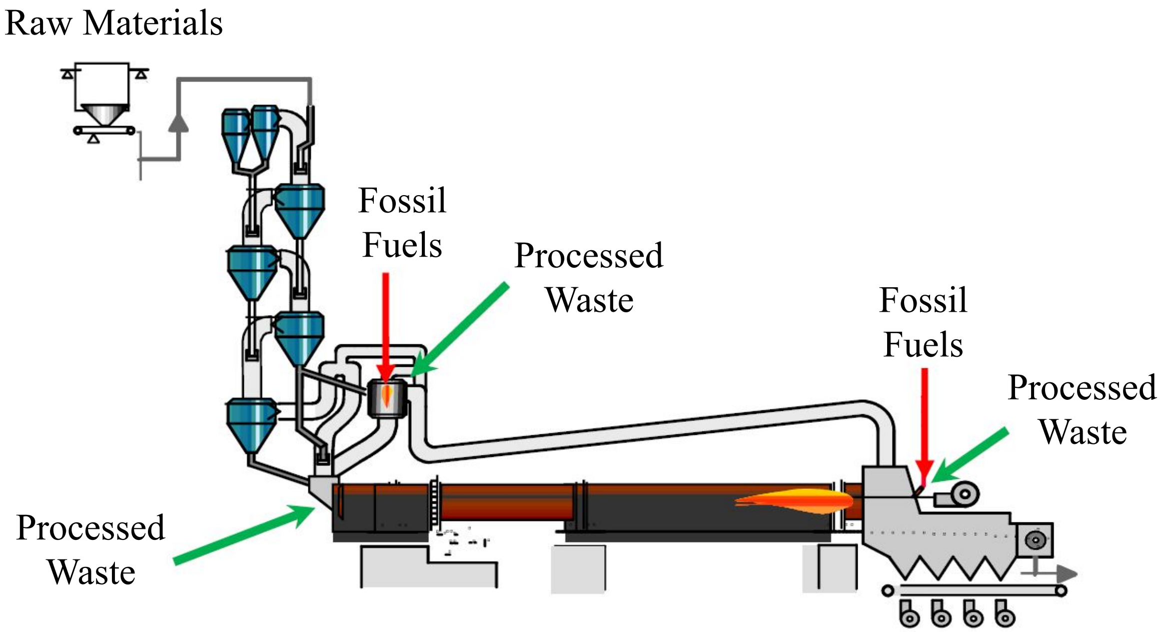


Promotes a circular economy

What happens to waste in a cement kiln?

The organic constituents are completely decomposed due to:

