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Waste Management Statistics and Methodologies in the United States and the European Union

Demetra A. Tsiamis

Associate Director

The Earth Engineering Center at The City College of New York

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Outline

- Introduction to The Earth Engineering Center
- Municipal Solid Waste (MSW) Landscape in the United States (US) and the European Union (EU)
- Understanding the EU Waste Statistics Methodology
- Understanding the US EPA Materials Flow Methodology
- Discrepancies in US MSW Data
- Conclusions

The Earth Engineering Center

- A non-profit organization dedicated to **advancing <u>technical</u> research and education** in the field of **waste sustainability**

- Part of the global research network on waste sustainability, ***Global Waste-to-Energy Research & Technology Council (WtERT)***

<u>Earth Engineering Center Team:</u>

Directors:

Marco J. Castaldi

Associate Directors:

Demetra Tsiamis

Nickolas Themelis

Thanos Bourtsalas

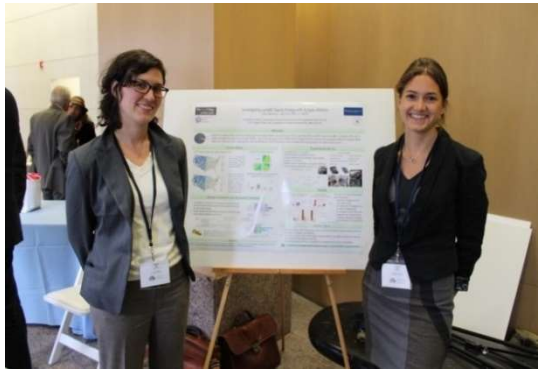
The Szechuan Environmental Protection Agency (EPA) from China visited EEC|CCNY in October 2017 to learn more about waste management methods in the US

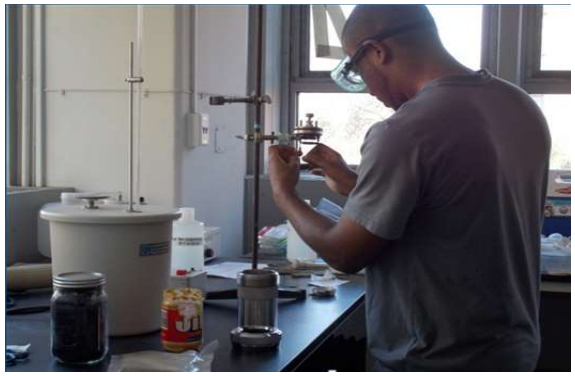
The Earth Engineering Center at The City College of New York (EEC|CCNY)

- We collaborate with **industry, government agencies, and municipalities** on **applied research** to advance and innovate the field of **waste sustainability**

- Our research spans **laboratory experimental analyses** to **pilot scale testing** of commercial technologies

- Our **worldwide network of EEC Research Associates** include:
  - Students (undergraduate, graduate)
  - Academic faculty
  - Engineering professionals





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Analysis of Waste Statistics and Methodologies in the United States and the European Union

- **<u>Primary Objectives</u>:**

  1)To determine how the **United States Environmental Protection Agency (USEPA)** uses the **materials flow methodology** to yield US municipal solid waste (MSW) statistics

  2) To understand **waste statistics methodologies** employed in the **European Union (EU)**

  3) To gain insight **into reasons behind discrepancies** in waste data

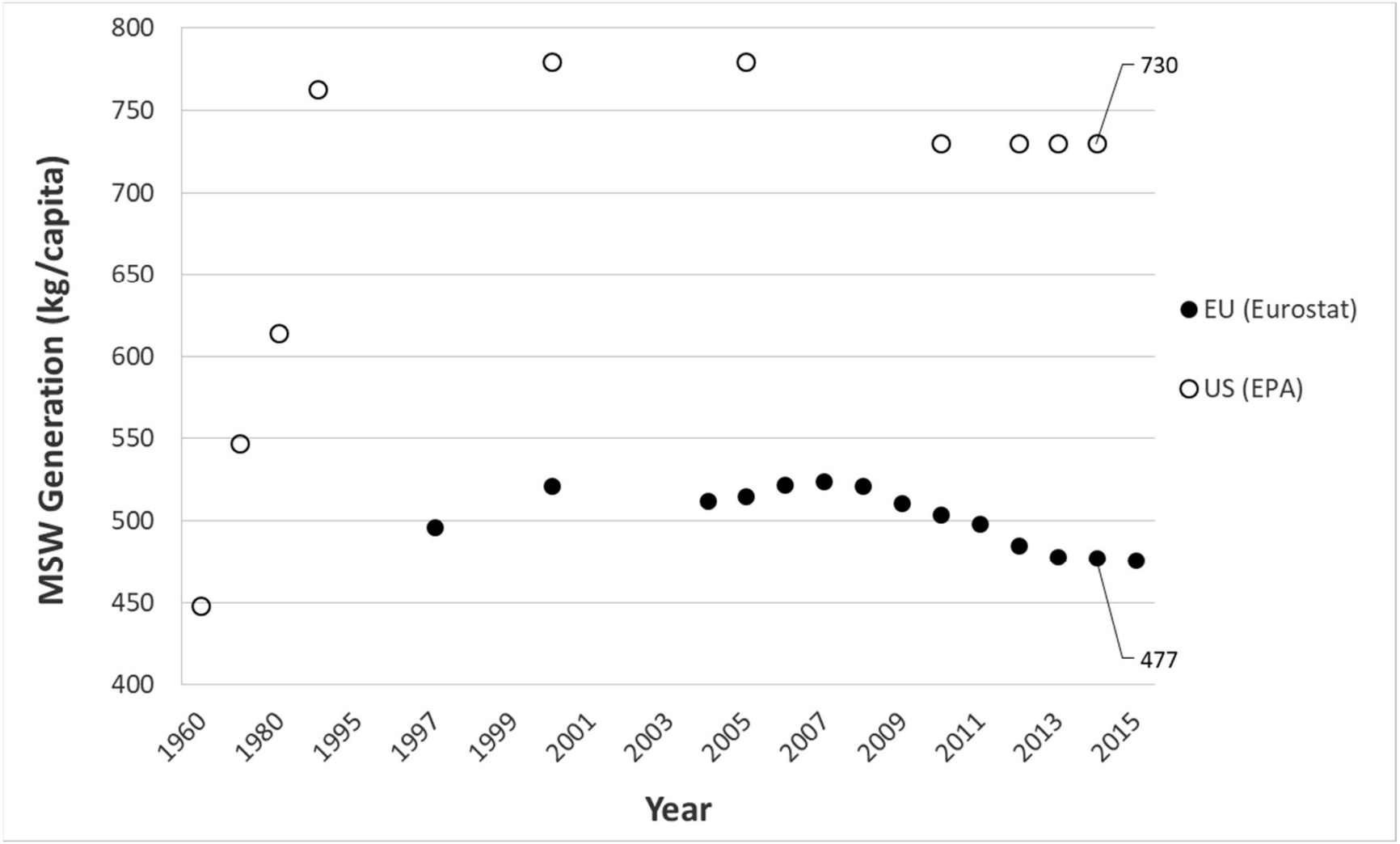
- Study conducted in collaboration with **WtERT-Italy member, Mater**, at the Polytechnic of Milan (Politecnico di Milano) under the directorship of Professor Stefano Consonni

