Better Plants
U.S. DEPARTMENT OF ENERGY

Source Reduction and Waste Minimization Techniques

Virtual INPLT Training

Session 3

Tuesday – March 4, 2025

10:00 am – 12:30 pm EST

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DOE's Waste Reduction Network:

- Open to all existing Better Plants partners
- Goals are flexible
- Six goal options based on partner feedback
- Quarterly webinars
- Bi-monthly newsletter
- Access to new waste-related tools, trainings and programmatic elements

Waste Virtual INPLT Agenda

- **Week 1 (February 18th) – Introduction: Waste Diversion and Reduction 101**
- **Week 2 (February 25th) – How to Effectively Track and Measure Your Waste**
- **Week 3 (March 4th) – Source Reduction and Waste Minimization Techniques**
- **Week 4 (March 11th) – Finding Outlets for Hard to Manage Waste Streams**
- **Week 5 (March 18th) – Construction Waste Management and Green Building Certifications**
- **Week 6 (March 25th) – Scope 3 Emission Considerations**
- **Week 7 (April 1st) – Implementation of a Waste Diversion Program – Developing a Roadmap to Zero Waste**
- **Week 8 (April 8th) – Conclusions, Summaries, and Wrap up Presentations**

Plan of Action

Today, we will:

- Review the previous training
- Discuss the homework
- Lecture on today's topic, "Source Reduction and Minimization Techniques"
- Test your knowledge with a Kahoot! quiz
- Conduct a Q&A session

Takeaways

Today, you will learn to:

- Reduce and manage waste streams
  - Source reduction techniques and where to apply them
- Identify source reduction opportunities
- Understand the benefits of proposed waste minimization strategies

Presenters from Sustainable Solutions Corporation

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Julia Mascho, EIT, LEED Green Associate
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Quick Review

Remembering Session 2

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Session 2 Review: What are the 9 steps for waste tracking discussed last week?

Please type any of the 9 in the chat

Waste Tracking Methodology

Waste tracking can be broken into the following steps:

1. Select a system
2. Delegate responsibility and accountability
3. Gather and input data
4. Validate data
5. Utilize data to act
6. Conduct an onsite assessment
7. Conduct a waste characterization (recommended)
8. Set realistic goals
9. Review on recurring basis

Review: How to Effectively Track and Manage Your Waste

- Establish standard procedure for data collection and review
- Develop a system to segregate waste streams results for increased data granularity
- Assess waste onsite utilizing waste assessment and characterization procedure
  - Conduct a site walk-through
  - Understand production process
  - Evaluate onsite waste collection
  - Characterize waste to understand feasible diversion
- Evaluate onsite waste collection strategies

Homework Discussion

Homework Takeaways

Overview

- Identify a process that generates a waste stream and review its end-of-life scenario. Brainstorm some possible solutions to minimizing the waste generation and describe their implementation.

Takeaways

- Everyone who submitted described a possible solution to reducing a waste stream
  - Improvement of training or procedures
  - Implementation of new process or equipment
  - Segregating a major waste stream into several for easier diversion
- Implementation of proposed solutions always involved multiple parties

Today's Topic:
Source Reduction and Waste Minimization Techniques

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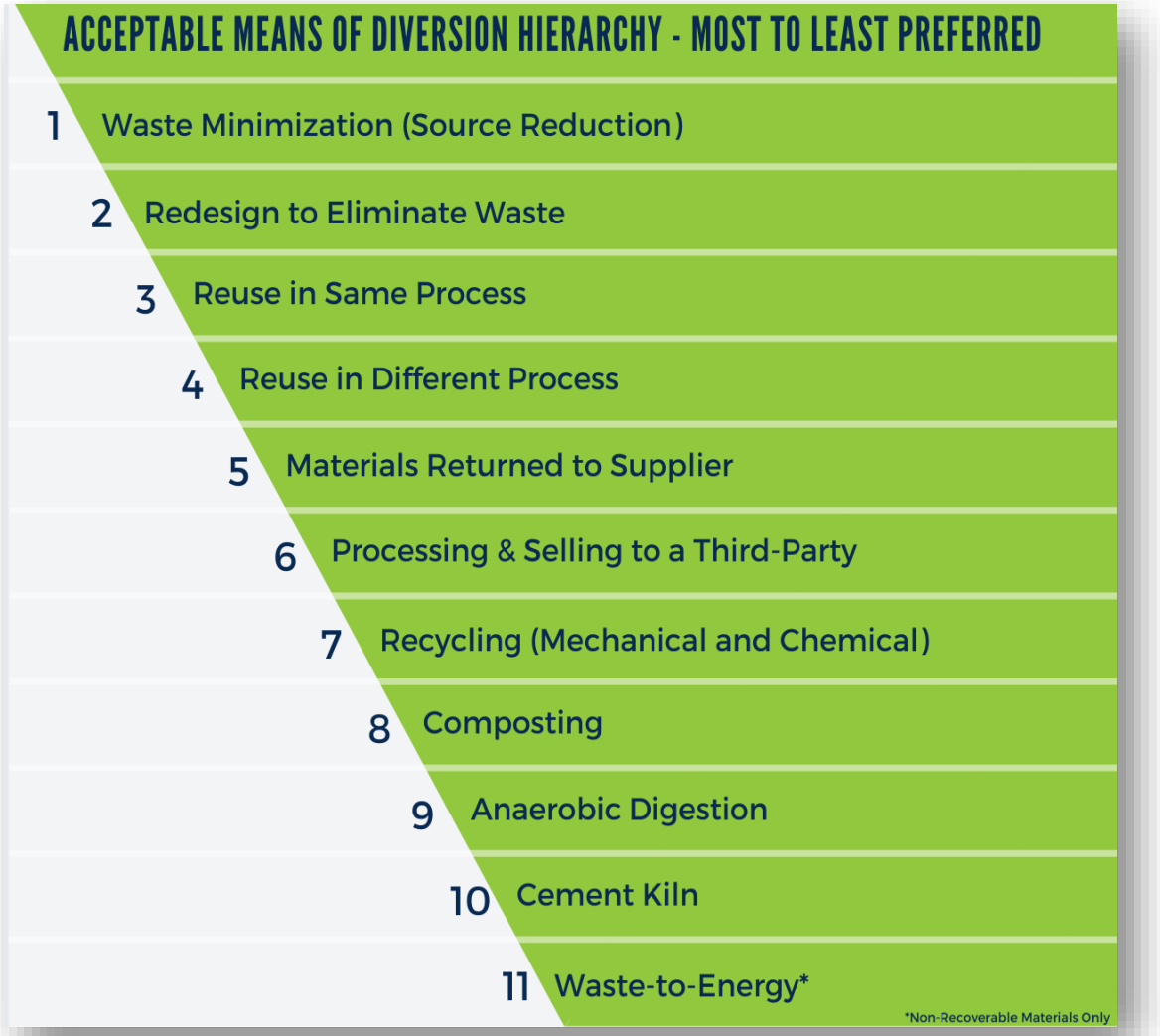
Poll: From most preferred to least preferred method of diversion, how high on the waste diversion hierarchy is source reduction?