- Long residence time
- High temperatures
- Oxidizing conditions

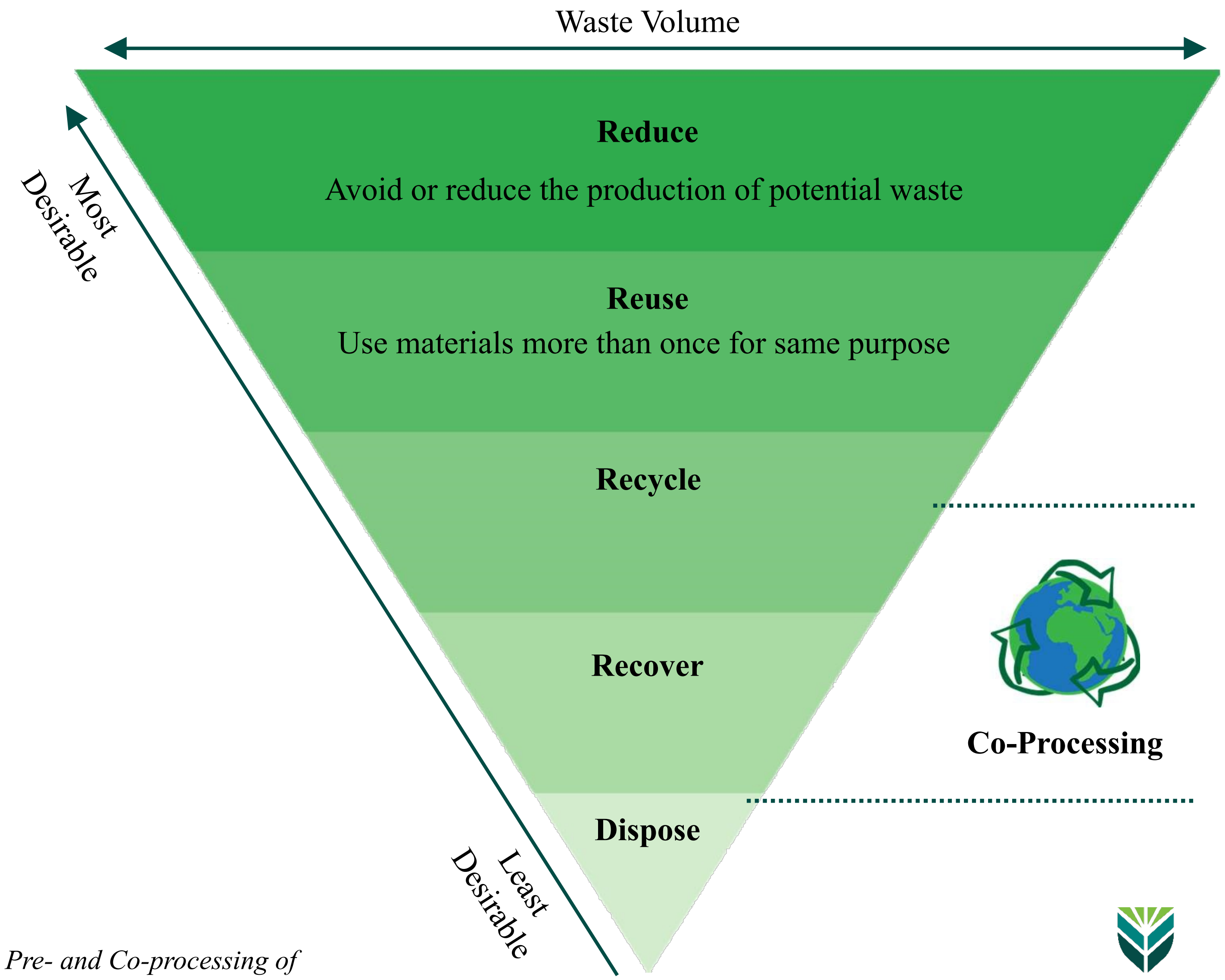


Acid gases such as HCl and SO2 are absorbed and neutralized by the lime and other alkaline materials within the kiln

The inorganic constituents including heavy metals reacts with the raw materials in the kiln and are incorporated in the clinker matrix

Waste Management Hierarchy

- Broadly accepted global framework for policymakers on designing waste management systems
- Prevention or reduction of waste is most desired solution followed by reuse and recycling
- Disposal (sanitary landfill, incineration with no or limited energy recovery) is least desired solution
- **Co-processing recovers energy, recycles & reuses materials and leaves no residue at all, therefore it is a more desirable option than disposal**



Source: LH-GIZ Guidelines on Pre- and Co-processing of Waste in Cement Production, 2019

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Co-Processing Compared to Incineration

Benefits of co-processing over the most commonly used methods:

Co-Processing

A “2 in 1” process

- Treats the waste while producing cement
- Recycles the mineral content
- Recovers 100% energy content
- Thermal destruction with temperatures up to 1450 ℃
- Zero residue

Incineration

An elimination process

- Heavy investment
- No recycling
- Recovers energy inefficiently
- Thermal destruction at 800 ℃
- Residue 20% ashes

Landfilling

A disposal solution

- No recycling
- No waste recovery
- In case of open dumps: Strong impact on the environment (ground, water, soil) and local community (health & odor), risk of open fire, high GHG emissions

