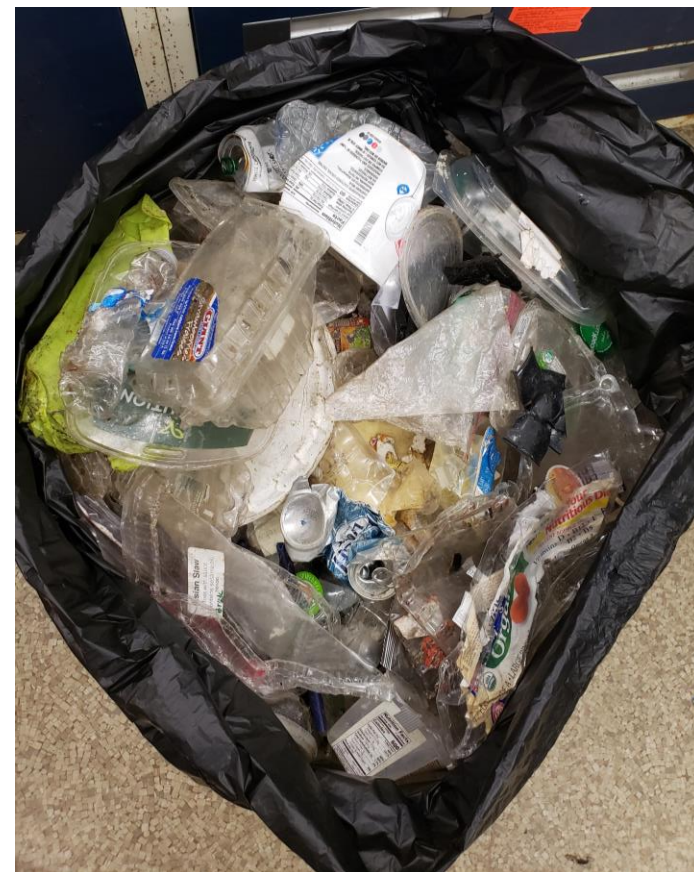


DOE Bioenergy Technologies Office (BETO) 2021 Project Peer Review

WBS 1.2.1.7 Municipal Solid Waste (MSW) Decontamination



March 12, 2021
Feedstock Technologies
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Project Overview

- *China's National Sword policy instituted in 2018*
 - *Loss of US markets for #3-7 plastic and mixed paper waste*
 - *These materials are too contaminated to be economically recycled*
 - *Currently these materials are going to landfills*
 - *Societal issues (Pacific garbage patch, microplastics)*
- *Project Goals*
 - *Understand types of contamination present and their impact on conversion yields*
 - *Develop decontamination strategies*
 - *Understand the TEA/LCA tradeoffs for these strategies*
- *Risks*
 - *Rapidly shifting markets (paper shortage during pandemic)*
 - *It may be too expensive to decontaminate materials*
 - *Waste materials may not be suitable for the conversion pathways chosen (fast pyrolysis and fermentation)*



1 – Management

Task Title	Lead (s)	Responsibilities
MSW Assessment	Vicki Thompson and RRS	Suitability of MSW for fast pyrolysis and fermentation
Contaminant Identification	Amber Hoover, Jordan Klinger and Becca Brown	Contaminant identification and impact on conversion yields
Contaminant Mitigation	Becca Brown and Brad Wahlen	Identification of current and future strategies to decontaminate MSW
Technoeconomic Analysis	Damon Hartley and RRS	Identify the most cost-effective decontamination methods
Final Demonstration	Amber Hoover, Jordan Klinger and Becca Brown	Demonstrate yield improvements for decontaminated MSW using the most economic methods

- Risks

- Waste industry markets are in flux
- Decontamination may be too expensive
- Potentially biohazardous materials present

- Mitigation

- Consulting with Resource Recycling Services (waste consultant company)
- TEA/LCA task
- Staff trained to handle biosafety level 2 materials

1 – Management

- Communication
 - Biweekly and as needed meetings with team members
 - Quarterly meetings with BETO TMs
 - FCIC
 - Input on screening conversion yields of waste materials
 - Providing materials to NREL for screening in conversion AOPs
 - REMADE
 - Thompson is the deputy node lead for Recycling and Recovery
 - Collaborated with MTU on plastic circular economy analysis
 - Projects on e-waste and plastic film
 - Biomass Feedstock National User Facility
 - Regularly meet with BFNUF upgrade team to help select equipment for processing and separating MSW