Please respond to the Zoom poll

Answer: It's the most preferred.

Waste Diversion Hierarchy



Source Reduction Targets

Example targets for source reduction are:

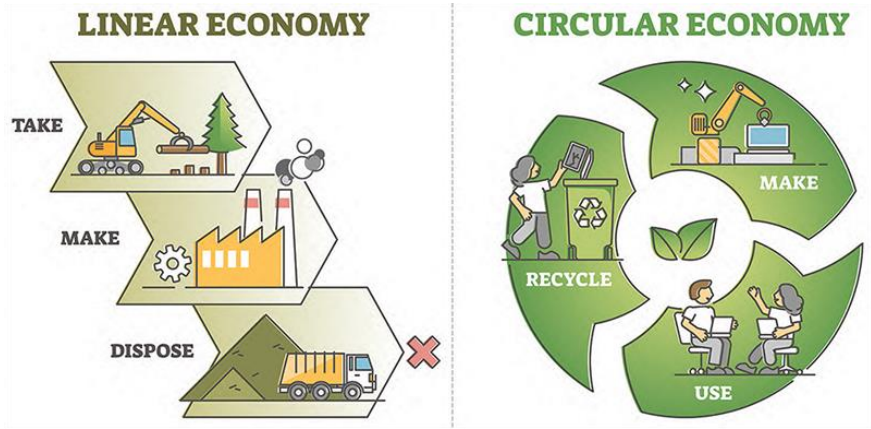
- Finished/packaged good waste
- Raw material usage
- Inventory losses
- Packaging wastes
- Hazardous and solid wastes
- Spills and releases

Source Reduction Techniques

Source reduction is the elimination of waste before it is created

Techniques for source reduction include:

- Supplier takeback programs
- Product enhancement
- Process efficiency improvements
- Onsite recycling
- Material substitution
- Inventory control
- Industrial hygiene
- Preventative maintenance



Who Has a Role in Source Reduction?

- Most business groups will influence the waste that is generated and, therefore, source reduction
  - Level of influence will depend on the industry

Strategy	Business Group
Supplier takeback program	Procurement
Product enhancement	R&D
Process efficiency improvements	Operations, R&D, EH&S
Onsite recycling	R&D, Operations, EH&S
Material substitution	R&D
Inventory control	Procurement, Warehouse Teams, Operations
Industrial hygiene	EH&S
Preventative maintenance	Maintenance, Operations

Supplier Takeback Programs

Question: Do any of you engage your suppliers in a takeback programs? If so, what materials?

Please respond to Question in the chat

Supplier Takeback Program

Strategy

- Work with suppliers to find strategies to enact returnability
  - Implement returnable packaging program to reuse packaging materials
  - Target local suppliers
- Work with suppliers to identify what materials may be returnable
  - Packaging materials
    - Wood or cardboard cores
    - Pallets
    - Totes
    - Foam padding
    - Plastic straps
    - Spools
  - Raw material scraps
  - Store returnable materials onsite until there is enough to ship

Supplier Takeback Program: Industry Example

- A textile manufacturer was throwing away tons of cardboard cores per year
- Discussions with the supplier determined that they were returnable if not damaged
- The site stored carboard cores until a pallet could be filled and were able to ship these back to the supplier for reuse, essentially eliminating this waste stream

Product Enhancement

Product Enhancement

- Work with research and development teams to minimize raw material use in the product and packaging
- Consider conducting a product mass intensity (PMI) analysis

$$PMI = \frac{\sum mass\ of\ materials}{mass\ of\ isolated\ product}$$

  - Align materials with their process and work to identify improvements

Product Enhancement

Strategy

- Optimize the size of the product or components
  - Enhance packaging sizes for products
  - Minimize or eliminate filler materials
- Reduce the use of environmentally harmful materials
- Minimize variances in design between products to reduce changeover requirements
- Adjust product or production design to increase material usage
  - Minimize trim requirements
  - Capture and reuse scrap
  - Adjust product formula to allow captured bulk or product to be reworked in new batches

Product Enhancement: Industry Example

Amazon is working to reduce packaging waste

Amazon is enhancing their packaging in many ways:

- In 2024, they removed plastic air pillows from global fulfillment center
- Avoided 446,000 metric tons of packaging in 2023
- In 2023, Amazon shipped 12% of their orders without additional packaging
- Avoided 80,500 metric tons of single use plastics in packaging since 2020
- Reduced average packaging weight per shipment by 43% since 2015

Amazon article

Question: Has anyone enhanced their product to reduce waste? If so, what did you do?

Please respond to Question in the chat

Process Efficiency Improvements

Process Efficiency Improvements

Process efficiency is the amount of effort required to make a product

Improvements to process efficiency could be:

- Reduce or eliminate startup and shutdown waste
- Improved machinery or equipment
- Increasing yield-decreasing waste generated
- Scheduling changes
- Physical location improvements

Process Efficiency Improvements: General Strategies

Strategy

- Institute collection system for spillage during unloading
- Create measurable requirements for raw material use, eliminating operator discretion
- Limit rework
  - Institute increased quality checks
  - Install automated sensors and monitoring where feasible
- Work to reduce startups and shutdowns by tracking causes and optimizing
  - Utilize scrap materials as feed for startups
- Utilize digital platforms to share materials between sites
- Do not use liners in recycling bins
- Engage laundry service for rags and uniforms

Process Efficiency Improvements: Industry Example

- A manufacturer was losing raw materials during the granule unloading process
  - Adding a boarder around the unloading area blocked granules from dispersing