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Co-Processing: Proven Solution for Sustainable Waste Management of Residual Streams

- **Safe energy recovery** and **mineral recycling of residual streams** that cannot be kept in the loop of a circular economy
- **Conservation of natural resources** by replacing them with secondary resources
- **Use of existing industrial infrastructure** with moderate additional investments into pre-processing and co-processing facilities
- Evaluated **globally** for more than **40 years**
- Endorsed by **Basel Convention** as Best Available Technology for disposal of various streams
- Recommended for the destruction of POPs and ODS under **Stockholm Convention**
- Endorsed by several international bodies such as **UNEP**, **GIZ** and **SINTEF**

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Co-Processing: Proven Solution for Sustainable Waste Management of Residual Streams

Environmental, Social and Economic Benefits of Co-Processing

Climate Change Mitigation

Recycling and Resource Efficiency

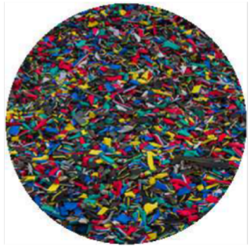
No additional public expenditure

Local jobs

Types of Waste Cement Kilns Manage





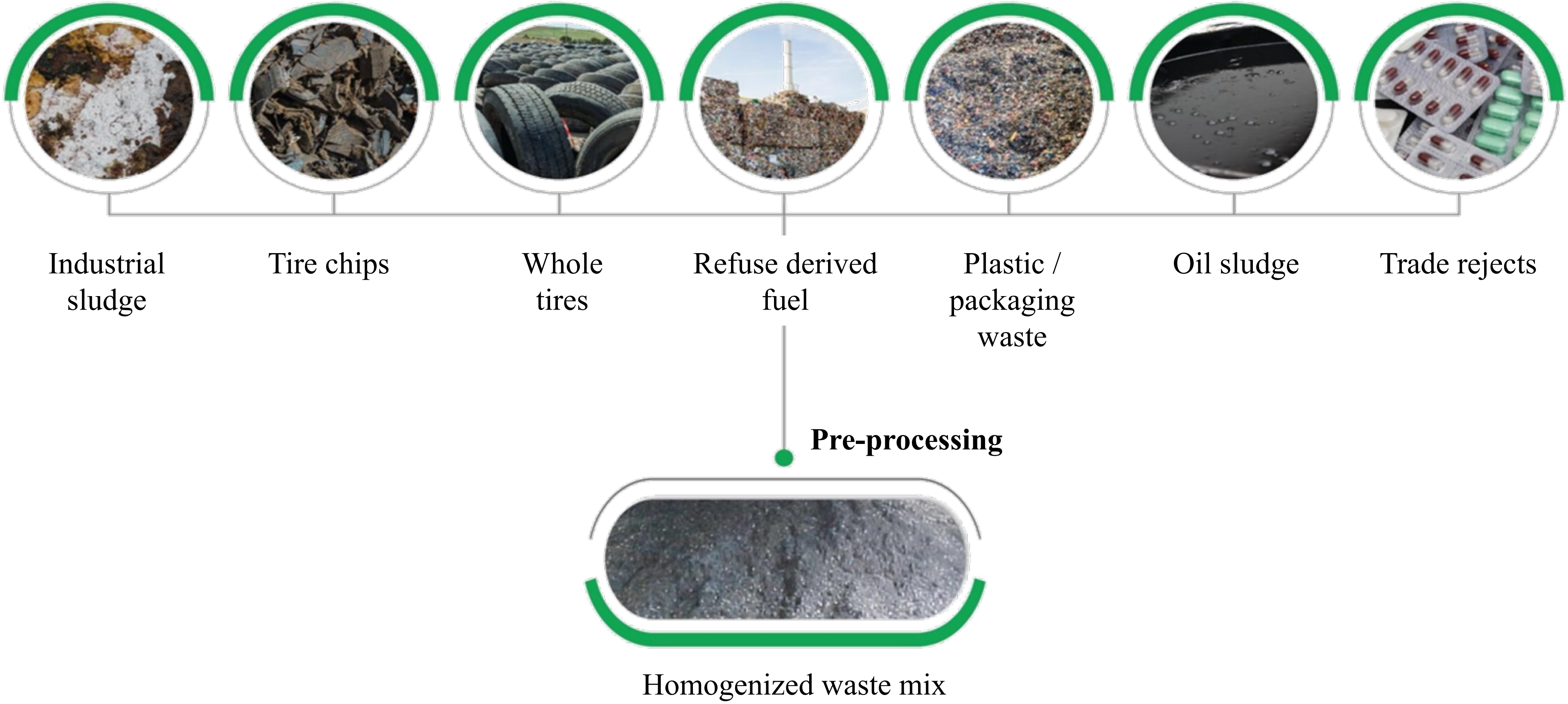
- Biomass
- Calcium fluoride
- Carbon fines
- Contaminated soil
- Diaper trimming
- Diatomaceous earth
- ETP sludge
- Expired corn seed
- Expired food/health products
- Expired consumer goods

