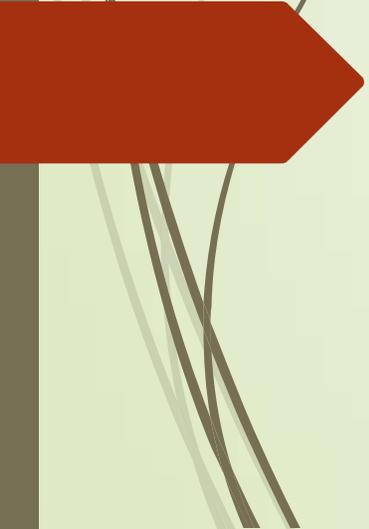


What is the best disposal option for the "Leftovers" on the way to Zero Waste?



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Working to Build Zero Waste Communities

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Why focus on “leftovers”

Maximizing the 3Rs is the most important thing to keep working on

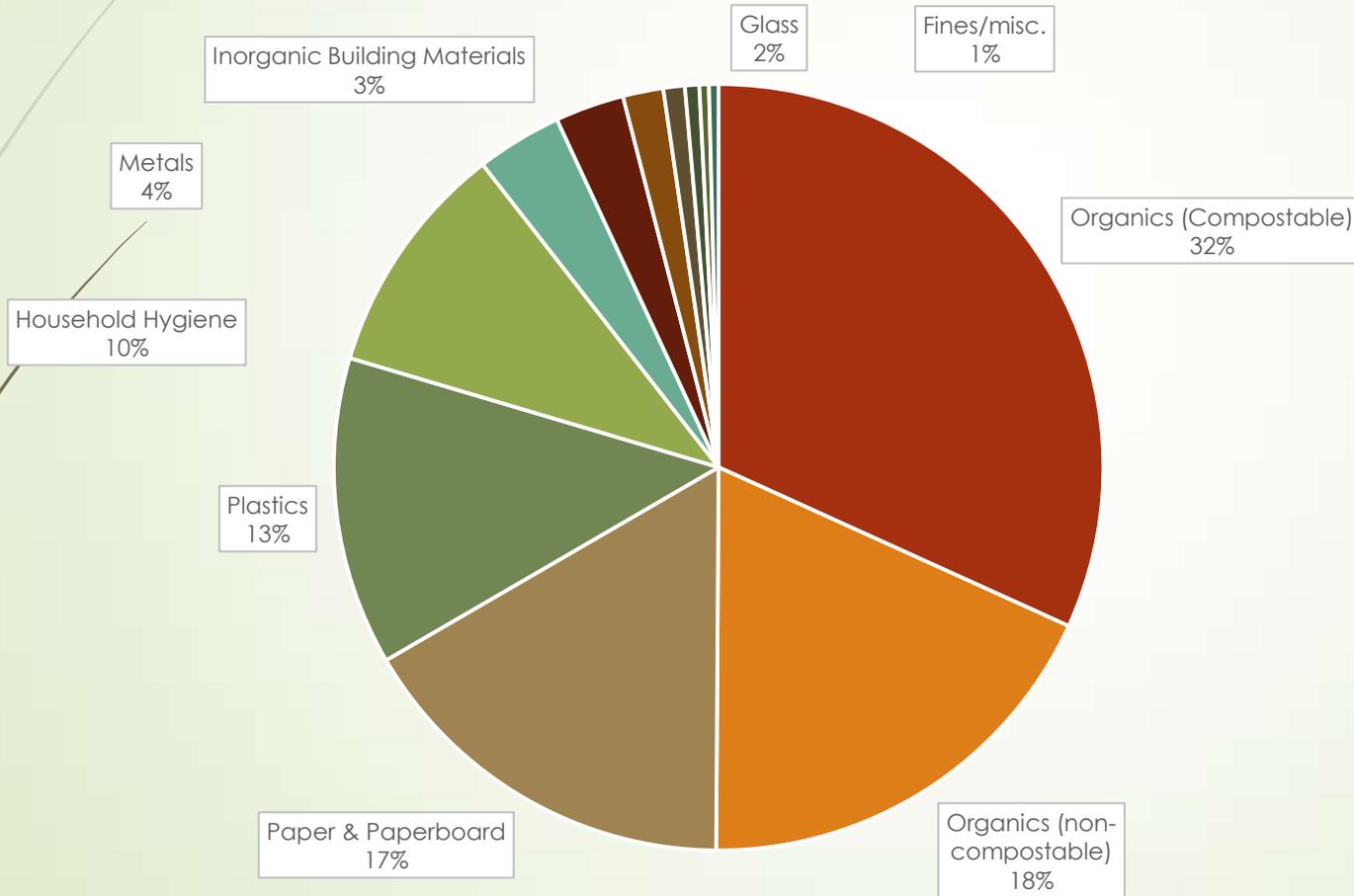
Getting to Zero Waste is a journey, takes time, still producing trash along the way