Process Efficiency Improvements: Machine Design

Strategy

- Install guards, trays, or covers on production lines
  - Keep materials dry
  - Reduce spills
  - Capture re-workable materials
- Adjust quality checks to reduce waste from:
  - Packaging counts being incorrect from product removal
  - Materials being not added after a quality issues is noted
- Utilize air or pig to clean lines between batches
- Reduce evaporative loss in heated tanks for material or product treatment by installing hard or flexible covers
- Avoid unnecessary changes or replacement of chemicals by installing pH sensors or conductivity meters

Process Efficiency Improvements: Industry Example

A BMW plant in Germany reduced paint use, operating hours, and carbon emissions by utilizing a robotic painting system

- Increased precisions allows designs to be applied without stencils or masking the vehicle
- Reductions in overspray chemicals and compressed air have resulted in over 7,000 operating hours saved
  - This resulted in a reduction of 2,000 tons per year from the carbon footprint

Article Source

Process Efficiency Improvements: Industry Example

- A rice mill was losing 1% of their final product due to a shaker filter process
  - Adding a cover to this process eliminated this waste stream

Process Efficiency Improvements: Industry Example

- A food manufacturer was disposing of over 100 lb. of product per batch due to issues with consistency
- This waste was equal to over $150,000 annually in final product
- Installing a valve at the packaging line to remove water from the product prior to packaging eliminated this waste stream

Process Efficiency Improvements: Industry Example

- A manufacturer installed conductivity meters on their chemical tanks for metal treatment
- The meters resulted in over a 50% reduction in water treated along with reduced chemical use and generation of hazardous wastewater sludge

Question: Has anyone improved a process onsite to be more efficient, thus reducing waste? If so, what did you do?

Please respond to Question in the chat

Onsite Recycling

In-Process Recycling

Process of capturing waste for reuse before it goes to a MMO

- The feasibility of in-process recycling is highly dependent on the manufacturing process and the product(s) being created
- Look for opportunities to institute a closed loop system to capture and recycle materials

In-Process Recycling: Closed Loop Design Considerations

Closed Loop (Cradle-to-Cradle) Design:

- Closing the loop is the process of collecting end-of-life or scrap products and materials and recycling them back into the same or equal products
- Using a closed loop process not only reduces the amount of waste going to a landfill but also saves significant resources and energy
- Sustainable Product Innovation can facilitate the design of more closed-loop and reusable products

Onsite Recycling

Strategy

- Collect products that do not meet specifications for remelting, mixing, or regrinding
  - Capture grindings, trimmings, shavings, or dust for remelting
  - De-pack packaged products to re-process
  - Mix captured bulk into new batches
  - Utilize new batch to push final amount of previous batch out of piping and into packaging
- Establish onsite process for regrinding captured trim, final goods, etc. to create materials which can go back into the process

In-Process Recycling: Industry Example

- An injection mold had brackets which needed broken off at the end of the line
- Brackets are reground and remelted with raw materials
  - Imperfect products are also reground and remelted

Question: Does anyone have a process that currently has in-process recycling or possibly could in the future? If so, what is it?

Please respond to Question in the chat

Material Substitution

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Material Substitution

Raw material substitution is the replacement of materials with those which will produce less waste

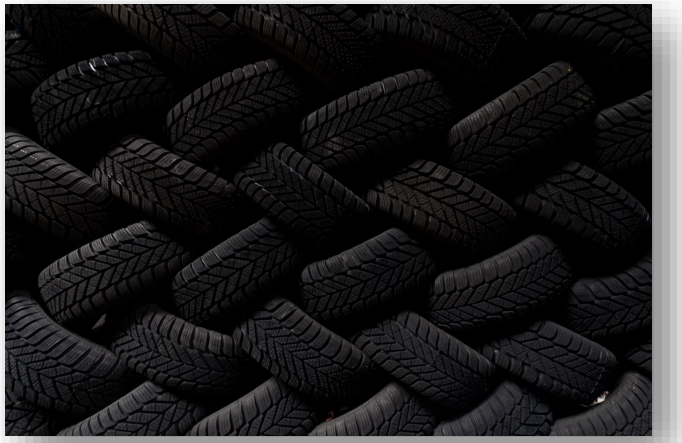
Some examples include:

- Using fewer toxic alternatives to achieve the same result
- Identify materials from one waste stream that could be used in place of a raw material
- Using raw materials which have a longer lifespan

Material Substitution

Strategy

- Research products which are made of the same or similar materials as required for your product and see if the production waste could be used as a replacement for virgin materials
  - Scrap plastics being used in building products
  - Fluff waste being used to make pet pee pads
  - Scrap food waste being used to make animal feed for farms
- Consider replacing virgin materials with bio-based substitutes, which may be more easily reused
  - Bio-plastics
  - Corn-plastics
  - Plant-based



Material Substitution: Industry Example

- ByFusion's ByBlock is made from landfill-bound plastic and is a substitute for building products which are more energy intensive to manufacture
- Due to the design, the blocks do not crumble, assisting with minimizing waste on construction sites

ByFusion ByBlock

Material Substitution: Industry Example

- Dyper's products utilize plant-based liners, reducing single use plastic waste
- Additionally, Dyper has a recollection network in certain cities, where they collect, process, and compost their dirty diapers

Dyper

Material Substitution: Industry Example

- Bridgestone is developing guayule shrub as commercially viable source of rubber
  - This shrub can be grown closer to manufacturing facilities and there are sustainable practices in place related to its growth and harvest
- Ford uses discarded tires for the seals and gaskets of new vehicles

