Life Cycle Inventory Analysis for Recycled Plastics:

The First Inventory to Include Recycled PET, HDPE, and PP

August 21, 2018

The Association of Plastic Recyclers

Today's Presenters

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The Association of Plastic Recyclers

Today's Session…

Who is APR

Industry Overview

Preview of Life Cycle Inventory Analysis

Questions

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Who is APR?

International trade association

The Voice of Plastics Recycling®

Companies committed to the success of plastics recycling

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Increase Supply

Enhance Quality

Expand Demand

Communicate Value

APR Primary Goals

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Timing is Critical

- Markets in Flux
- China Impact
- Industry Under Microscope
  - ‘Does Recycling Work?’
- Product Bans and Regulations

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Collaborative Efforts & Sustainability Goals

- Ellen Macarthur Foundation
- New Plastics Economy
- Global Definition of Plastics Recyclability
  - Demand Component
- Global Testing Harmonization
- EU Regulations

EPBP

APR The Association of Plastic Recyclers

PLASTICS RECYCLERS EUROPE

End Market Demand

Become an APR Recycling
DEMAND CHAMPION

- Key to Industry sustainability-for all materials
- LCI is major driver of PCR use
- Key to Brand Owner and Industry sustainability goals
- APR Design Guide
- Sorting Potential Protocol-all materials
- Collection and Sortation Enhancements

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Updated Life Cycle Assessment of Recycled Resins: PET, HDPE, and PP

Beverly Sauer

August 21, 2018

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Overview

- Project objectives, approach, data sources
- Updates/additions from 2010 study
- Compare HDPE and PET trends from 2010 and 2018 analyses
- Remaining steps to complete the project
- Preview of savings compared to virgin resins
- Use of results

Purpose

- Great demand for environmental data on recycled materials and products: manufacturers, retailers, large corporations, government agencies
- To quantify savings/benefits of using recycled content, first need to quantify environmental burdens for collection/sorting/reprocessing of postconsumer resin.
- Make data publicly available for use in modeling plastic products utilizing postconsumer recycled content

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Project Goals

- "Refresh" of the recycled HDPE and PET data from the original study
  - Update collection data (resin sources, collection vehicles, etc.) using published sources
  - Update sorting/separation data based on 2016-2017 MRF database
  - Update reclaimer data
  - Improve participation/coverage
- Addition of recycled PP
- Addition of more environmental results categories

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Life Cycle Approach

- Comprehensive: Inputs and outputs of raw materials, energy, and releases to the air, water, and land over the complete life cycle of a product system

- Since recycled resins can be used in all types of products, this analysis is conducted as a "cradle-to-gate" study, covering all steps from postconsumer resin collection through production of recycled resin ready for use.

- Product manufacturing, use, and end of life management depend on application in which recycled resin is used.

