Trends in recycling of plastic wastes and means for increasing recovery

Jawad A. Bhatti

Thesis Advisor: Prof. N.J. Themelis

Earth and Environmental Engineering,

Columbia University

Research sponsored by

COLUMBIA UNIVERSITY

EARTH ENGINEERING CENTER

Advancing the Goals for Sustainable Waste Management

Outline

- Rate of generation & recycling of plastic wastes in the U.S.
- Composition of plastic wastes
- Residues of 2 Waste Management-owned and operated Reclamation Facilities
- Benefits & difficulties of recycling
- Technical means to increase plastics recovery
- Legislative attempts to address plastics disposal
- Conclusions

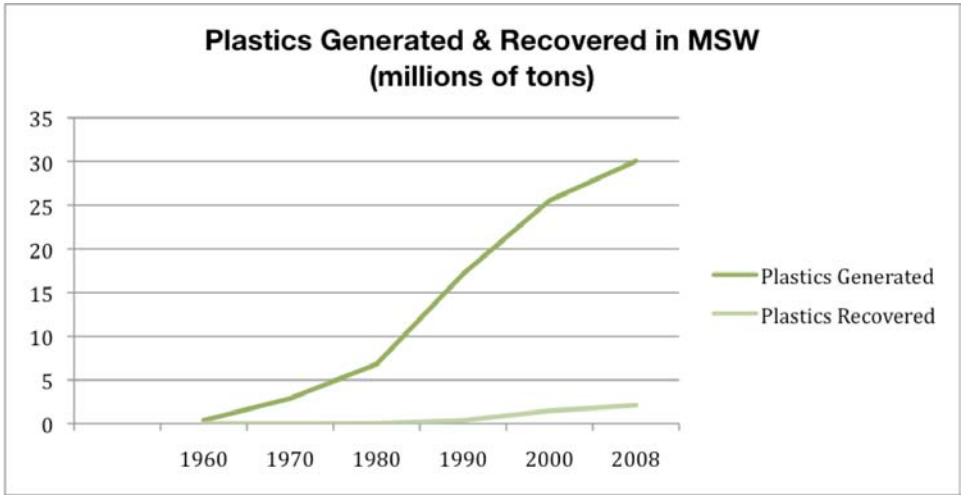
Rate of generation & recycling of plastic wastes in the US

U.S. plastics produced annually :	41 million tons/annually
Plastics disposed annually in MSW:	30 million tons/annually
Recycled:	2 million tons/annually
Waste-to-Energy (WTE):	3 million tons/annually
Plastics landfilled annually in MSW :	25 million tons/annually

Despite a lot of efforts by communities and the petrochemical industry, less than 10% of the plastic wastes are recycled and about 10% are combusted

Rate of generation & recycling of plastic wastes in the US (cont.)

- Plastics production in the U.S. has grown phenomenally in the last 50 years from virtually nothing in 1960 to over 40 million tons/year now.