Bridgestone Article
Ford Article

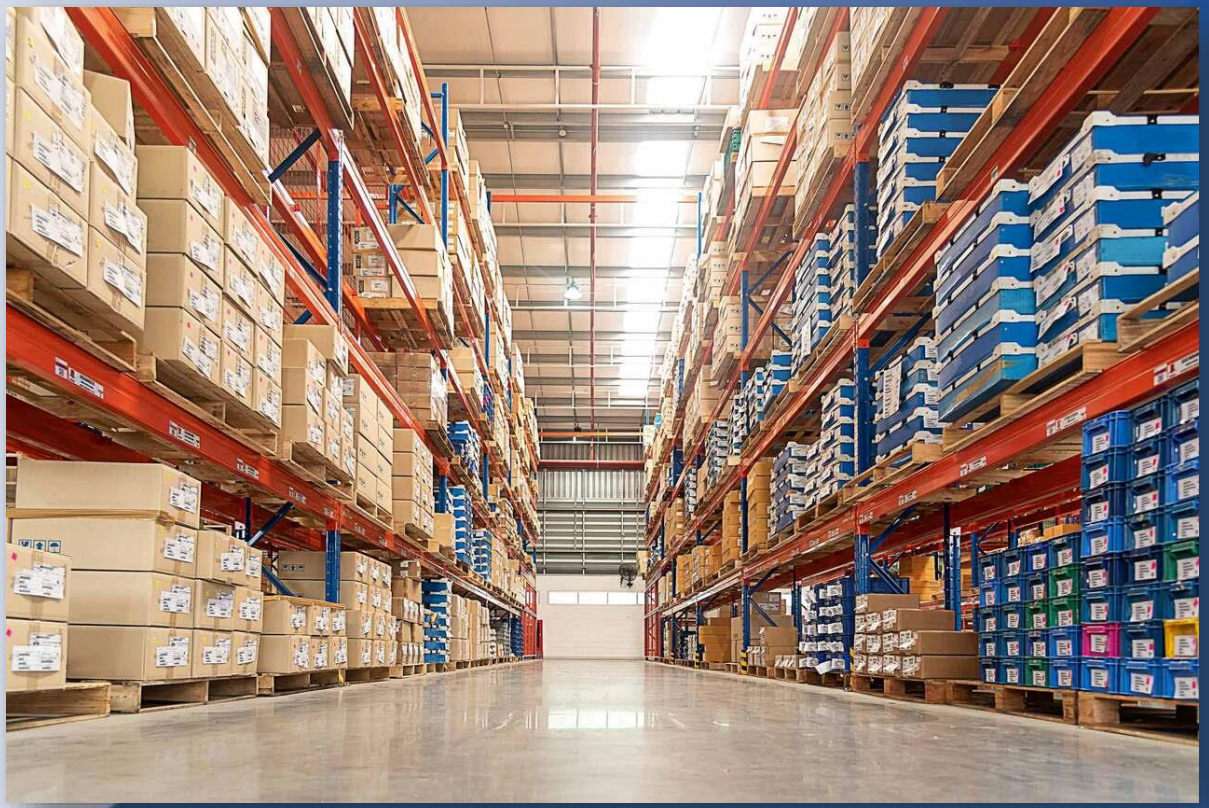
Material Substitution: Breakrooms

Strategy

- Reusable cutlery
- Reusable dishes and glasses
- Reusable takeout containers
  - Some places will allow you to use your own
- Coffee makers that are bean-to-cup coffee or utilize coffee grounds rather than single use pods
- Do not provide individual beverages at catered events
- Do not provide individual condiment packets

Question: Have any of your companies substituted materials before, reducing waste onsite? If so, what did you do?

Please respond to Question in the chat

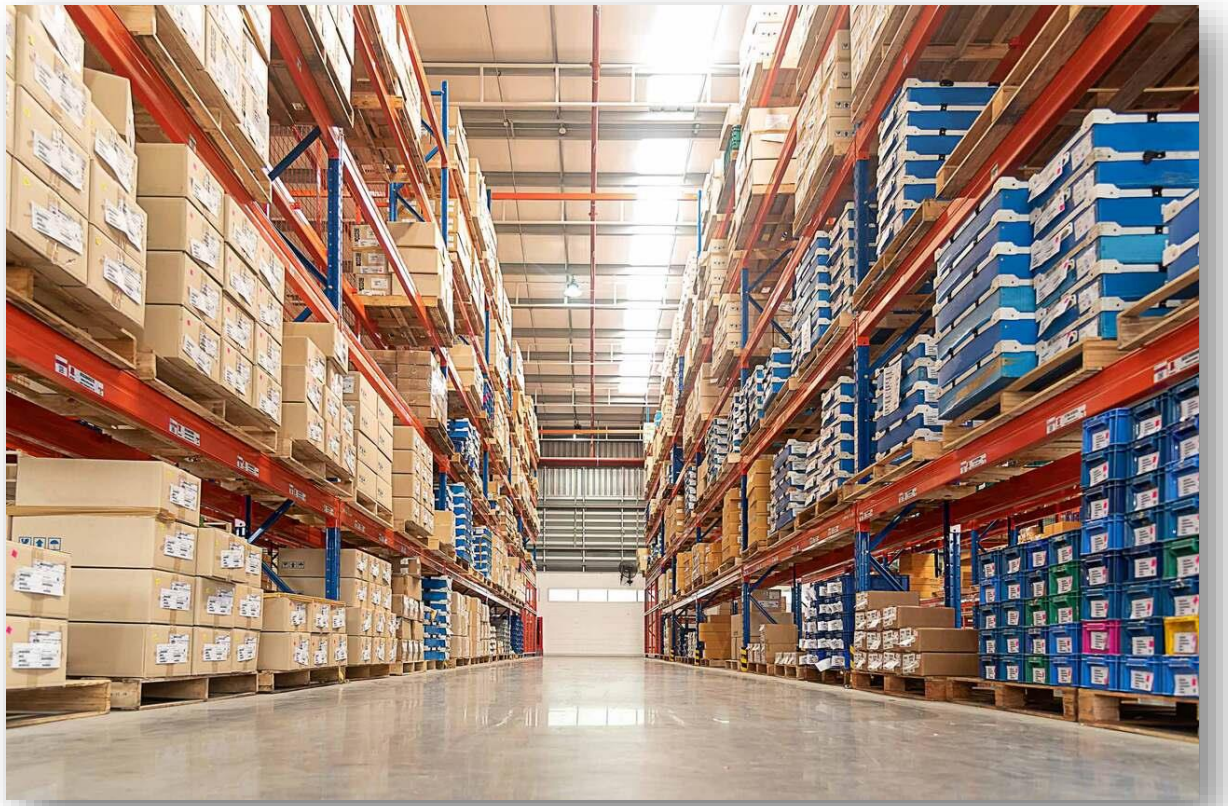


Inventory Control

Inventory Control

Inventory control relates to active monitoring, organization, and material selection

- Buy and use only what you need
  - Communicate with procurement
- Use the first in-first out or first in first-expiring approach
- Monitor shelf-life
  - Extend shelf-life where feasible
- Establish overflow database and communication between facilities
- Limit variety so that unused materials can be used elsewhere
- Separate reusable from recyclable waste
- Sell defect products at a discount to distributors



Inventory Control

Strategy

- Work with suppliers to ship in larger quantities
- Install silos or holding tanks onsite to hold raw materials
- Coordinate supplies between buildings or sites
  - Send materials which will not be used to other sites before they expire
- Purchase in lower quantities to reduce spoilage

Inventory Control: Industry Example

- A manufacturer was purchasing over 500 totes of a raw material per year
- Installing a holding tank would divert over 25 tons of waste from landfill annually

Question: Has anyone assessed inventory control to reduce waste onsite? If so, what did you find could be done?

