



Challenges and Opportunities Associated with the Municipal Solid Waste

July 2022

Changing the World's Energy Future

Nepu Saha



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**Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517**



July 15, 2022

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Challenges and Opportunities Associated with the Municipal Solid Waste

Outline

- What is municipal solid waste (MSW)?
 - Generation statistics
- How the MSW is being currently handling?
- How the MSW is destroying our world?
- Potential opportunities of MSW
- Challenges associated with MSW handling
 - Heterogeneity
 - Wet feedstock
 - Various hazards associated with it

Municipal solid waste (MSW)

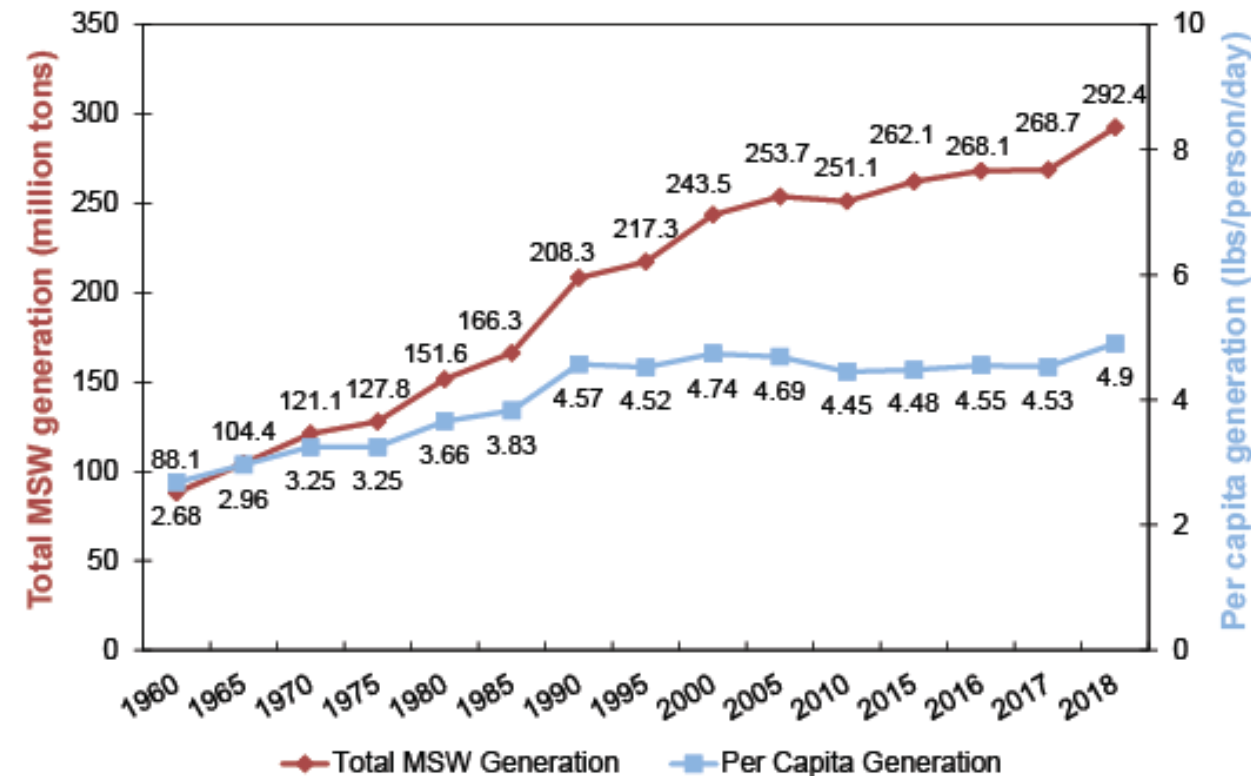
- Municipal Solid Waste (MSW), commonly called “trash” or “garbage” consists of everyday items we use and then throw away, such as:
 - Product packaging,
 - Grass clippings,
 - Furniture,
 - Clothing,
 - Bottles,
 - Food scraps,
 - Newspapers,
 - Appliances,
 - Etc.



Accessed at https://www.pngitem.com/middle/hxoJbRw_municipal-solid-waste-png-transparent-png/ on 06.28.2022

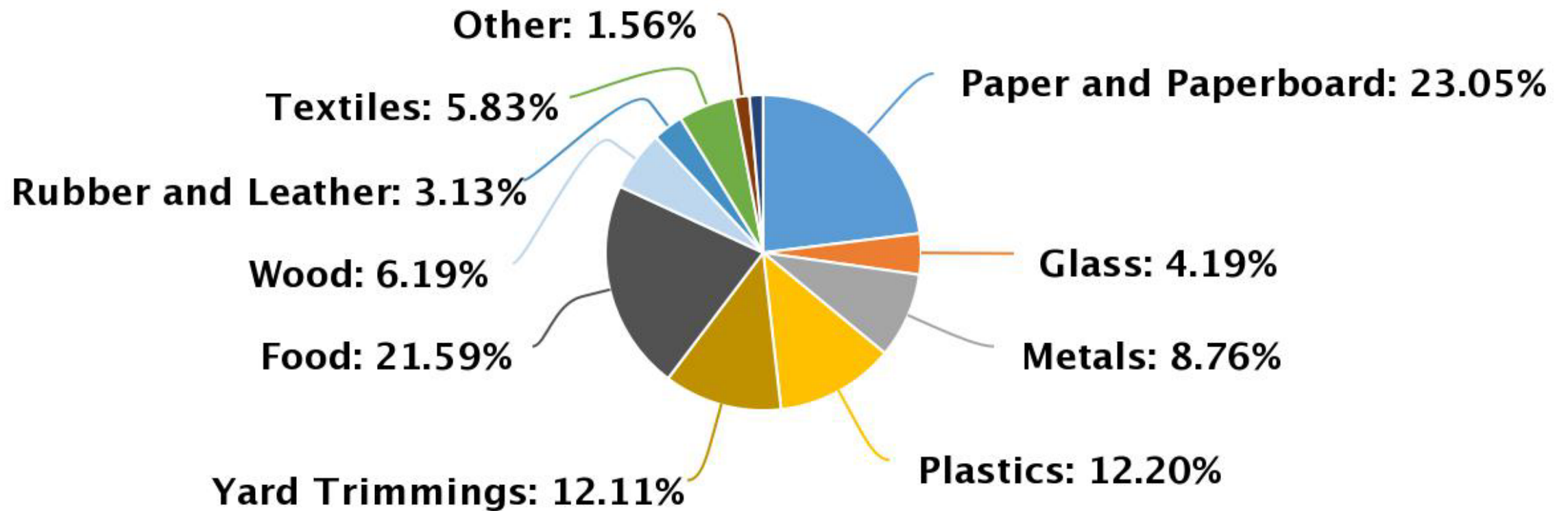
Generation of MSW

- Total annual MSW generation in the U.S. has increased by 93% since 1980 to 2018.
- Per capita MSW generation increased by 34% over the same time period (3.7 to 4.9 lbs per person per day). As comparison, MSW generation rates (lbs/person/day) are 2.8 in Sweden, 3.7 in Germany, and 2.7 in the United Kingdom.