- Filter cake
- Fly ash & bottom ash
- Foundry sand
- Mill scale
- Oily wastes
- Packaging materials
- Paint wastes
- Plastics
- RDF fluff & pellets
- Redmud

- Refinery wastes
- Rubber wastes
- Shipping wastes
- Sorted municipal solid waste
- Solvents
- Spent carbon
- Spent pot liner
- Textile waste
- Tires
- Used oil & grease

What is Pre-Processing?

Pre-processing is needed to convert a wide variety of waste streams into a homogeneous in-spec product suitable for co-processing in cement kilns.



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Zero to Landfill

Which waste streams can't be pre- & co-processed?

"Banned wastes" not to be pre- or co-processed:

- Radioactive waste
- Asbestos-containing waste
- Explosives and ammunition / weapons
- Anatomical medical waste

"Banned wastes" not to be co-processed:

- Electronic fraction of electrical and electronic waste (e-waste)
- Whole batteries as a targeted material stream
- Waste of unknown or unpredictable composition, including unsorted municipal waste

These wastes can, however, be co-processed after pre-processing to remove the banned portion of the waste

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Industries Cement Kilns Serve

Industrial & Service Companies

- Offer dedicated certifiable solutions for a variety of industries and service providers
- Work with customers to design and execute tailored solutions

Agricultural Sector

- Work with farmer and processing facilities to safely and sustainably manage agricultural residual streams
- Ensure management of agricultural residues contributes to local communities and is sustainable in terms of environmental impact and biodiversity

Municipalities, Counties

- Many face rising volumes of waste, tighter budgets and increased expectations from stakeholders and regulators
- Offer innovative solutions that eliminate need for large public investments

Waste Management Companies

- Require extensive capacity, flexibility and expertise in their waste management partners
- Create value by ensuring that waste is treated in a safe, compliant and responsible manner

Process to Achieve
Zero Waste to Landfill

- Evaluate and inventory current waste streams.
- Ensure you have all SDS's on current waste streams.
- Contact your preferred waste vendor.
- Request an audit of your site's waste streams.
- Have your waste vendor discuss logistics, possible options for waste, pricing, waste container information, and your schedule of operations.
- Generate a plan and schedule to meet your goals.
- Communicate your company's Environmental goals and timelines for success.
- Understand your ability to segregate waste streams, as successful segregation of waste will help save money.
- Communicate changes to your personnel, what is changing and how it will be accomplished. Educate employees on the importance to the company and to them.
- Celebrate your achievement with employees, their buy-in on your program is key to success.

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Sustainable solutions for total waste management and integrated environmental services

Safety. Expertise. Dependability.

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Expertise

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