Metrics to Assess Recycling Performance

Samantha MacBride, Ph.D.
Director of Research and Operations, Bureau of Recycling and Sustainability, New York City Department of Sanitation

Introduction

This document reviews definitions of common metrics used to assess recycling performance. The goal is to gain consensus on definitions, as well as agreement on categories and subcategories (e.g. residential vs. commercial) that provide detail on metrics.

This document does not comment on which metrics best reflect recycling performance, nor does it recommend any changes in policy or programming beyond the recording of consensus in a published EPA reference document.

Recycling Rate: Presently Underdefined

The term "Recycling Rate" is used frequently in common parlance and the media to refer to how well a company, locality, state or nation is progressing in sustainable materials management.

Discussion items

1. Do we want to equate "recycling rate" with one of the below rates (diversion, capture, participation) or leave it untethered to a particular rate definition?
2. If the latter, do we want to draft language on the different ways to look at the recycling rate, i.e. to say something to the effect of:

   "The recycling rate can mean several things. It may reflect how much discarded material is being diverted from disposal towards beneficial use; how much recycled material is being captured out of all potentially recyclable material; or how many people or households are participating in a recycling program."

Recycling – An Activity, Not a Material

Recycling, however we agree to define it, is a set of activities that can be carried out under a range of different conditions. Although the term may be used in common parlance to refer to materials at the curb, in trucks, or moving through MRFs, **I propose that the actual definition refer to actions, not materials.**

Actions include but are not limited to generation (sorting, storing internally, setting out at curb); collecting or dropping off (including redeeming); MRF reception, sorting and baling. Grey areas include shipping to market, marketing, and introducing into remanufacture (which may be part of the recycling process, but on their own would not be termed "recycling").

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Modifiers of Recycling as an Activity

Recycling may have an intuitive or default meaning in the minds of the public and press. However, modifiers can expand the definition to cover non-intiuitive forms.

- Generators: For example, "industrial recycling" or "public space recycling,"
- Collection methods: For example, curbside recycling or drop-off recycling. The terms "pre-" and "post-Collection Recycling" also reference collection.
- Stage in commodity chain: For example, pre-consumer, post-consumer recycling. Bottle to Bottle recycling.
    - *Discussion item: upcycling and downcycling as variants here.*
- Materials: For example, bottle PET recycling; carpet recycling.
- Processes: For example, mechanical, biological, and chemical recycling.

Discussion item: Mechanical recycling is probably the default definition in common parlance. If I am not mistaken, chemical and biological recycling only applies to polymers, if we exclude composting and fermentation from the definition of recycling. In other words, would chemical or biological recycling methods ever be applied to paper, metal, glass, electronics, etc.? Such questions are relevant to allowing chemical and biological recycling as accepted definitions of recycling, as the applicability of these processes to different materials may need to be explained.

Materials Undergoing Recycling

If the root "recycl" is to apply to materials, I propose it be distinguished as:

- Recyclable material, or recyclable(s) – materials that can be recycled under a particular set of circumstances. In theory, any material is recyclable. In practice, "recyclable" refers to a designation by a local authority, which usually reflects a market condition.
- Recycled material – materials that have been sorted and baled for marketing; also refers to input materials that substitute for raw materials (recycled HDPE flake, etc.)
- Recycled-content material or product – intermediate or finished good that was manufactured using recycled materials as inputs.

Diversion Rate

Discussion item Review origin of this term and its meaning related to diverting materials from disposal towards beneficial use. Is this the actual origin of the term? My web searches see it appearing in an MSW context only around 1990.

Formula:

Variant 1: From a collection operations (municipal) perspective:

$$\frac{\text{Weight of recyclables collected}}{\text{Weight of refuse and recyclables collected}}$$

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Variant 2: From a systems/processing perspective in the U.S. (corresponding to some comments made in our group already):

$$\frac{\text{Weight of recyclables processed and marketed}}{(\text{Weight of refuse delivered to landfill/WTE} + \text{Weight of recyclables processed and marketed})}$$

In either case, the issue of counting "contamination", however defined, needs to be addressed. Please see my recommendations about "Gross" and "Net" diversion and capture rates below.

