

Landfill Diversion from Labs: Where We Are Now and Creative Programs to Inspire Us

Presented by

Members of the I²SL Landfill Diversion Working Group

Established 2015

Learning Objectives



Learn about the environmental, social, and economic impacts of solid waste materials that come from research, healthcare, and teaching laboratories and why waste minimization and diversion from landfills is important



Identify challenges and opportunities related to the diversion of solid waste materials from laboratories in diverse settings



Hear about leading examples of lab user innovations to address these challenges



Gain tangible ideas for building connections among key stakeholders, and setting and achieving goals for closing the loop on the production and disposal of laboratory materials and supplies

Trail Guide

LDWG - Where we are now

LDWG – What we have learned

3 Presentations of
Creative Programs to Inspire Us

Panel Discussion

Where are We Now?

Ilyssa O. Gordon, MD, PhD

Associate Professor of Pathology
Medical Director,
Office for a Healthy Environment
Cleveland Clinic



RECYCLING



Recycling is messy



Workers sorting at the Waste Management Elkridge Material Recycling Facility in Elkridge, Md.
PHOTOGRAPH BY THE WASHINGTON POST/GETTY IMAGES

Clear messaging is lacking

DOs and DON'Ts of Recycling

DO recycle CLEAN items, including:

- Recyclable plastic containers
- Steel/tin/aluminum items
- Newspapers with no plastic wrap
- Junk mail
- Catalogs
- Phone books
- Magazines without wrappers
- Flattened cereal/snack boxes and cardboard

DO NOT Include:

- Loose plastic bags or package wrap
- Broken/sharp glass
- Ceramic materials
- Cloth/clothing
- Food/yard waste
- Hazardous items
- Shredded paper
- Scrap metal
- Nonrecyclable plastics
- Liquids
- Frozen food containers

Plastics come in a variety of shapes, colors and chemical formulations - all with different recycling needs. The code number does not mean the plastic can be recycled. It is simply a way to identify the resin, or plastic type.

How can you tell what kinds of plastic to put into your recycling bin? The code number on the bottom of your product is not a reliable indicator of whether something can get recycled. Recycle by shape!

Bottles, jars, and jugs – is the best way to know what is accepted.



THINK GREEN!

© 2013 Waste Management, Inc.
Printed on 100% post-consumer recycled paper.

RECYCLING RULES

1. NO LOOSE PLASTIC BAGS

2. NO CONTAINERS WITH FOOD STILL IN THEM

3. NO LIQUIDS OR SOGGY ITEMS

Certain offenders can slow down the process or even ruin the load. These no-no's include plastic bags, food or greasy containers, and liquids or soggy items. To the right is a quick reference list of DOs and DON'Ts you can keep right on your fridge.




Clear messaging is lacking

Plastic Recycling

Did you know recycling just ten plastic bottles saves enough energy to power a laptop for more than 25 hours?

Recycle plastics #1 thru #7. Look on the bottom of containers for a number inside the recycling arrows.

Acceptable Items

-  Milk jugs (no cartons)
-  Water/Soda containers
-  Shampoo/Soap/Detergent bottles



Clear messaging is lacking



- ♻️ We accept all plastics marked #1 – 7 on the bottom or top of containers.
- ♻️ Products made from recovered plastic bottles include drainage pipes, toys, carpet, filler for pillows and sleeping bags, and cassette casings.



Clear messaging is lacking

The image shows a screenshot of the Denver government website's recycling page. A large green rectangular overlay is centered on the page, featuring a white recycling symbol (three chasing arrows forming a triangle) and the text "dude, it's not that hard" in white, lowercase, sans-serif font. Below the overlay, a link reads "Click here to discover how your plastic gets a new life." The background website content includes the Denver logo, navigation links like "Neighborhood", "Business", "Visiting", "Government", "Online Services", and "Direct", and a section titled "Recycle, Compost & Trash" with sub-sections for "Schedules & Reminders" and "Plastic Containers". The "Plastic Containers" section lists examples of accepted items like rigid plastic bottles and detergent, and lists prohibited items such as Styrofoam, plastic toys, K-cups, plastic mugs, and plastic cups.

DENVER
THE MILE HIGH CITY

Neighborhood Business Visiting Government Online Services Direc

Recycle, Compost & Trash

Schedules & Reminders Hazardous Waste Resources

Plastic Containers

Rigid plastic bottle recycling symbols.

Examples of accepted items: detergent, & cat litter; mayonnaise jars; "microwave dinners" goods & salads (ready-to-eat); cartons & cookie containers.

- NO plastic bottles
- NO Styrofoam
- NO plastic toys
- NO "K-cups"
- NO plastic mugs
- NO plastic cups

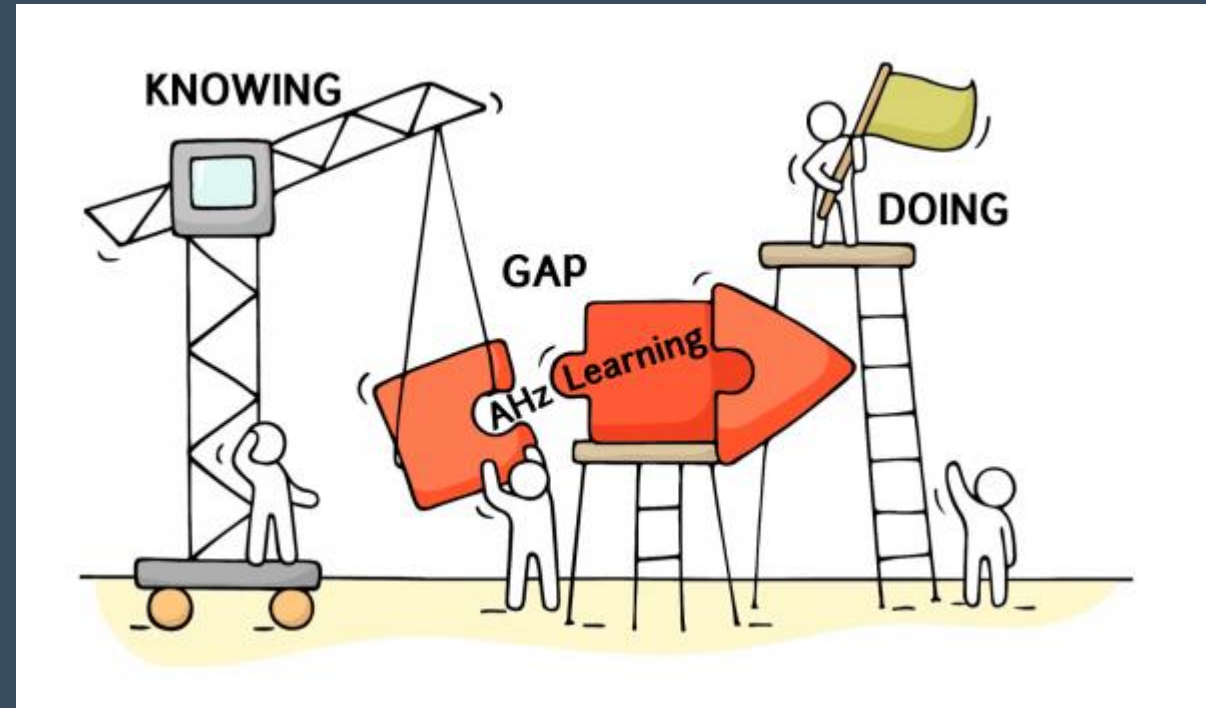
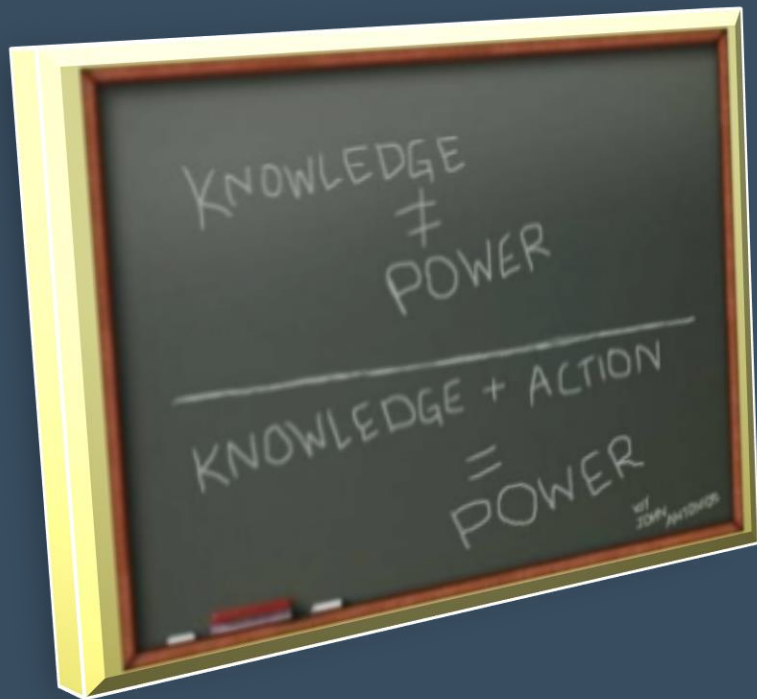
dude, it's not that hard

Click here to discover how your plastic gets a new life.

<https://www.denvergov.org/content/denvergov/en/trash-and-recycling/recycling/what-can-be-recycled.html>

Education doesn't always translate into action: Knowledge Action Gap

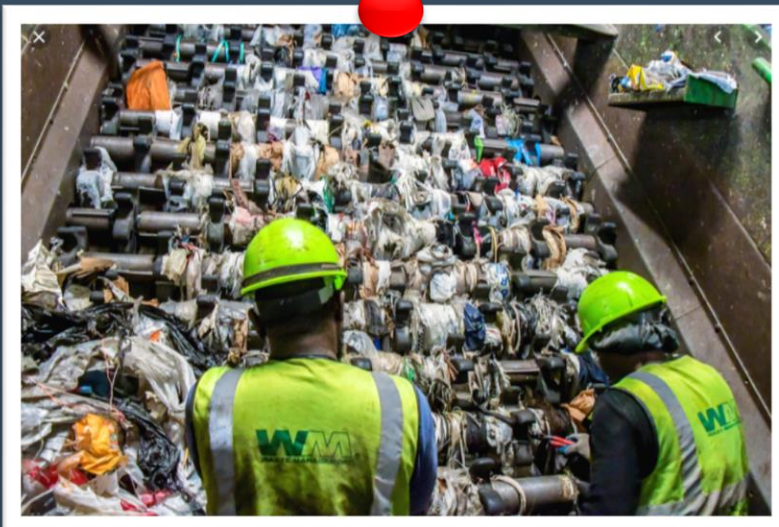
“You know what to do but you can't seem to make yourself do it right.” — Mel Robbins



We wish it could be easier...

"Wish-cycling today is a leading cause of contamination in the U.S."

- Contamination levels currently are 25%
- increases cost
 - decreases efficiency
 - lowers commodity values
 - increases risk



At Waste Management facilities...

Bowling balls per week:

- A. 10
- B. 100
- C. 1000

Batteries per month

- A. 28,000
- B. 72,000
- C. 136,000

Hours per year spent cleaning screens

- A. 14,000
- B. 70,000
- C. 140,000

Source: Brent Bell VP Recycling Operations Waste Management
Jan 2019 Waste Management Sustainability Forum

You say Contamination, I say Contamination

- What does “contamination” mean to you?
 - In a hospital setting, “contamination” refers to bodily fluids, chemicals, or potentially infectious material being present where they should not be, whether in a sterile area, on a patient’s body, or in the surrounding environment. This can get confusing when recyclers use “contamination” to refer to items in the waste stream that do not belong (i.e. paper in a plastic stream) but are not necessarily hazardous or infectious. It is important when healthcare professionals are having conversations with recyclers that everyone is clear about which type of “contamination” they are talking about.