MatER Team at Laboratorio Energia e Ambiente Piacenza (LEAP) in Piacenza, Italy

mater
materia & energia da rifiuti
materials & energy from refuse

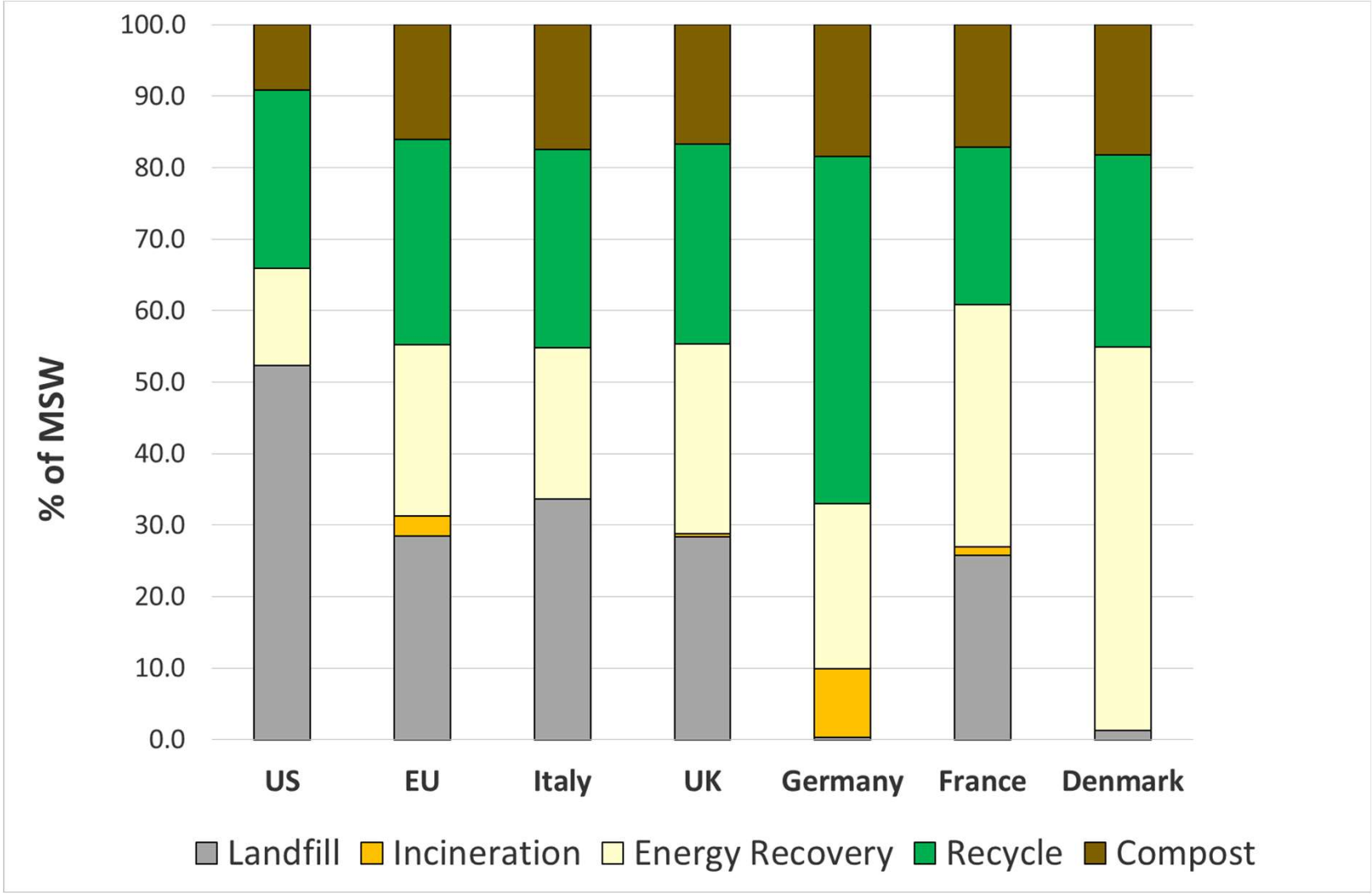
POLITECNICO
MILANO 1863

Municipal Solid Waste Generation in the US and the EU



Municipal Solid Waste (MSW) Generation in the US and the EU

MSW Disposition in the US and the EU



MSW Disposition in the US and the EU

Where do the numbers come from?

- For **US waste statistics**, the United States Environmental Protection Agency (USEPA) uses the **materials flow methodology**, referred to as a **"top-down" approach**

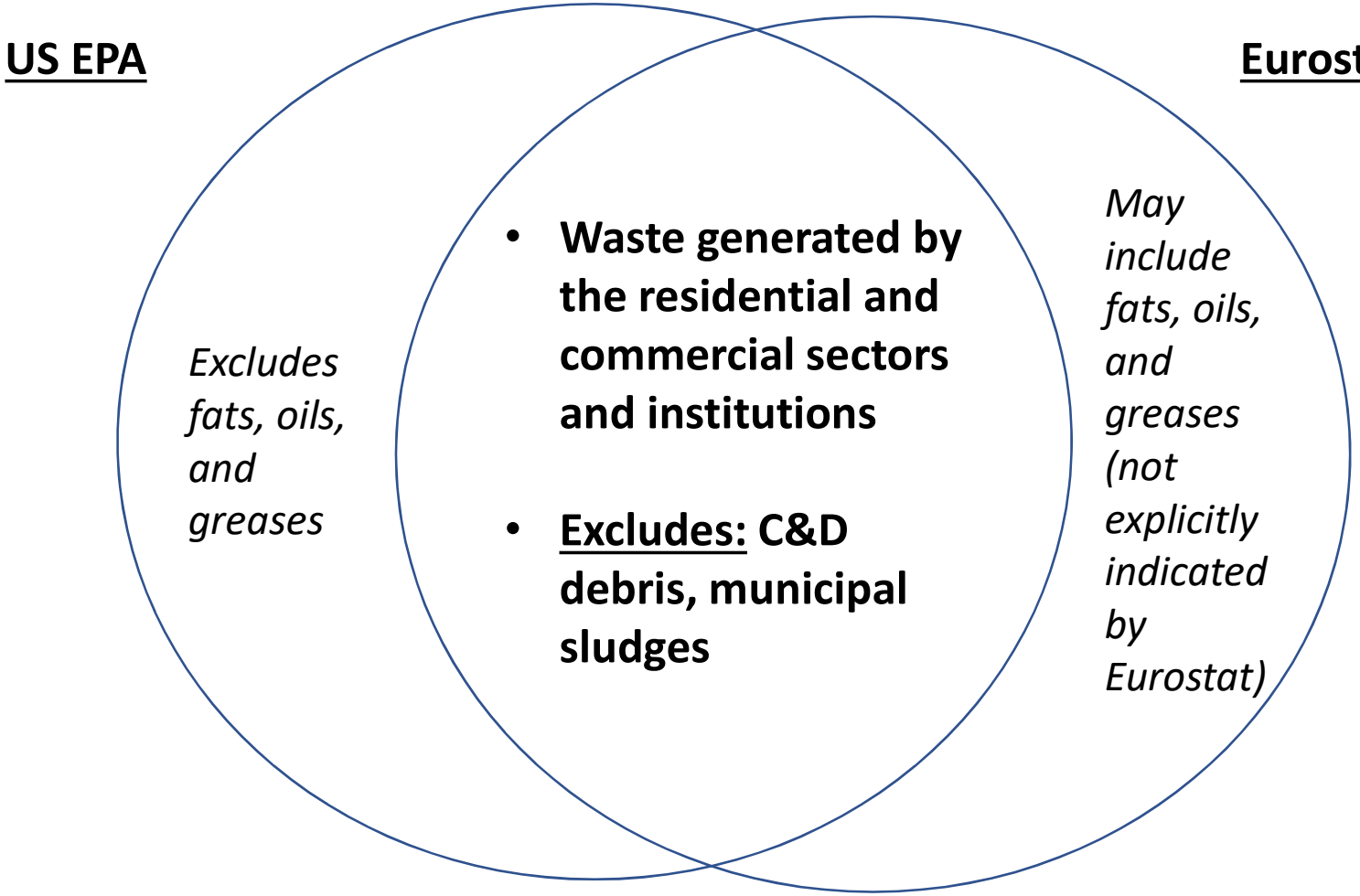
- For **EU waste statistics, Eurostat**, the agency which assembles and standardizes all data from EU member states, uses a "**bottom-up" approach**

- The purpose of this study was to **quantitatively understand how the waste statistics are determined from the methodologies, with a focus on the US methodology**, in an effort to provide further insight into reasons for discrepancies in data

- Study consisted of in-depth analyses of **Eurostat database and documents**, **US EPA database and documents**, and **discussions** with the **methodology team** at the **US EPA**

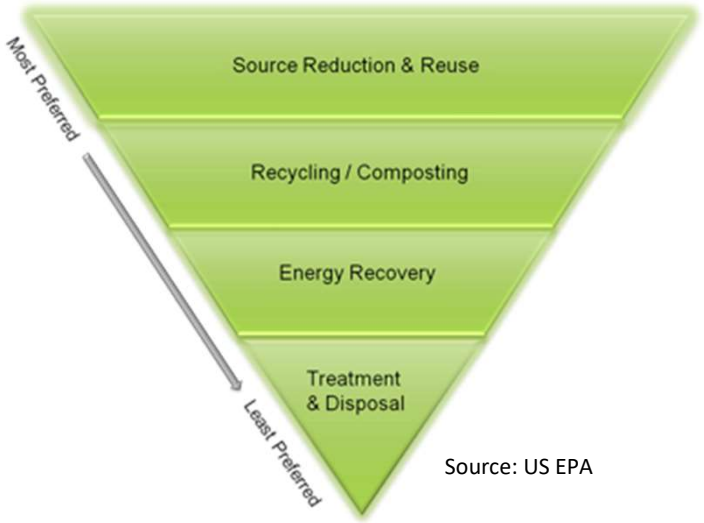
Brief Comparison of MSW Definitions and Treatments in the US and the EU

- MSW is defined as……



Brief Comparison of MSW Definitions and Treatments in the US and the EU (ctd.)