Accessed at <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials> on 06.28.2022

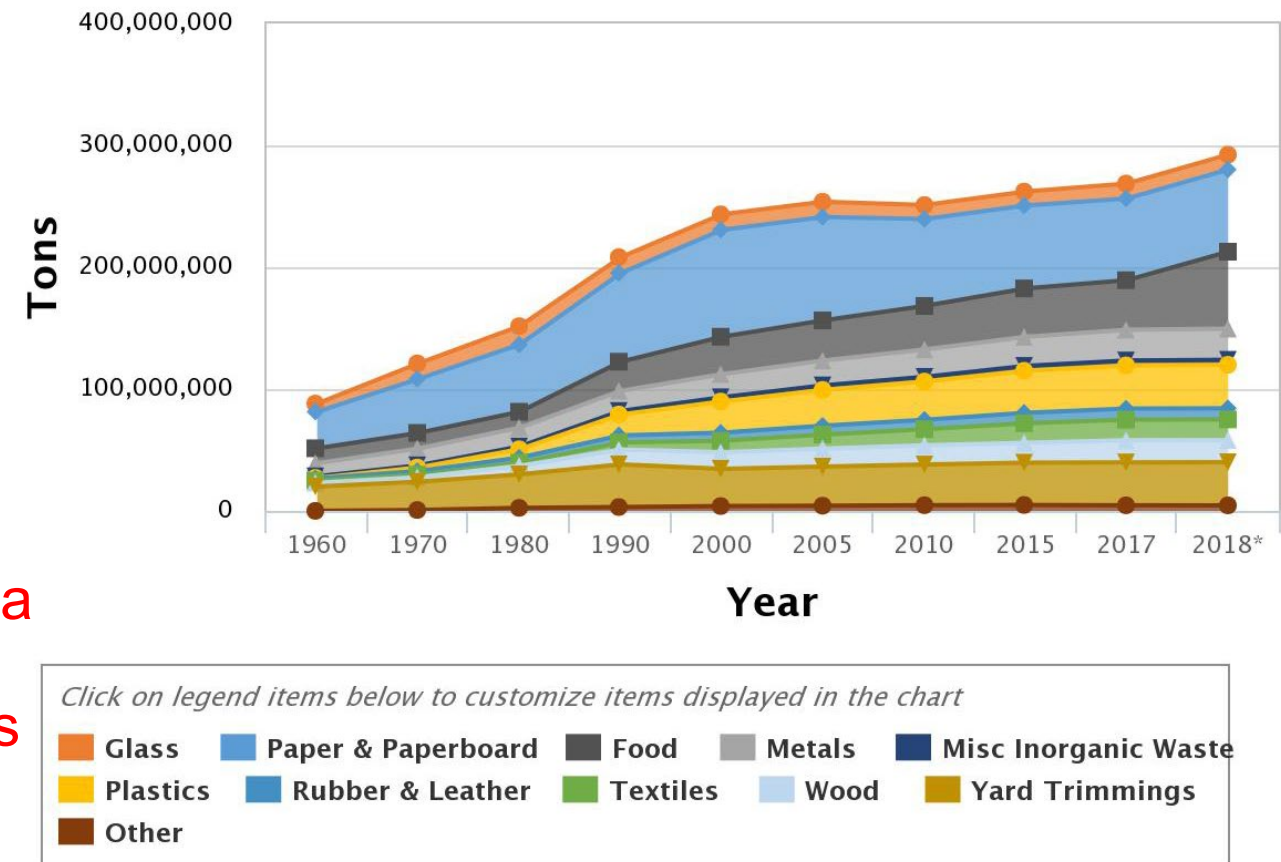
Typical fraction in MSW



Accessed at <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials> on 06.28.2022

Alarming contributions!

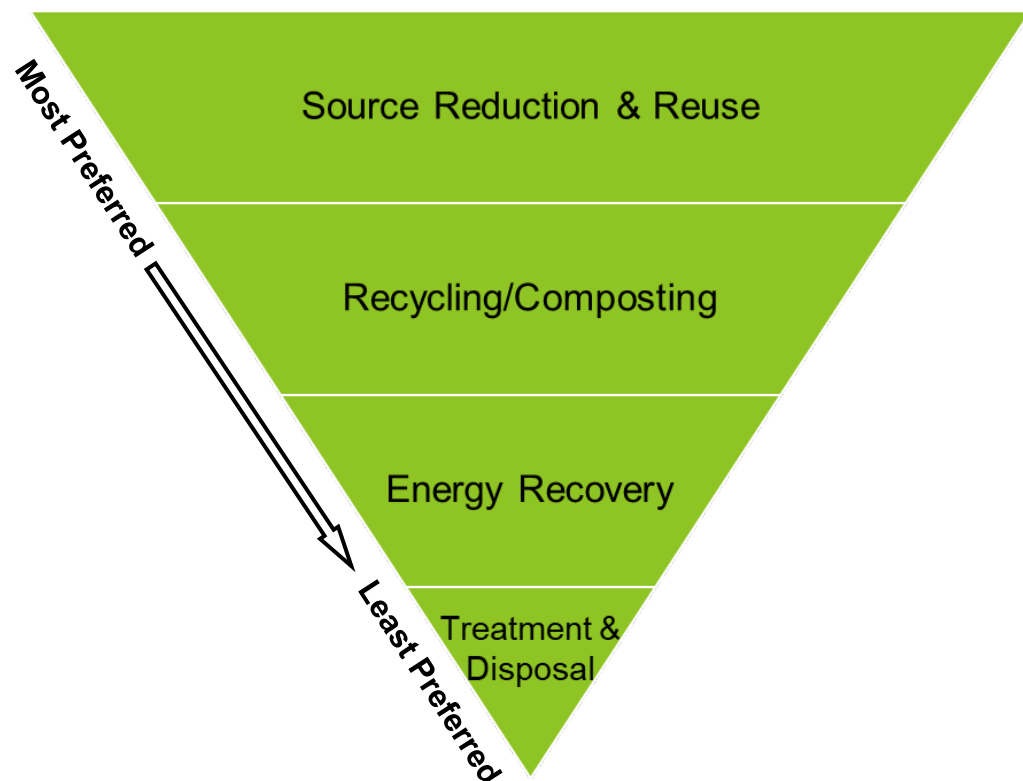
- Alarming contributions are from:
 - Food ((increased 30 million tons from 2010 to 2018)
 - Plastic (increased 4.3 million tons from 2010 to 2018)
 - Metal (increased 3.3 million tons from 2010 to 2018)
- The handling and disposal of MSW is a growing concern as the volume of waste generation in the U.S. continues to increase.