Geography complicates the picture

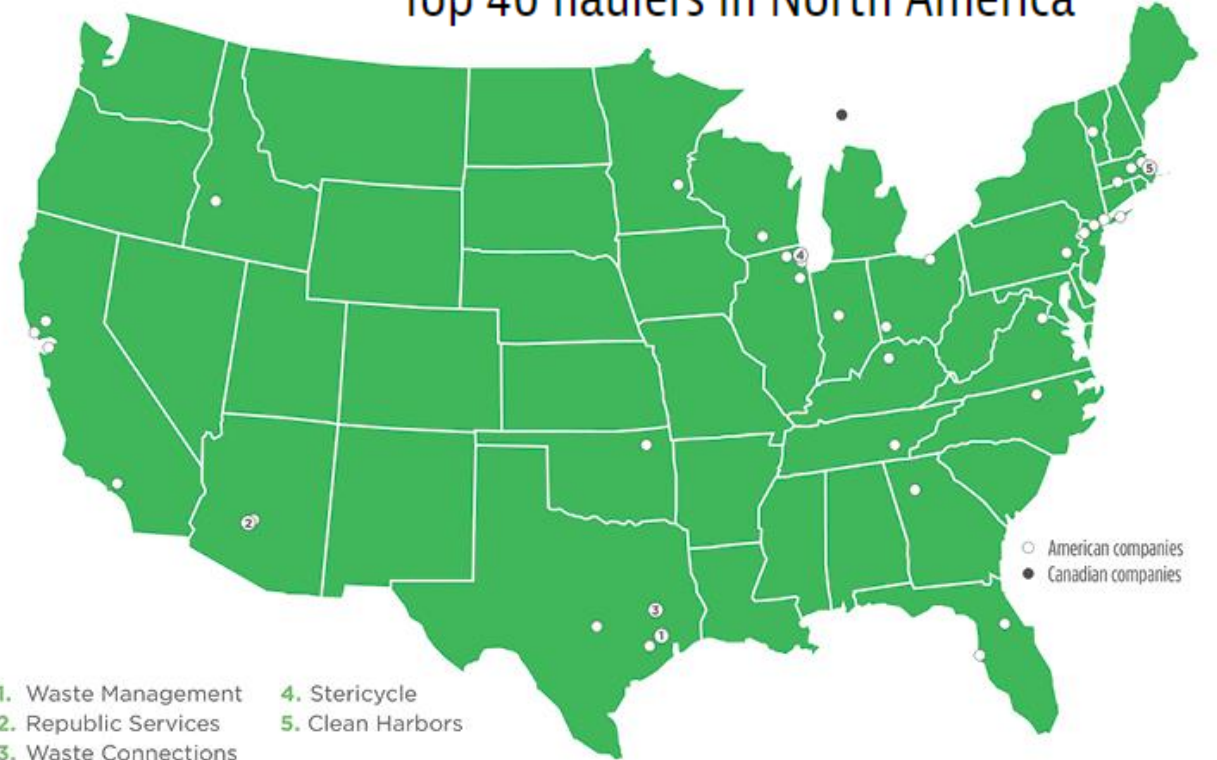
MAP & LIST OF NORTH AMERICA'S LARGEST MRFS



MRF: Materials Recovery Facility (sorting)

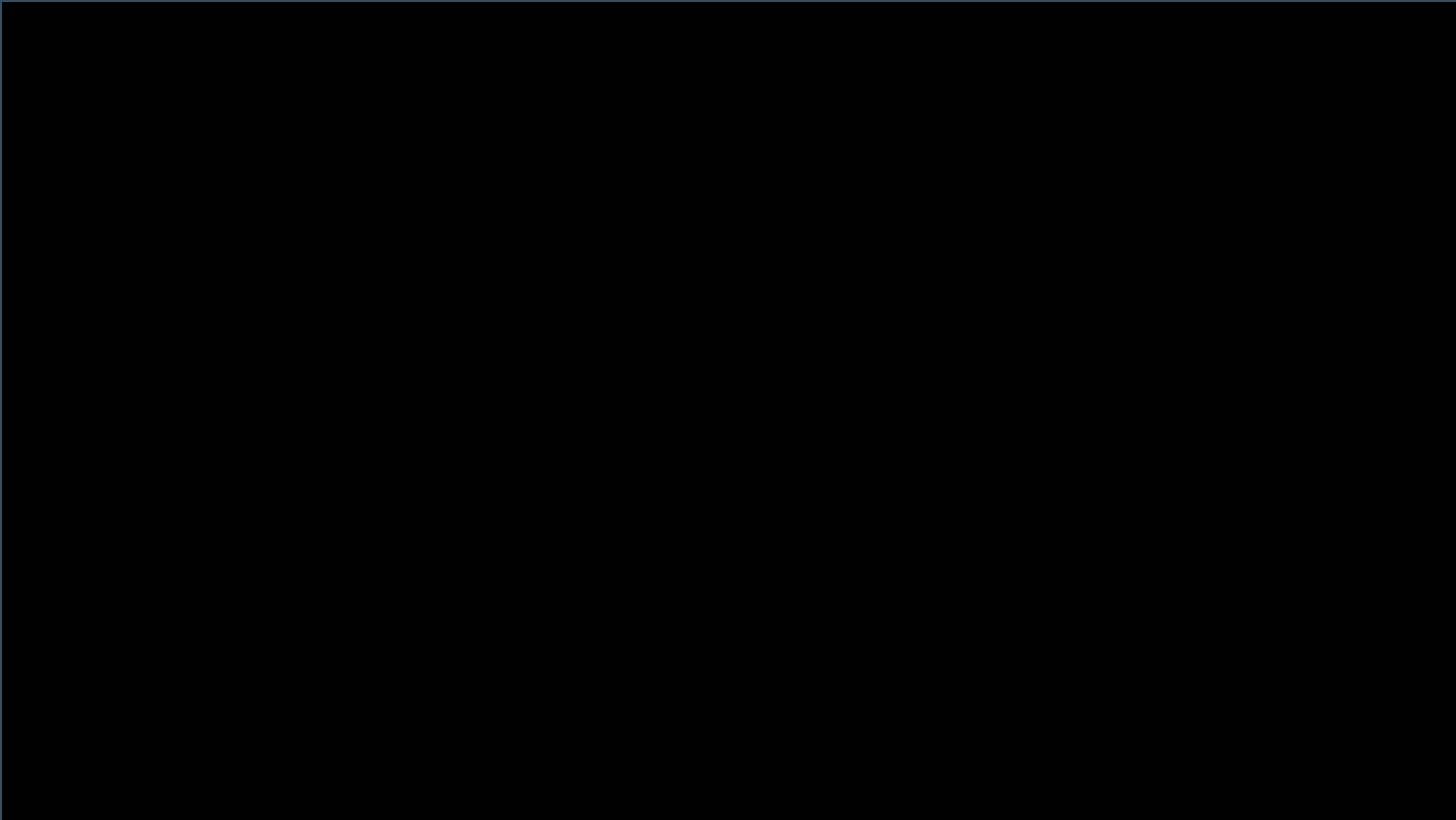
GEOGRAPHIC BREAKDOWN

Top 40 haulers in North America



<https://giecdn.blob.core.windows.net/fileuploads/document/2019/09/05/poster%202019.pdf>

<https://www.wastetodaymagazine.com/article/top-40-haulers-in-north-america/>



USA

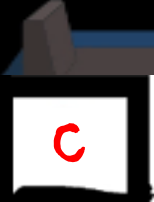


A

B



USA



What just happened??

- China market basically cut us off, even though only 40% of US plastics were going there, this action flooded domestic markets.
- In the past, companies using domestic markets were able to find value in putting resources into lowering contamination rate at their MRF because it increased the value for their plastics.
- Now with domestic plastics markets flooded, this lowers the price the company can get, so it is not profitable for them to clean up contamination at their MRF...they pass this on to us - asking us for low contamination rate.

What we have
learned

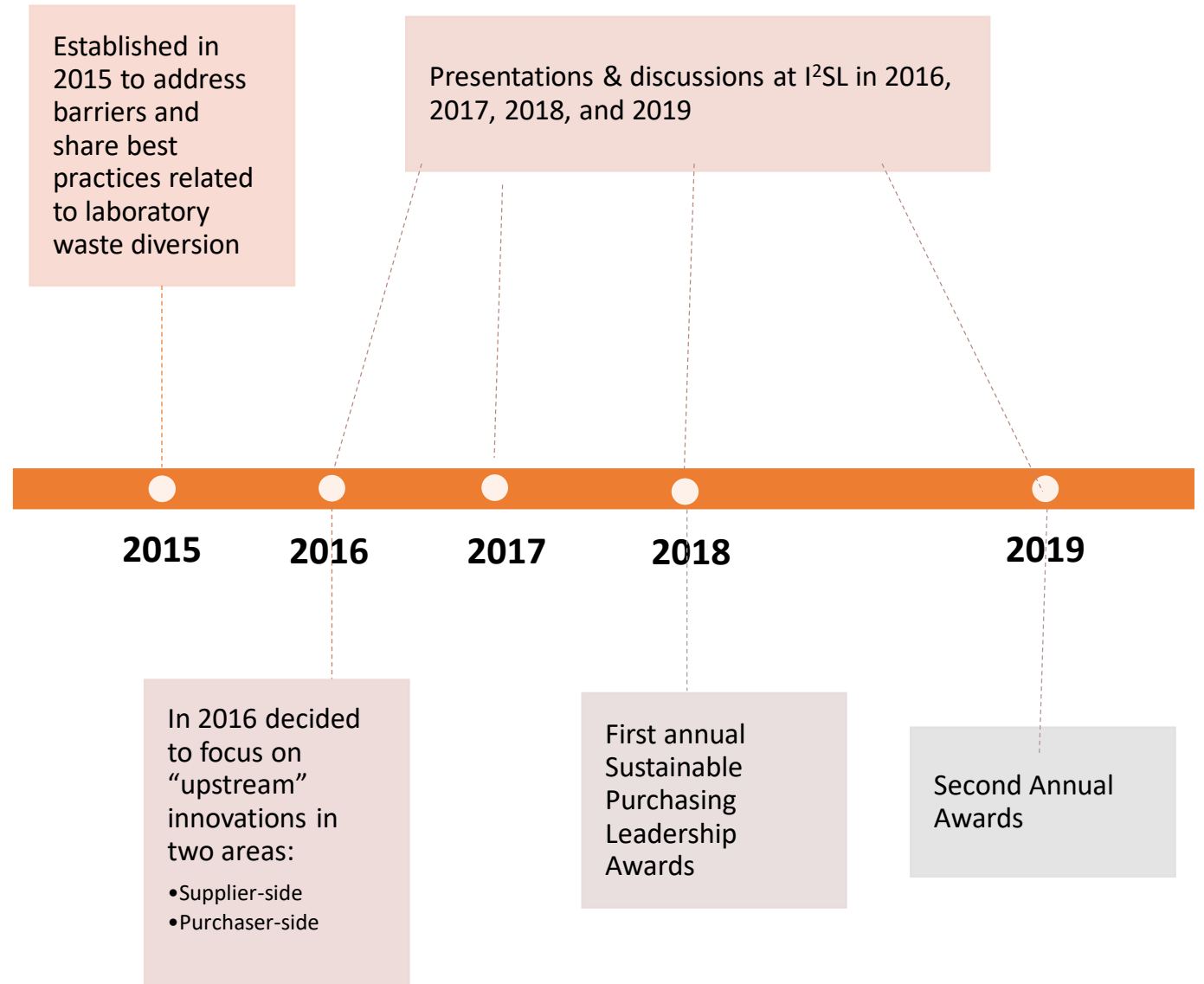


EMORY



Kelly O'Day Weisinger
Assistant Director of Sustainability
Emory University & Healthcare
Atlanta, Georgia

I²SL Landfill Waste Diversion Working Group



Themes from past conferences



2016 –
manufacturer/supplier
interviews, onsite user
challenges, downstream
diversion innovations

Key discussion
theme was hard-to-
recycle materials
like ice packs and
foam boxes



2017 – panel discussion
with suppliers and
manufacturers regarding
innovations in landfill
diversion of products

Key theme was that
suppliers and
manufacturers want
to be engaged in
this working group's
work



2018 – summary of what
we know. Your help
identifying next steps.

Support the ACT
label
LDWG resources to
guide upstream and
downstream
innovations

Are any lab product suppliers helpful in your efforts to divert lab items from landfills?