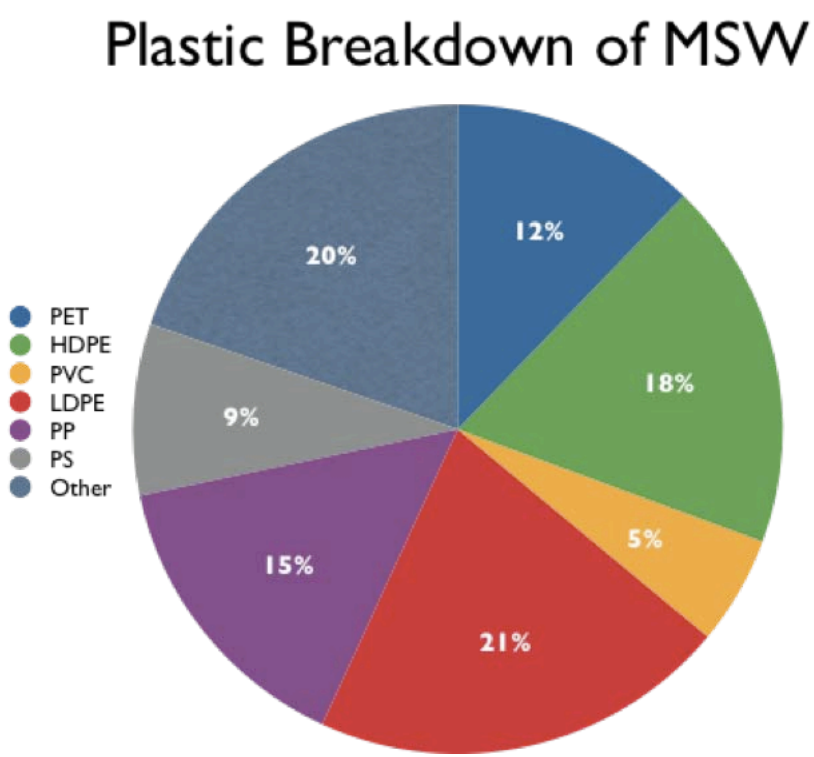


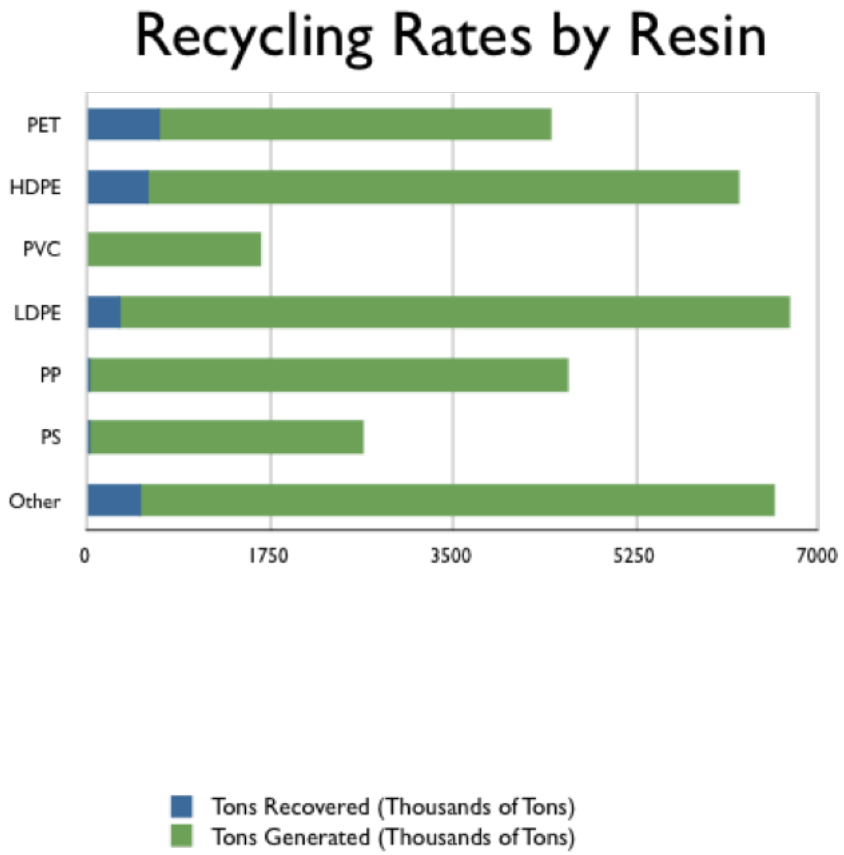
- Plastic wastes in MSW have followed, to 30 million tons/year
- Plastic waste recovery has not kept pace with the disposal rates – virtually nothing in 1985 to now 2 million tons/year

Plastics in U.S. municipal solid wastes (MSW) by resin (thousands of tons)

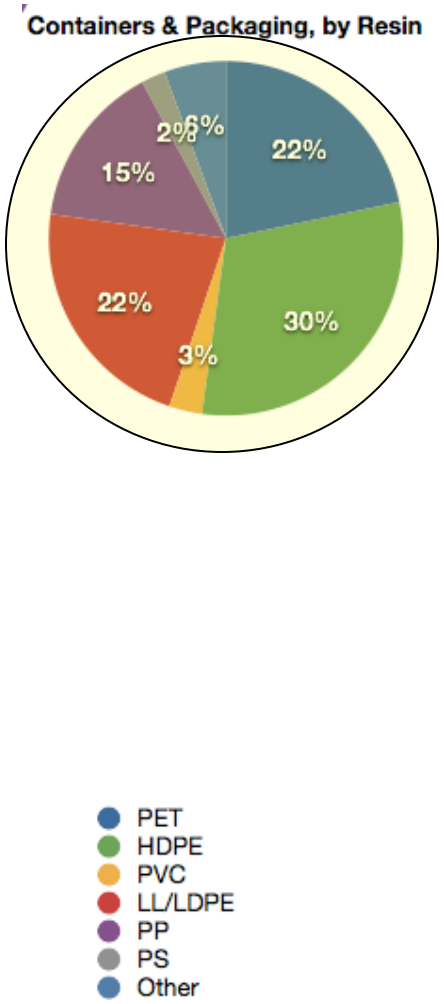
Code	*Abbreviation*	*Generated*	*Recovered*	*Combusted/ Landfilled*	*% Recycled*
	PET	3,760	680	3080	18.1%
	HDPE	5,650	570	5,080	10.1%
	PVC	1,660	negligible	1,660	<0.1%
	LDPE	6,400	310	6,090	4.8%
	PP	4,570	10	4,560	0.2%
	PS	2,620	20	2,600	0.8%
	O	6,070	500	5,570	8.2%
Total:		**30,730**	2,090	28,640	6.8%