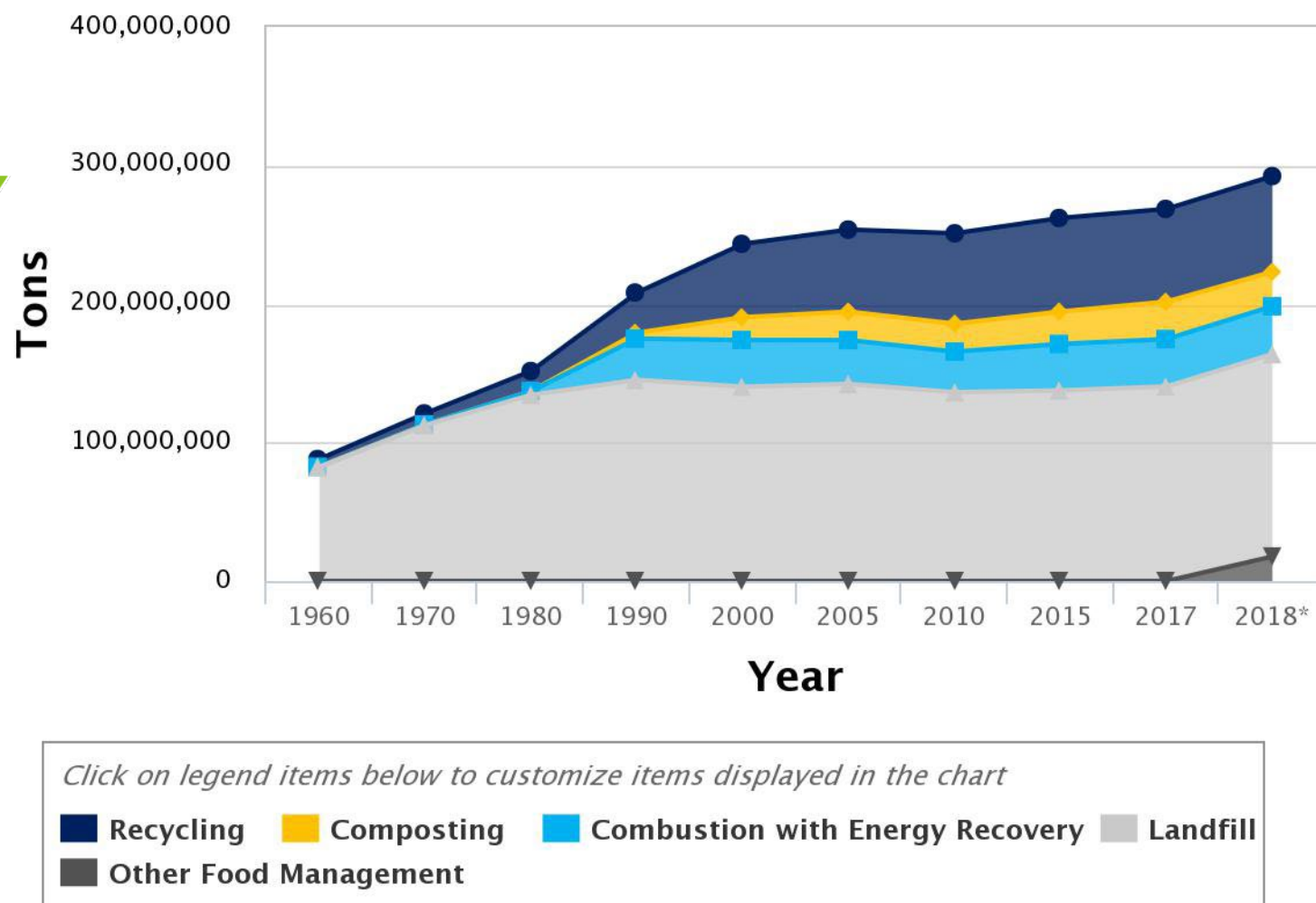
Accessed at <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials> on 06.28.2022

Management methods

Waste Management Hierarchy



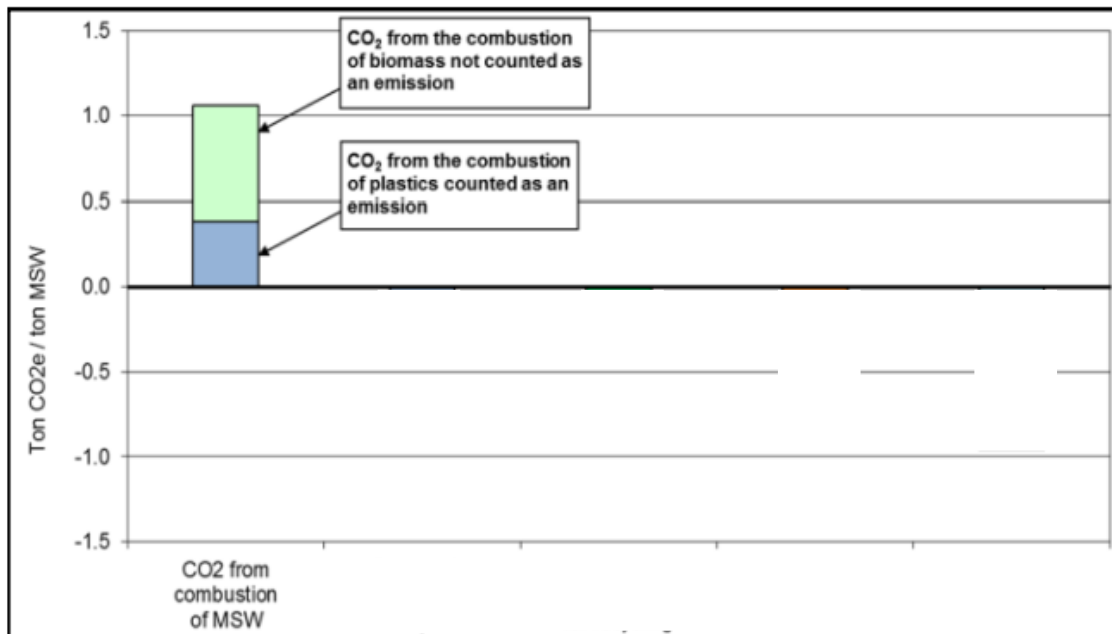
Municipal Solid Waste Management: 1960–2018



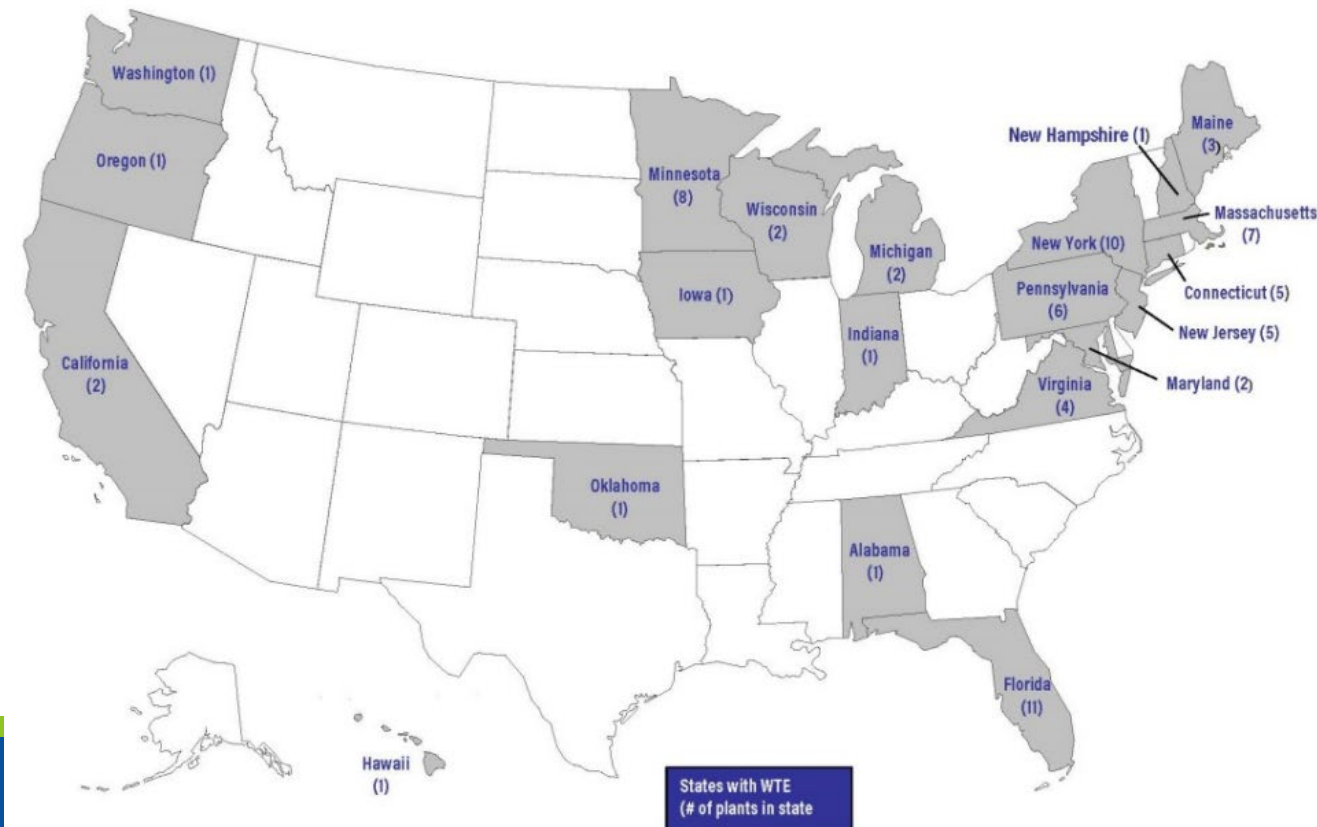
Accessed at <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials> on 06.28.2022