Big \$\$\$\$ already invested in landfills and incinerators

Wrong investment jeopardizes a community's Zero Waste future



Household “leftovers” after 71% recovery in Seattle, WA



Top materials remaining in leftovers

Food	29%
Animal byproducts	13%
Disposable diapers	10%
Compostable/soiled paper	7%
Mixed low-grade paper	5%
Other plastic film	4%
Textiles/clothing	3%

Every disposal option requires a landfill

Direct to landfill

- **LFGTE 80%:**
80% of landfill gas captured and used for energy production
- **LFGTE 40%:**
40% of landfill gas captured and used for energy production

LFGTE = landfill-gas-to-energy:

Gas capture rates are controversial, ranging from 20% lifetime capture to 90% point-in-time capture

WTE to landfill

- **WTE:**
mass burn incineration with energy recovery

WTE = waste-to-energy:

No "conversion techs" were analyzed because no commercial-scale emissions data available; assumed 10% residue by weight to landfill, 25% by volume

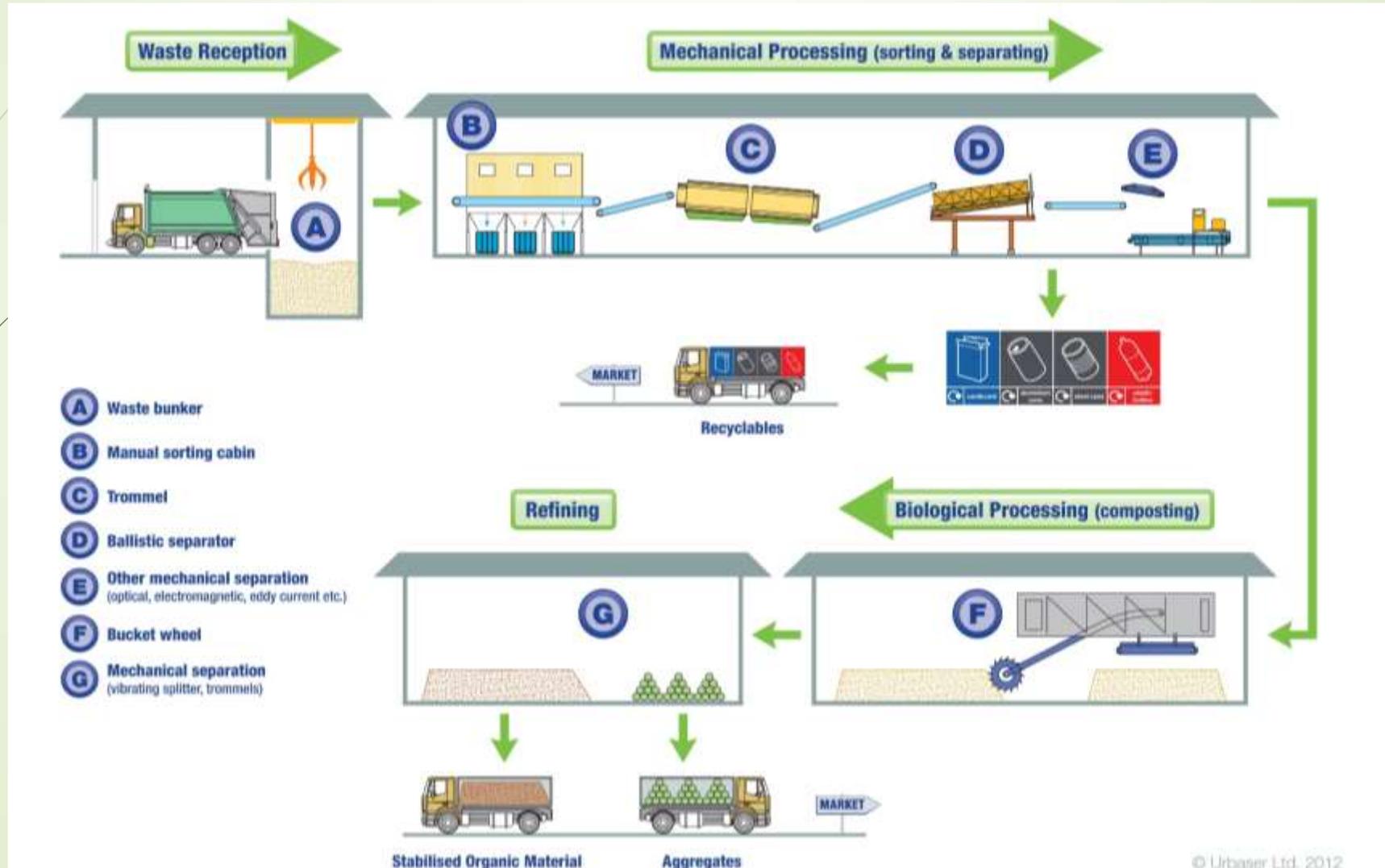
MRBT to landfill

- **MRBT Hi**
higher recovery of recyclables,
no landfill gas capture
- **MRBT Lo**
lower recovery of recyclables,
no landfill gas capture

MRBT = material recovery, biological treatment:

No energy/fuel is produced as a product

What is MRBT ?