US Waste Management Hierarchy



Source: US EPA

EU Waste Management Hierarchy

Source: Eurostat

- **Waste treatment hierarchies** in the **US and the EU** are **similar**
- **Main difference is that Mechanical Biological Treatment (MBT)** is not as prevalent in the US as it is in the EU
  - **Recycling sorting in the US** happens at material recovery facilities (**MRFs)**
  - **Refuse derived fuel production** generally occurs on-site of thermal conversion processes
  - 1st MBT facility in the US developed by Entsorga – status to be confirmed

Understanding EU Waste Statistics Methodology: Waste Statistics Regulation (WStatR)

- For waste data collection, all EU member states are required to follow guidelines set forth in the **Waste Statistics Regulation (WStatR)**
  - WStatR covers all waste, including MSW

- WStatR requires that EU Member States **submit 3 data sets**:
  - Data Set 1: **Waste Generation**
  - Data Set 2: **Waste Treatment**
  - Data Set 3: **Waste Infrastructure and Collection Scheme**

- **Waste reporting** must be according to the **NACE codes** which classify waste generation by source of **economic activity** and **EWC-Stat** which classify waste by **waste type**
  - 19 NACE categories (household waste is 19th category)
  - 51 EWC-Stat categories for all waste
  - Municipal waste is included as component of “Household and similar wastes” in EWC-Stat (EWC-Stat, 10.1, item 34)

Understanding EU Waste Statistics Methodology: WStatR Treatment Classifications

- WStatR **categorizes waste treatment practices** and assigns a **classification code**
- **R1 formula** in WStatR determines distinction between **energy recovery and incineration** based on **energy efficiency**

Breakdown by Waste Treatment Type from WStatR

Energy Recovery (R1)
Waste Incineration (D10)
Recovery (R2-R11)
Landfilling (D1, D5, D12)

$$\text{Energy efficiency} = \frac{E_p - (E_f + E_i)}{0.97 * (E_w + E_f)}$$

In which:

E_p *means annual energy produced as heat or electricity. It is calculated with energy in the form of electricity being multiplied by 2.6 and heat produced for commercial use multiplied by 1.1 (GJ/year)*
E_f *means annual energy input to the system from fuels contributing to the production of steam (GJ/year)*
E_w *means annual energy contained in the treated waste calculated using the net calorific value of the waste (GJ/year)*
E_i *means annual energy imported excluding* E_w *and* E_f *(GJ/year)*
0.97 *is a factor accounting for energy losses due to bottom ash and radiation*

In addition, Annex II of the WFD highlights that this formula shall be applied in accordance with the Reference Document on Best Available Techniques for Waste Incineration (BREF WI).

R1 Energy Efficiency Formula (Source: EU Commission)

Understanding EU Waste Statistics Methodology: Waste Data Collection

- Waste data collection can be assembled via **survey, administrative sources, estimation methodologies**, or a combination of the methods mentioned

- **Data on <u>waste generation</u> is preferred from surveys** provided by the waste generator enterprises (more reliable than administrative sources)

Table 12: Part 1 of the questionnaire for waste generators: Identification of the addressee and specification of the parts of the enterprise

Information on the enterprise		
1	Identification code of the enterprise in the SBR or, if unavailable, in another register (chamber of commerce, social insurance, etc.) and the contact details of the enterprise:	This information can be entered in the questionnaire beforehand, with enterprises being asked to correct it if necessary
2	Starting date of the business:	
3	Main kind of activity of the enterprise and its NACE code:	
4	Further kind-of-activity units operating in the enterprise and their NACE-codes at four-digit level:	
5	Kinds of waste treatment activities carried out at the enterprise and the KAUs to which they belong:	
6	Ancillary activities carried out at the enterprise and the estimated percentage distribution of their services over the KAUs, including the aforementioned treatment facilities:	

Source: Eurostat

Understanding EU Waste Statistics Methodology: Waste Data Collection (ctd.)

- **Data collection for <u>waste treatment</u> is preferred from waste facility registers** (more reliable than surveys)

- **Waste collectors should fill out surveys** to identify waste transport and consequently avoid <u>double-counting</u> of waste

- Challenge with EU methodology is **double-counting**
  - This can be addressed through **clarification between waste transporter and final waste facility**

Table 16: Questionnaire for waste collectors and transport operators: Waste quantities collected and received

Waste collection and transport							
1	2	3	4	5	6	7	8
Waste types pursuant to LoW and/or EWC-Stat	Total amount collected and transported (except for internal recycling)	Waste collection from enterprises			Municipal waste collection		
		Waste collected or received from other enterprises	Waste received from own enterprise	Waste collected or received from waste traders	Waste collected from households	Commercial waste collected together with household waste	Waste collected from public places and others
Code (a)							
Code (b)							

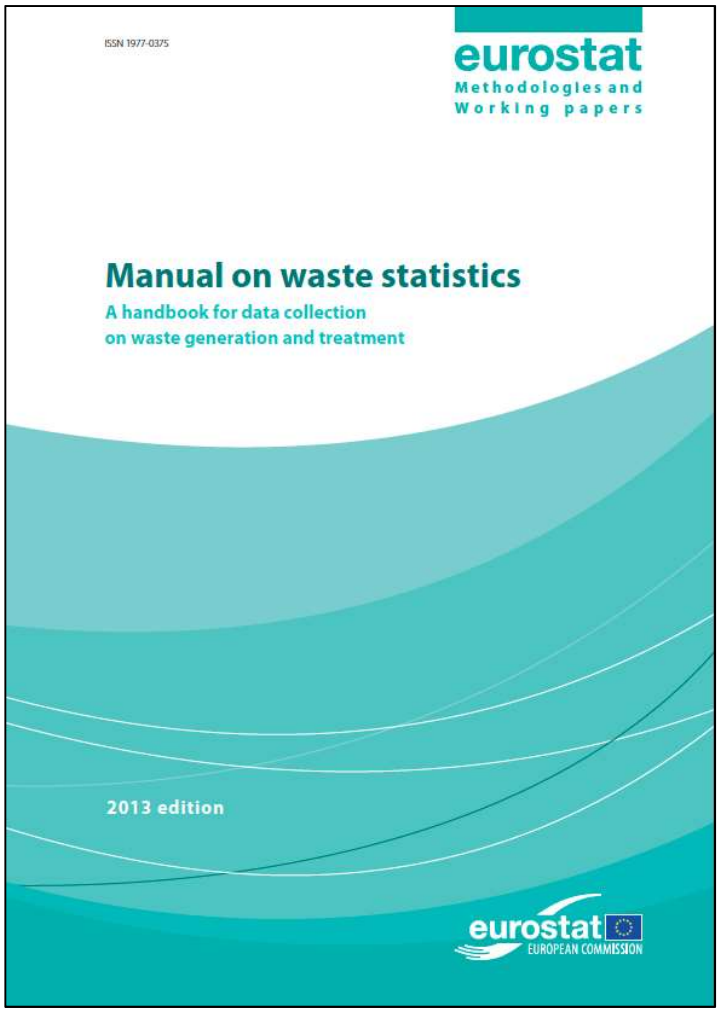
Code (z)							

Source: Eurostat

Understanding EU Waste Statistics Methodology: Brief Summary

- **WStatR** attempts to **homogenize MSW data collection and reporting** from the 28 EU member states
- EU methodology is **based on measurement of waste streams**, from generator to final treatment
- **Challenge with EU methodology** is possibility for **double-counting**

- *150 page manual for EU members on waste data collection and reporting, published by Eurostat*



Understanding US Materials Flow Methodology: Brief Summary

- The US EPA's **materials flow methodology** is a "top-down" approach that estimates national MSW generation and disposition based on *"production data (by weight) for the materials and products in the waste stream"* (EPA, Facts & Figures full report, 2013)