2 – Approach

- *Previous research*
 - *Corn stover could be blended with up to 40% yard waste or mixed paper with no yield impact*
 - *Yard waste and mixed paper alone had lower yields due to contaminants*
- *Approach for SEED project*
 - *Identify most impactful MSW fractions*
 - *Identify contaminants and their impact on yields for fast pyrolysis and fermentation pathways*
 - *Identify decontamination strategies and conduct TEA/LCA*
 - *Determine the optimum process and demonstrate at small-scale*

2 – Approach

- *Challenges*

- *Decontamination may be too expensive*
- *Rapid shifts in MSW markets result in expensive materials*

- *Go/No-Go*

- *Decontamination method that improves yields by 10% at no more than \$30/ton*
- *Previous work showed that mixed paper yields were 10% lower than corn stover*
- *\$30/ton comparable to corn stover feedstock costs*

- *BETO FT Goals from MYP*

- ***Ft-A Feedstock Availability and Costs** by enabling the use of lower cost high-volume feedstocks*
- ***Ft-E Feedstock Quality** by offering solutions to contamination issues that lower MSW quality.*

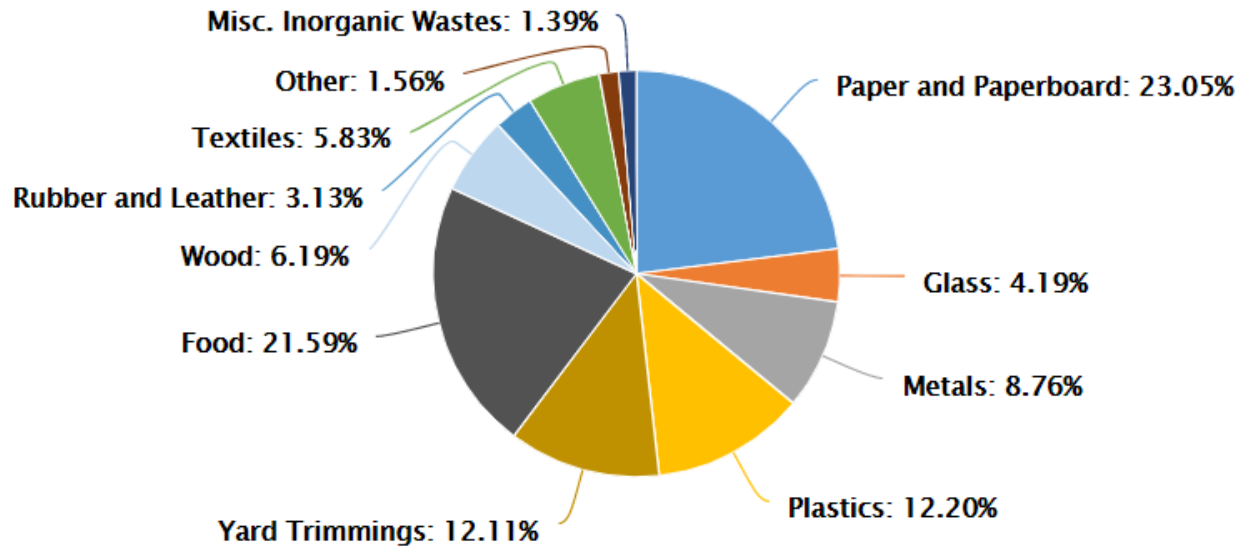
3 – Impact

- *China's National Sword Policy (2018)*
 - *Banned mixed paper and plastics unless contamination <0.5%*
 - *Typical materials recovery facilities contamination levels 15-20%*
 - *Many U.S. cities discontinued or scaled back recycling programs*
 - *Value per ton of mixed paper and plastics became negative*
 - *Microplastics in the environment*
- *A solution*
 - *Mixed paper and plastics could be feedstocks for fermentation and fast pyrolysis conversion to fuels and chemicals*
 - *Provide markets for displaced materials*
 - *Contribute to a circular economy*
- *Dissemination of Results*
 - *Work with RRS to reach industry stakeholders*
 - *Publications in high impact journals and trade journals*
 - *Presentations at trade shows and conferences*