Combustion: Waste to Energy

- Generates energy that otherwise would likely be generated by fossil fuel.
- Recovers metals for recycling, thereby saving the GHGs and energy associated with the production of products and materials from virgin inputs.
- Diverts waste from landfills where it would have emitted GHG.

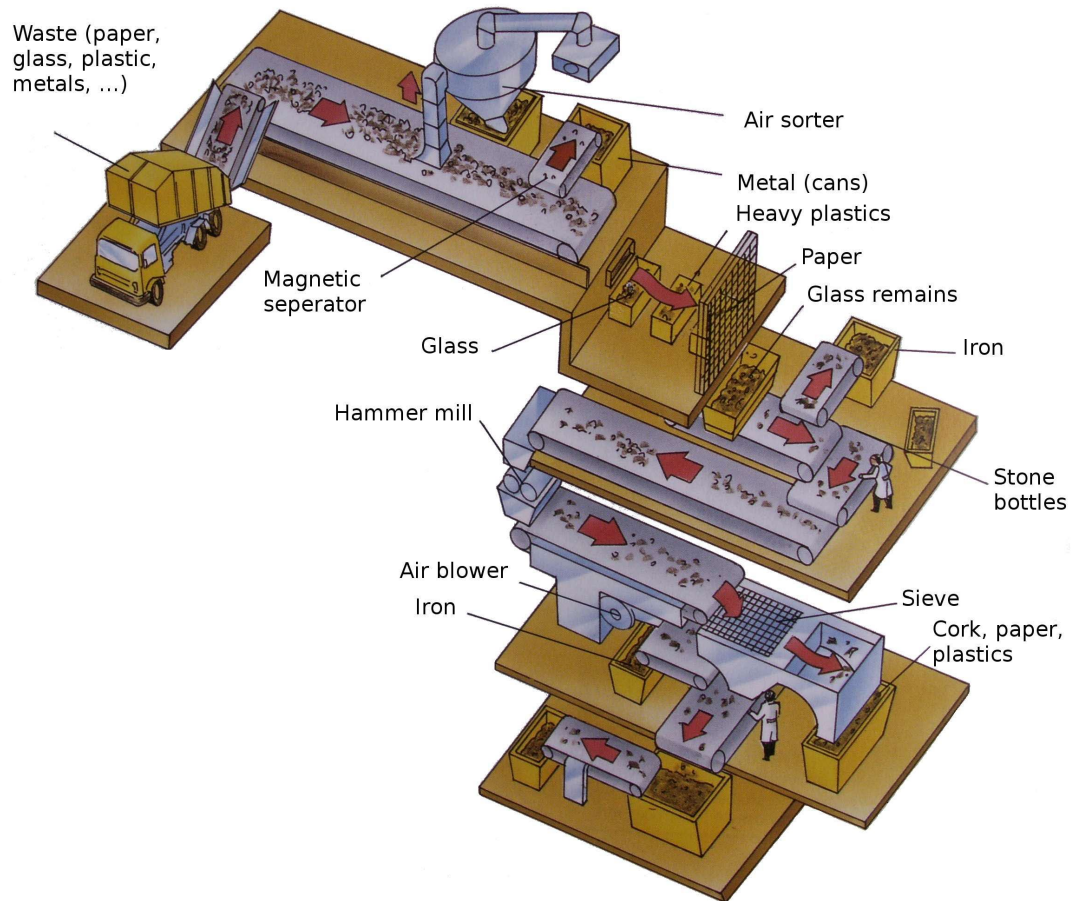


Accessed at <http://energyrecoverycouncil.org/wp-content/uploads/2019/10/ERC-2018-directory.pdf> on 06.28.2022

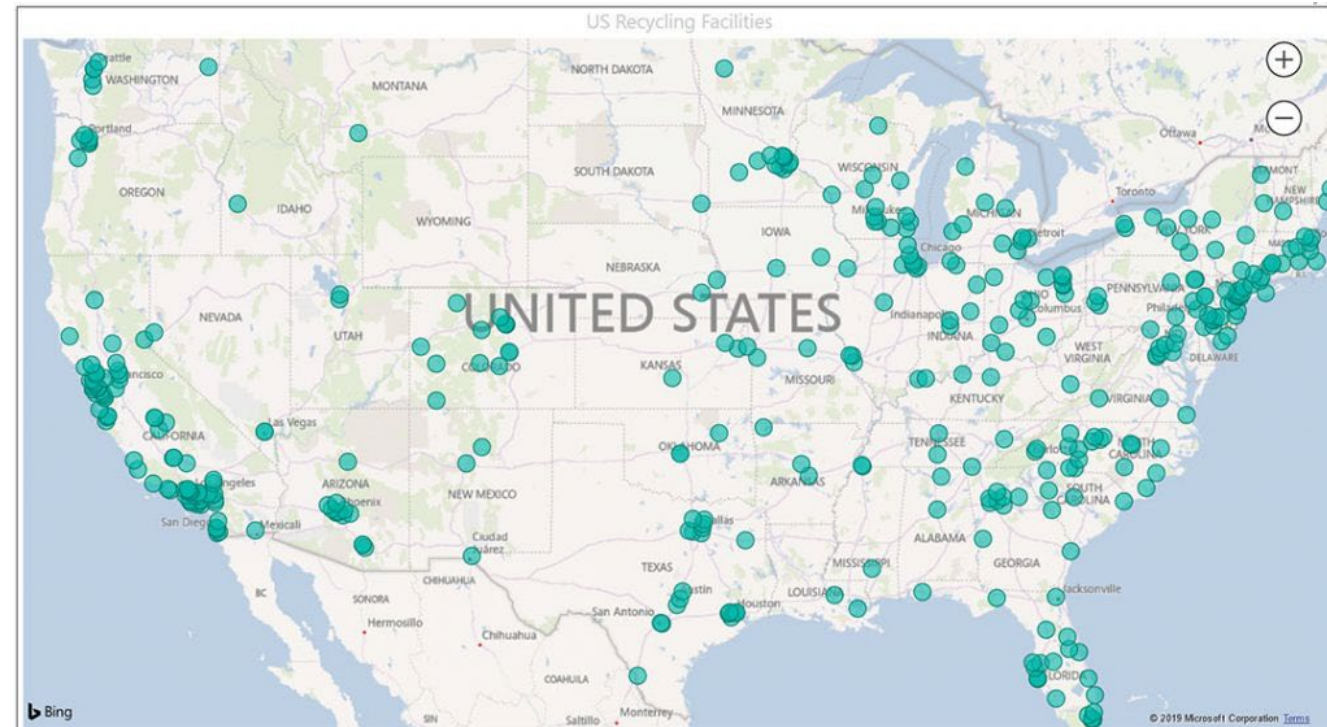


Recycle: Material recovery facilities (MRF)