Discussion item

The diversion rate is a ratio that allows for comparison across jurisdictions. However, because it is ratio, nothing in the rate itself informs reader about which material streams, or materials, are included in its calculation.

This is particularly relevant when diversion of fill, inert C&D waste, ADC material and/or biosolids is part of the diversion rate calculation.

Recommendation:

- The MSW diversion rate should be the default rate for assessing recycling performance. I.e. when we talk of "diversion rate" without a modifier for a jurisdiction (especially a locality) it should reflect MSW materials only.
- If C&D or biosolids are included in rate calculation, this fact should at least be noted.
- We should discuss a term for the combined MSW, C&D, and biosolids diversion rate.
- Many states and localities have laws regarding counting of diverted materials to ADC as diversion. In states/localities in which inclusion of, for example, dirty mixed cullet to ADC is counted as diversion, how do we address this in the definition of a (default MSW) diversion rate?

Contamination and Contamination Rate

Contamination can be broken out into (at least) three variants, each in need of definition

By generator:

- **Malicious** contamination (see this helpful article: [1]) Example: ¾ full glass jar of peanut butter in recycling bin.
- **Innocen**t Contamination or Wish-cycling. Example: Leaded crystal vase in recycling bin.

At processor:

- Post-processing **residue**: Example: Label paper washed from dirty cullet in a glass beneficiation facility.

[1] . Terms suggested by Daniel Hackney, Los Angeles Bureau of Sanitation, in Forester Media, "Costly Contamination," January 1, 2000, [HYPERLINK "https://www.foresternetwork.com/msw-management/waste/article/13000309/costly-contamination"],

Grey Areas

The definition of contamination complicated by the fact that:

1. Variations and changes in local designation of materials as recyclable move materials back and forth over the "contamination" line. Contamination in one jurisdiction may be a designated recyclable in another.
2. Some materials remain designated for educational consistency but lack markets. (Has anyone ever really marketed MRF-sorted plastic forks?)
3. Sources of malicious contamination are not limited to bad-acting generators; such contaminants may enter clean recyclable collections via passersby at curbside and/or unauthorized collection practices (co-collection).
4. In many cases, 32 gallon or larger clear plastic recycling bags are necessary for recycling programs and collection systems. Do these count as contamination?
5. Processing residue depends on processing technology (and markets).
6. Knowledge about collection tonnages of recyclables is known daily from MRF scales. Knowledge about contamination tonnages requires monthly MRF reports or periodic waste characterization studies. Monthly MRF reports' output tonnages may not match scale input tonnages due to evaporation, fugitive dust, variable delivery and shift operations, or other factors. Waste Characterizations of refuse and recyclable streams are typically only done every few years.

Nonetheless, it is important understand the role of contamination in calculation of diversion rates as well as capture rates (to be discussed below). I propose the terms:

- "Gross" – to reflect weight based calculations **without** subtraction of contamination
- "Net" – to reflect weight based calculations **with** subtraction of contamination (however determined).

Example:

- If City A collects 10K tons of recyclables and 10K tons of refuse over one year, its gross diversion rate will be 50% (10K/20K)

- If a waste characterization study or MRF report show that the recyclable contamination rate is 10% (1K tons), the diversion rate drops to 9K/20K. City A's net diversion rate is 45%.

I do not recommend requiring that any jurisdiction qualify diversion rate as "gross" or "net" each time they report such a rate. However, these distinctions should be available upon request, understanding that some jurisdictions reporting gross diversion rates may simply not be able to provide net data due to lack of consistent information, or any information.

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Capture Rate

Formula:

Variant 1: From a collection operations (municipal) perspective:

$$\frac{\text{Weight of recyclables collected}}{\text{Weight of recyclables collected + estimated weight of recyclable items in refuse (known from a WCS)}}$$

Variant 2: From a systems/processing perspective in the U.S.

$$\frac{\text{Weight of recyclables processed and marketed}}{\text{Discussion item}}$$

What would an appropriate denominator be for a systems calculation? Total consumption of waste-generating products in an area and time period? Weight of recyclables in refuse stream delivered to landfills plus weight of recyclables processed and marketed?

Additional considerations:

In the above examples, "recyclables" would refer to the sum total weight of all designated recyclables in collections or processing systems. With a concurrent WCS of refuse *and* recycling streams, one can further calculate precise capture rates for different materials and products.