4 – Progress and Outcomes – Municipal Solid Waste Landscape

Total MSW Generated by Material, 2018

292.4 million tons

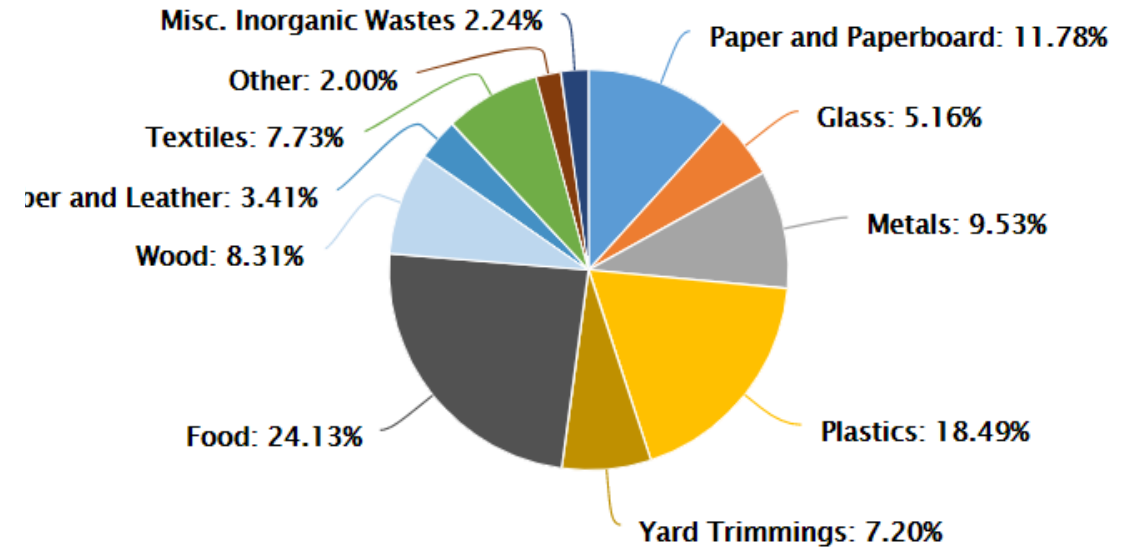


Generated per year

- 67 million tons of paper
- 36 million tons of plastic
- 63 million tons of food waste

Total MSW Landfill by Material, 2018

146.2 million tons



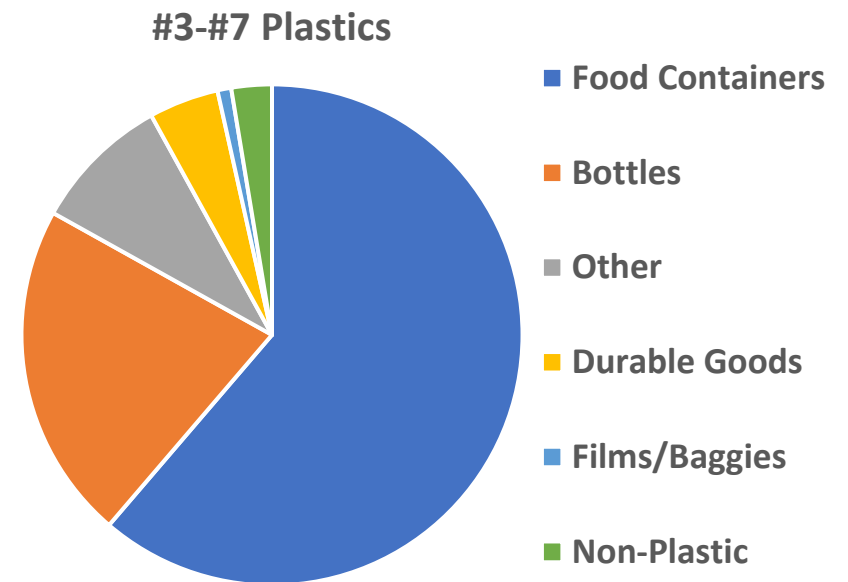
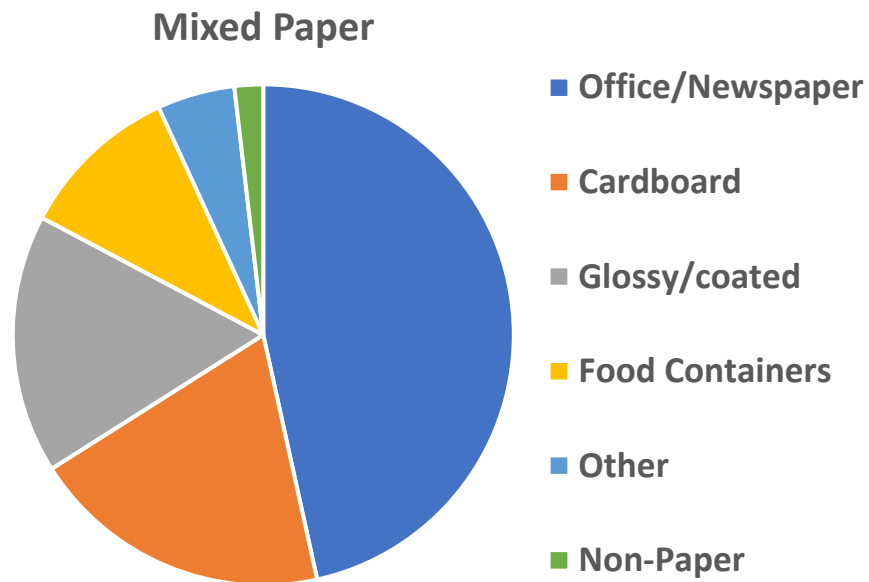
Landfilled per year