- In the United States, as of 2019
 - Over 300 MRF
 - Market size is \$6.6b



Accessed at https://en.wikipedia.org/wiki/Materials_recovery_facility#/media/File:Non-selective_domestic_waste_sorting_machine.JPG on 06.28.2022

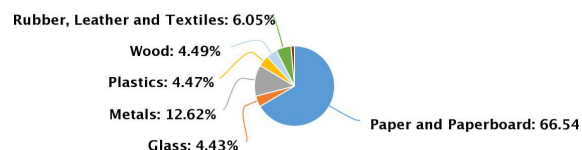


Accessed at <https://resource-recycling.com/recycling/2019/10/22/mapping-out-mrf-infrastructure-nationwide/> on 06.28.2022

Summary of management methods

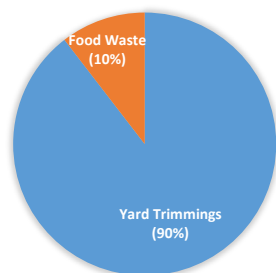
Recycled:

In 2018, 69 million tons MSW was recycled.



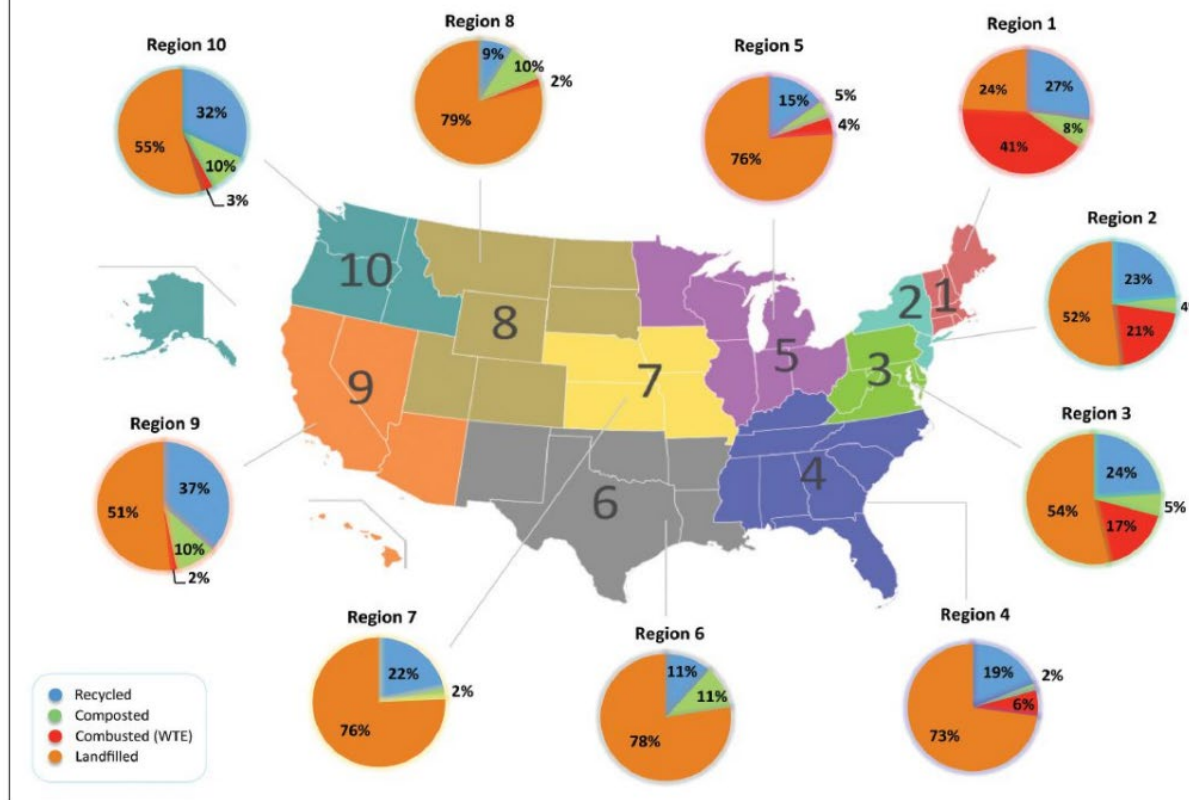
Composted:

In 2018, 25 million tons MSW was composted.



Breakdown by EPA Regions

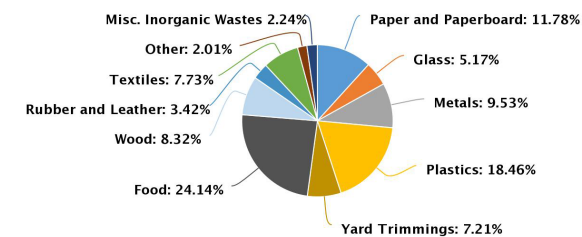
Recycling, composting, combusting, and landfilling rates by regions



Accessed at <https://www.mswmanagement.com/> on 06.28.2022

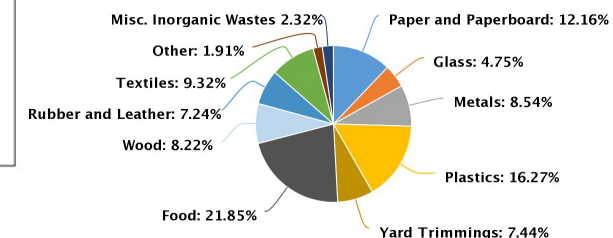
Landfilled:

In 2018, 146 million tons MSW was landfilled.



Combusted:

In 2018, 35 million tons MSW was combusted.



Greenhouse gas benefits

In 2018,

Recycled (MT)	Composted (MT)	Combustion with Energy Recovery (MT)	Landfilled (MT)
69	25	35	146

Note: numbers in parentheses indicate a reduction in either greenhouse gases or vehicles, and therefore represent environmental benefits.

MSW's environmental impact

- MSW breaks down in landfills to emit greenhouse gas, and potential leaching of hazardous materials to groundwater.
- Change in climate and destruction of ozone layer due to waste biodegradable.
- Combustion of MSW generates a variety of pollutants (CO_2 , heavy metals, dioxins, particulates) that contribute to impacts on both environment and human health.