Example:

$$\frac{\text{Weight of recycled aluminum beverage cans [collected, processed and marketed]}}{\text{Weight of aluminum beverage cans in total generation}}$$

Discussion item

Small tonnage materials and products can have very high capture rates and vice versa. Obviously weighted averages are needed to average over different materials. How to convey this to the lay public?

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Recycling Participation Rate

In my experience, the general public and media may conflate the "recycling rate" with the "recycling participation rate." Moreover, these audiences may expect statistics on the recycling participation rate at the same frequency as other metrics.

Discussion Items

- I recommend that we explain that the participation rate measures how many people, households or businesses engage activities leading to the setout of recyclables for collection, over a defined time period.
    - E.g., one can only talk about the "average weekly recycling participation rate" over a year, not "the participation rate," as an abstract fact.
- I recommend that we explain that assessing recycling participation rate requires surveys or direct observation. Unless these methods are administered weekly or monthly, the data is only a snapshot, as compared to continuous monitoring of tonnages that allow diversion rate calculation.

Normalized Generation Estimates

Another widely discussed metric of recycling success is the weight of generated refuse, recyclables, and/or total discards, divide by a normalizing metric.

- For residential generation, this is typically population or (occupied) households.
- For commercial generation, it is typically # of employees or square footage.
- For combined commercial and residential generation, it would probably have to be population, but varying influxes of commuter-employees may skew comparability across jurisdictions.

Example: In NYC, Manhattan's population of 1.5 million residents swells to over 3 million residents plus workers on weekday.

Discussion items

- What are the best units to use for normalization of residential, commercial, and combined streams?
- Can we agree on recommended sources of population, occupied units, and/or sectoral employee counts being US census products (ACS, BLS data, etc.)

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The Issue of Generator Subcategories and the Legislative/Operational Waste Management Systems that Go with them

Examples of "industrial recycling" and "public space recycling" were mentioned above. Obviously other broad generator categories include residential recycling, commercial or business recycling, and institutional recycling.

Lack of Complete Data on Commercial Tonnages in Some Jurisdictions

Collection and processing arrangements vary by generator category from jurisdiction to jurisdiction. Reporting may follow such variation.

- Some cities (NYC, other East Coast cities) manage and report residential/institutional collections handled by local public works departments. Commercial collections are managed via free-market systems that resist complete quantification, especially as private carters may transfer recyclables or refuse outside of jurisdictional border.
- Other jurisdictions (often West Coast) have unified private systems under local contract and possess full data on both streams.

Recommendation: Cross-jursidictional comparisons should take such variation into consideration and report, if possible, residential, institutional, and commercial tonnages and rates separately, as well as combined where applicable.

Discussion Items: State-level data may or may not experience similar challenges in data compilation.

Important Residential Subcategories

Across the U.S., the status of "multi-family" or multi-unit recycling varies in terms of which generator category multi-unit householders are assigned to. This breaks down as follows:

- Some cities (such as NYC) have one, uniform recycling program that applies to single/two and multi-family programs alike.
- Others, like Seattle, have a single/two family program (sometimes just called "residential") and a separate program for multi-family dwellings.
- Others have a recycling program for single/two family homes but no program for multifamily dwellings.
- Others consider multi-family buildings part of the commercial waste sector.

- Furthermore, the line distinguishing multi-family varies in terms of units for the cutoff; these may be 3, 4 or 5 units in structure.

Discussion item

When discussing residential vs. commercial diversion, contamination, or capture rates, and making comparisons across jurisdictions, it is important to at the least note these variations because single/two family diversion and capture rates are well known to be higher than multifamily rates. A locality with no multifamily recycling program, or very few multifamily buildings as part of housing stock, will have a

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higher diversion rate than another reporting a combined rate, especially if multifamily housing is more prevalent.

- How can we address the issue of comparability in such cases? How can we explain it to the public and media?
- Census data regularly reports occupied households by "units in structure". This argues for a per-housing unit normalization metric when we also have data on the residential subcategories included in a rate or generation estimate, along with the cutoff defining "multifamily".