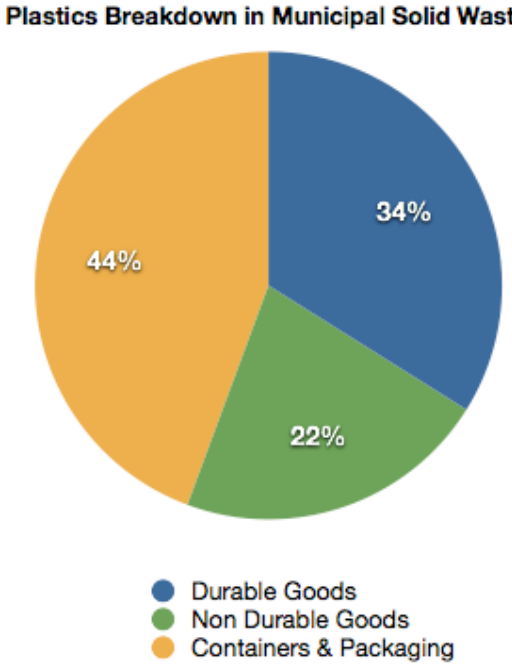
Plastics in U.S. municipal solid wastes (MSW) (cont.)

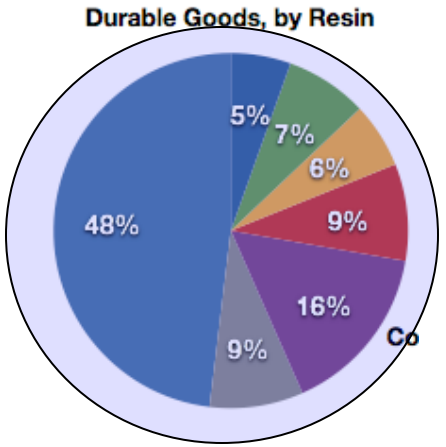


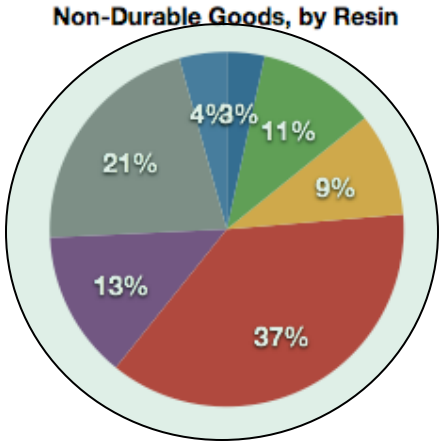


Breakdown of plastics in MSW by use and resin









Plastic Resins

- Six major resins + final catch-all =
  #1 - PET (Polyethylene Terepthalate),
  #2 - HDPE (High Density Polyethylene),
  #3 - PVC (Polyvinyl Chloride),
  #4 - LDPE (Low Density Polyethylene),
  #5 - PP (Polypropylene),
  #6 - PS (Polystyrene),
  #7 - “Other”

#1+2+3+4+5+6 = 80% of plastic wastes!