MSW's environmental impact

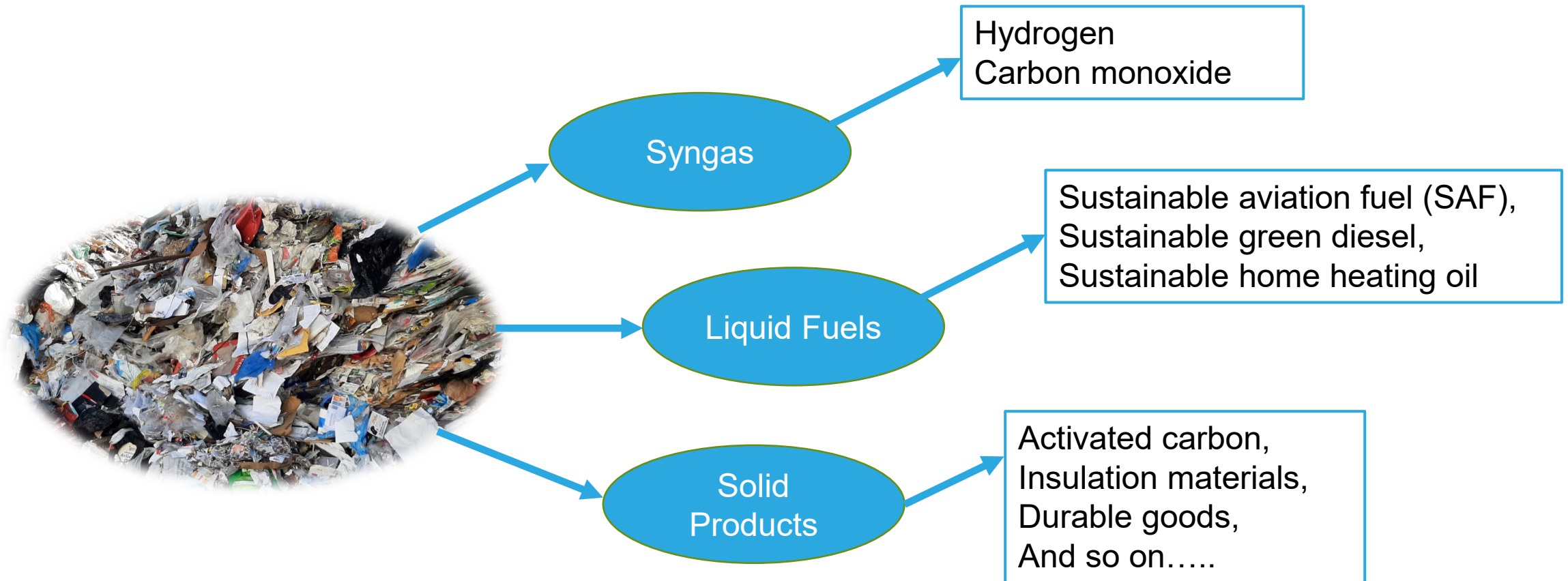
- >15% of methane emissions in the USA.
- These methane amounts
 - Are equal to emissions released by over 20 million passenger vehicles driven over the year.
 - Can trap 20 times more solar radiation than CO₂.



What are we sending to landfill?

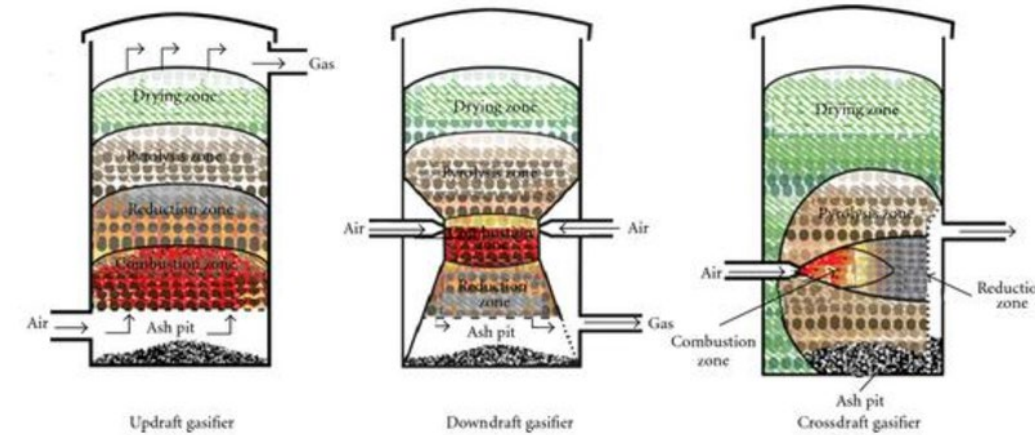
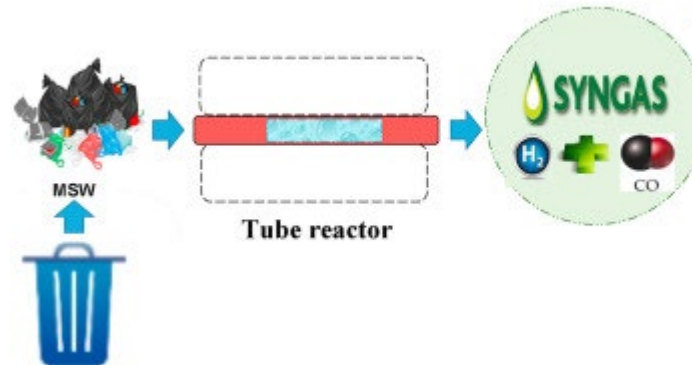


Potential opportunities of MSW utilization

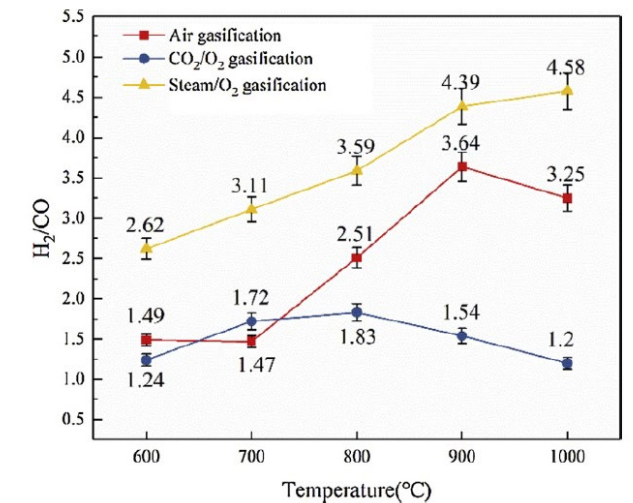


MSW to syngas

- Many companies have developed waste gasification technology:
 - Enerkem
 - Energy Products of Idaho
 - ENERGOS
 - Foster Wheeler
 - Lurgi
 - Thermoselect
 - Westinghouse Plasma Corporation
 - Ze-gen