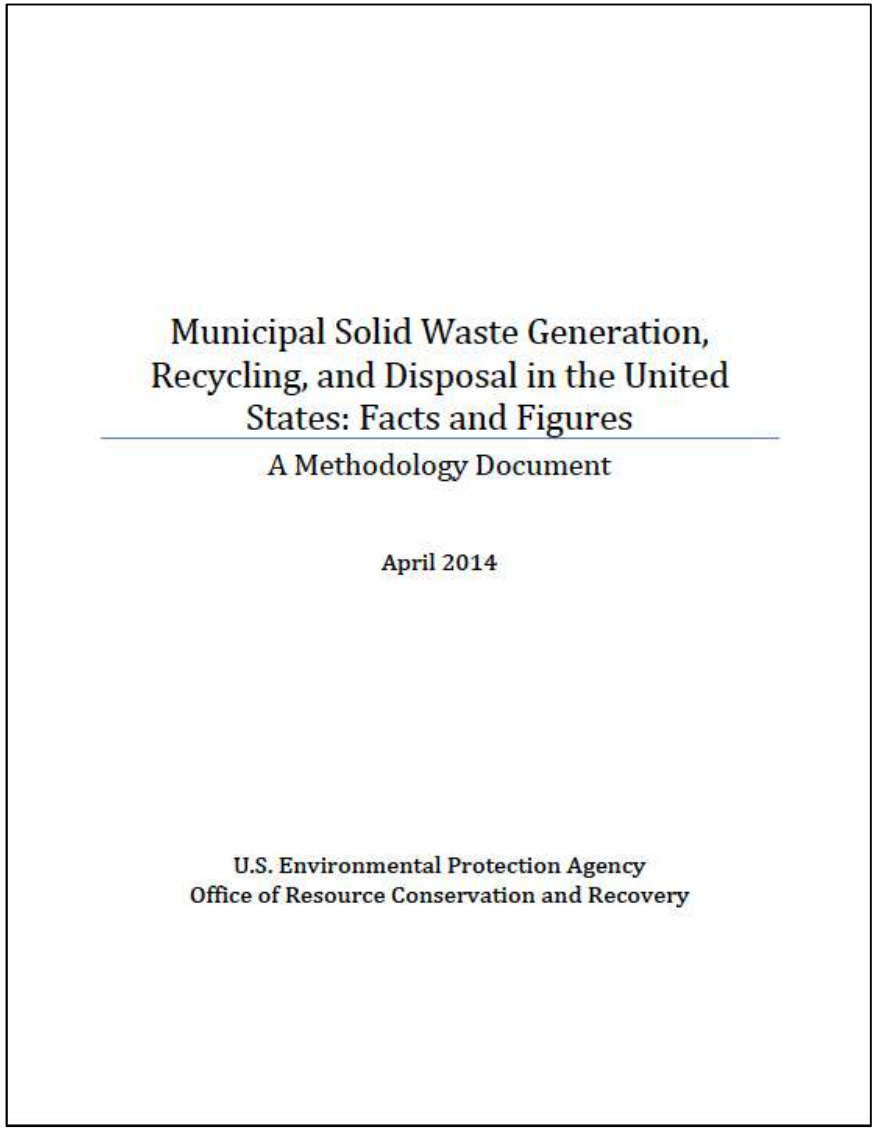
- In the materials flow methodology:
  - **Tonnage estimates** are derived **from industry and association reports** for product generation

  - **Measurements of MSW** incorporated in the methodology **are limited**
    - Measurements of MSW that are included in this methodology are **energy recovery tonnages, composting facility tonnages, and sampling studies for characterization of food waste**

    - **US EPA does not use reported measured landfill tonnages** in their annual national waste reports because these Subtitle-D landfills can include non-MSW waste

  - There is **no tracking of waste** from generator source to final treatment

Understanding US Materials Flow Methodology: US EPA Materials Flow Document


Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures

A Methodology Document

April 2014

U.S. Environmental Protection Agency
Office of Resource Conservation and Recovery

- 49 page document by the US EPA
- Shows how the US EPA uses the materials flow methodology for several waste material streams in MSW

Understanding US Materials Flow Methodology: General Calculations

Objective: What are the **inputs** of the materials flow methodology? What are the **outputs**? **How do we get from the inputs to the outputs?**

Equation (1):

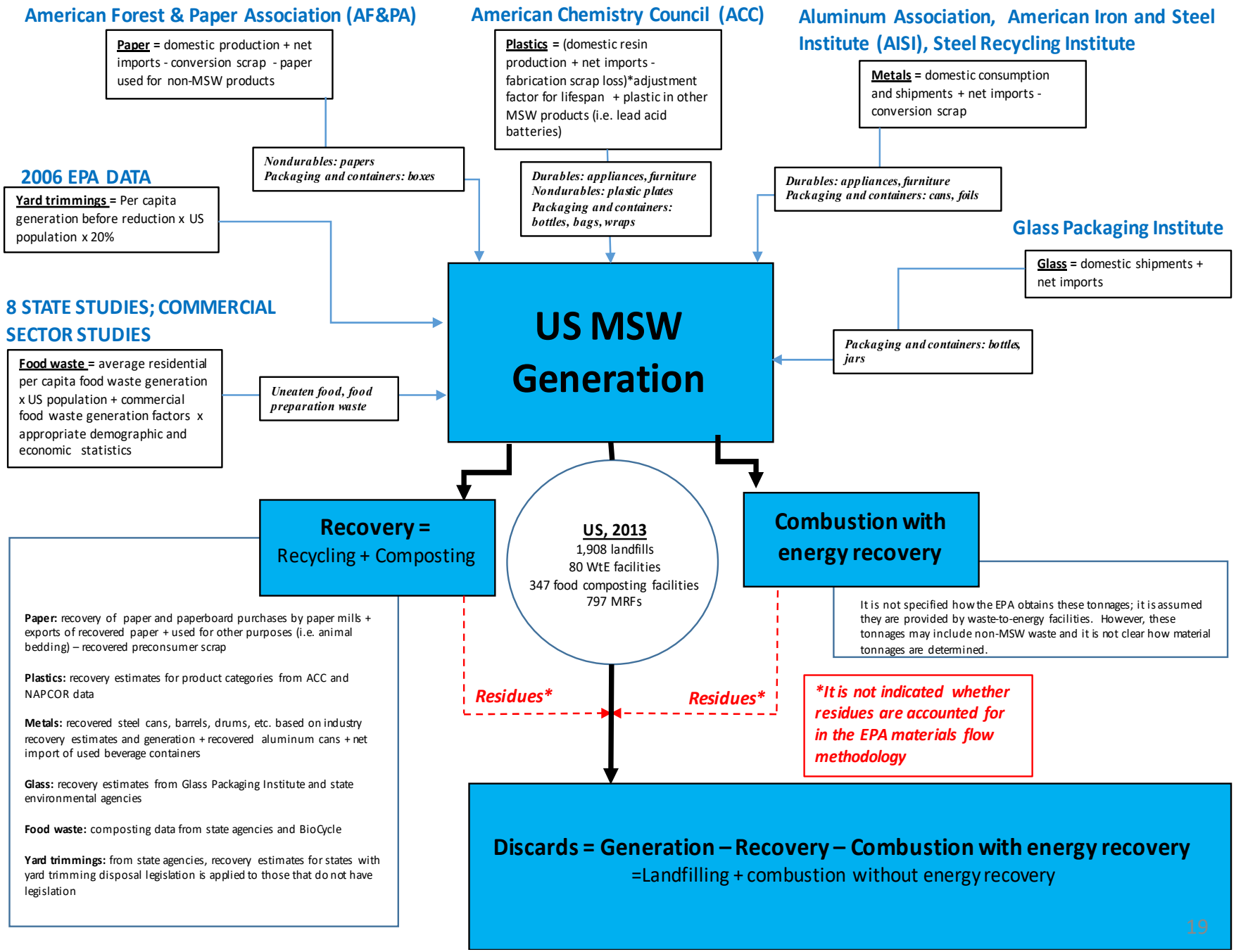
$$\boldsymbol{MSW\ Generation} = (material\ production\ based\ on\ industry\ data + net\ imports - fabrication\ scrap\ loss - material\ used\ for\ production\ of\ non\ MSW\ related\ products)_{adjusted\ for\ life\ span\ of\ durable\ goods}$$

Equation (2):

$$\boldsymbol{Recovery} = Purchases\ by\ recyclers + Tonnages\ received\ at\ composting\ facilities$$

Equation (3):

$$\boldsymbol{Discards} = MSW\ generation - MSW\ recovery$$


American Forest & Paper Association (AF&PA)
Paper = domestic production + net imports - conversion scrap - paper used for non-MSW products
Nondurables: papers
Packaging and containers: boxes
American Chemistry Council (ACC)
Plastics = (domestic resin production + net imports - fabrication scrap loss)*adjustment factor for lifespan + plastic in other MSW products (i.e. lead acid batteries)
Durables: appliances, furniture
Nondurables: plastic plates
Packaging and containers: bottles, bags, wraps
Aluminum Association, American Iron and Steel Institute (AISI), Steel Recycling Institute
Metals = domestic consumption and shipments + net imports - conversion scrap
Durables: appliances, furniture
Packaging and containers: cans, foils
2006 EPA DATA
Yard trimmings = Per capita generation before reduction x US population x 20%
8 STATE STUDIES; COMMERCIAL SECTOR STUDIES
Food waste = average residential per capita food waste generation x US population + commercial food waste generation factors x appropriate demographic and economic statistics
Uneaten food, food preparation waste
Glass Packaging Institute
Glass = domestic shipments + net imports
Packaging and containers: bottles, jars
US MSW Generation
Recovery = Recycling + Composting
US, 2013
1,908 landfills
80 WtE facilities
347 food composting facilities
797 MRFs
Combustion with energy recovery
It is not specified how the EPA obtains these tonnages; it is assumed they are provided by waste-to-energy facilities. However, these tonnages may include non-MSW waste and it is not clear how material tonnages are determined.
Residues*
Residues*
*It is not indicated whether residues are accounted for in the EPA materials flow methodology
Paper: recovery of paper and paperboard purchases by paper mills + exports of recovered paper + used for other purposes (i.e. animal bedding) – recovered preconsumer scrap
Plastics: recovery estimates for product categories from ACC and NAPCOR data
Metals: recovered steel cans, barrels, drums, etc. based on industry recovery estimates and generation + recovered aluminum cans + net import of used beverage containers
Glass: recovery estimates from Glass Packaging Institute and state environmental agencies
Food waste: composting data from state agencies and BioCycle
Yard trimmings: from state agencies, recovery estimates for states with yard trimming disposal legislation is applied to those that do not have legislation
Discards = Generation – Recovery – Combustion with energy recovery
=Landfilling + combustion without energy recovery

US EPA Materials Flow Document:
Paper & Paperboard

PAPER AND PAPERBOARD

Summary

Collectively, the many products made of paper and paperboard materials comprise the largest component of MSW. The paper and paperboard materials category includes products such as office papers, newspapers, corrugated boxes, milk cartons, tissue paper, and paper plates & cups.