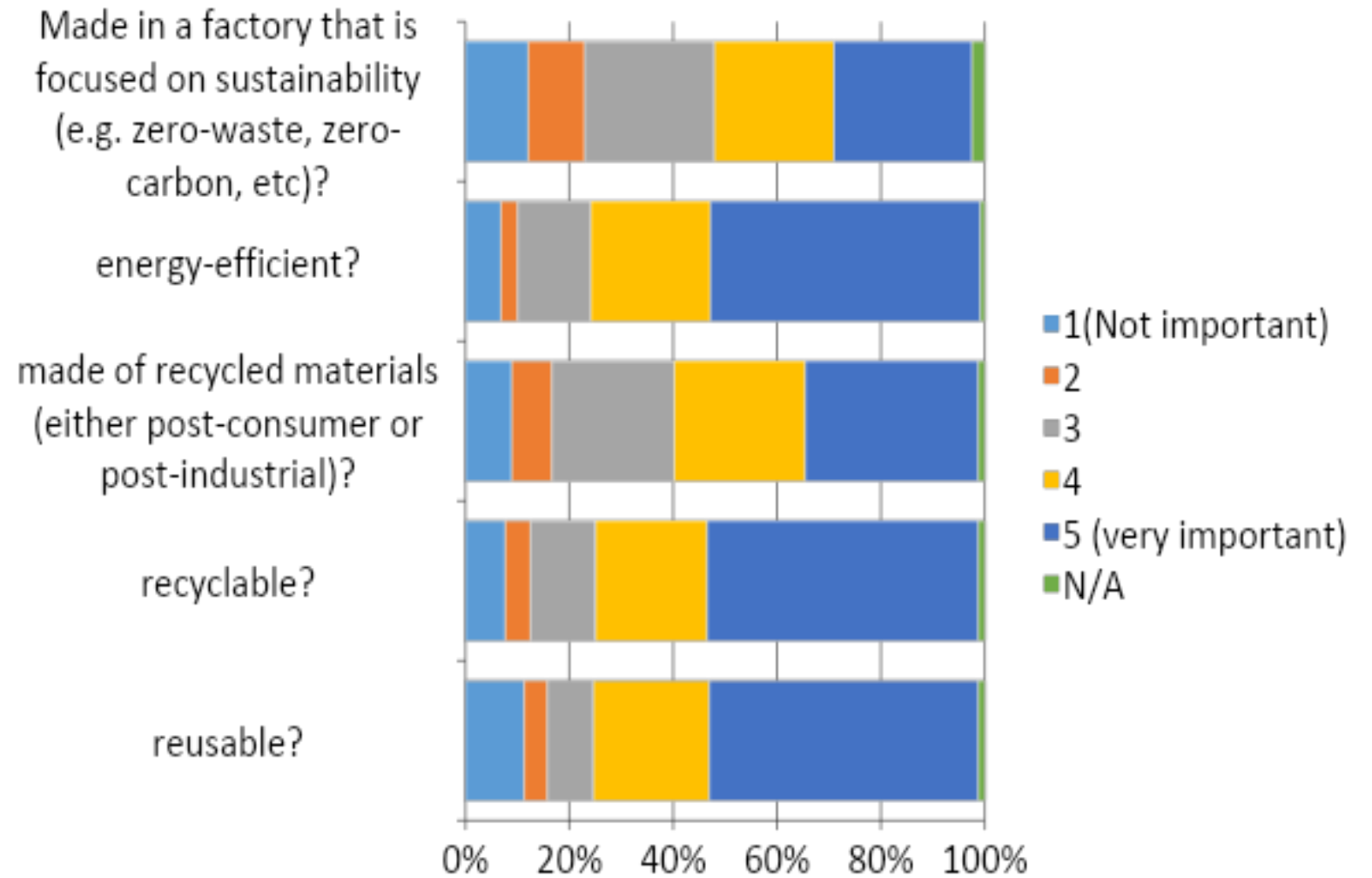
Yes: 68%
No: 32%

Which ones?

- VWR
- Kimberly Clark
- New England Biolabs
- Thermo Fisher Scientific
- Millipore-Sigma
- Starlab
- Addgene
- E&K Scientific
- Cardinal
- Triumvirate
- RightCycle

Customer Voice

How important is it to you to purchase lab products that are:



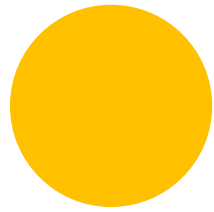
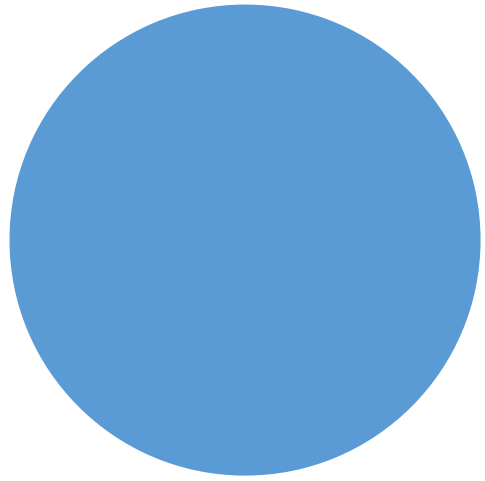
Upstream Focus on Suppliers & Manufacturers

LDWG looking upstream for culture shift

Better understand and enhance communication of researcher needs regarding sustainability of their products.

What we learned:

- Suppliers & Manufacturers want to hear directly from *customers*
- Willing to change, but motivations are two ends of spectrum
- Ideas for engagement with working group



In the meantime . . .

institutions are doing innovative work to divert waste from landfills. These are some stories

Animal Bedding Composting Case Study

First LDWG
resource!

Will publish
Fall 2019

Participants:

- University of Georgia
- University of Virginia
- MIT
- and Emory University

Stay tuned!

Creative Programs to Inspire Us

University of Georgia

University of Virginia

Massachusetts Institute of Technology



Creative Landfill Diversion Programs from University of Georgia

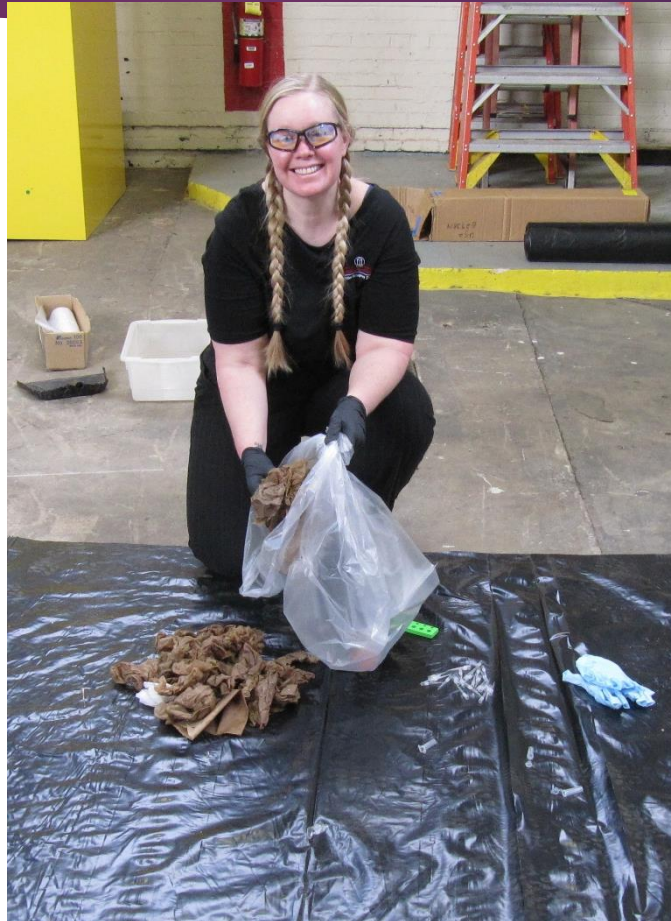
STAR SCOTT, GREEN LABS PROGRAM COORDINATOR
I2SL, SESSION A3, MONDAY OCTOBER 21ST 2019



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Lab Specific Waste Audit

- ▶ Spring 2018
- ▶ 4 different types of labs
 - ▶ Pathology Lab (for profit)
 - ▶ Molecular Genomics Lab
 - ▶ Plant Pathology Lab (BSL)
 - ▶ Plant Biology Lab
- ▶ 3 day period



CATEGORIES FOR SORTING

- ▶ Paper Towels
- ▶ Gloves
- ▶ Plastic Film
- ▶ Recyclable Plastics (ACC)
- ▶ Non-Recyclable Plastics
- ▶ Paper
- ▶ Cardboard
- ▶ Glass
- ▶ EPS Foam
- ▶ Aluminum
- ▶ Organics
- ▶ Landfill