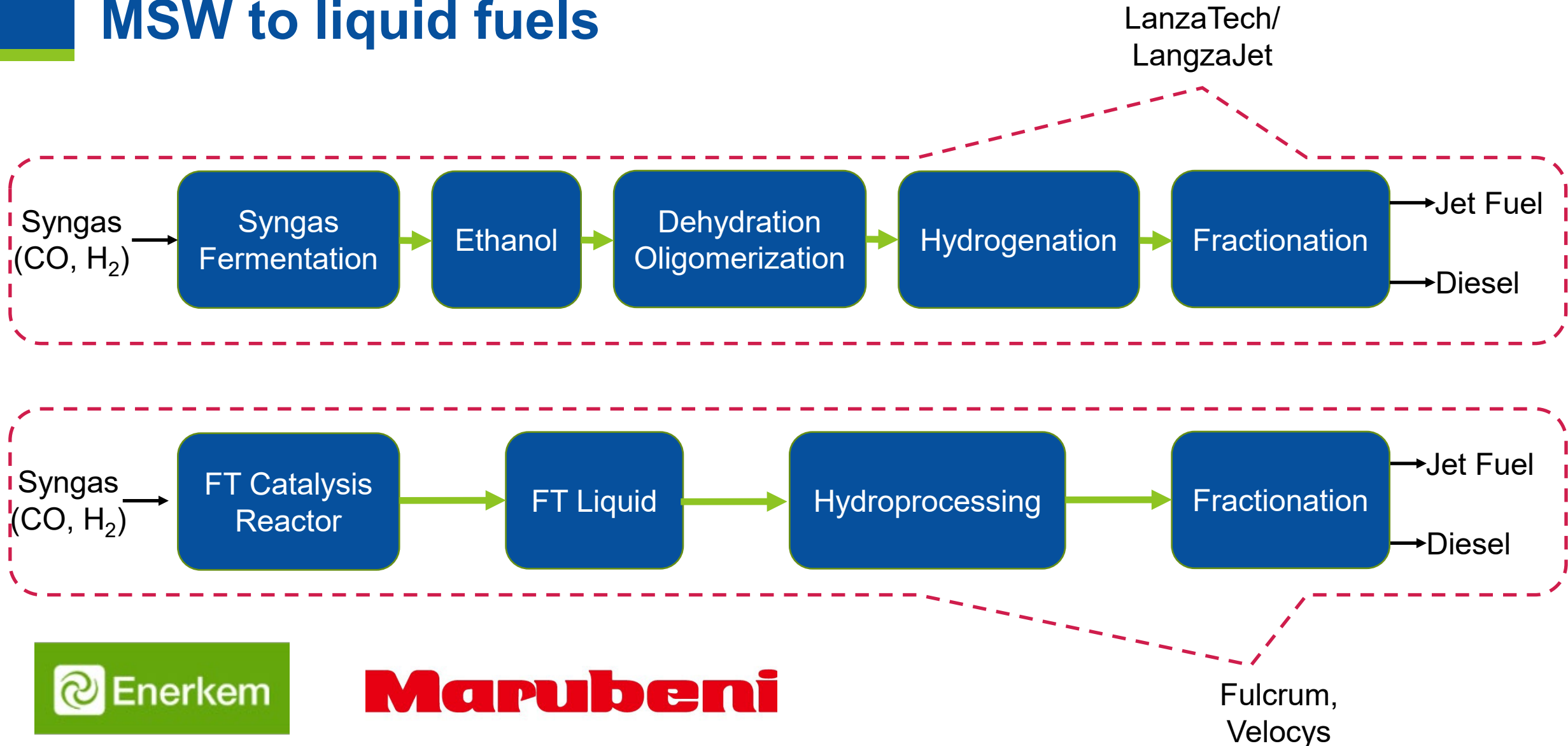


Accessed at https://www.researchgate.net/figure/Different-zones-of-gasification-depending-upon-the-types-of-gasifier-Image-source_fig2_258383817 on 06.28.2022



Accessed at https://papers.ssrn.com/sol3/papers.cfm?abstract_id=4074329 on 06.28.2022

MSW to liquid fuels

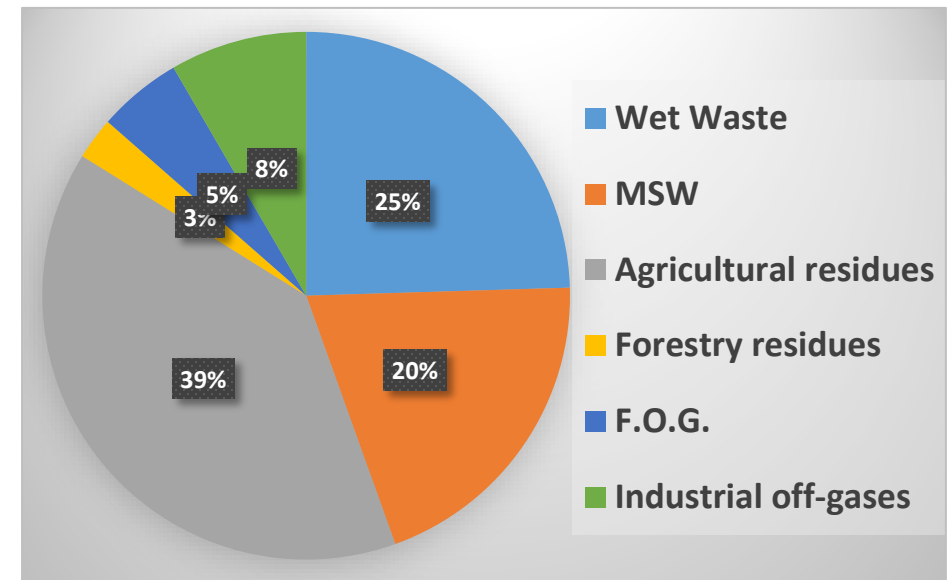


Marubeni

MSW to liquid fuels

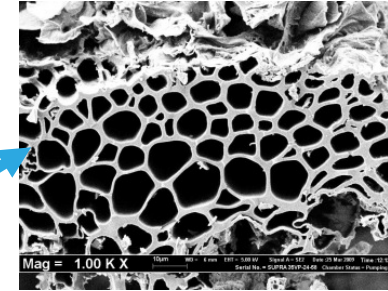
SAF: Targets of opportunity that do not compete for food or land use change

- Wet Waste: manures, sanitary, misc streams
- MSW: wood, paper, yard, plastics, textiles, food
- Agricultural residues: primary crop residues only, 31% removal
- Forestry residues: 30% of production uncommitted
- F.O.G.: Fats oils and greases
- Industrial off-gases from steel, aluminum, petroleum industries



Accessed at https://portal.ct.gov/-/media/DEEP/waste_management_and_disposal/CCSMM/Public-Comments/038_RichardAltman_20201026.pdf on 06.28.2022

MSW to solid products



Activated Carbon



Thermal Insulation

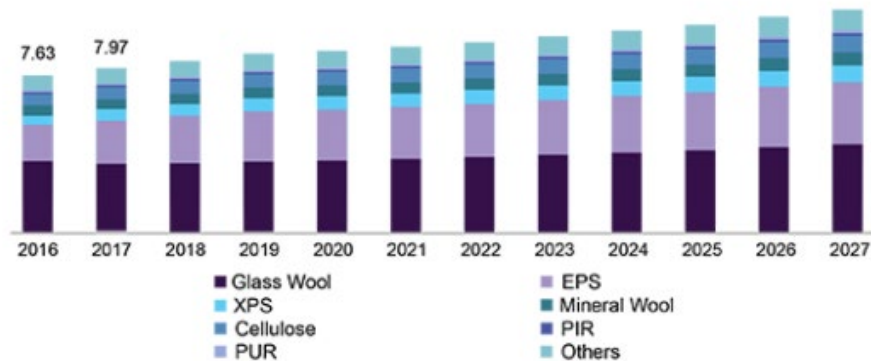


Cementitious

Solid products: Case study for co-products creation

- Investigation of off-spec material properties and carbon structures for reuse in coproduct production
 - Building materials
 - High surface area carbon materials
 - Carbon fiber composites