Please respond to Question in the chat

Industrial Hygiene

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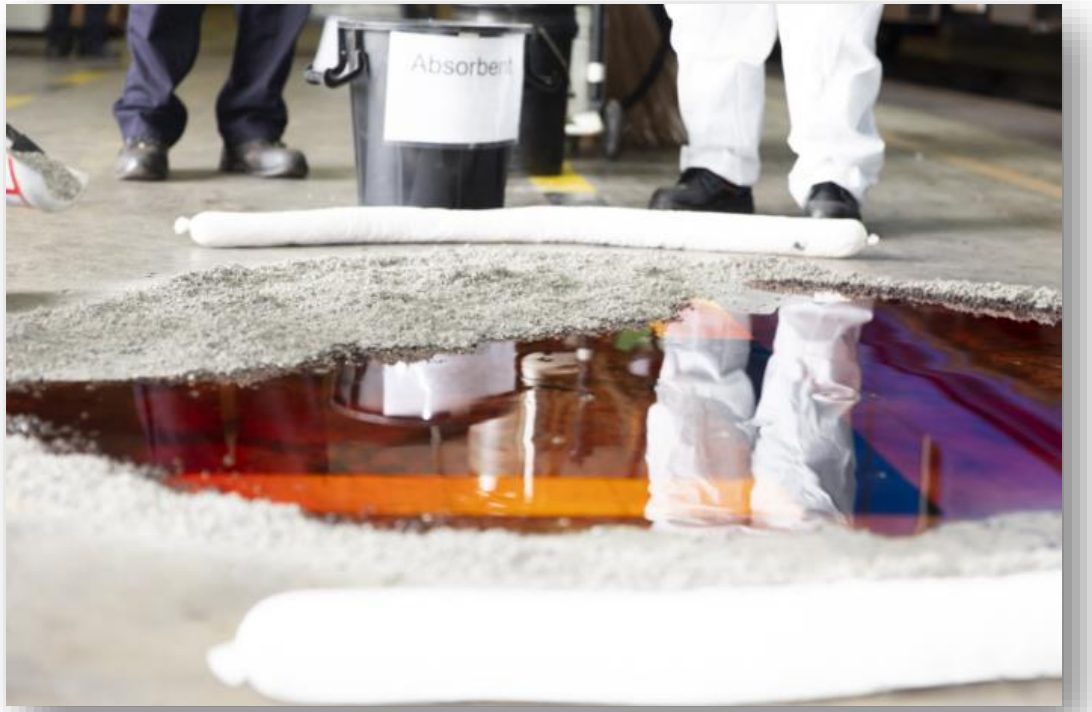
Industrial Hygiene

Industrial hygiene can assist with managing wastes and reducing unplanned waste streams

- Do not mix wastes
- Keep areas clean
- Minimize spills
- Reduce waste streams onsite
- Conduct a training for employees on waste segregation, handling, and diversion



Industrial Hygiene

Strategy

- Do not mix hazardous and non-hazardous wastes
  - Increase sampling of waste streams to ensure segregation
- Empty hazardous wastes out of individual containers into one larger communal
  - Cleaning original containers will prevent them from being hazardous waste

Example:
Do not dispose of rags used for general cleaning in the same bin as those contaminated with hazardous waste. This will increase the volume of the hazardous waste stream and increase treatment fees

Industrial Hygiene: Industry Example

- A manufacturer was a large quantity generator of hazardous waste due to their hazardous paint waste
- Processing this waste paint into pucks and grease cleaner significantly reduced their waste weight and volume
  - Grease cleaner could be used elsewhere onsite
  - This process reduced them from a large quantity generator to a small quantity

Question: What are some housekeeping strategies you employ onsite to reduce waste generated?

Please respond to Question in the chat

Preventative Maintenance

Preventative Maintenance

Assists with limiting costly or unplanned equipment failures which could lead to downtime or production wastes

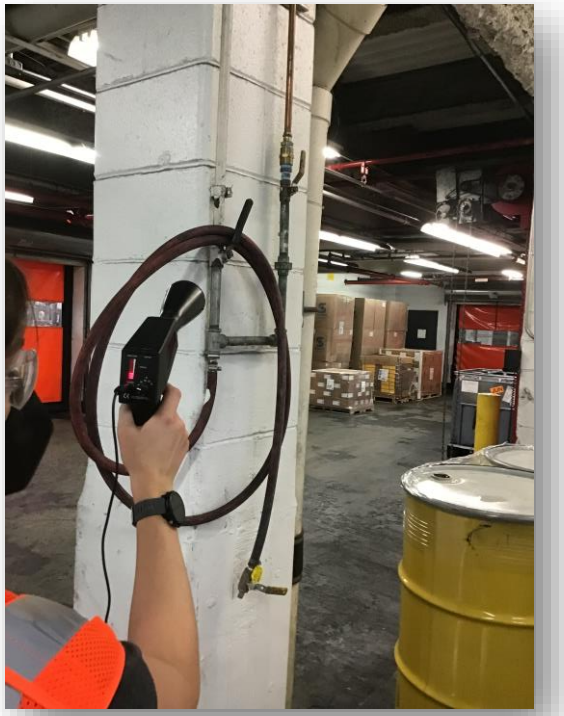
- Adhere to maintenance schedules
- Minimize leaks from piping and equipment
- Look for opportunities to reduce wastes associated with maintenance, plant outages, and unit overhauls
- Keep an up-to-date maintenance log

Preventative Maintenance: Industry Example

- A chemical manufacturer had a leak in a piece of equipment which would cost them $3.50 per gallon in materials and another 11 cents per gallon in wastewater costs
- A 50-gallon leak once a shift for a year would over $100,000

Preventative Maintenance: Industry Example

Maintenance issues increase waste and may require significantly more materials and resources to address



Question: Are there pieces of equipment or processes that undergo specific preventative maintenance? If so, what are they and what does this PM help reduce?

Please respond to Question in the chat

Poll: Which of the following is not a source reduction technique?

Please respond to the Zoom poll

Answer: Increase purchasing frequency.