Avoidable

Recoverable

Non-Recoverable

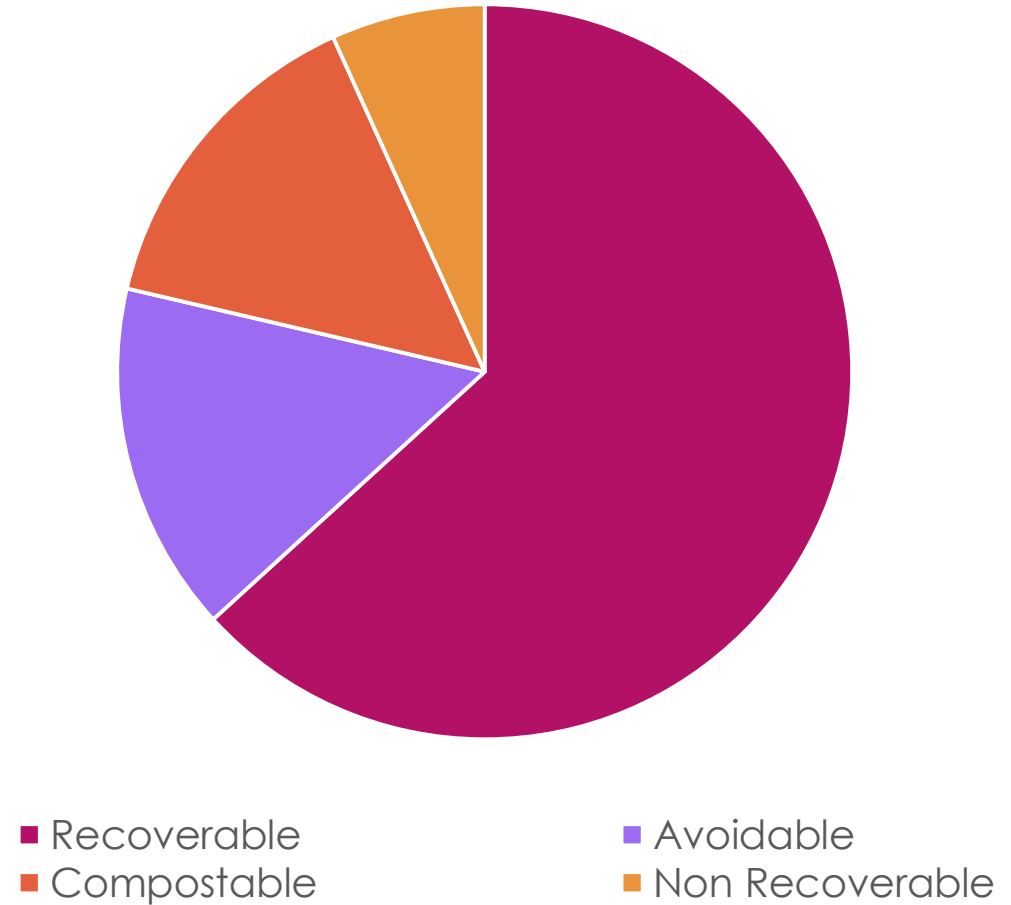
Compostable



SNAP SHOT OF RECOVERABLES

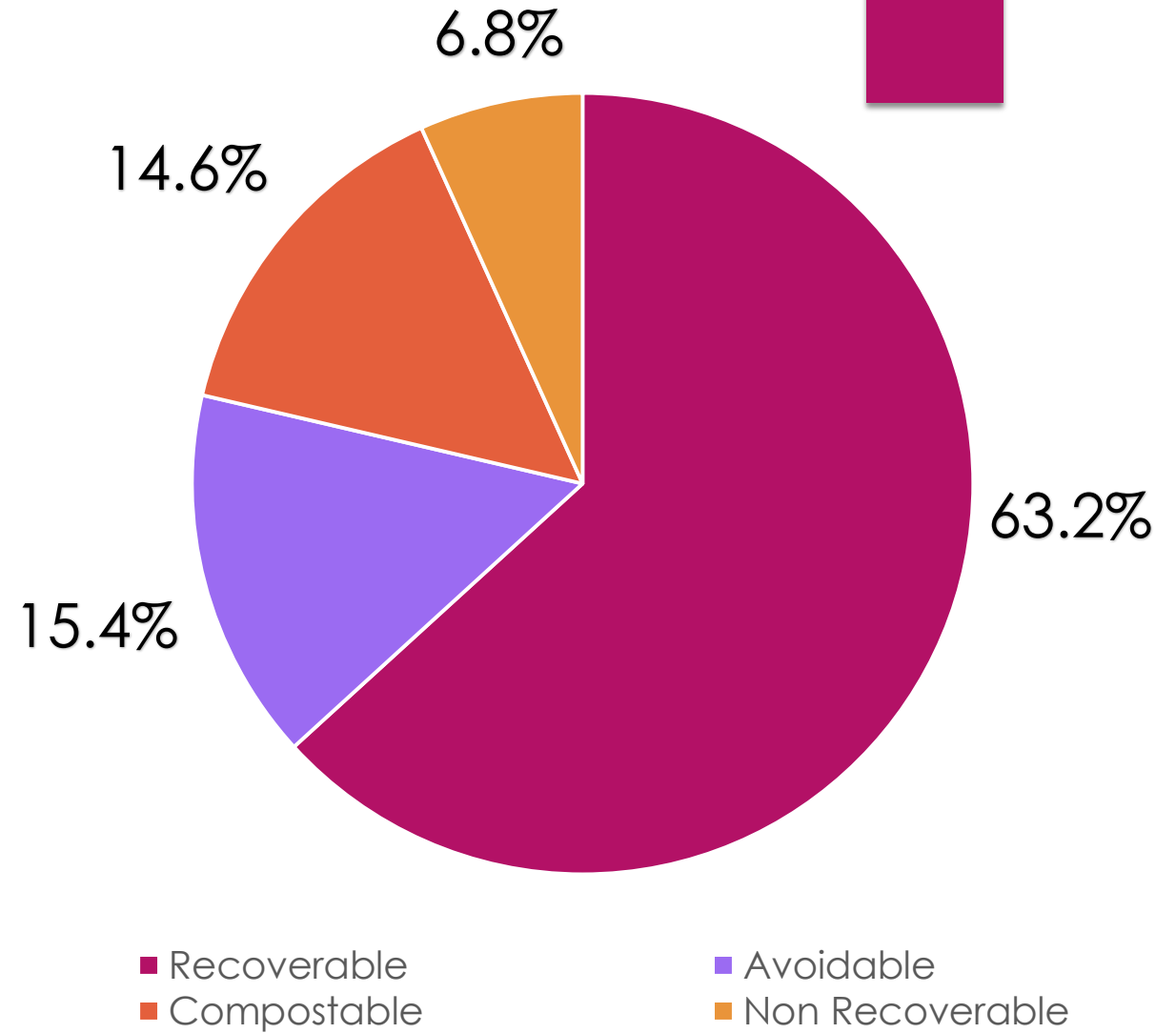
- Average of 656 g/day/lab
- ~659,482 pounds of potentially-recoverable materials annually
- ~300 metric tons

Lab Waste Audit



THIS IS GREAT NEWS

- 93% of this waste stream can potentially be impacted by existing initiatives
- Keep going
- Be Creative
- Share

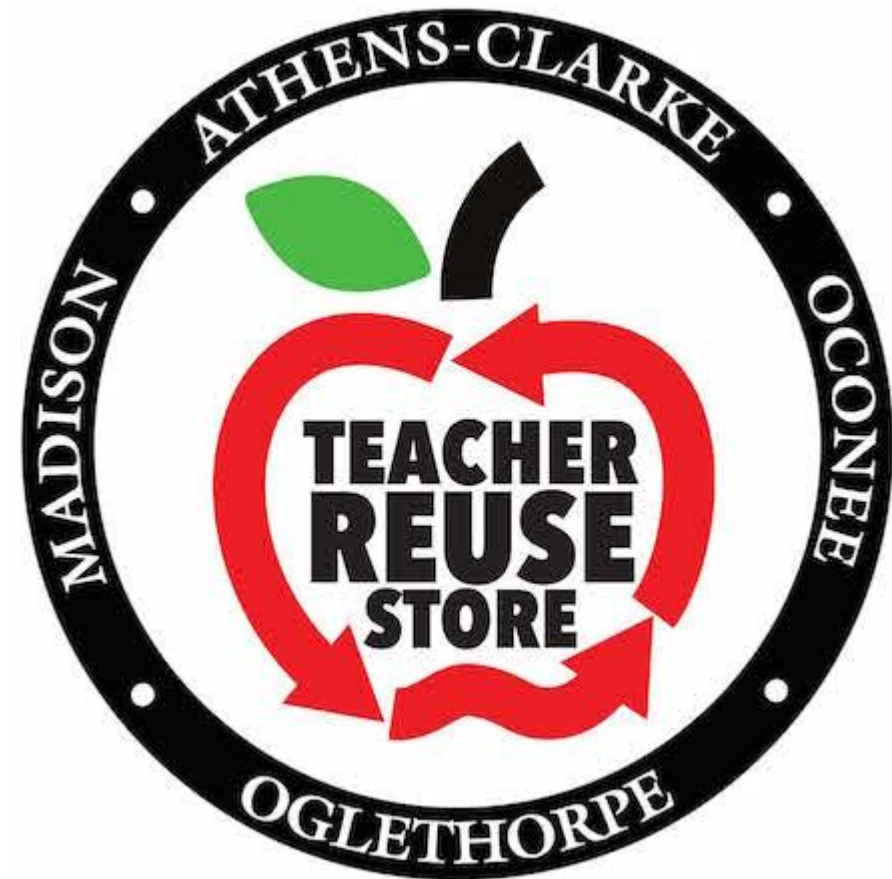


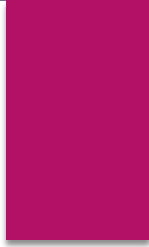
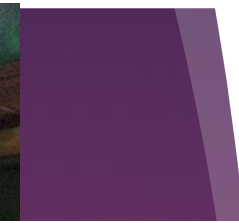
Lab Glass Rehoming Program

- Partnership between UGA and Athens Clarke County (ACC)
- Keeps lab glass and other non-inventoried lab equipment out of landfill
- Serves our future scientists



- Located at ACC CHaRM
- Local teachers can “shop” for free
- School supplies, furniture, bulletin boards, books
- NOW--Scientific supplies





TEACHER REUSE STORE SHOPPING INSTRUCTIONS

Each teacher must present proper identification - public, private, or homeprofessionals are welcome but must present identification. Proper identification includes district badges, letter on school letterhead stating teaching status and signed by the principal or director, and home schooling paperwork - letter of intent. UGA Professors are welcome with proper identification.



A program of the ACC Recycling Division
K&L'S, K&L'S, & Ophelippe Co.

Teacher must be from Clarke, Madison, Oglethorpe or Gwinnet County Schools (M&T)

These counties are supporting the Teacher Reuse Store with monetary contributions, staffing, donations and promotion.

Basic facility rules:

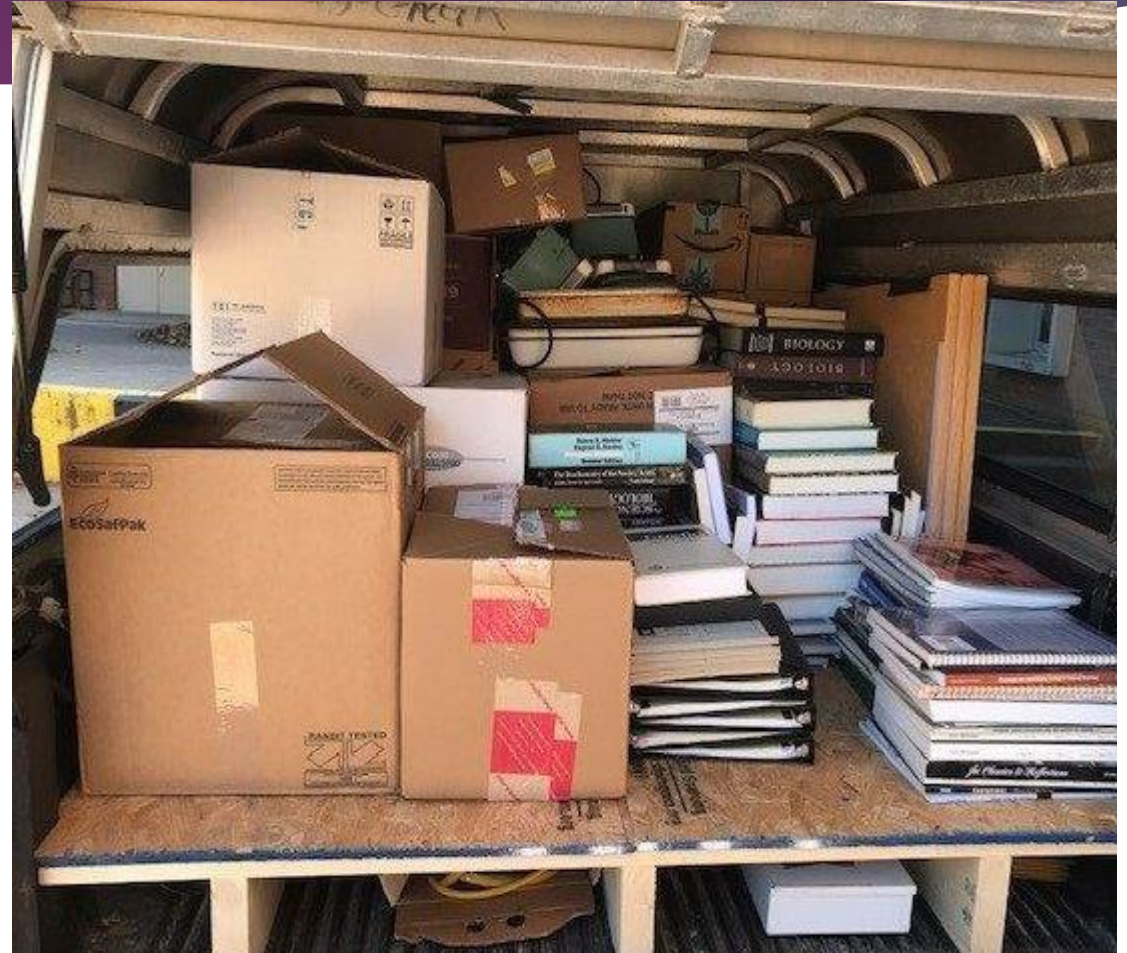
- Park in designated parking area only
- NO CHILDREN OR HELPERS ARE ALLOWED IN THE STORE. PLEASE DON'T LEAVE YOUR CHILDREN OR PETS UNATTENDED IN CAR. PARKING LOT OR CHARM WHILE SHOPPING IN THE TEACHER REUSE STORE.
- No wagons, carts, or strollers allowed in the store
- Staff will hold items for two weeks only. Put name and date on paper or sticker provided by staff to affix to held items.
- Shop at your own risk.

Each teacher must sign in on the clipboard prior to entering the Teacher Reuse Store.

Thank you for shopping at the Teacher Reuse Store!

Lab Glass Rehoming Program Benefits

- ▶ Serves future scientists
- ▶ Assists underfunded programs
- ▶ Diverts waste from landfill
- ▶ Optimizes space in UGA research areas



Animal Bedding Composting at UGA

- ▶ Created in 2015
- ▶ Composting bedding from non-treatment animals in Coverdell Vivaria
- ▶ Bedding Composted at UGA BioConversion Facility
- ▶ Once composted, used in our award-winning landscaping on main campus



Animal Bedding Composting Details

- 23.5 tons bedding/year diverted from Coverdell Center
- 3 Locations Added
- Used UGA Sanitation Services existing routes
- Ran successfully for ~1 year



1 year in...

- ▶ Office of Sustainability stopped providing compostable bags
- ▶ Vivaria decided to stop participating
- ▶ No management
- ▶ No communication between stakeholders
- ▶ Sanitation Services continued pick-ups
- ▶ Costly, ineffective



What's working?

- 2 Roll-off Augers, size of large dumpster
- Fill once/week
- Unbagged
- Helpful for BioConversion Facility

Moving forward

- Established management
- Connect with stakeholders
- Beta-test bagless system
- Cost analysis



SUSTAINABILITY UVA
From the Grounds Up



UNIVERSITY *of* VIRGINIA

Landfill Diversion in Labs

Christine Alencar, Green Labs Specialist for the University of Virginia

Road Map

1. Upcycle Programs

- MERCI
- ROSE
- ReUSE Store

2. When you can't clone yourself, make a Task Force!

3. Landfill Diversion in Animal Research Facilities





Upcycling: MERCI

- “Medical Equipment Recovery of Clean Inventory”
- Participating departments donate clean unused medical (and some lab!) supplies throughout the week
- Sorting operates once / week by volunteers (Thursdays)
- UVA employees and community members can “shop” by visiting the stock room during sorting hours
- Materials are donated to animal shelters, wildlife centers, pregnancy centers, and medical missions





Upcycling: ROSE Program

- “Reusable Office Supply Exchange”
- Collects gently- or never-used office supplies from across campus
- Includes books, folders, binders, writing utensils, desk organizers, and more
- Supplies stored at UVA Recycling warehouse where employees, students, and community members can “shop” or donate
- Monthly “ROSE Closet” set up in medical center conference room to provide access to patients and hospital employees



Upcycling: ReUSE Store

- Newest upcycle program
- For re-homing unneeded surplus property
- Reduce need for warehouse space
- Furniture, artwork, some tech (ex. desktop monitors), and some medical / lab furniture (lab tables / benches, chairs, medical exam tables)
- Materials rehomed on campus are free
- Private sales for local shelters, law enforcement agencies, non-profit organizations etc. held before public sales
- Public sales held every other Friday



GREEN LABS CERTIFICATION

There are 3 levels of Green Lab Certification: Bronze, Silver, and Gold. To become certified, earn the necessary amount of Badges for each level. Each Badge represents a different Green Labs focus area. To earn a Badge, complete at least 4 actions for that focus area. Labs can earn up to 2 badges per focus area.