- 17 million tons of paper
- 27 million tons of plastic
- 35 million tons of food waste

4 – Progress and Outcomes

- **Sourcing Municipal Solid Waste**

- *Emmet County Michigan*
- *Dual stream recycling facility*
- *Removes #1 and #2 plastics and metals for recycling*
- *Removes office paper and corrugated cardboard for recycling*
- *INL received residuals after sorting*

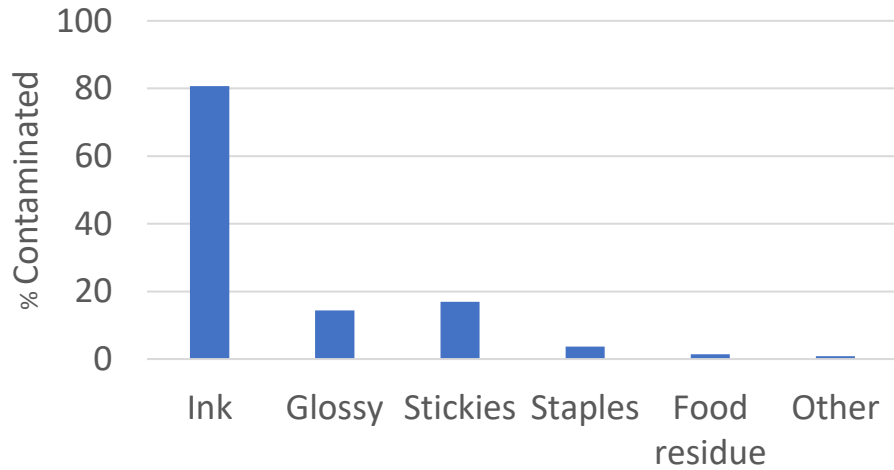


4 – Progress and Outcomes

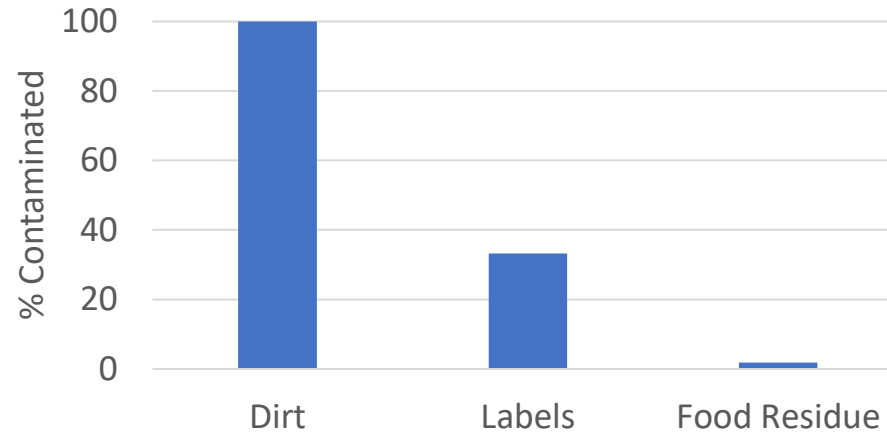
- **Contamination types**

- *Inherent contamination (food/chemical residues, cross contamination)*
- *Incorrect sorting (paper in plastic, plastic in paper, glass, metals)*