On the Recycled Plastics Trail – WM-St. Charles MRF

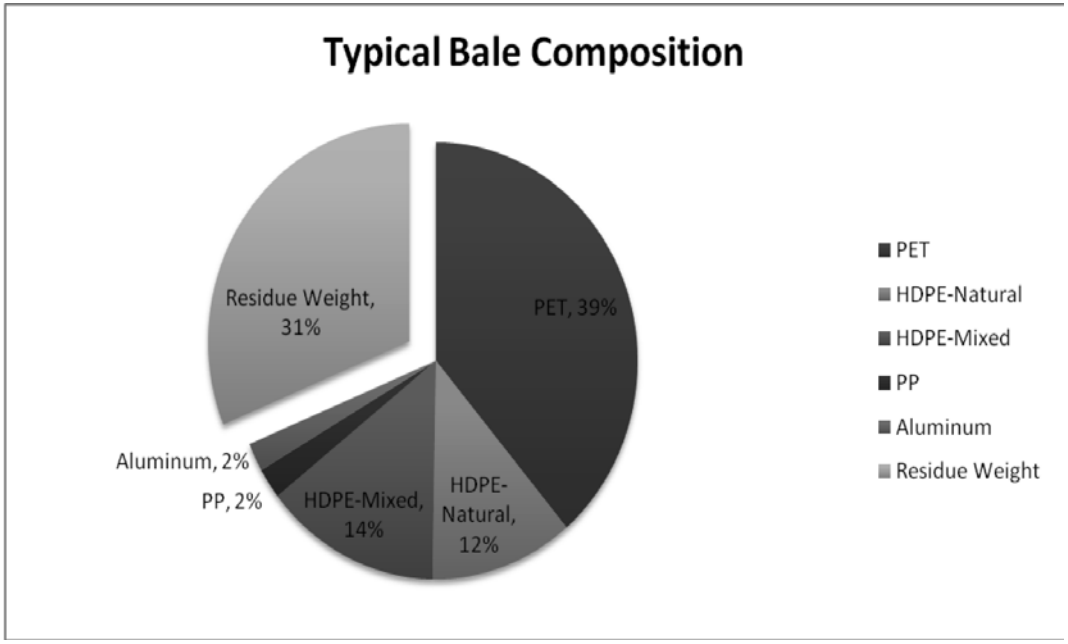
• I visited the Waste Management-Recycle America MRF located in Newark, NJ courtesy of EEC/SUR in May 2009

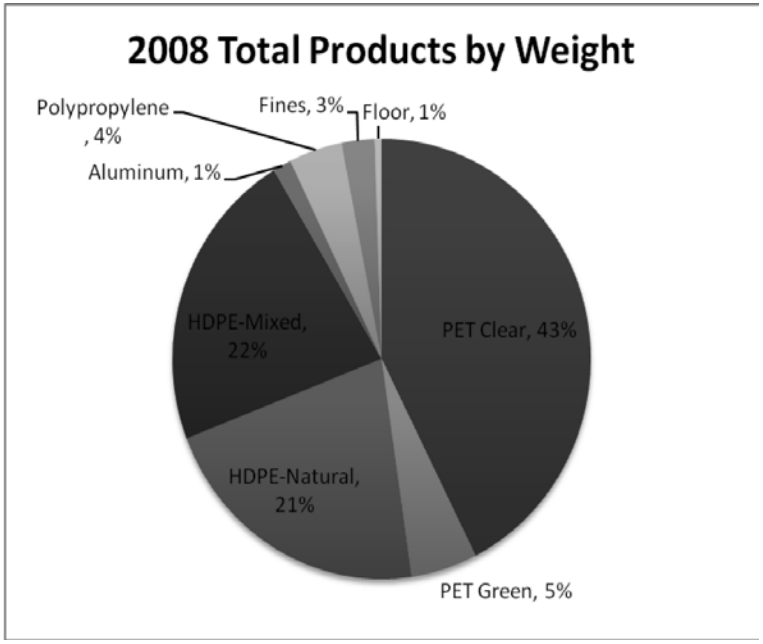
•The facility processes single stream recycling, and produces bales of mixed plastics

•Overall residue of single stream recycling is 10.5%

On the Recycled Plastics Trail – WM-Raleigh Plastics PRF

- I visited the Waste Management-Recycle America facility located in Raleigh, NC courtesy of EEC/SUR in June 2009
- The PRF processes baled mixed plastics from 150 MRFs and produces shredded PET & shredded HDPE as main products, as well as other plastics and aluminum
- Raleigh Plastics debales ~10 million pounds monthly, 69% of which translates to saleable product
- Spends ~$1M annually on landfilling trash
- Trash is largely paper fiber, although 6-12% is “good” material; roughly a quarter of the trash overall is plastic