3 BADGES
12 ACTIONS



4 BADGES
16 ACTIONS



5 BADGES
20 ACTIONS

Get started:

1. Identify your lab's Green Leader. The Green Leader will be the primary contact between the participating research group and the Office for Sustainability's Green Labs Specialist, and will coordinate their lab's efforts to earn Badges and Certification.
2. Email greenlabs@virginia.edu to express interest in pursuing the program.
3. Fill out the electronic survey sent to your Green Leader.
4. Meet with the Office for Sustainability's Green Labs Specialist for 30 minutes to develop Certification action plan.

Actions completed within the last calendar year qualify as completed pending reasonable verification. To verify, labs describe their approach or explain actions taken for each lab sustainability action item pursued using the Green Labs Badge and Certification forms.

Badge and Certification awards last up to two years following award date. Certification timelines override Badge expiration (if, for instance, a Badge "expires" during the life of an awarded Certification).

Timeline flexibility will be addressed on a case-by-case basis (if, for example, a lab is interrupted by renovations or if the lab can verify that past actions have been updated over time).

Email greenlabs@virginia.edu or visit sustainability.virginia.edu for more information.

GREEN LABS BADGES

To earn a Badge, complete at least 4 out of 9 actions in a single focus area. Labs can earn a maximum of 2 Badges per focus area. Use this checklist to keep track of your lab's progress.

IN PROGRESS	COMPLETED	Focus Area	Action
●	●	COLD STORAGE	C-1 International Lab Freezer Challenge
●	●		C-2 Energy Star freezers & refrigerators
●	●		C-3 Warmer storage temperatures
●	●		C-4 Cold storage inventories
●	●		C-5 Scheduled de-icing and defrosting
●	●		C-6 Scheduled preventative maintenance
●	●		C-7 Share cold storage space
●	●		C-8 Clean out emergency cold storage
●	●		C-9 Cold storage innovation
●	●	CHEMICALS & REAGENTS	R-1 Shut the Sash competition
●	●		R-2 Improved & shared chemical inventory
●	●		R-3 Fume hood & cabinet cleanout
●	●		R-4 Shut the Sash stickers & questionnaire
●	●		R-5 Closed loop or alternative cooling
●	●		R-6 Use of high quality water & pledge
●	●		R-7 ACS 12 Principles of Green Chemistry
●	●		R-8 Green Alternatives Wizard
●	●		R-9 Chemical & reagent innovation
●	●	MATERIALS & REFUSE	M-1 Recycling
●	●		M-2 UVA reuse & upcycle programs
●	●		M-3 Reusable materials (e.g. pipette tips, vials, etc.)
●	●		M-4 ACT label
●	●		M-5 Sustainable vendor programs
●	●		M-6 Material sharing
●	●		M-7 "Try Just One" signs
●	●		M-8 Sustainable printing
●	●		M-9 Refuse & materials innovation
●	●	ELECTRONICS & APPLIANCES	A-1 Equipment sharing & core facilities
●	●		A-2 Timer implementation
●	●		A-3 Lights Out best practices
●	●		A-4 Holiday Energy Saving Checklist shared
●	●		A-5 Equipment temperature settings
●	●		A-6 Color Dot, Shut it Off equipment checks
●	●		A-7 Ice maker etiquette pledge
●	●		A-8 Autoclave etiquette pledge
●	●		A-9 Electronics & appliances innovation
●	●	ENGAGEMENT	E-1 Lab leadership support for sustainability
●	●		E-2 Green Labs Working Group participation
●	●		E-3 Sustainability event attendance
●	●		E-4 Sustainable lab training
●	●		E-5 Sustainability minute
●	●		E-6 Certification survey
●	●		E-7 Sharing OFS communications
●	●		E-8 Lab retreat or activity
●	●		E-9 Engagement innovation

M-2 When discarding or procuring materials for lab operations, we prioritize reuse or upcycle programs at UVA. We utilize the hospital's [Medical Equipment Recovery of Clean Inventory \(MERCI\) program](#) (Thursdays, G102 Primary Care Center), the [Reusable Office Supply Exchange \(ROSE\)](#) (open 8am – 3pm, Recycling Warehouse on Leake Drive OR every third Tuesday 9:30am to 2pm, main hospital conference room) and / or the [UVA Reuse Store](#) (business hours, Recycling Warehouse) to donate items or shop.

Describe your approach or explain actions taken:

Expanded Polystyrene Task Force



- Part of UVA Green Labs Working Group
- Working Group can form task forces as needed to explore solutions for specific initiatives
- EPS universally recognized as a pervasive, stagnant material in laboratories
- Many working group members wanted to do more, formed a task force
- **Task force has explored procurement-, technology-, and recycling-based solutions**
- Survey initiatives have sought to assess the amount of EPS coming into our campus labs
- UVA Procurement and Supplier Diversity Services (Kristin Floyd) prompting vendors to change their shipping containers
- UVA Green Labs program informing community about vendors offering greener shipping alternatives

Animal Care Facility Initiatives



- Eight vivaria at UVA can produce up to 12 tons of waste in a single month
- **2% of ALL of UVA's landfill waste!**
- Gloves, gowns, masks, hair nets, shoe covers, soiled bedding, uneaten food, etc.
- Green Labs worked with vendors providing recycling programs for personal protective equipment used in animal care operations to initiate best possible prices for recyclable materials
 - Kimberly-Clark, Fisher Scientific (Right Cycle, nitrile)
 - VWR (Gown Up Give Back for gowns, hair nets, face masks, shoe covers)
- Trained vivarium employees to sort refuse: Gloves, PPE, and compost (cage waste)



SUSTAINABILITY · UVA



CENTER *for* COMPARATIVE MEDICINE
UNIVERSITY of VIRGINIA



Black Bear
composting

avantor™



RightCycle

by KIMBERLY-CLARK PROFESSIONAL®



fisher scientific

part of Thermo Fisher Scientific

Animal Care Facility Initiatives

- First implemented composting; saw a 47.9% reduction in landfill waste
- Saw additional 35.4% landfill waste reduction after implementing PPE recycling programs (83.3% reduction in total landfill waste)
- Reduced load on area trash compactor
- Supported by all staff and Center for Comparative Medicine Director
- Challenges:
 - Environmental Health and Safety concerns
 - EHS personnel change resulting in (hopefully temporary) discontinuation of program
 - Inconsistent service from UVA Recycling– Difficulty managing increased pickups with current personnel bandwidth
 - Monitoring / tracking shipping needs and specialized quotes





SUSTAINABILITY UVA
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Contact:

Christine Alencar

cda4k@virginia.edu OR greenlabs@virginia.edu

434.924.9531

Disposable Lab Gloves Recycling and Life Cycle Assessment

Whitney Hess, MIT.nano Manager of Safety Systems and Programs

Jennifer Ballew, Green Labs Program Coordinator

Jeremy Gregory, Research Scientist, Civil & Environmental Engineering

Elizabeth Moore, Postdoc, Materials Research Laboratory

Nicole Zhao, UROP, Wellesley College

Beyza Yurt, UROP, Wellesley College



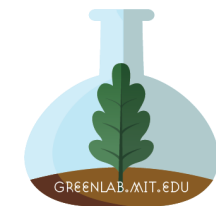
Massachusetts
Institute of
Technology



MIT / Office of Sustainability

ChemE

MTL ● ● ●



A close-up photograph of a person's hands wearing blue nitrile gloves. The right hand is being pulled over the left hand, demonstrating the process of putting on a glove. The background is a plain, light gray color.

MIT uses and disposes of lots of disposable gloves.

Is there an alternative to throwing them in the trash?

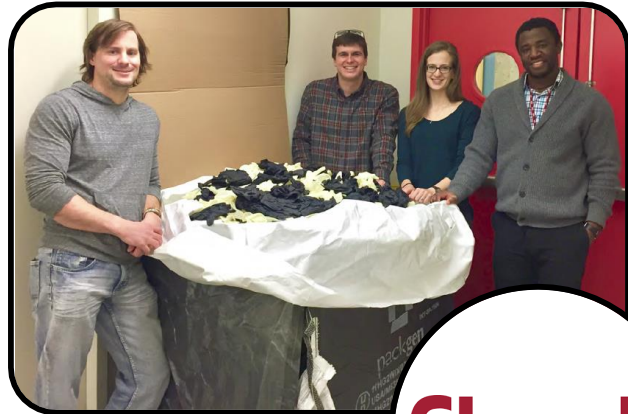
MIT Disposable Glove Recycling Projects

Implement Glove Recycling Pilot Program

Estimate Environmental Impacts

**Evaluate Source Segregation
Effectiveness**

Glove Recycling Pilot Program



Launched 2016

ChemE

Expansion 2017

MTL

Green Labs + ChemE
Additional Engagement 2019



Recycling Vendor: Terracycle

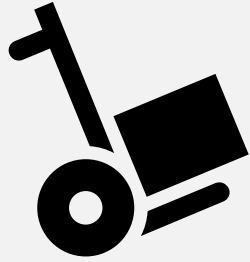
Disposable Glove Types: Nitrile, Latex, Vinyl

Total Weight Recycled: 3.3 tons

**What is the environmental
impact of recycling
disposable lab gloves
compared to landfill
disposal and waste-to-
energy incineration?**

Approach: life cycle assessment

Life Cycle Assessment Approach



1. Quantify MIT glove procurement data

Determine quantities of gloves purchased by vendor, material type, and size

Source: MIT procurement data



2. Collect life cycle inventory data

Manufacturing, disposal, transportation

Sources: glove production company, publicly available data, ecoinvent database



3. Calculate environmental impacts

Compare different disposal methods: recycling, incineration, landfill

Calculations conducted in SimaPro software

How many gloves does MIT buy in one year?

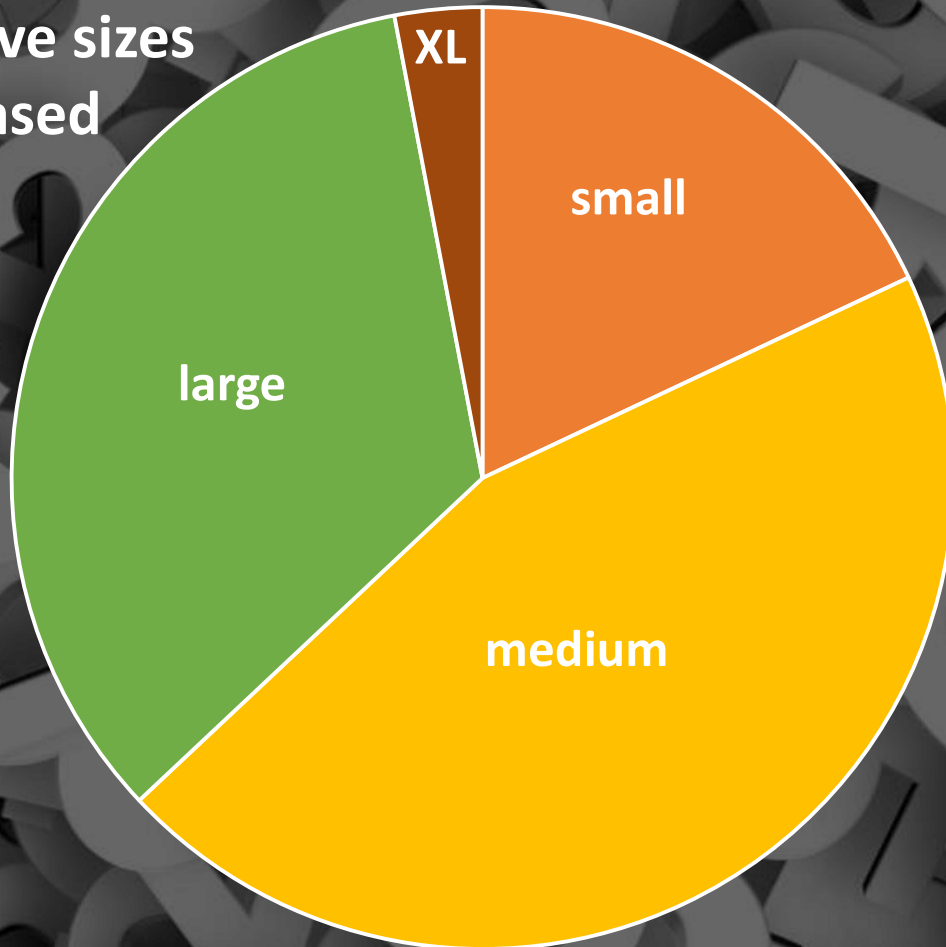
500,000

1,000,000

3,000,000

How many gloves does MIT buy in one year?