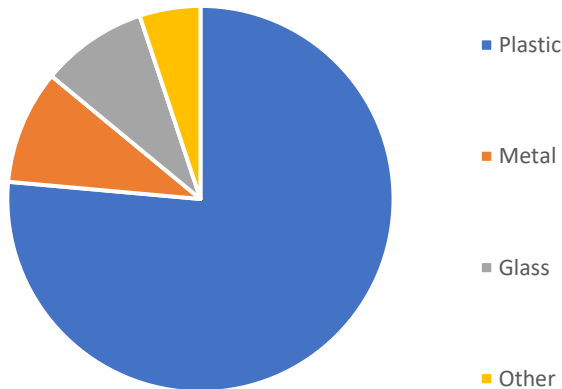
Inherent Paper Contamination



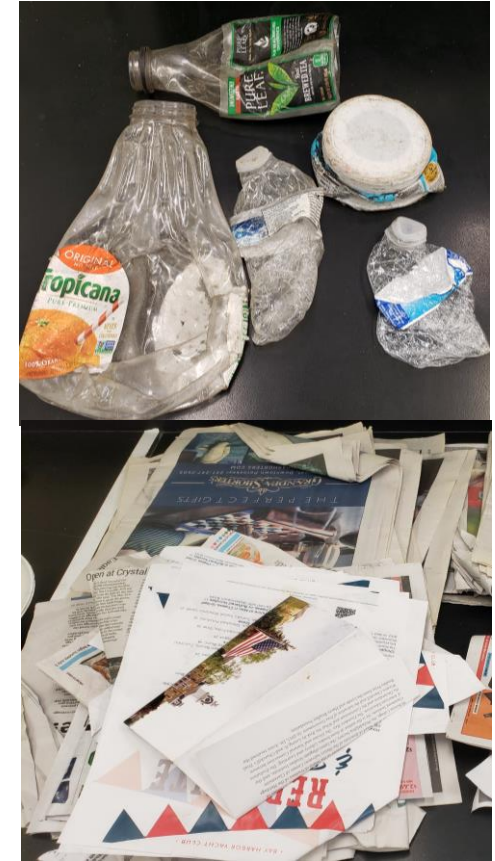
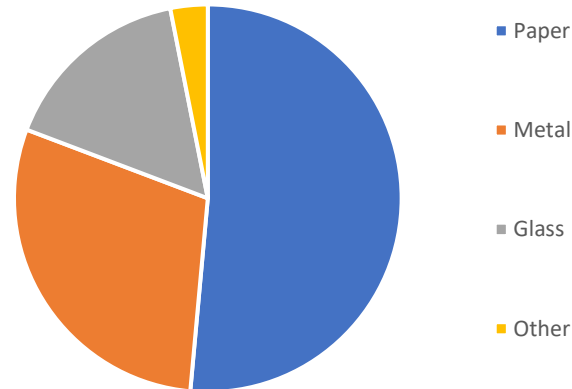
Inherent Plastic Contamination