Estimates of paper and paperboard generation are based on statistics published by the American Forest & Paper Association (AF&PA). These statistics include data on new supply (production plus net imports) of the various paper and paperboard grades that go into the products found in MSW. The AF&PA new supply statistics are adjusted to deduct converting scrap, which is generated when sheets or rolls of paper or paperboard are cut to make products such as envelopes or boxes. Converting scrap rates vary from product to product; the rates used in this report were developed as part of a 1992 report for the Recycling Advisory Council, with a few more revisions as new data became available. Various deductions also are made to account for products diverted out of municipal solid waste, such as gypsum wallboard facings (classified as construction and demolition debris) or toilet tissue (which goes to wastewater treatment plants).

Estimates of recovery of paper and paperboard products for recycling are based on annual reports of recovery published by AF&PA. The AF&PA reports include both post- and preconsumer recovery of paper and paperboard purchased by U.S. paper mills, plus exports of recovered paper, plus a relatively small amount estimated to have been used in other products such as insulation and animal bedding. Adjustments are made to the recovery as reported by AF&PA to remove preconsumer recovery from the postconsumer recovery estimate.

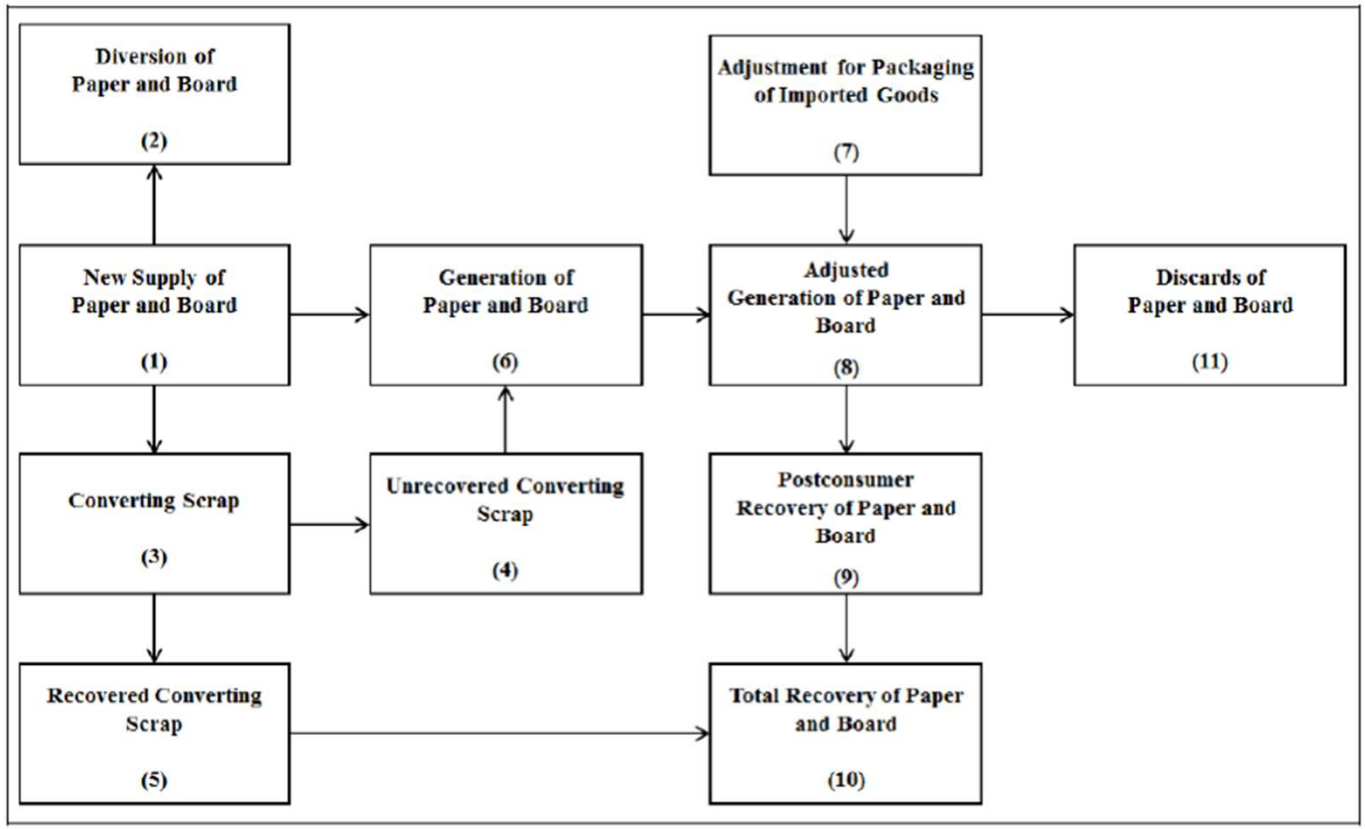
Figure 7 is a flow chart illustrating estimates of paper and paperboard discards. Each block of the flow diagram contains a reference number, which corresponds to the following remarks.

1. New supply of paper and board. Includes production for domestic use plus imports minus exports. Includes office paper file diversion reentering the paper supply.
2. Diversion of products. Includes office paper in files, magazines, books, and of products not counted as MSW, e.g., construction paper and board, toilet tissue.
3. Converting scrap (non-MSW industrial scrap).
4. Unrecovered converting scrap.
5. Recovered converting scrap.
6. Generation of paper and board = new supply of paper and board (1) – converting scrap – diversion of paper and board (2).
7. Adjustment for packaging of imported goods.
8. Adjusted generation = generation of paper and board (6) + adjustment for packaging of imported goods (7).
9. Postconsumer recovery.
10. Total recovery of paper and board = postconsumer recovery (9) + recovered preconsumer converting scrap (5).
11. Discards of paper and board = adjusted generation (8) – total Recovery of paper and board (9).