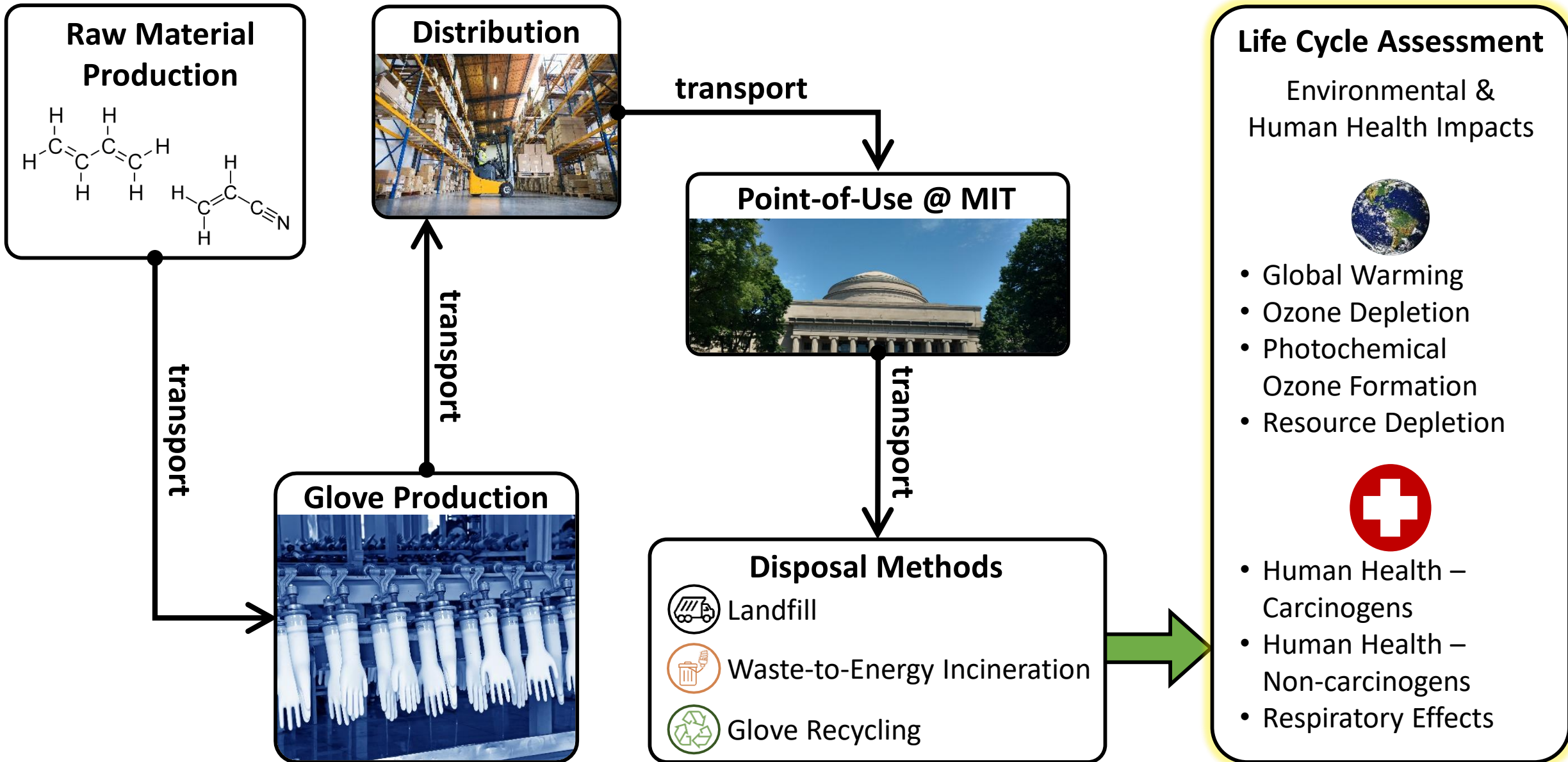
A range of glove sizes are purchased



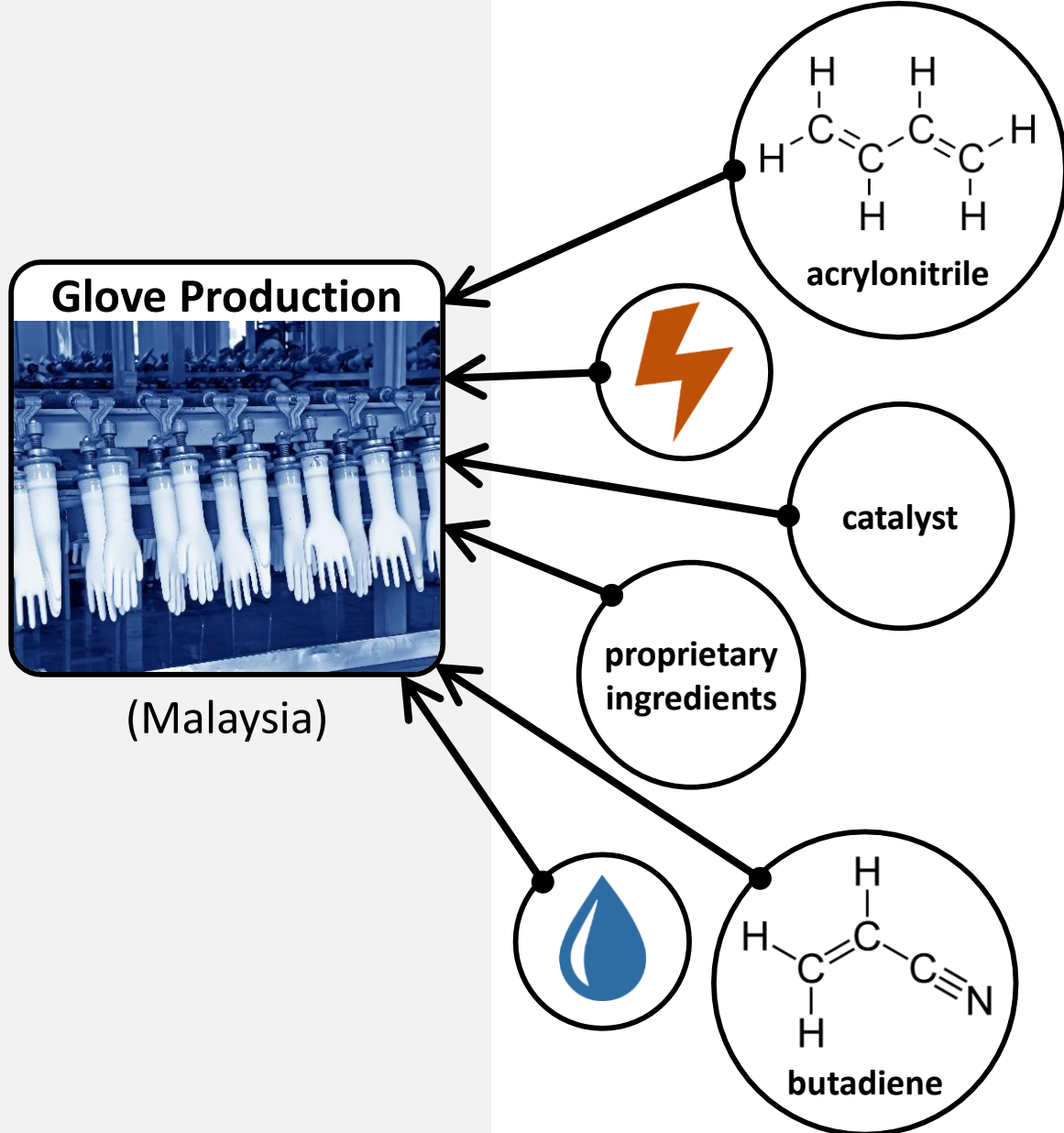
3,000,000

Nitrile gloves make up
>90% of purchased gloves

Life Cycle Assessment (LCA) Approach



LCA Scope and End-of-Life Scenarios

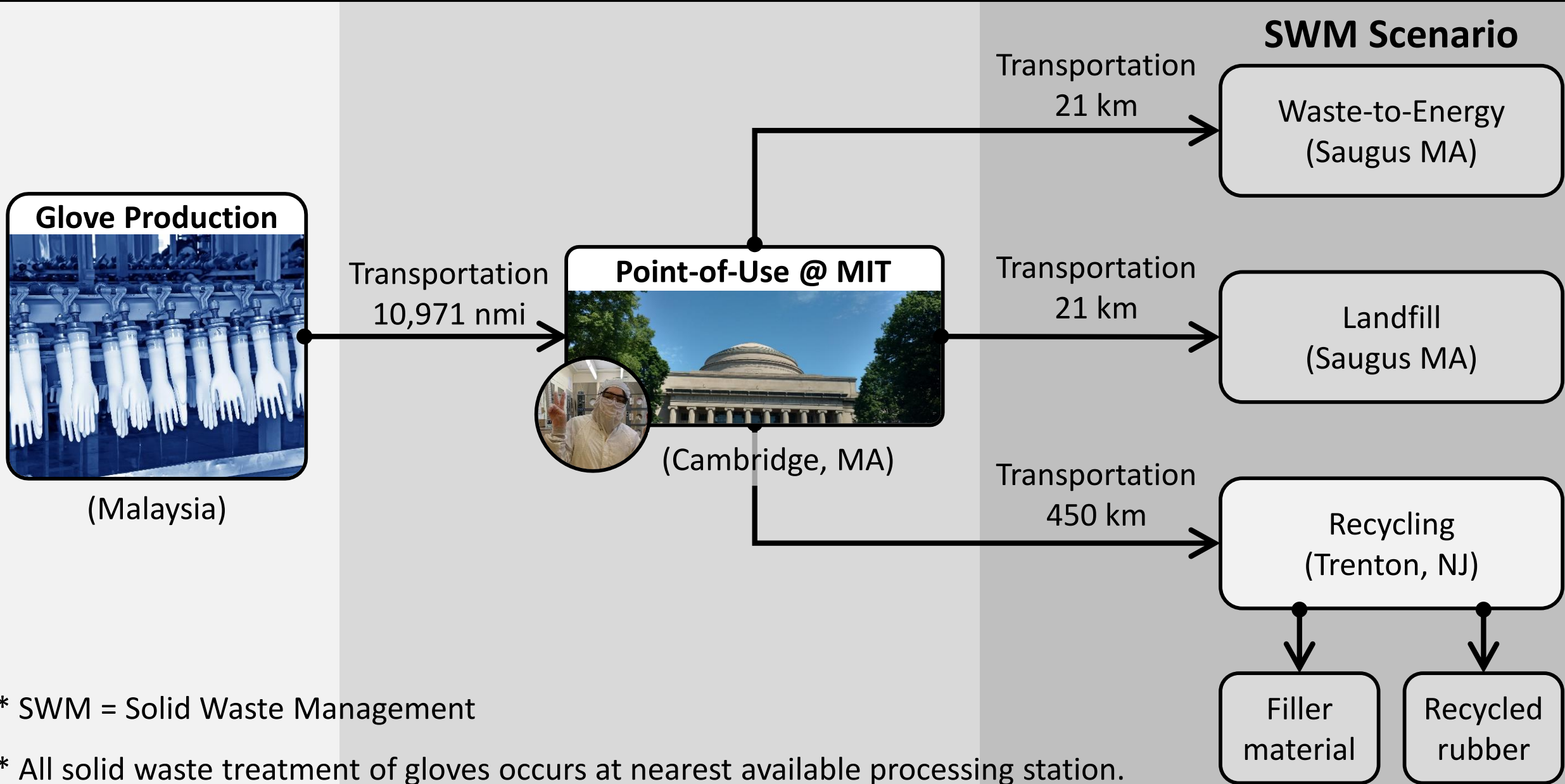


Key Assumptions –

ABS used as a proxy for nitrile

Biomass heat used as a proxy for energy production

LCA Scope and End-of-Life Scenarios



* SWM = Solid Waste Management

* All solid waste treatment of gloves occurs at nearest available processing station.