Incorrectly sorted into mixed paper



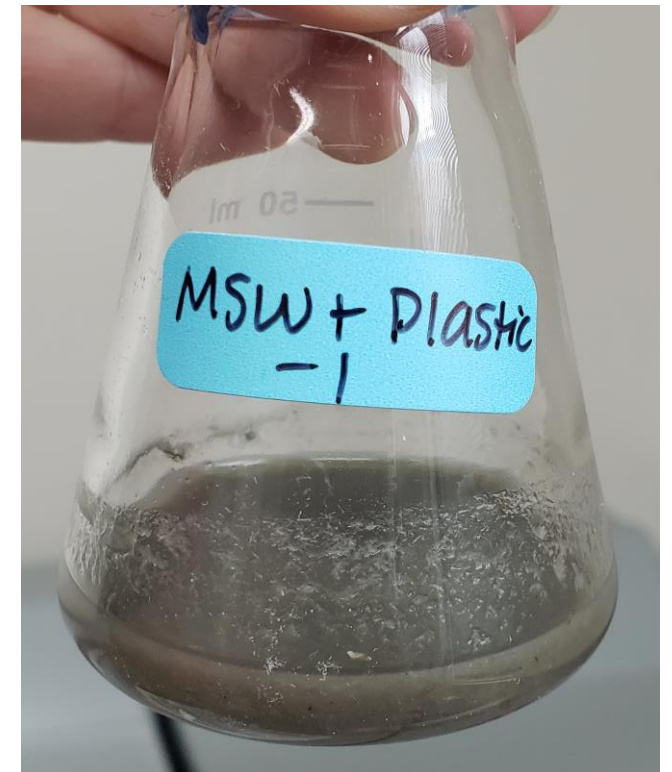
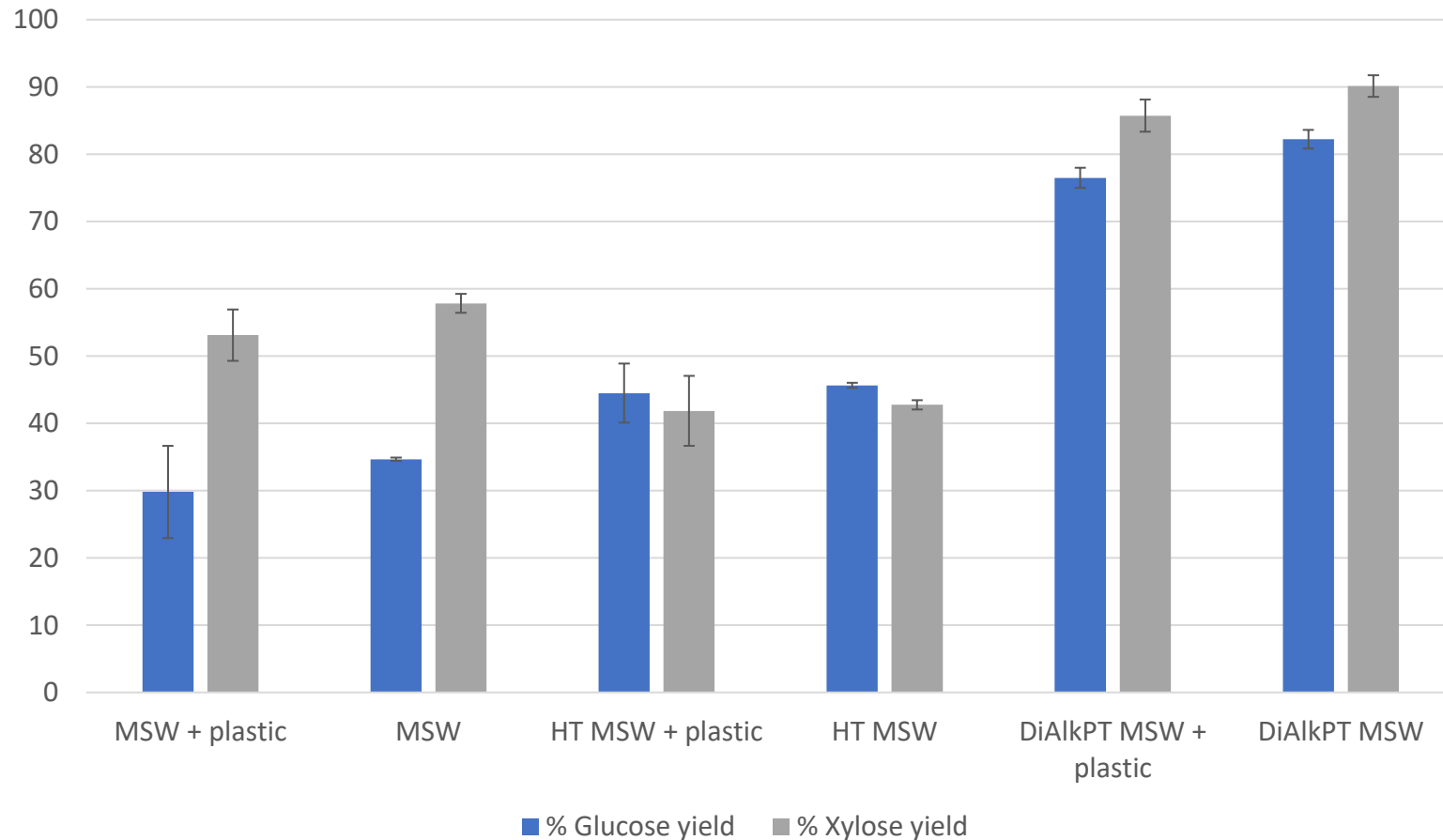
Incorrectly sorted into plastics