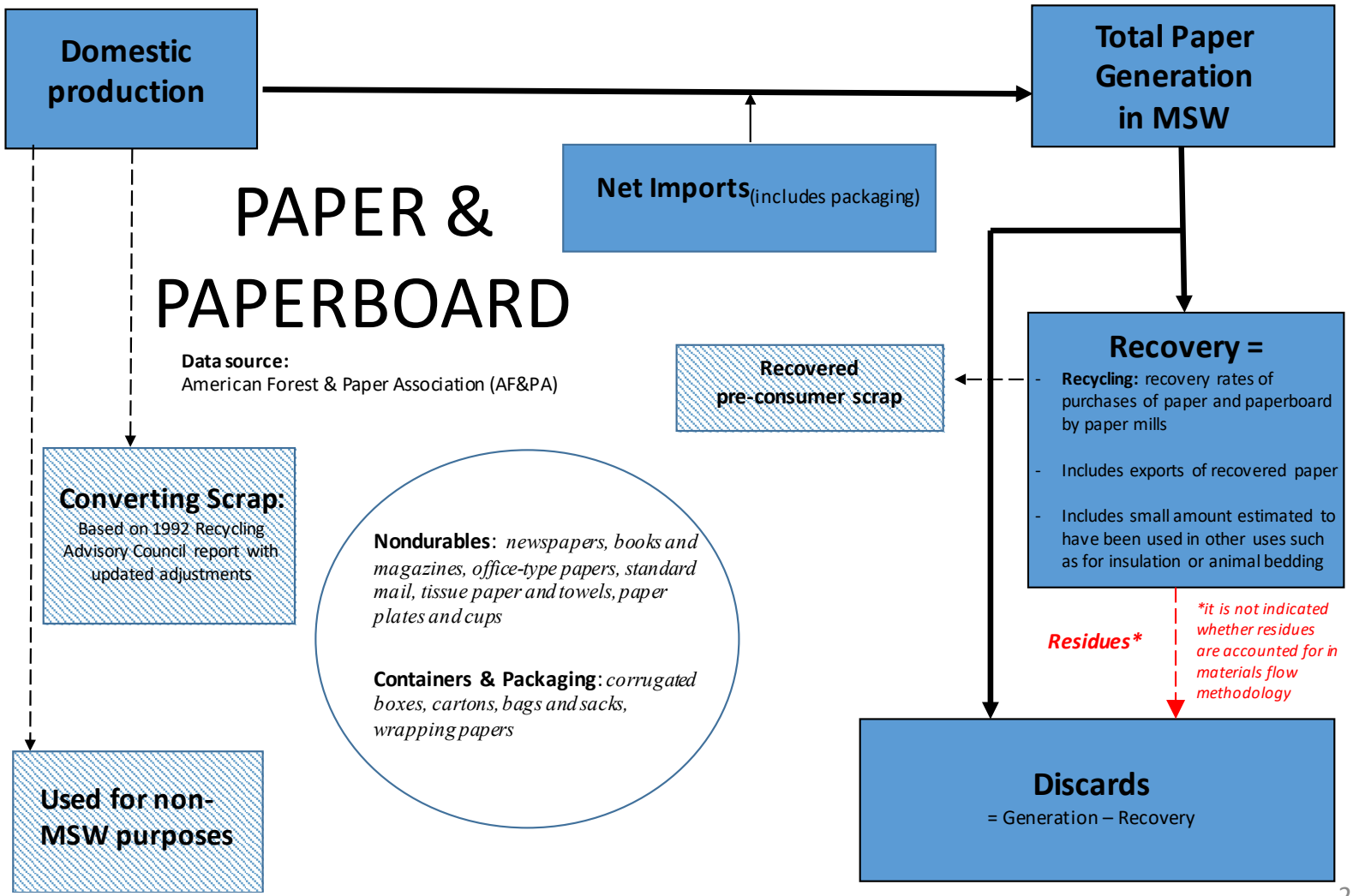
Data Gaps

- Current data for adjustments for packaging of imported goods are not available.
- Current data on adjustment for converting scrap are not available.

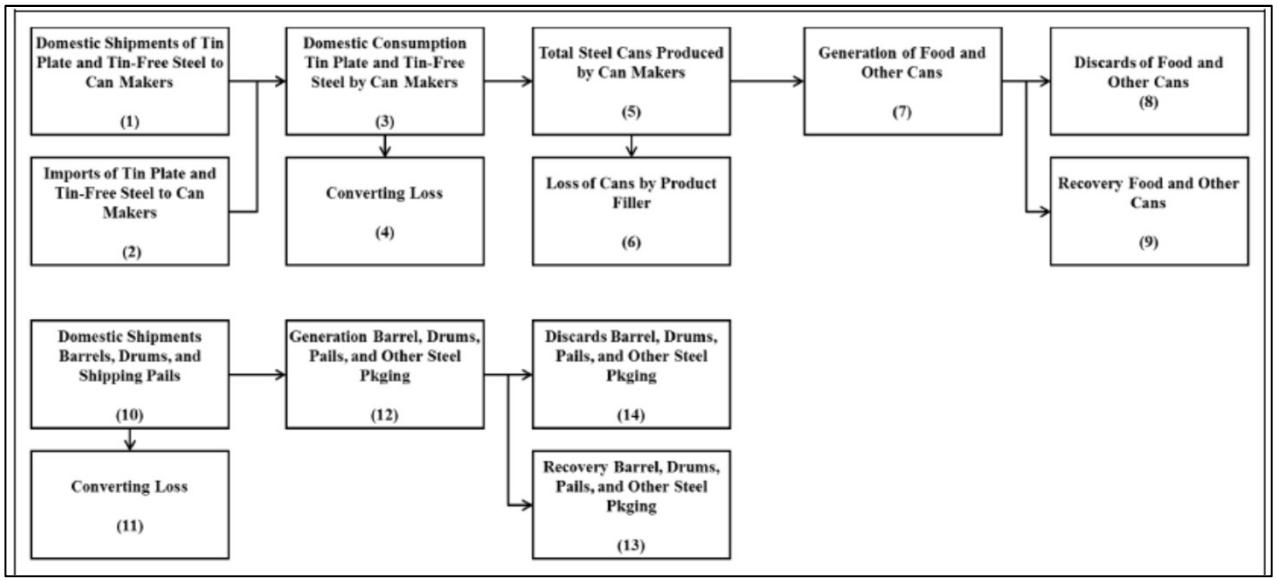
US EPA Materials Flow Diagram:
Paper & Paperboard