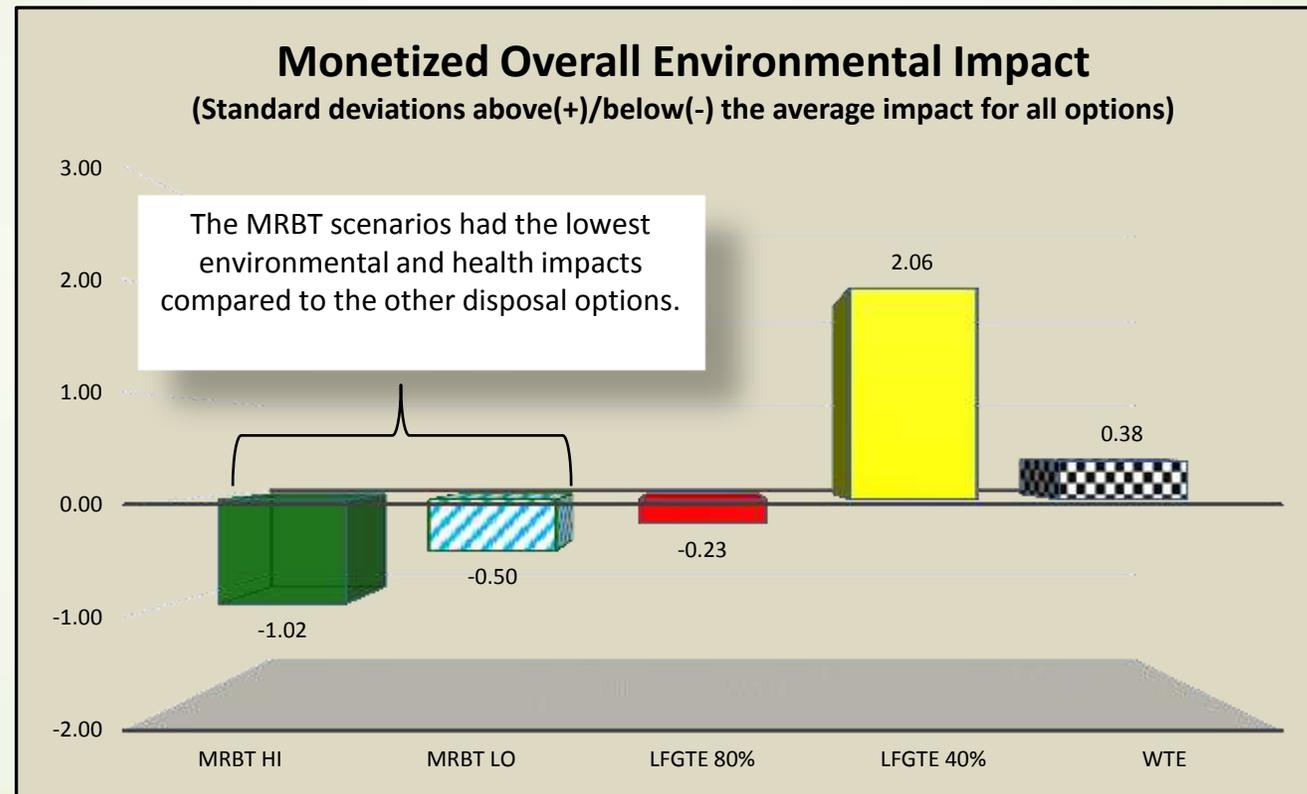


Results: MRBT the clear winner

- Highest reductions in overall environmental impacts
- Lowest environmental impact in 5 of 7 categories
- Environmental benefit valued at \$7 and \$13 per ton of leftovers



Overall impacts with standard deviation



Analyze impacts with MEBCalc™



Climate Change
(eCO₂)



Acidification
(eSO₂)



Eutrophication
(eN)



Respiratory
(ePM_{2.5})



Non-cancer (eT)



Cancer (eB)



Ecotoxicity (e2,4-D)

- More assumptions and background at www.ecocycle.org/specialreports/leftovers



What MEBCalc™ Does

- ▶ **Inventories pollutants** (100s) from solid waste management activities that are released at no cost to their generators
- ▶ **Sorts & aggregates pollutant effects** into 7 types of environmental and human health impacts
- ▶ **Aggregates 7 environmental & human health impacts** into overall estimate of solid waste system external costs
- ▶ **Compares external costs** for diversion scenarios to disposal scenarios