4 – Progress and Outcomes

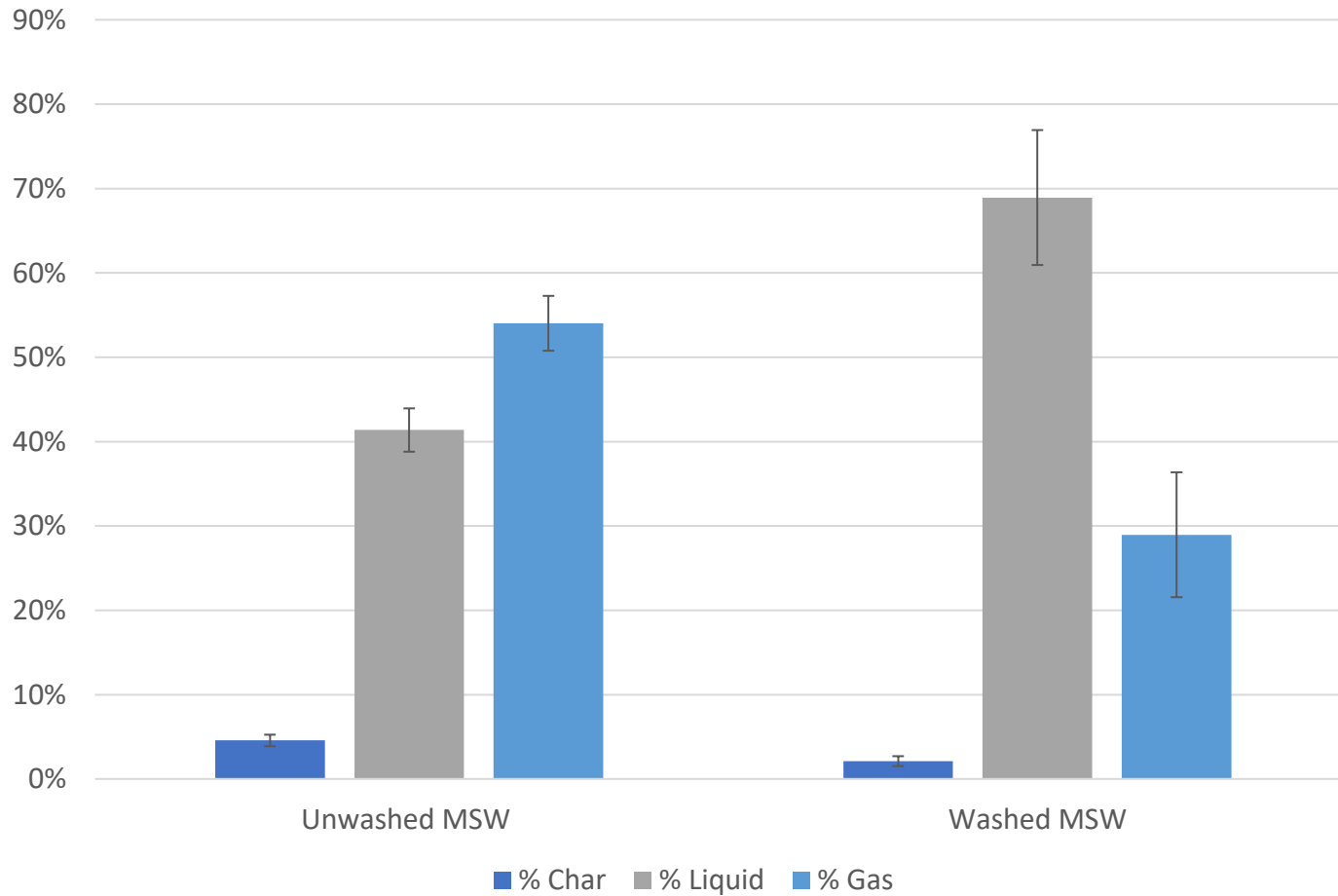
- **Conversion Screening for Paper (Enzymatic Hydrolysis)**

- Remove plastic from paper (better sorting)
- Heat treatment (better enzymatic hydrolysis of waste paper)
- Deacetylation (7% NaOH) + PFI milling (shear used in pulp & paper industry)