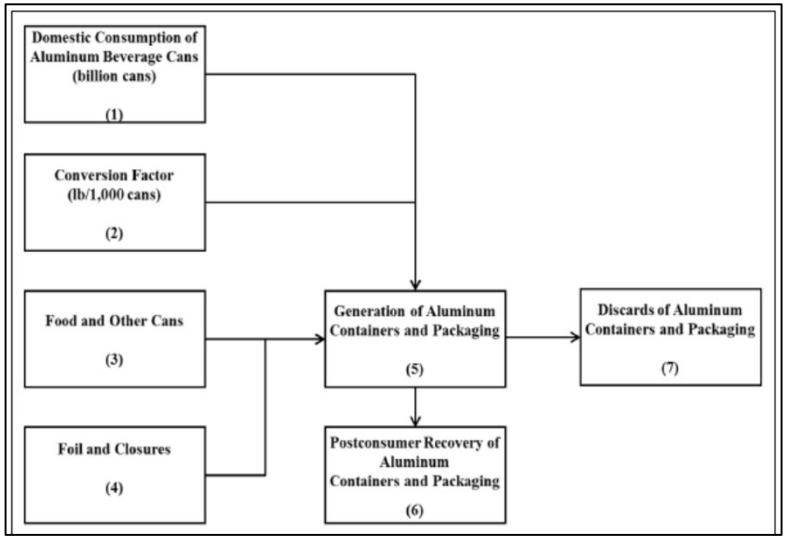


EEC|CCNY Elaboration of US EPA Materials Flow Diagram for Paper & Paperboard

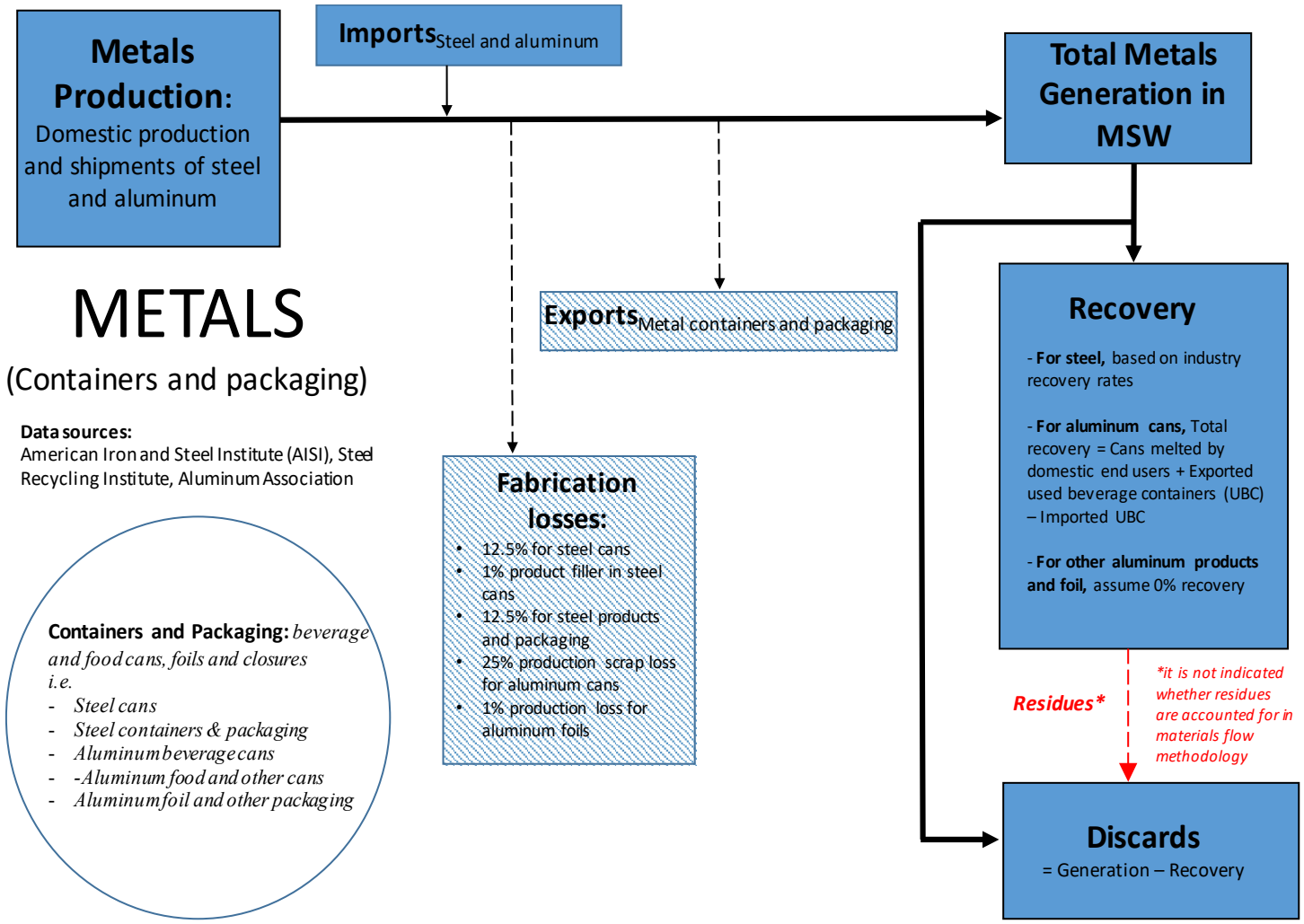


US EPA Materials Flow Diagram:
Aluminum and Steel Containers and Packaging

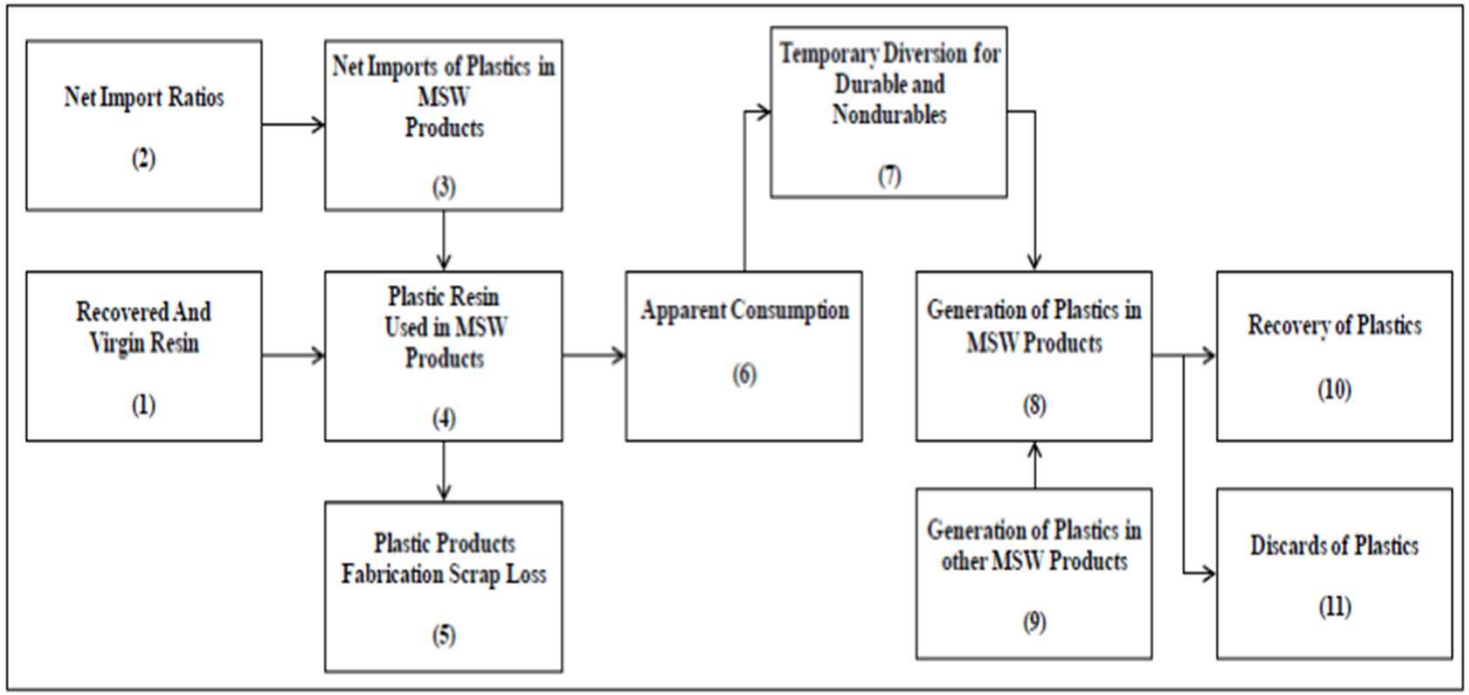




EEC|CCNY Elaboration of US EPA Materials Flow Diagram for Metals



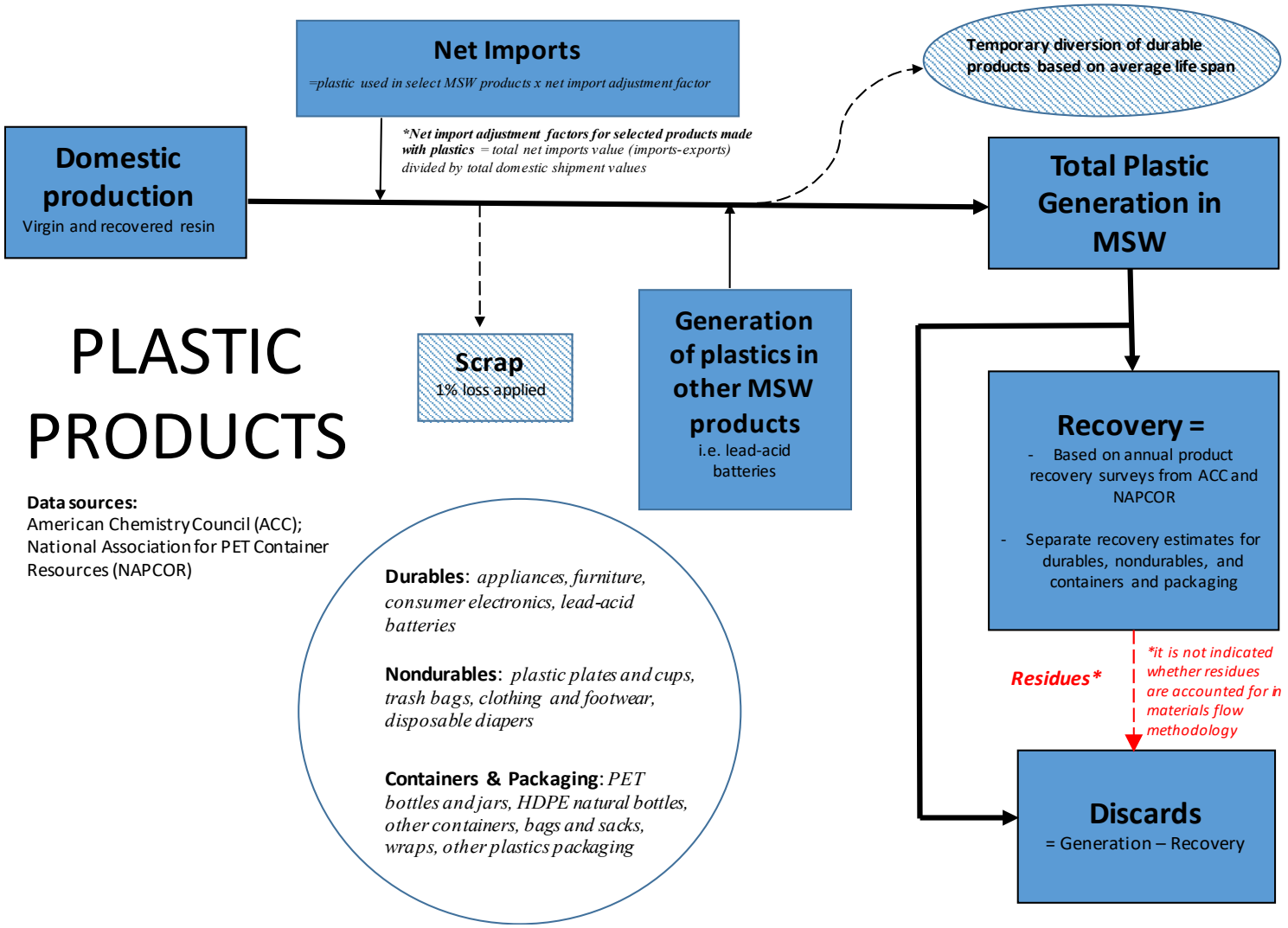
US EPA Materials Flow Diagram:
Plastics



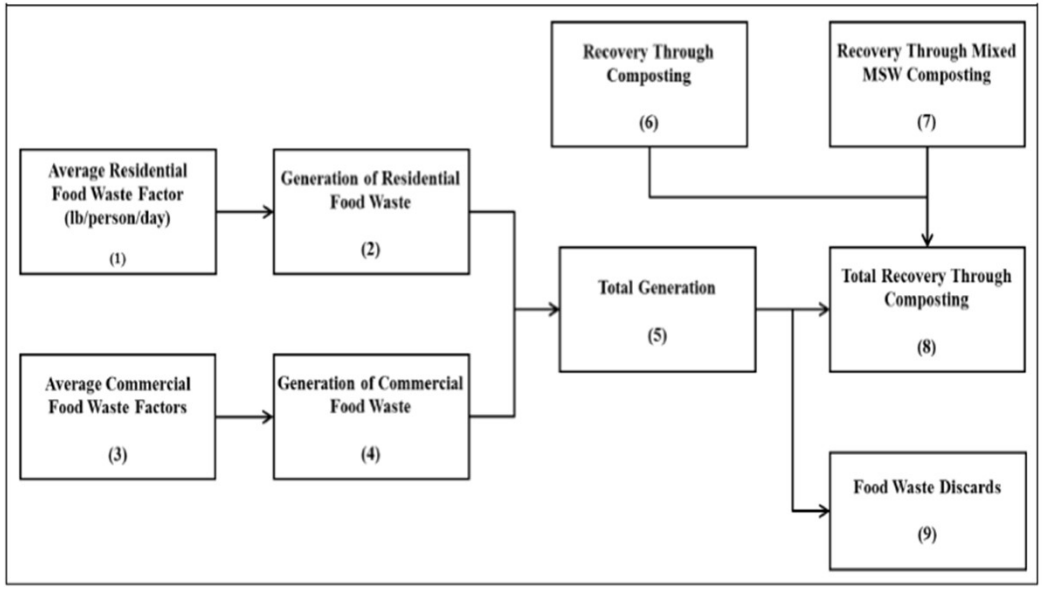
Data Gaps

- Net import adjustment generation factors for products made with plastics do not cover all products; shipment values for some HTS/NAICS product codes are missing. Therefore imports of some plastic products are not accounted for.
- Recovery data for durable goods are limited.
- Fabrication loss may be underestimated for some products.

EEC|CCNY Elaboration of US EPA Materials Flow Diagram for Plastics



US EPA Materials Flow Diagram: Food Waste

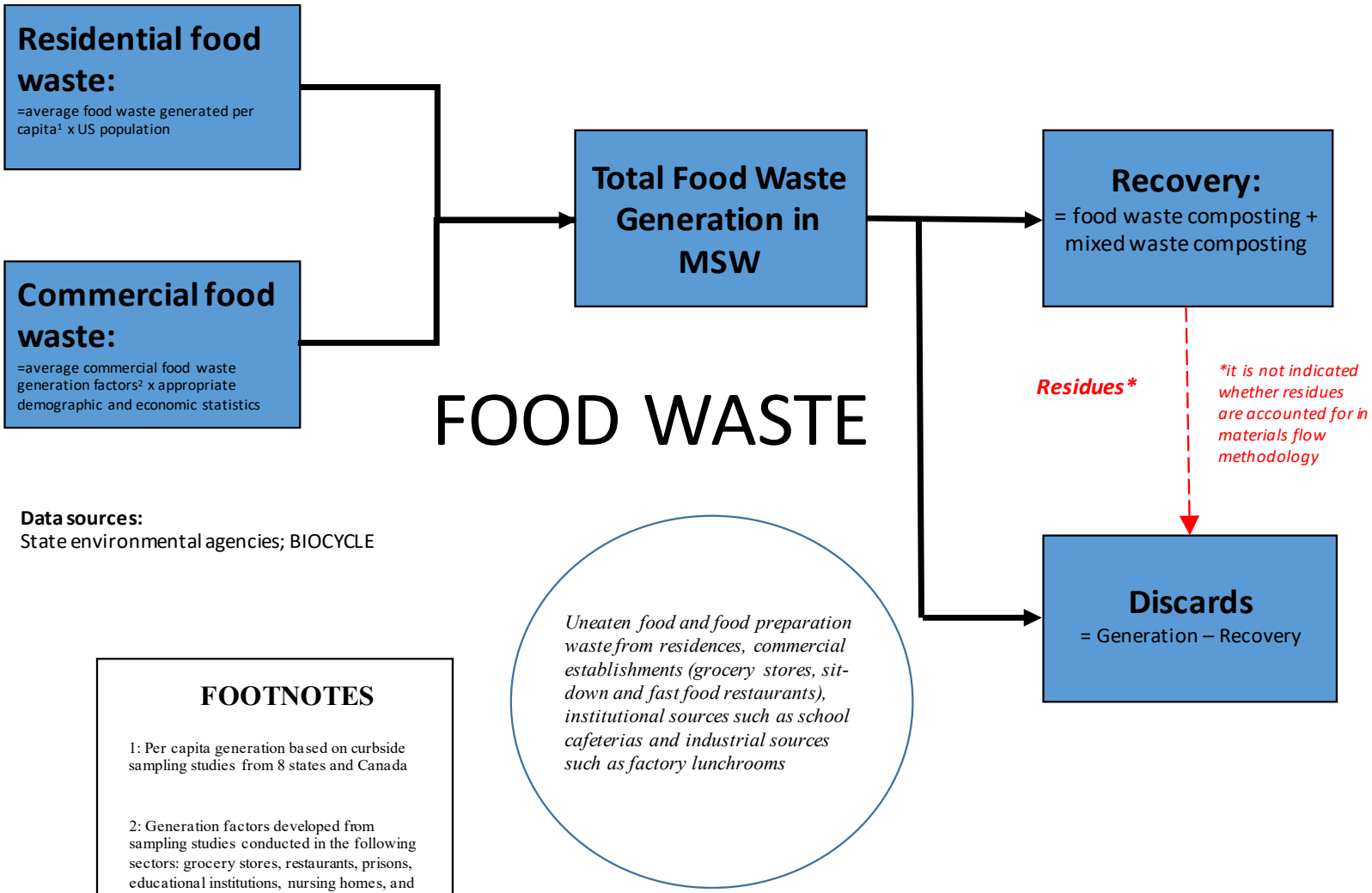


Data Gaps

- Recovery through MSW composting includes non-food products and materials.
- Some food waste may be collected with yard trimmings and not accounted for as food waste recovery.
- There may be some additional commercial and institutional sources of food waste that are not accounted for due to the lack of available onsite sampling studies.
- State agency reported food waste composted may include non-MSW food waste from industrial sources including high volume food waste composting from processors. Recovery data for food waste other than composting is not available (e.g., food donations).
- Latest available state agency reported food waste recovery through composing data are used, therefore data year will vary. Methodology assumes food waste composting is fairly constant (i.e., an established composting program continues to operate, at a minimum, at the last reported level). For 2011, data were found for 33 states with the following data years

Number of States	Data Year
1	2008
7	2009
17	2010
8	2011
33	Total

EEC|CCNY Elaboration of US EPA Materials Flow Diagram for Food Waste



FOOTNOTES

1: Per capita generation based on curbside sampling studies from 8 states and Canada