MEBCalc™ LCA Impact Categories

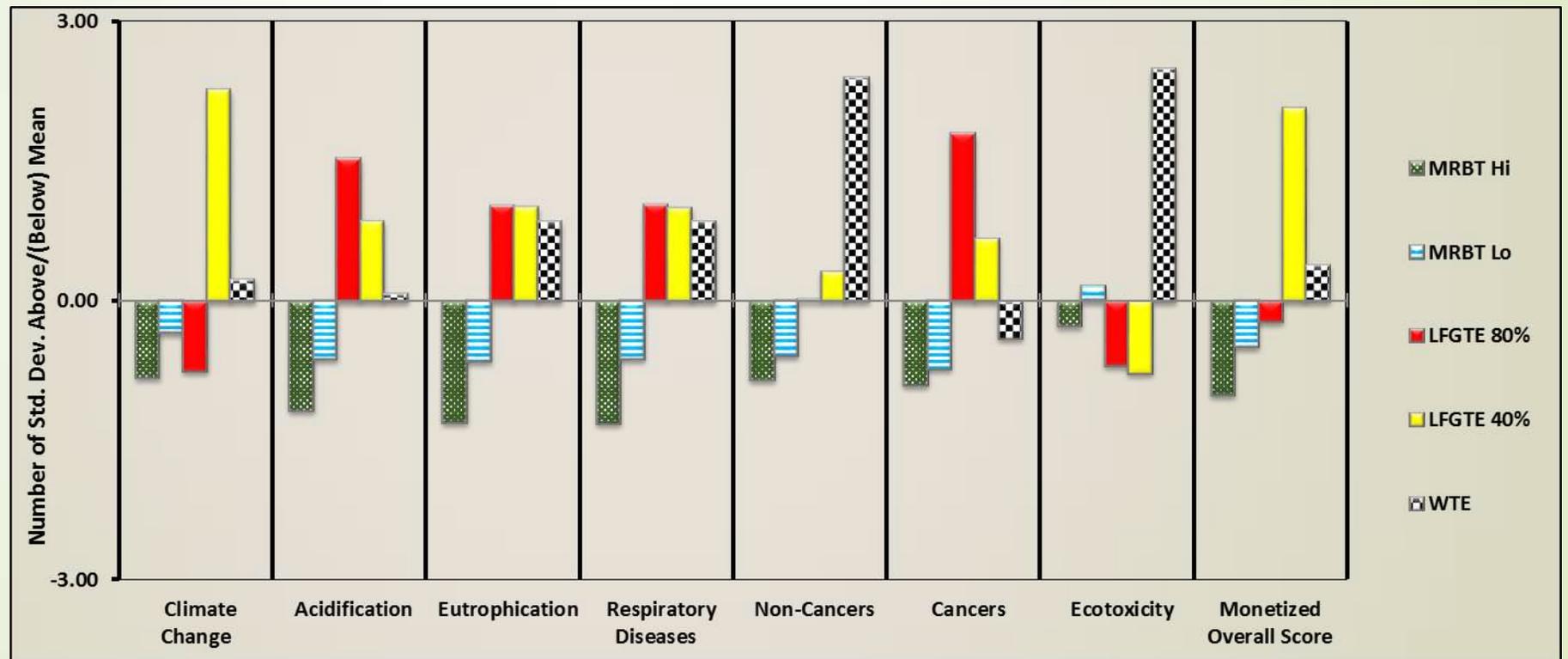
- **Climate Change** – carbon dioxide equivalents (eCO₂)
- **Human health - respiratory diseases** – particulate matter no more than 2.5 microns equivalents (ePM_{2.5})
- **Human health - non-cancers** – toluene equivalents (eToluene)
- **Human health - cancers** – benzene equivalents (eBenzene)
- **Eutrophication** – nitrogen equivalents (eN)
- **Acidification** – sulfur dioxide equivalents (eSO₂)
- **Ecosystems toxicity** – herbicide 2,4-D equivalents (e2,4-D)



Cost of LCA Impacts

- **Climate change:** \$40/ton eCO₂
- **Human health - respiratory diseases:** \$10,000/ton ePM_{2.5}
- **Human health - non-cancers :** \$118/ton eToluene
- **Human health – cancers:** \$3,030/ton eBenzene
- **Eutrophication:** \$4/ton eN
- **Acidification:** \$410/ton eSO₂
- **Ecosystems toxicity:** \$3280/ton e2,4-D