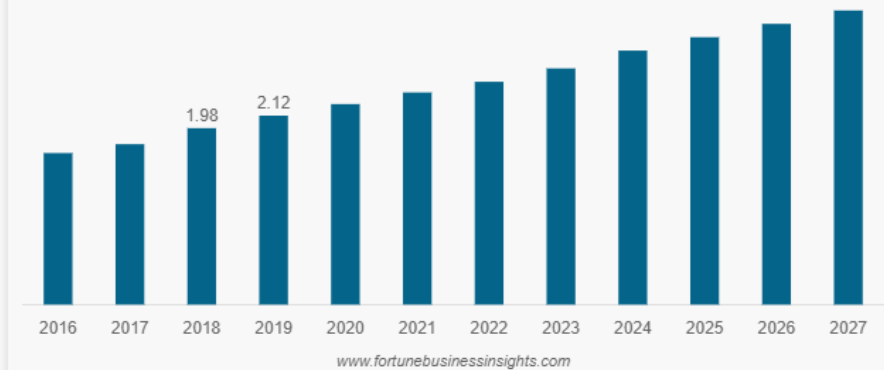
U.S. building thermal insulation market size, by product, 2016 - 2027 (USD Billion)



Source: www.grandviewresearch.com

Accessed at <https://www.grandviewresearch.com/industry-analysis/building-thermal-insulation-market> on 12.01.2021

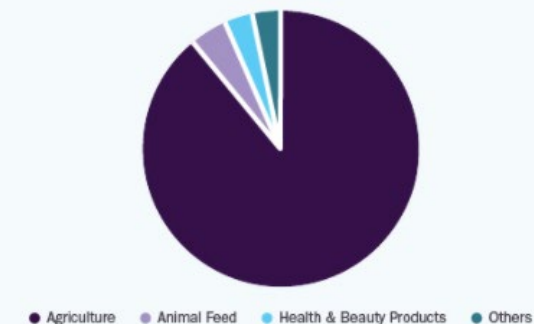
North America Wood Plastic Composite Market Size, 2016-2027 (USD Billion)



www.fortunebusinessinsights.com

Accessed at <https://www.fortunebusinessinsights.com/wood-plastic-composite-market-102821> on 12.10.2021

U.S. Biochar Market
share, by application, 2020 (%)



\$125.3M
U.S. Market Size,
2020

Source:
www.grandviewresearch.com

Accessed at <https://www.grandviewresearch.com/industry-analysis/biochar-market> on 05.26.2021.

MSW to thermal insulation: Processing



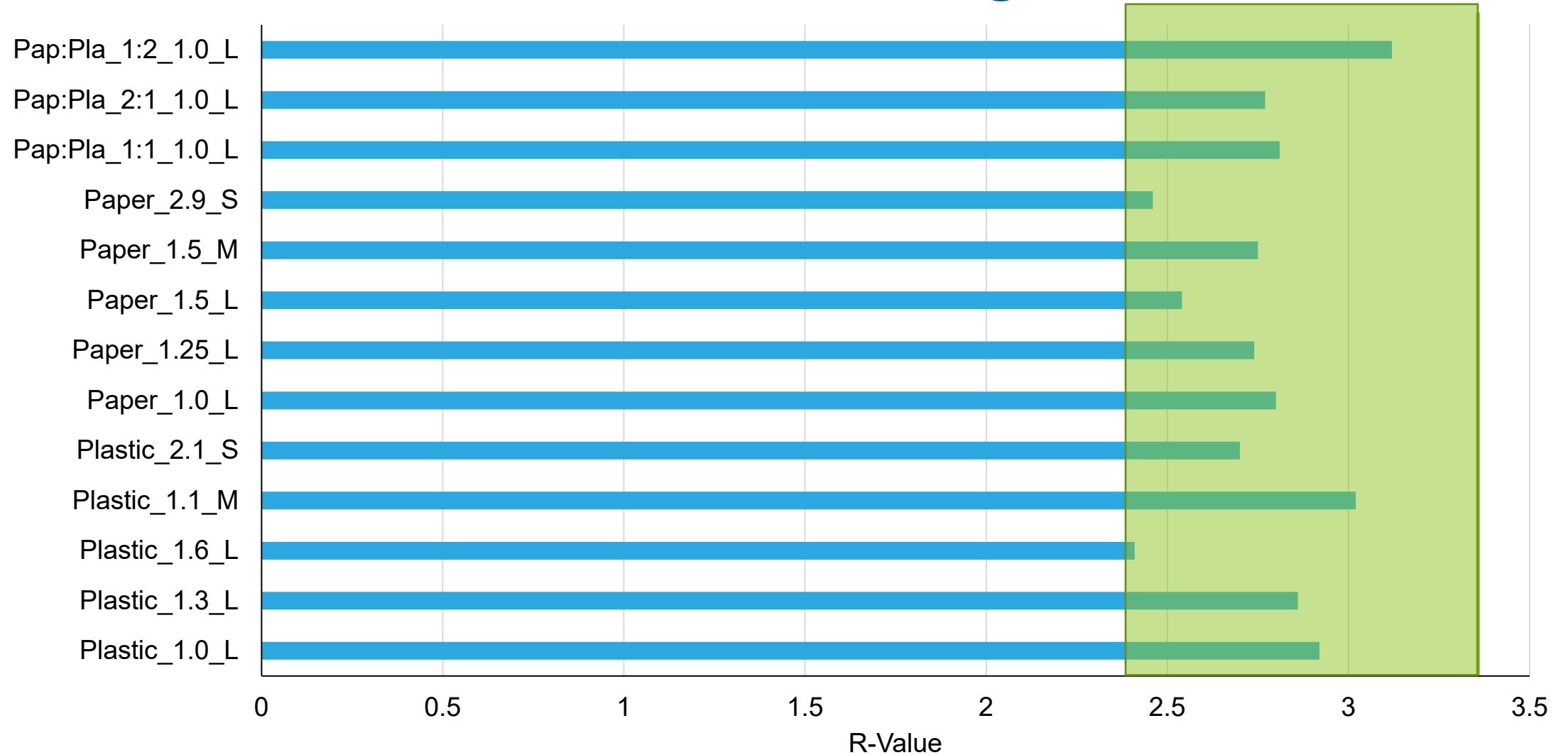
Thermal
insulation and/or
energy material



Potential
cementitious
material



MSW to thermal insulation: Findings



Challenges associated with MSW handling

- Heterogeneous
 - Mechanical preprocessing
 - Chemical treatment
- Health and safety problems
 - Mechanical Hazards
 - Ergonomic Hazards
 - Chemical Hazards
 - Biological Hazards



Solutions and sustainable alternatives

- Source Reduction:
 - Identify opportunities to reuse materials at home or in your community.
 - Select efficiently packaged products or buying in bulk as packaging and containers made up 28% of the MSW generated in 2018.
 - Choose reusable plates, cups, and silverware over disposable goods as 2.5 million tons of paper and plastic plates and cups were disposed in 2018.
 - Reduce food waste through efficient meal planning and composting of scraps.
- Encourage Supportive Public Policy:
 - Implement Pay-As-You-Throw programs which could limit the MSW generation per household.
 - Implementation of recycling and composting programs can help reduce the burden of waste disposal.
 - A few (10) states have deposit laws that encourage the return of empty beverage containers for refunds.

Thank You!

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