Benefits of Recycling

- Energy savings – 40-100 MJ/kg, depending on polymer
- Economic benefits
- Reduces demand for virgin polymer
- Preferable to landfilling

Difficulties in Recycling

- Hard to separate from non-plastics (no “magnet” equivalent)
- Differing composition of plastic resins means they are largely incompatible
- Degradation of polymer lengths
- Recycled polymer is of lower quality than virgin polymer
- Most waste plastics beyond jugs & bottles have limited market value, and therefore effort is not spent in collecting them

Mechanical means of separation

- Manual sort rates are typically 1200+ bottles/hour
- Automatic sort rates can be up to 40,000 bottles/hour
- Mechanical methods include : electrostatic separation, dry and wet gravity separation, froth flotation, near-infrared rays (NIR), color sorting

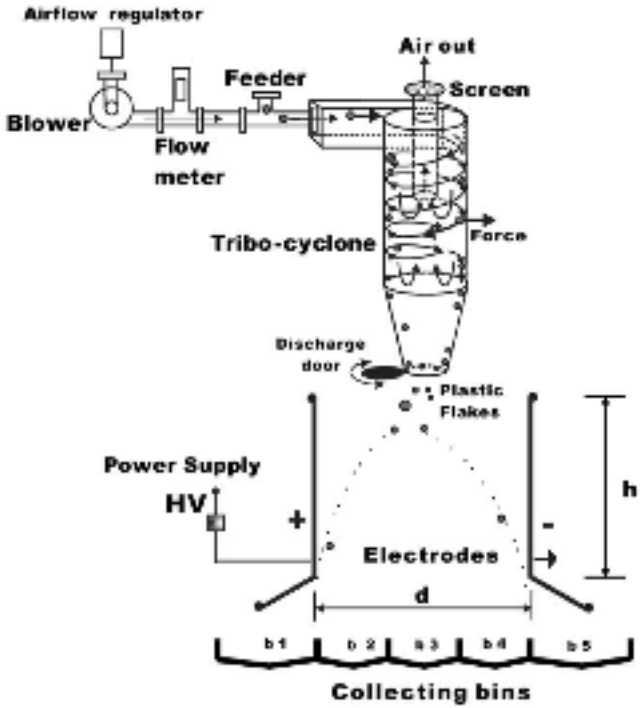
Near-Infrared Rays (NIR)

Triboelectric Separation

Mechanical means of separation - NIR

- Uses optical sorting to positively identify different resins
- As used in Waste Management-Raleigh Plastics (10 Ti-Tech brand sensors)
- Used for whole bottles & jugs
- Requires a minimum particle size of 50mm

Mechanical means of separation – Triboelectric Separation



Triboelectric Separation

- Electrostatically charges particles by passing them through a PE tribocyclone
- Negatively charged particles gravitate towards the postively charged plate and vice versa
- Requires a smaller particle size than NIR
- Can classify 3+ resins at once

Legislative means to increase recovery

- NYS & NYC as a good example ：
  - Widespread (although not always mandatory) curbside recycling programs – often Single Stream (outside NYC)
  - NYS Returnable Container Law (1982) and its update, “The Bigger, Better Bottle Bill” (2009)
  - NYS Plastic Bag Reduction, Reuse and Recycling Law (2009)
  - NYC Electronics Equipment Collection, Recycling and Reuse Act (2008)
  - NYS Electronic Equipment Recycling and Reuse Act (2010)
  - NYC textile recycling initiative (new in Fall 2010)

Conclusions

- Plastic waste recovery has not kept pace with the disposal rates – from virtually no recycling of plastics in 1985 to about 7% now.

- Technical advancements allow for more efficient separation that previously possible.

- Legislation may be the best way to divert plastic wastes to recovery facilities, in order to increase recycling rates.

Sources

- Bakker, E.J. “Upgrading mixed polyolefin waste with magnetic density separation.” Waste Management 29 (2009) 1712-1717.
- Beck, R. W. . *Preliminary Waste Characterization Study*. Final Report prepared for the New York City Department of Sanitation, September 2004.
- Dodbiba, G. et al. “The use of air tabling and triboelectric separation for separating a mixture of three plastics.” Minerals Engineering 18 (2005) 1350-1360.
- EPA, "Municipal Solid Waste Generation, Recycling, and Disposal in the United States" 2008