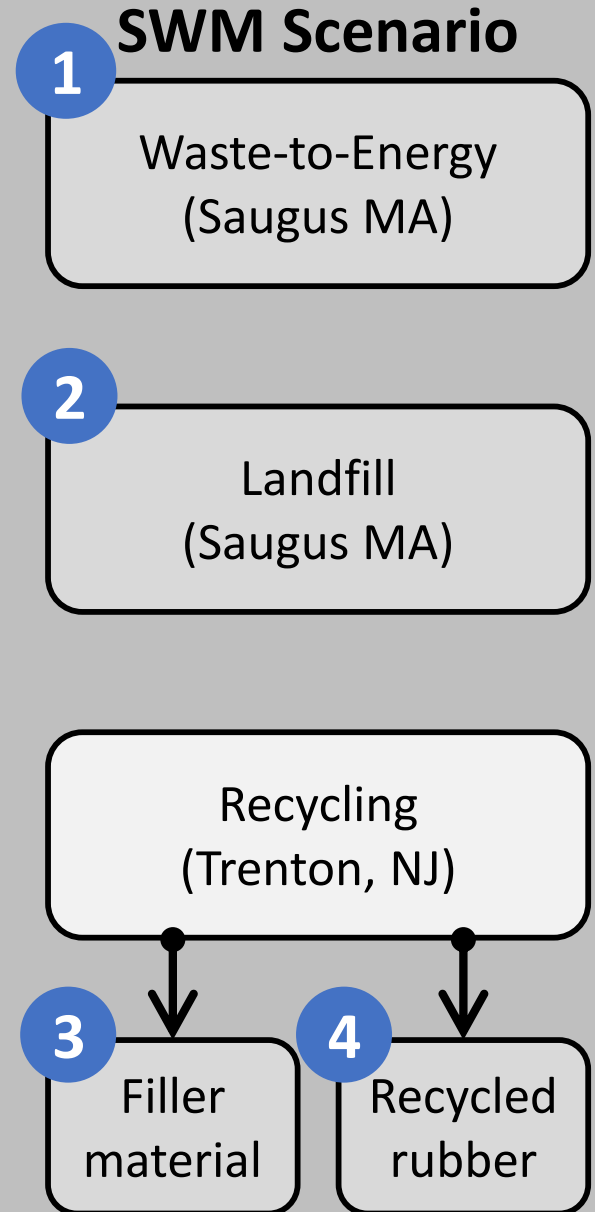
LCA Scope and End-of-Life Scenarios

Recycled glove product data –

True destinations unknown

Key Assumption –

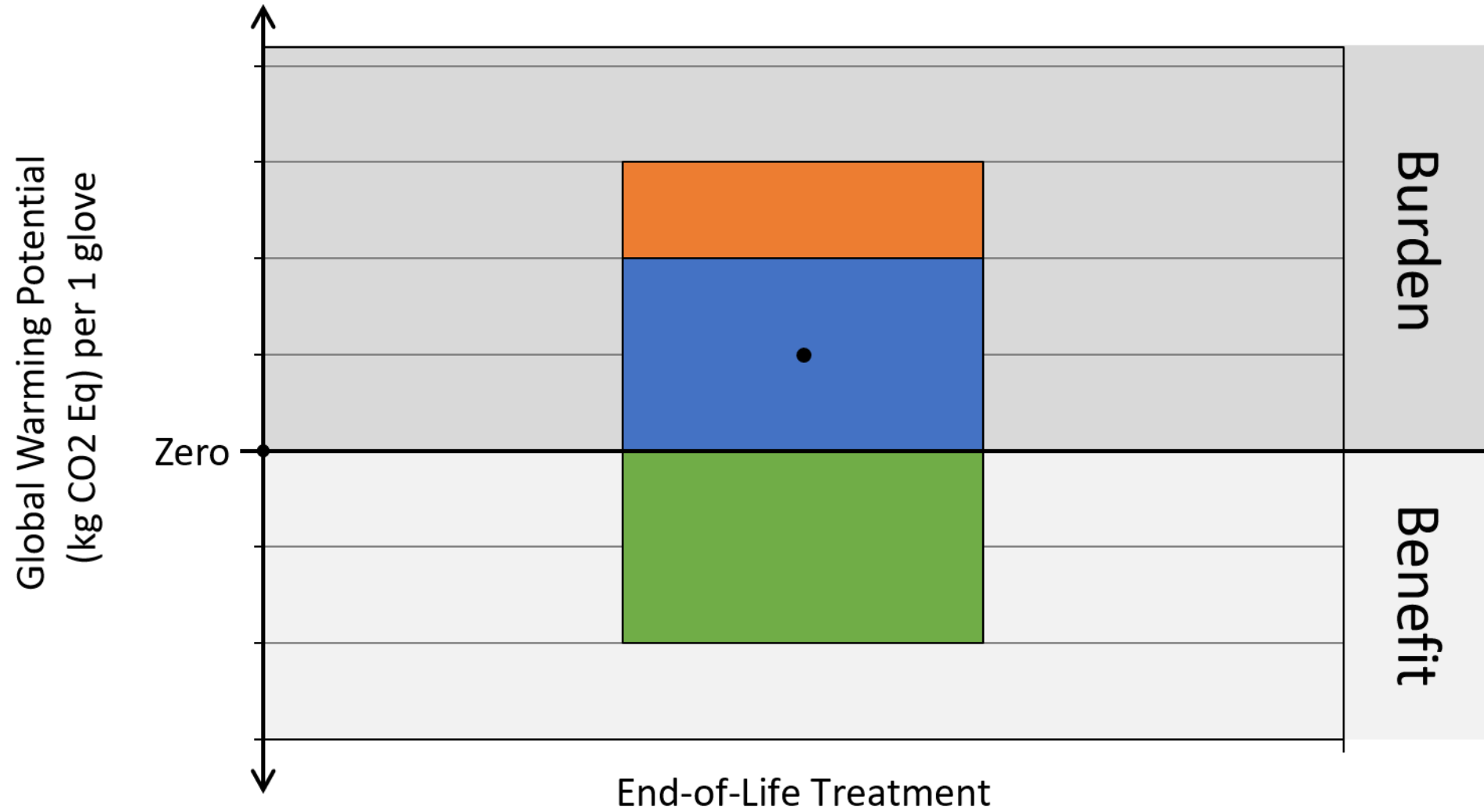
Sawdust used as a proxy for filler material



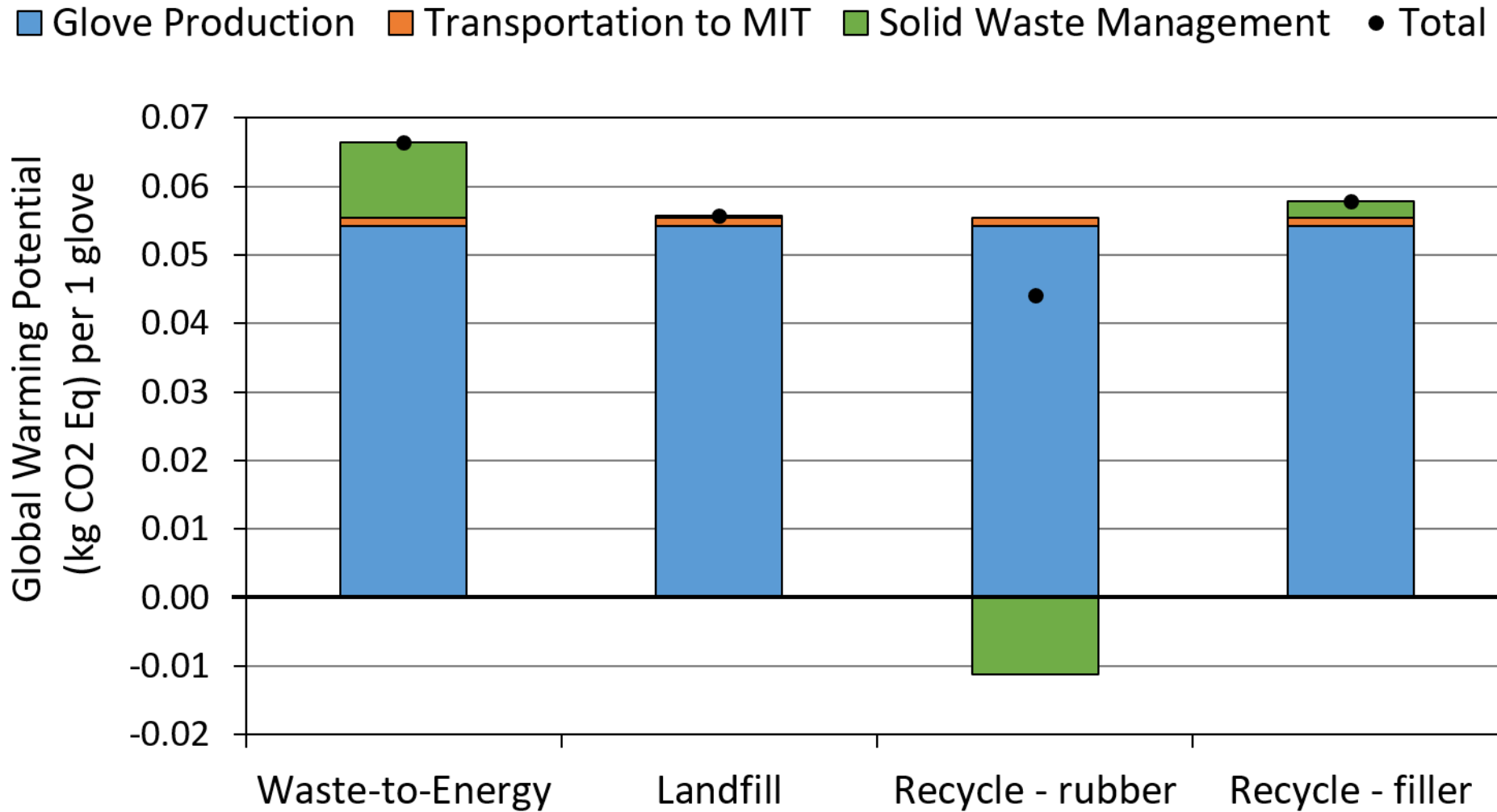
* Recycling vendor has indicated recycled glove product is used in industrial applications like lumber, furniture, flooring, and mats.

What will the LCA results look like?...

■ Glove Production ■ Transportation to MIT ■ Solid Waste Management • Total

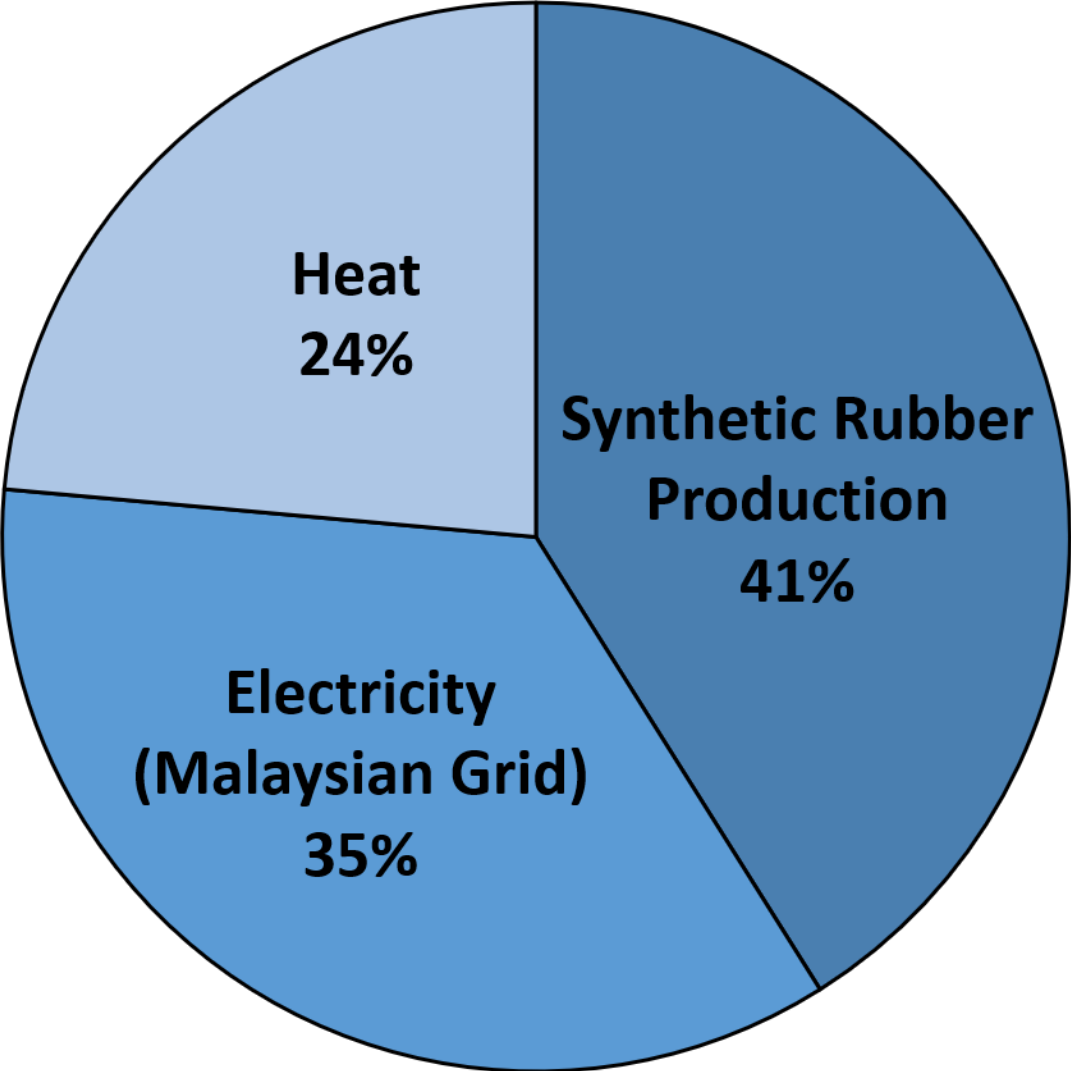


Glove production is the largest life cycle phase for all end-of-life scenarios.