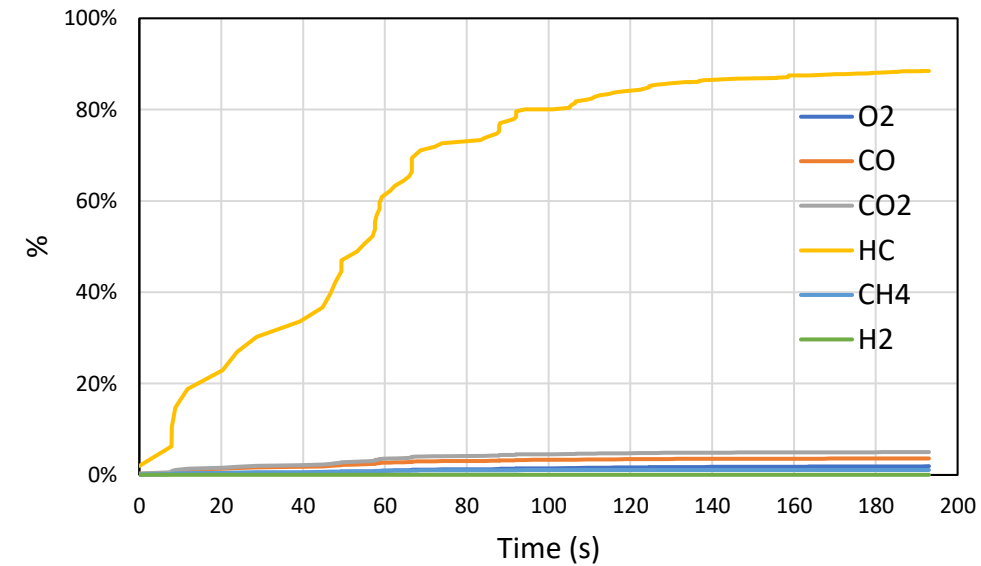
4 – Progress and Outcomes

- **Conversion Screening for Plastic (Microwave-Assisted Fast Pyrolysis)**
 - Detergent wash to remove dirt



% Yield	Unwashed	Washed
Char	4.6	2.1
Liquid	41.4	69.0
Gas	54.0	29.0

Gaseous Pyrolysis Products of Plastic



Summary

- *Management*
 - *Consultation with waste industry experts (RRS)*
 - *Expert team conducting experimental and analysis tasks*
- *Approach*
 - *Tasks designed to identify cost effective approaches to convert MSW to biofuels*
 - *Targeted Go/No-Go decision point*
 - *Mitigation strategies developed for identified risks*
- *Impact*
 - *China's National Sword policy collapsed existing waste recycling markets*
 - *Waste industry is looking for solutions*
- *Progress*
 - *Despite Covid-19 delays, project is back on track*
 - *Identified promising decontamination strategies*
 - *Currently conducting TEA/LCA*

Quad Chart Overview – MSW Decontamination 1.2.1.7

Timeline

- Project start date: 10-01-19 (funding received 12-01-2019)
- Project end date: September 30, 2021

Project Goal

Demonstrate that decontamination of currently landfilled MSW fractions can be economical for BETO conversion pathways (DMR/enzymatic hydrolysis and ex-situ catalyzed fast pyrolysis)

	FY20	Active Project
DOE Funding	\$250K	\$500K

End of Project Milestone

Demonstrate that MSW fractions can be decontaminated at a modeled cost no higher \$25/ton and the decontaminated MSW fractions have 15% higher yields compared to contaminated materials.

Project Partners*

Resource Recycling Services

NREL

Barriers addressed

Ft-E Feedstock Quality by offering solutions to contamination issues that lower MSW quality. By utilizing these currently landfilled waste feedstocks, we also address **Ft-A Feedstock Availability and Costs** by enabling the use of lower cost feedstocks..

Funding Mechanism

AOP



Additional Slides

Responses to Previous Reviewers' Comments

- This project was new in FY20 and has not been previously reviewed
- Go/No-Go – none during the review period

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Publications, Patents, Presentations, Awards, and Commercialization

- R. Brown, A. Hoover, J. Klinger, B. Wahlen, V. Thompson. 2021. Decontamination strategies to increase conversion yields of municipal solid waste: A review, Submitted to ACS Sustainable Chemistry and Engineering.

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