Standardized environmental impact scores for the five management options

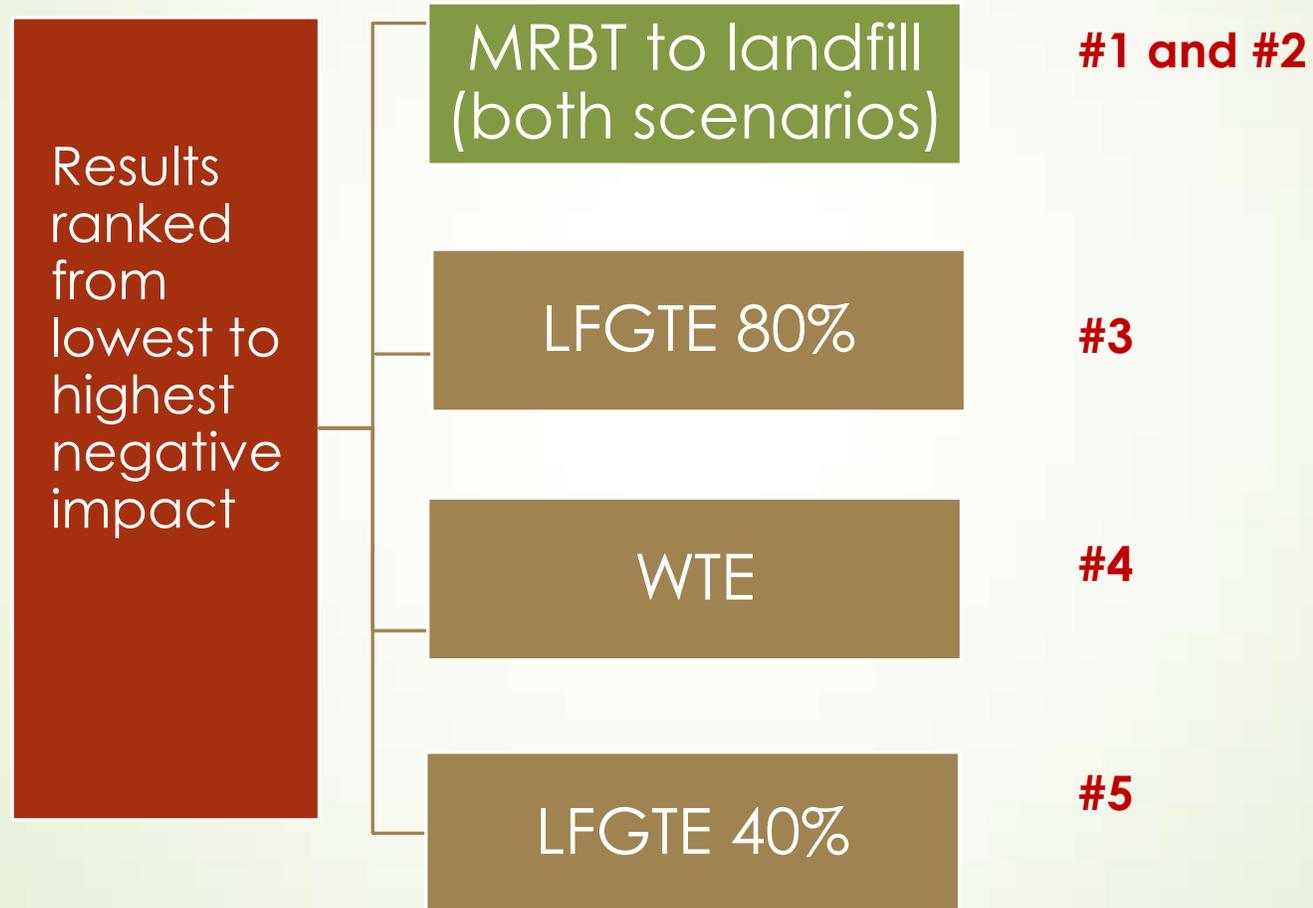


Detailed analysis in MEBCalc™

Impact Category	Increase/Decrease in Environmental Impact Potential (measured in pounds of each impact category's indicator pollutant per incoming ton)					Monetized Impact (\$/Ton of Emissions)
	MRBT Hi	MRBT Lo	LFGE 80%	LFGE 40%	WTE	
Climate Change (eCO ₂)	-3.90E+02	-1.50E+02	-3.60E+02	1.10E+03	1.30E+02	\$40
Acidification (eSO ₂)	-2.50E+00	-1.40E+00	2.80E+00	1.50E+00	-3.40E-02	\$290
Eutrophication (eN)	-1.80E+00	-1.30E+00	1.30E-01	1.20E-01	-1.10E-02	\$4
Respiratory (ePM _{2.5})	-7.00E-01	-4.90E-01	2.70E-02	1.50E-02	-2.80E-02	\$10,000
Non-cancer (eT)	-5.20E+01	-4.10E+01	-1.20E+01	1.20E+00	9.70E+01	\$30
Cancer (eB)	-3.20E-01	-1.50E-01	2.30E+00	1.20E+00	1.70E-01	\$3,030
Ecotoxicity (e2,4-D)	1.00E-03	1.60E-03	3.60E-04	2.30E-04	5.10E-03	\$3,280
MONETIZED OVERALL SCORE	- \$13	- \$7	- \$3	+ \$25	+ \$4	

The actual environmental impacts of each leftovers management strategy with the total environmental impact expressed as an economic cost in the bottom row through a technique called monetization.

Hierarchy of disposal options



WTE *not* the best option

- ▶ Next to worst overall option
- ▶ Still relies on landfills for 10% by weight