Identifying Source Reduction Opportunities

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Data Review

- Review data to search for:
  - Waste streams with large volumes or disposal costs
  - Raw materials that end up in waste streams and their costs
  - Trends related to certain production processes or products

- Review data from different business groups
  - Quality
    - Reasons for final products failing quality testing
    - Quality reasons which generate the most waste
  - Production
    - Scrap rates
    - Startup and shutdown frequency
  - Inventory
    - Write-offs
    - Material expiration

Onsite Assessment

Recall strategies and processes from Session 2

- Prepare for the site assessment
- Walk through the facility evaluating manufacturing processes and procedures
- Identify where and how waste is being generated
- Conduct additional analyses as needed

Evaluating Opportunities

- After an onsite assessment, compile findings and begin assessing source reduction opportunities
- Consider the following:
  - What processes or procedures need to change to minimize waste?
  - What personnel need to be involved?
  - Which opportunities will yield the largest or most important results?
  - Does a product or process redesign need to occur?
  - Does there need to be any external coordination?

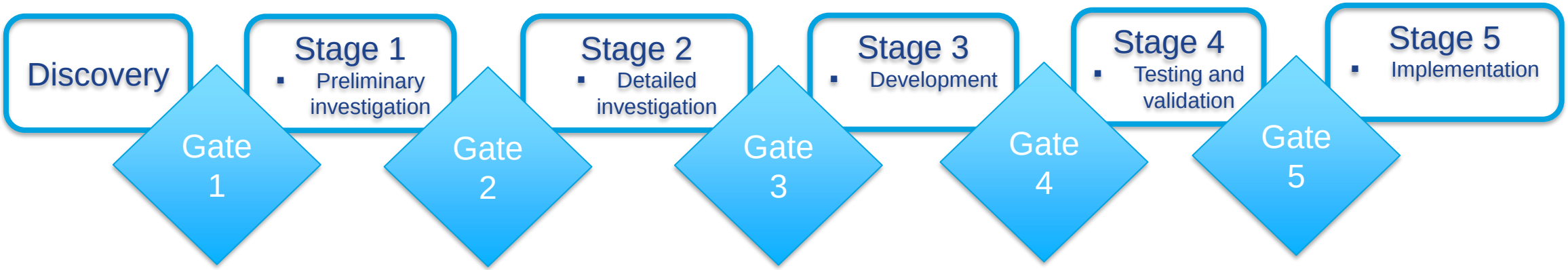
Utilizing Familiar Strategies

Waste can be part of the discussion for product innovation

- Understand where waste is generated and how
  - What stages and processes of the production process
    - Feeding or mixing raw materials
    - Treatment, product movement, adding in more materials, trimming, etc.
    - Final specification review and packaging
- Determine what can change to reduce or eliminate waste
  - Utilize source reduction strategies in the conversation
  - Focus on high-cost raw materials or difficult to divert waste streams first

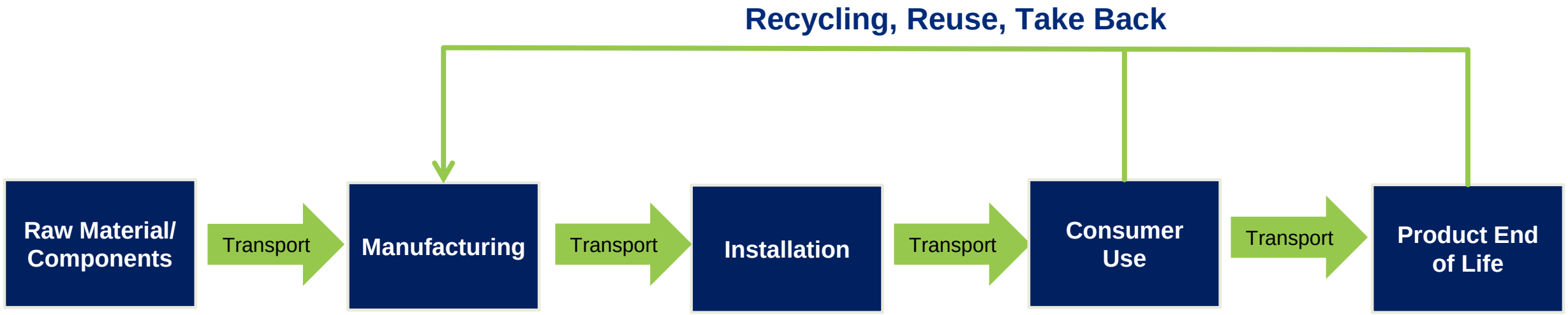
The Stage Gate Process

- The Stage Gate process is used for:
  - New product development
  - Optimization of an existing product
  - Enhancement of a production process