2: Generation factors developed from sampling studies conducted in the following sectors: grocery stores, restaurants, prisons, educational institutions, nursing homes, and residential hospitals, hotels, and employee cafeterias

Discrepancies in US Waste Data

- **Independent national surveys** were conducted by **WtERT-US** and by the Environmental Research Education Foundation **(EREF)** utilizing ***measurement methodologies***: WTERT-US: state-based survey ; EREF: facility-based survey

- Major discrepancies between data from WtERT-US and EREF compared to US EPA

- Reasons for discrepancies include:
  - There are **data gaps in EPA materials flow** - it does not account for **residues**
  - **WTERT and EREF** surveys have **data gaps** since **states are not required to report recycling data**

Source	Total MSW Generation	Recycled	Composted	Combusted	Landfilled
WTERT-US	388,959,390	87,808,128	24,646,893	29,507,191	246,997,177
EPA	250,540,000	66,400,000	20,570,000	31,800,000	131,770,000
Delta	*138,419,390*	*21,408,128*	*4,076,893*	*2,292,809*	*115,227,177*
% difference	***43.3***	***27.8***	***18.0***	***7.5***	***60.8***

Source	Total MSW Generation	Recycled	Composted	Combusted	Landfilled
EREF	346,958,499	72,981,065	21,305,480	30,657,715	222,014,238
EPA	254110000	64740000	22440000	32660000	134270000
Delta	*92848499*	*8241065*	*1134520*	*2002285*	*87744238*
% difference	***30.9***	***12.0***	***5.2***	***6.3***	***49.3***

Conclusions

- Materials flow methodology **relies on industry production data** and is **limited in how much measured waste data** is used to determine waste statistics in the US

- EU methodology is **standardized and homogenize**d and is **based on measurements of waste** streams

- Challenges with the US methodology are that it **does not have high resolution data for waste streams like food waste** and it **does not account for residue flows**

- Challenges with the EU methodology involve **double-counting of measured waste** streams

- **Materials flow methodology is the "best" approach for the US currently** since there is **no US national policy related to waste management and data collection**

Thank You!

Questions?

***Demetra Tsiamis**, Associate Director*
Earth Engineering Center|CCNY
E-mail: dtsiamis@ccny.cuny.edu
Website: http://ccnyeec.org/

Earth Engineering Center
CITY COLLEGE of NEW YORK