- ▶ Environmental damages are greater than the environmental benefits of creating energy



**Costs of environmental damages:
\$4 per ton**

Additional benefits of MRBT over WTE



Quicker and cheaper to build and operate



Flexible to meet local needs and growth of source separated collection system



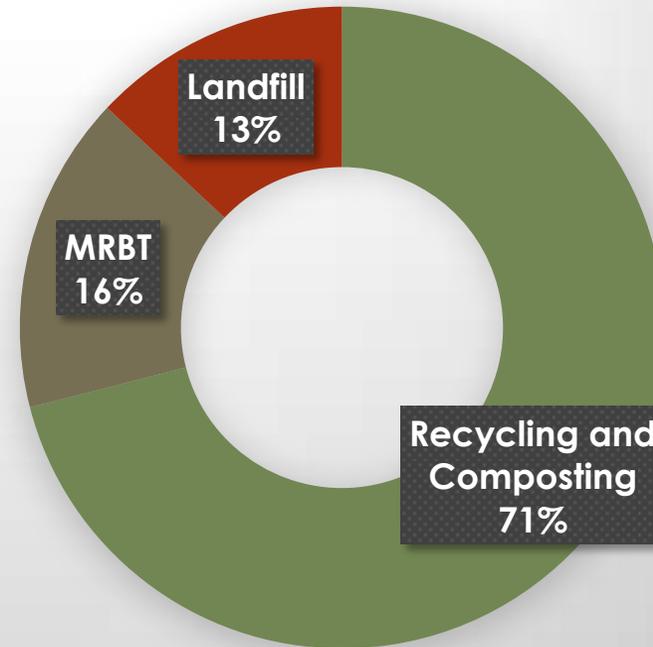
More politically attractive

MRBT facilities are “**flexible and dual-purpose**” since they work for both source-separated materials and mixed-waste trash



Material recovery a bonus - Screening for non-recyclables an education

87%
landfill reduction
projected for
city of Seattle
households
using MRBT



Sorting residuals in Italy & partnering with industry

- ✓ Capannori, Italy – ZW Research Centre
 - ✓ First target – coffee capsules
 - ✓ Dialogue with Lavazza, “Italy’s favorite coffee”



ZERO WASTE EUROPE

If you are not for Zero Waste, how much waste are you for?



Conclusion

- ▶ MRBT-to-landfill is not a replacement for source-separated recycling and composting, but it is a valuable tool for helping communities reduce the environmental impacts from the disposal of their leftovers on the way to Zero Waste.



www.ecocycle.org/specialreports/leftovers

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