Recycling to rubber has the lowest global warming potential (GWP) impact.

Glove production GWP impacts...



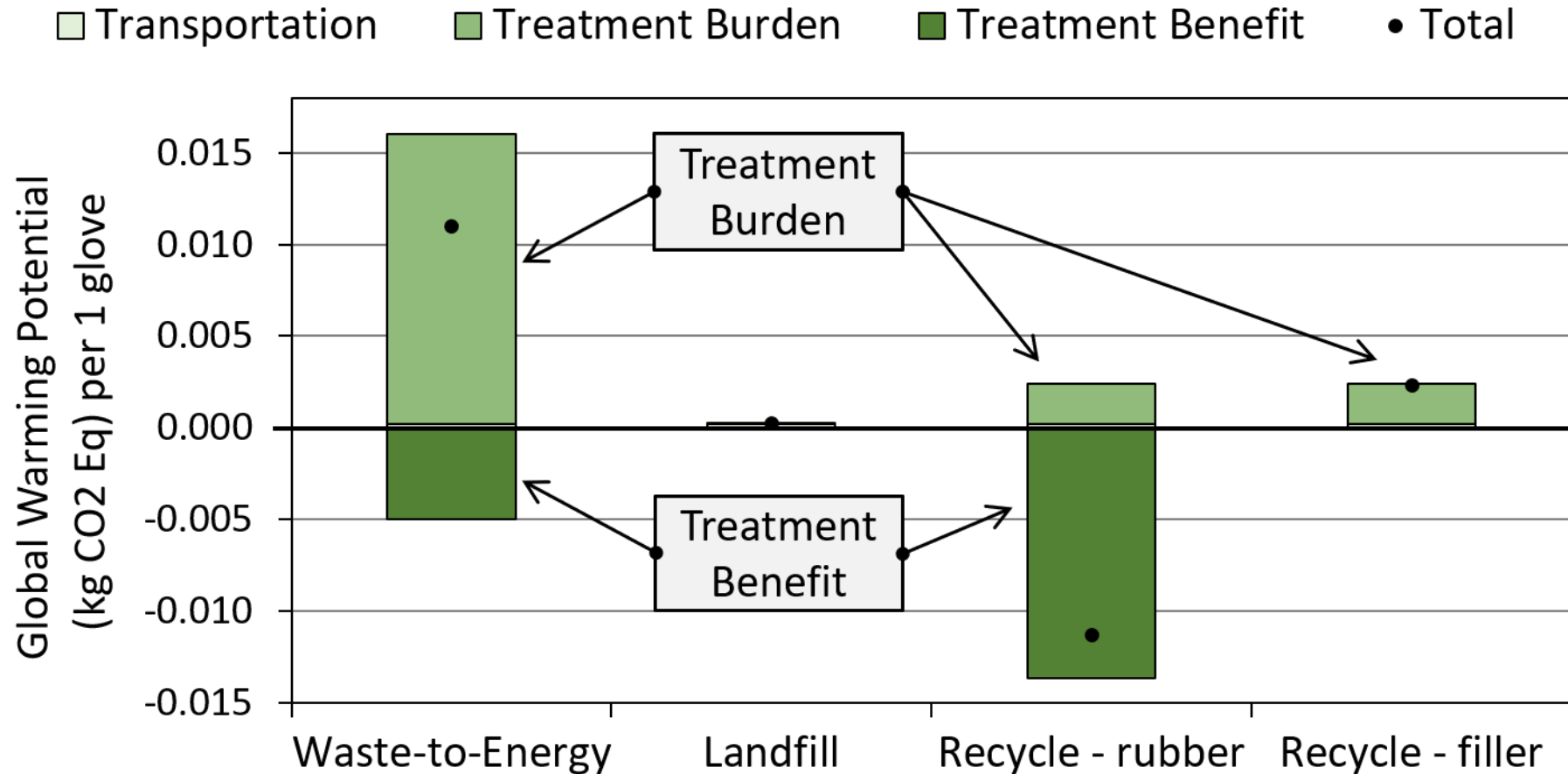
...are driven by raw material production and energy generation

A photograph of a multi-lane highway with several vehicles. In the center, a white and yellow city bus is driving towards the camera. The bus has '558 DOWNTOWN EXPRESS' on its destination sign and '0481' on its front. To the right of the bus, there are two dark-colored cars. In the background, there are more cars in the adjacent lanes. The image is slightly dimmed to make the overlaid text stand out.

The GWP burden of producing MIT's 3M gloves in one year is the equivalent to:

**Driving 35 passenger vehicles for one year
or
398k miles driven by an average
passenger vehicle**

The end-of-life treatment determines the extent of avoided emissions.



Recycling to rubber has the largest GWP life cycle benefit.

** Results consistent with other human health and environmental impacts.*

Evaluate Source Segregation Effectiveness

*Duration:
2 weeks*

Waste Streams:

- *Trash*
- *Single stream Recycling*
- *Glove Recycling*
- *Plastic Film*

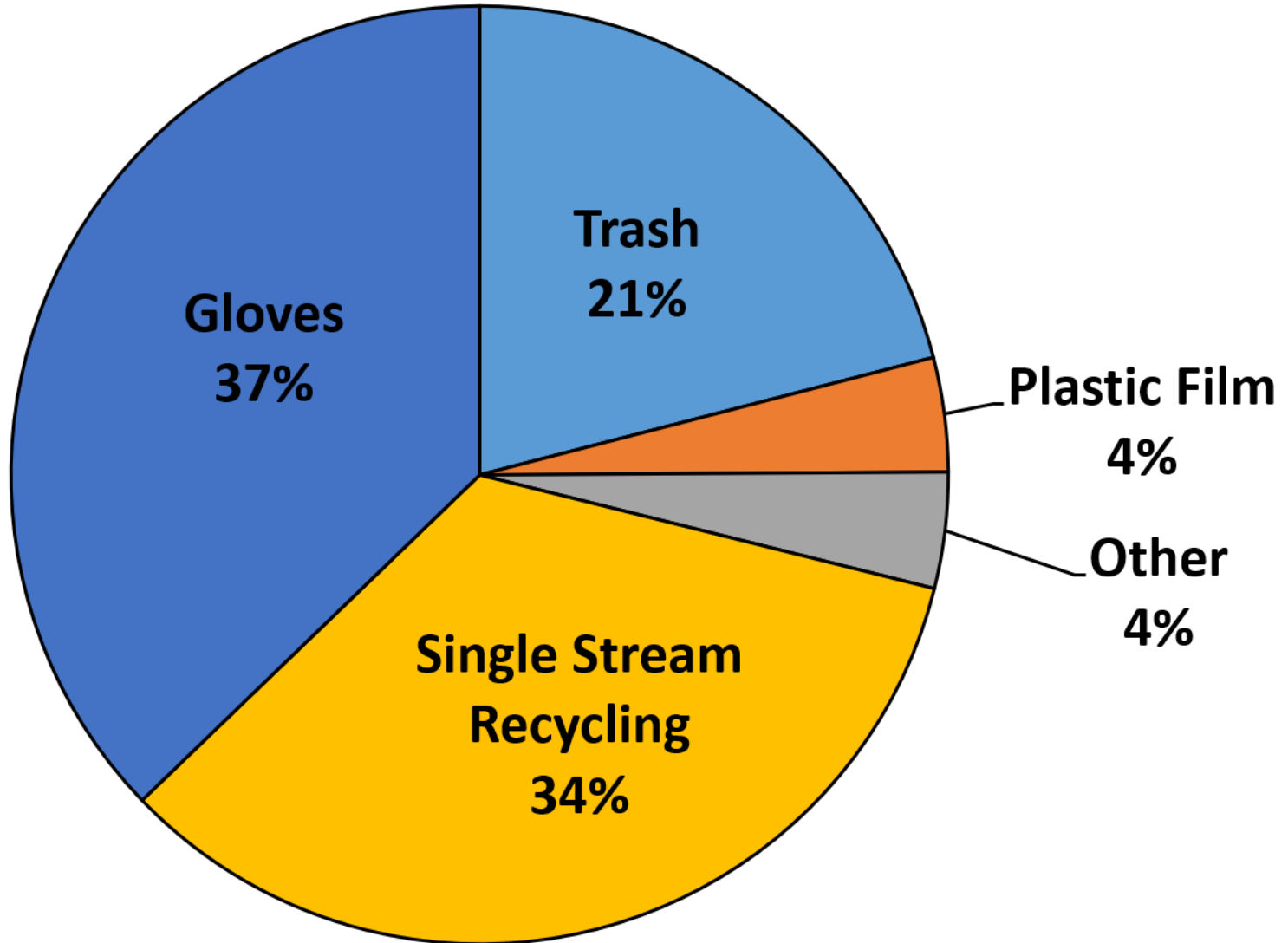
*Collected
130 kg waste*

Participating labs:

- *ChemE 1: biofunctional and bioinspired materials*
- *ChemE 2: multifunctional polymeric nanomaterials*
- *ChemE 3: heterogeneous catalysis and design*
- *MTL 1: Shared cleanroom fabrication facility*



37% (by weight) of lab waste collected was disposable gloves.



Labs are an average 95% effective at segregating gloves for recycling.

Conclusions

Based on available data, recycling to rubber is the best alternative.



*Recycling to filler is worse than landfilling.
Waste-to-energy has the highest GWP impact.*

Conclusions

Significant assumptions were made due to lack of data availability.



*We need to better understand the market
for recycled glove material.*

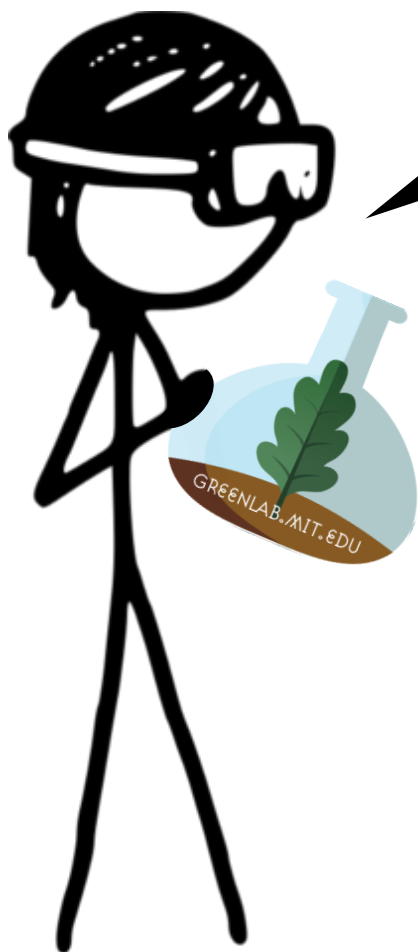
Acknowledgements

- Lisa Anderson (Postdoctoral Associate, Biological Engineering)
- Elsa Olivetti (Assistant Professor, Materials Science & Engineering)
- Brian Smith (ChemE & EAPS EHS Coordinator)
- Niamh Kelly (EHS Senior Officer)
- Ruth Davis (Recycling Manager)
- Thomas Hardy and Pedro Tejeda (Custodial Services)

Glove Recycling staff support and funding: ChemE and MTL

LCA and Waste Audit funding: Campus Sustainability Incubator Fund

Questions?

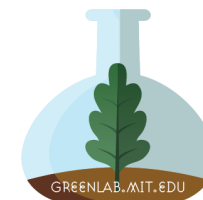


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MTL ● ● ●
ChemE



Panel Discussion