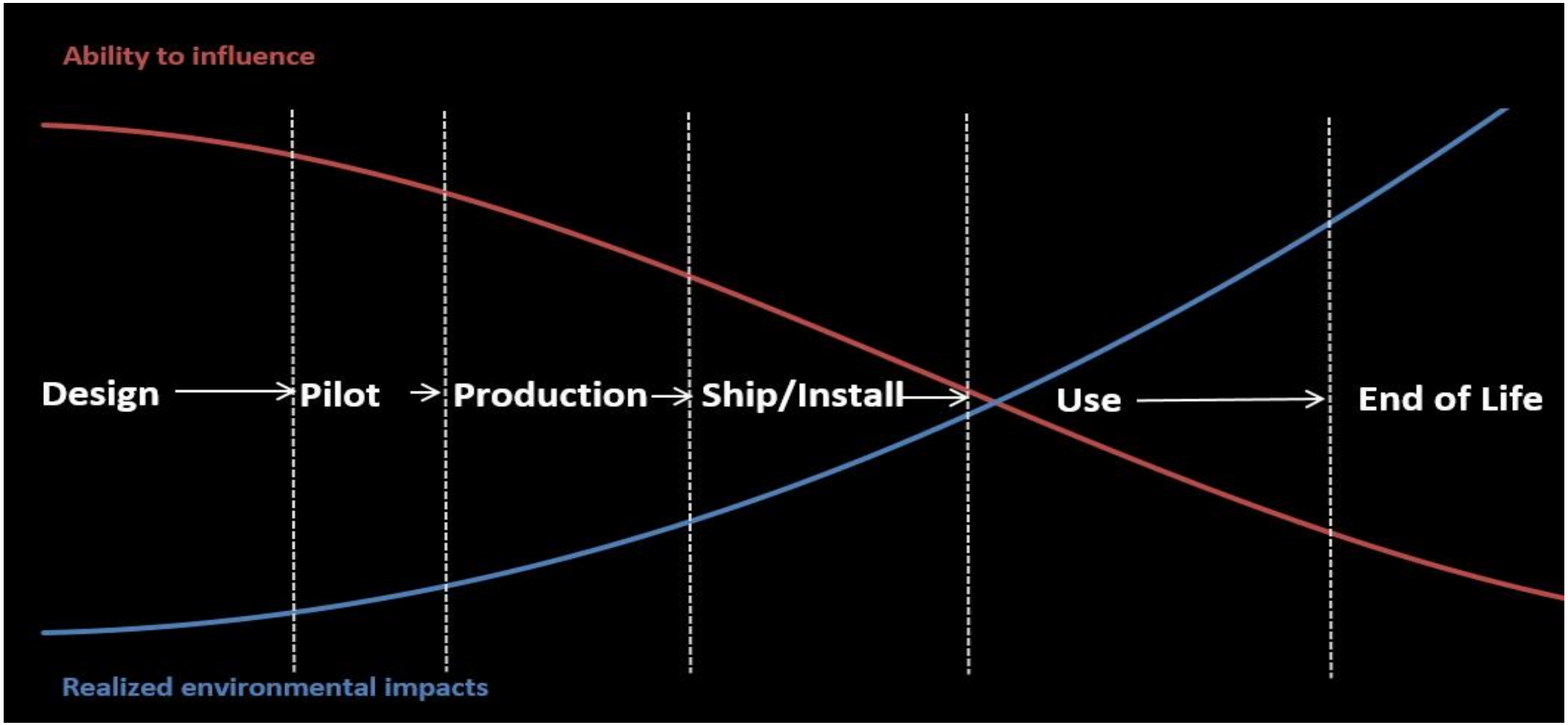


Sustainable Product Innovation

- Integration of sustainability reduces the impacts of the product in all life cycle stages with a goal of improving long-term competitive advantage



Influence Versus Realized Environmental Impacts



Benefits of Waste Reduction and Minimization

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Poll: Which of the following is not a potential benefit of waste minimization and diversion?

Please respond to the Zoom poll

Answer: None of the above.

Benefits to Waste Minimization

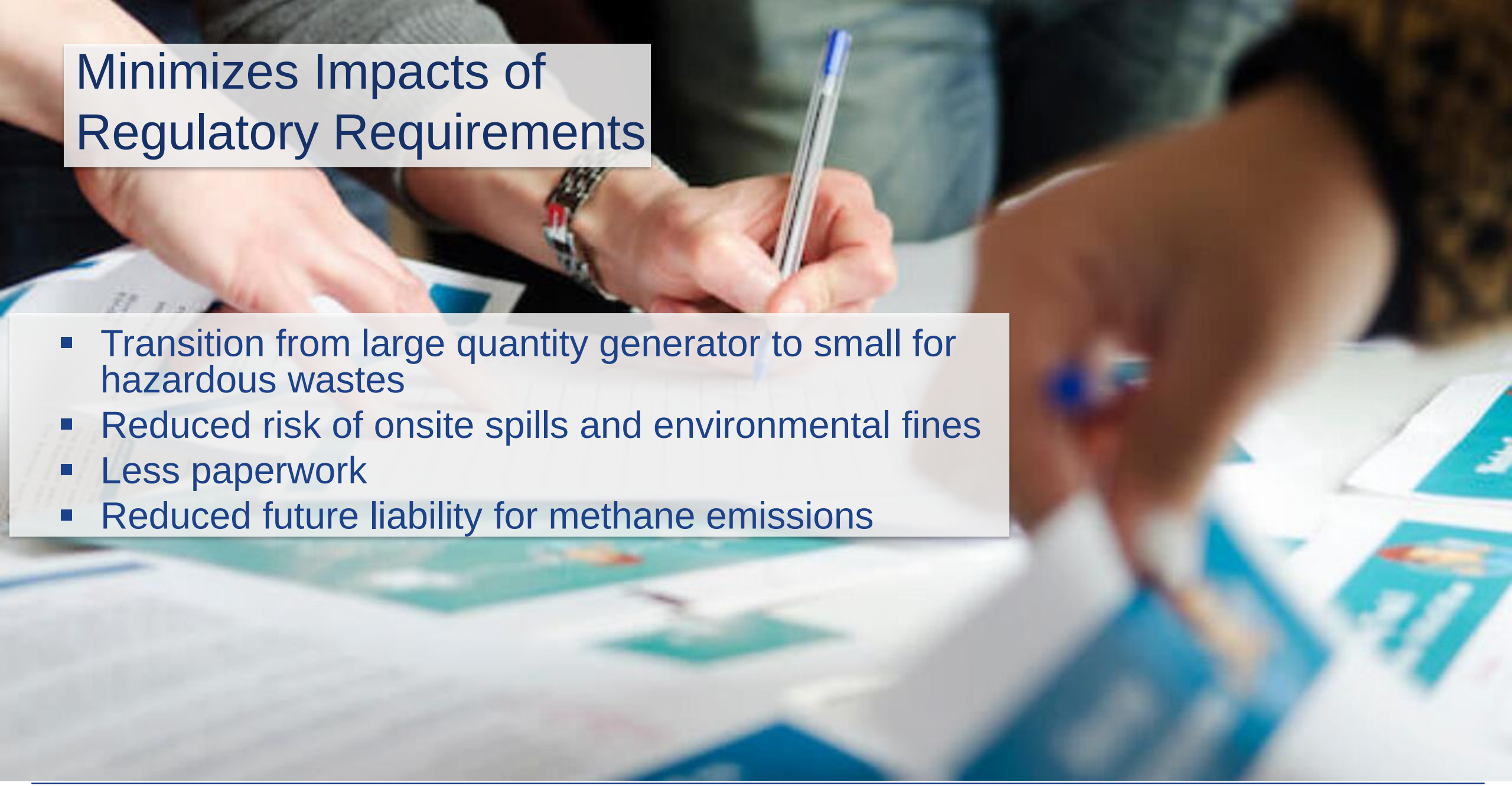
- Reduces disposal and management costs
- Improves worker health and safety
- Reduces impacts of regulatory requirements
- Minimizes potential environmental liability
- Reduces company emissions
- Demonstrates environmental leadership to stakeholders
- Improves public image