Using the Defunct Waste and Recycling News Municipal Recycling Survey as a Reporting Model

This survey, administered 2000 to 2013 by Waste and Recycling News (Crains), addresses many of the topics raised above. It is attached in full for the last year it was published, and screenshots here highlight how it presents data usefully:

The survey shows population so that tonnages can be normalized easily
It immediately breaks out residential vs. commercial diversion rates.
It immediately informs the reader about the range of materials included in rate calculation.

	NEW YORK**	LOS ANGELES	CHICAGO	
Population**	8,244,910	3,819,702	2,707,120	2,61
Rate Includes:				
Residential	Yes	Yes	Yes	Yes
Commercial	N/A	Yes	Yes	No
Rates by Category:				
Residential	27.0%	43.8%	5.7%	49.0
Commercial	N.A.	77.4%	58.3%	N/A
Materials Included:				
Paper, metal, plastic, glass	Yes	Yes	Yes	Yes
Organic	Yard, Food	Yard, Food	Yard	Yar
Electronic	Yes	Yes	No	Yes
Hazardous	Yes	No	No	Yes
Bulk	Yes	Yes	No	Yes
Other	N/A	No	FOGs, construction waste	Can bu

The survey also presents tonnages, and breaks them out by collection category.

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Total Tonnage Collected:	1,236,176	10,000,000	2,531,514
By city	1,236,176	1,600,000	57,785
By contracted haulers	N/A	8,400,000	2,473,729
Tonnage Collected Per Material:			
Paper	331,598	N/A	303,780
Metal	228,649	N/A	1,551,207
Plastic	N/A	N/A	4,384
Glass	N/A	N/A	28,993
Organics	14,830	N/A	156,613
Other	661,097	N/A	60,916 single-stream, 365,049 concrete, 60,572 other

In this section, the survey asks about single-vs. multi family collections, as well as public/private sector service provision:

Collection Methods:			
Number of city employees	8,000	1,300	1,550
Size of containers used	30 gallon bin	60 gallon for refuse; 90 gallon for yard trimmings; 90 gallon for recyclables	96 gallon
Curbside	Yes	Yes	Yes
Program operated by:	City crews	City crews	City crews and private haulers
Frequency	Weekly	Weekly	Bi-weekly
Number of households	3.5 million	743,000	260,000
Percentage of households in the city	100%	100%	43%
Program mandatory	Yes	No	No
How materials collected	Source-separated	Source-separated	Commingled
Vehicles run on alternative fuel	100%	79%	0
Dropoff	Yes	Yes	Yes
Program operated by:	City crews	City crews	City crews
Number of sites	5	7	38
Apartment/ Multifamily Dwelling	Yes	Yes	Yes
Program operated by:	City crews	Private haulers	City crews and private haulers
Other	N/A	No	No
Program operated by:	N/A		

Budgetary and contact information is provided

Financial Information:			
Annual revenue from the sale of recyclables	N/A	$6,060,000	N/A
Recycling budget	N/A	N/A	N/A
Overall solid waste budget	N/A	$159,196,758	N/A
How are residents charged for recycling	Property taxes	Monthly fee: Single family=$36.32/month, multi-family=$24.33/month	No charge
Recycling Director:	Robert Lange	Javier Polanco	Chris Sauve
Title	Director	Division Manager	Program Director
Telephone number	212-437-4656	213-485-3825	312-744-4616
Fax number	212-514-7612	213-485-2961	312-744-2667
Website	www.nyc.gov/wasteless	www.san.lacity.org	www.chicagorecycles.org
Email address	rlange@dsny.nyc.gov	javier.polanco@lacity.org	csauve@cityofchicago.org
Mailing address	44 Beaver Street, 6th Floor New York, NY 10004	Bureau of Sanitation, Public Works Bldg. 1149 S. Broadway, Ste. 500 Los Angeles, CA 90015	121 N. LaSalle, Room 704 Chicago, IL 60602

The survey appeared to be completed by the top 40 or so municipalities in North America with regularity. The status of WRN as a neutral reporting party may have helped in this compliance. Furthermore, although WRN did sell the dataset for the survey results as a product, the survey results as

shown above were available to anyone with a February issue of WRN (the traditional month of survey results publication). The underlying database was provided gratis to municipalities as a thank you for participation.

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