Reduced Disposal and Management Costs

- Less waste will equal less hauling which results in lower costs
- Additional strategies:
  - Compacting and baling
  - Segregating waste streams to eliminate charges based on minimum weight
  - Single stream recycling

Improved Worker Health and Safety

- Reduced material handling
  - Limiting disposal of expired materials
  - Less handling of more impactful materials such as chemicals and hazardous wastes
- Less waste onsite
- Waste can stay cleaner when segregated well



Minimizes Impacts of Regulatory Requirements

- Transition from large quantity generator to small for hazardous wastes
- Reduced risk of onsite spills and environmental fines
- Less paperwork
- Reduced future liability for methane emissions

Reduces Company Emissions

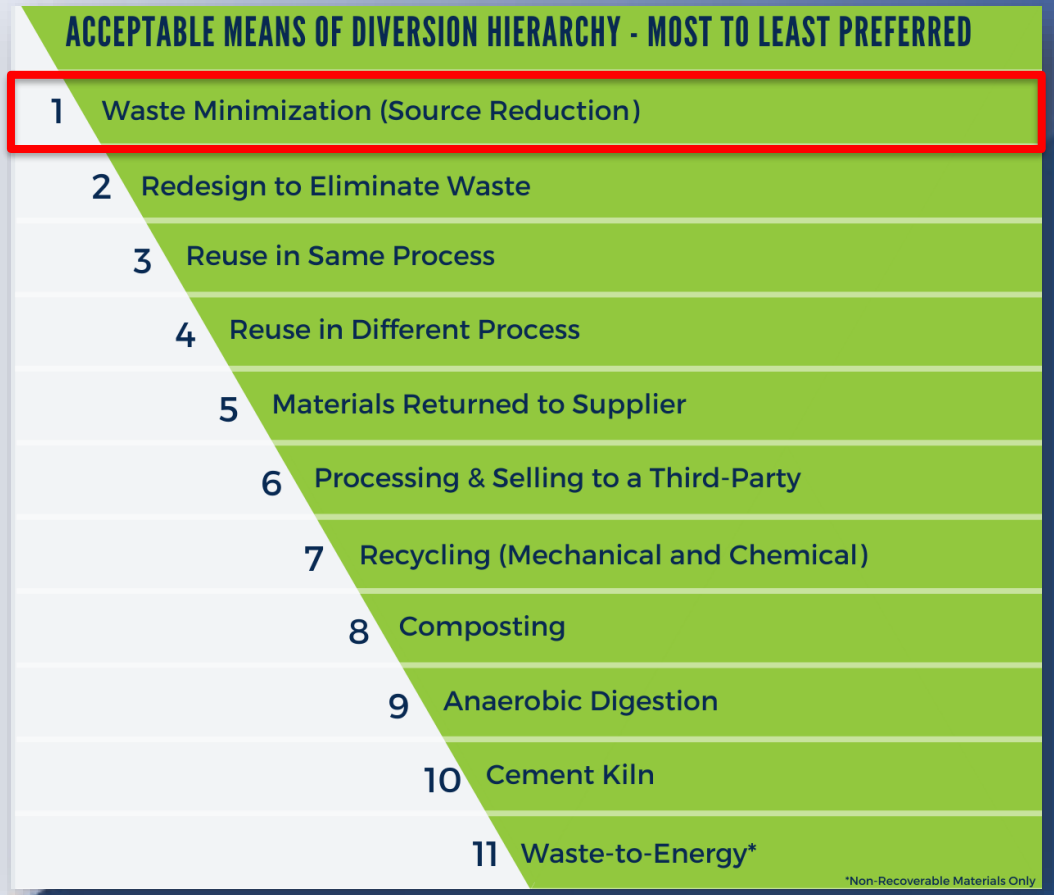
- Less waste = less emissions
  - Scope 1
    - Onsite water treatment
    - Onsite vehicle use
      - Material handling and transport
  - Scope 3
    - Supply chain
    - Waste transport
    - End-of-life

Benefits to Waste Minimization and Diversion – Industry Example

- Sprint, a participant in the DOE's Waste Reduction Pilot, executed a company pilot program from 2010-2014 with goals to reduce waste to landfill by 30%
- Results of the program included
  - Increased recycling rate from 23% to 46%
  - Decrease in annual waste cost per square foot from $0.283 to $0.164
  - Diverting more than 175 million lb of e-waste from landfill in 2013, saving an estimated $275 million for the company
- As part of the program, Sprint established steps for waste profile analysis, diversion strategies for the company, and steps for program implementation

Sprint's Waste Pilot Achievements

Closing Remarks



- Reduce and manage waste streams
  - Source reduction techniques and where to apply them
- Identify source reduction opportunities
- Understand the benefits of proposed waste minimization strategies
- Homework!
- Next training:
  - Finding outlets for hard to manage waste streams
  - March 11, 2025

Session 8 Participation

- We are looking for participants to present during week 8!
  - Hearing from participants provides a lot of value, as other attendees can see specific details related to real situations that may provide insights on how they can approach waste minimization and diversion
- Interested people will be provided with a base template to follow, giving guidance on what to discuss
  - Development of a few slides
  - Slides will be provided to Nick so that he can combine them all into one presentation
- Session 8 will **not be publicly available** on the ORNL Better Plants website

Homework Overview

- Homework will:
  - Engage participants in the topics to be discussed in the following session
  - Serve as a guide for waste diversion and minimization
- If a homework is completed, please send to presenter, Nick, at nick@sustainablesolutionscorporation.com
  - Please use the subject “Better Plants Session # Homework: Complete – Company Name”
  - Participants will be asked to share their learnings and experiences in session 8, and if you would like to participate in this, please reach out to Nick

Homework Overview – Session 3

Assignment

1. Review the waste materials generated at the facility and list which are considered hard to manage or difficult to divert.
2. Of the material(s) listed from Question 1, please describe what makes the material(s) hard to manage or difficult to divert.
3. Based on the response to Question 2, brainstorm some strategies that would make waste materials(s) easier to manage or divert.
4. Reflecting on the response to Question 3, what would the implementation steps be to assist in making the waste material(s) easier to manage or divert?

Goal

- Identify hard to manage waste streams onsite and understand what makes them difficult to manage
- Begin understanding what steps need to be taken to make a waste stream easier to manage

Q&A

Kahoot!