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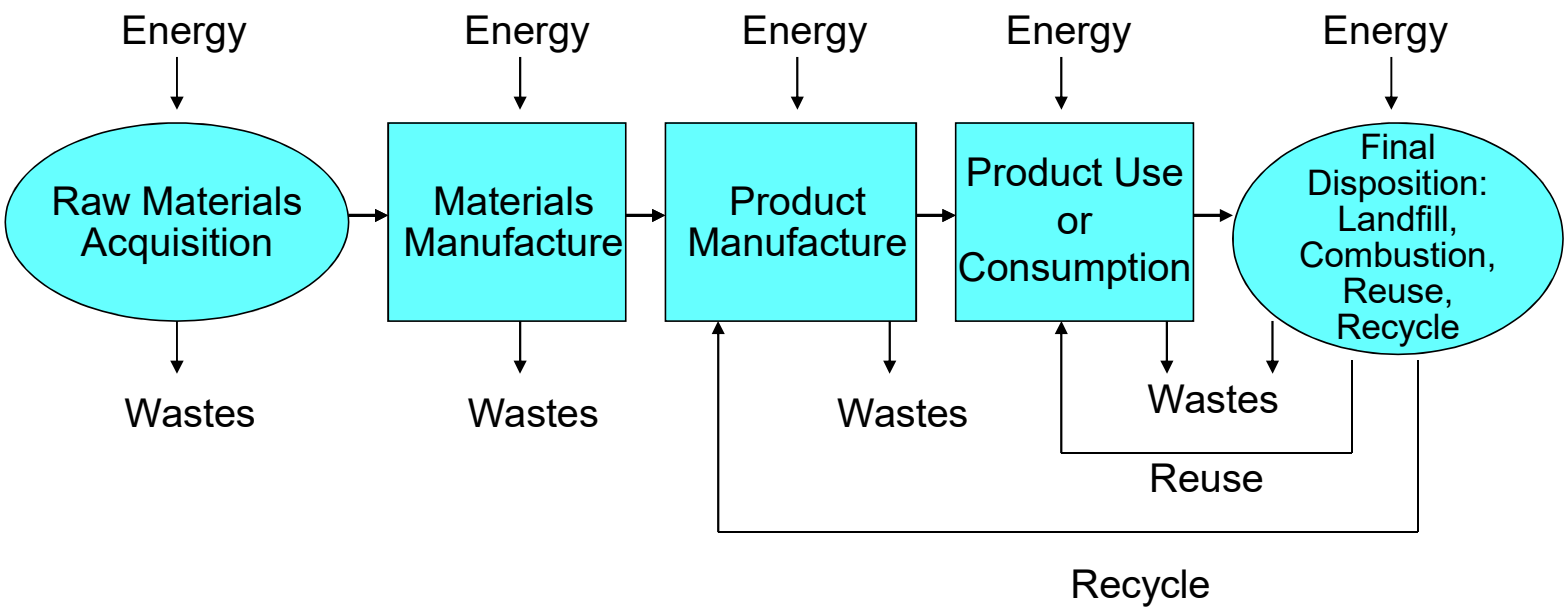
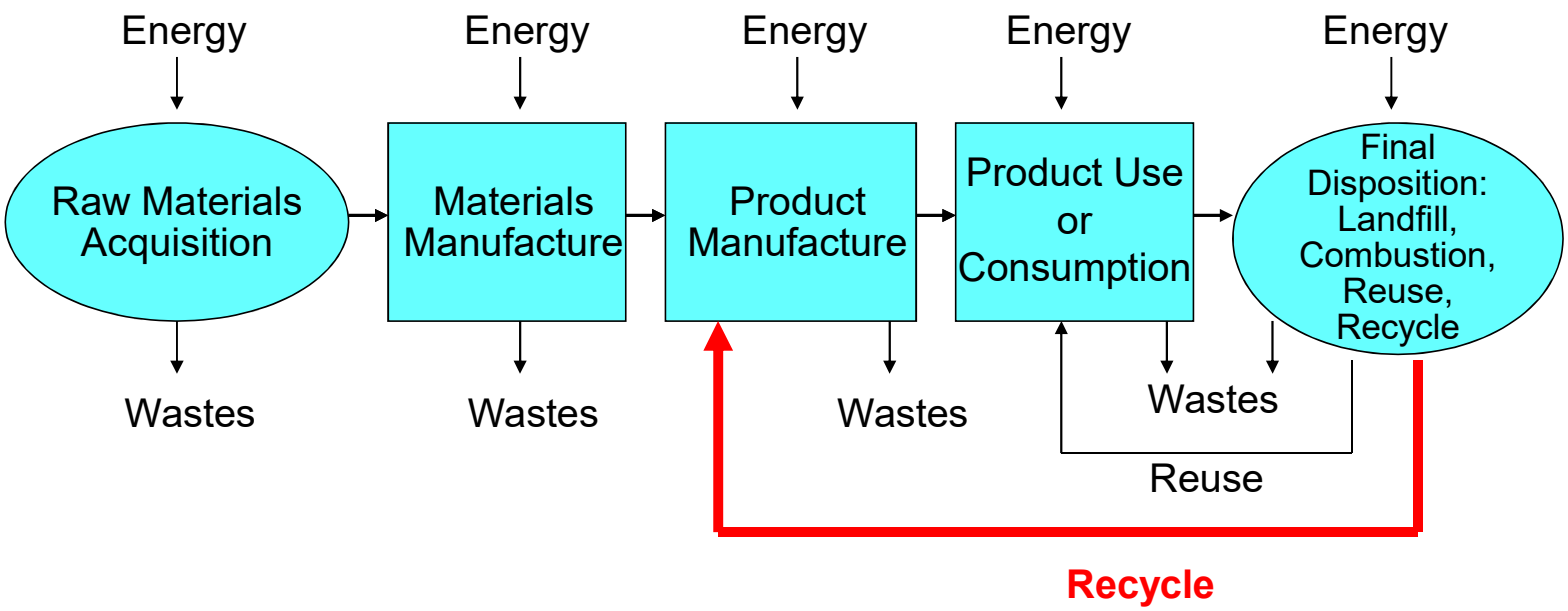
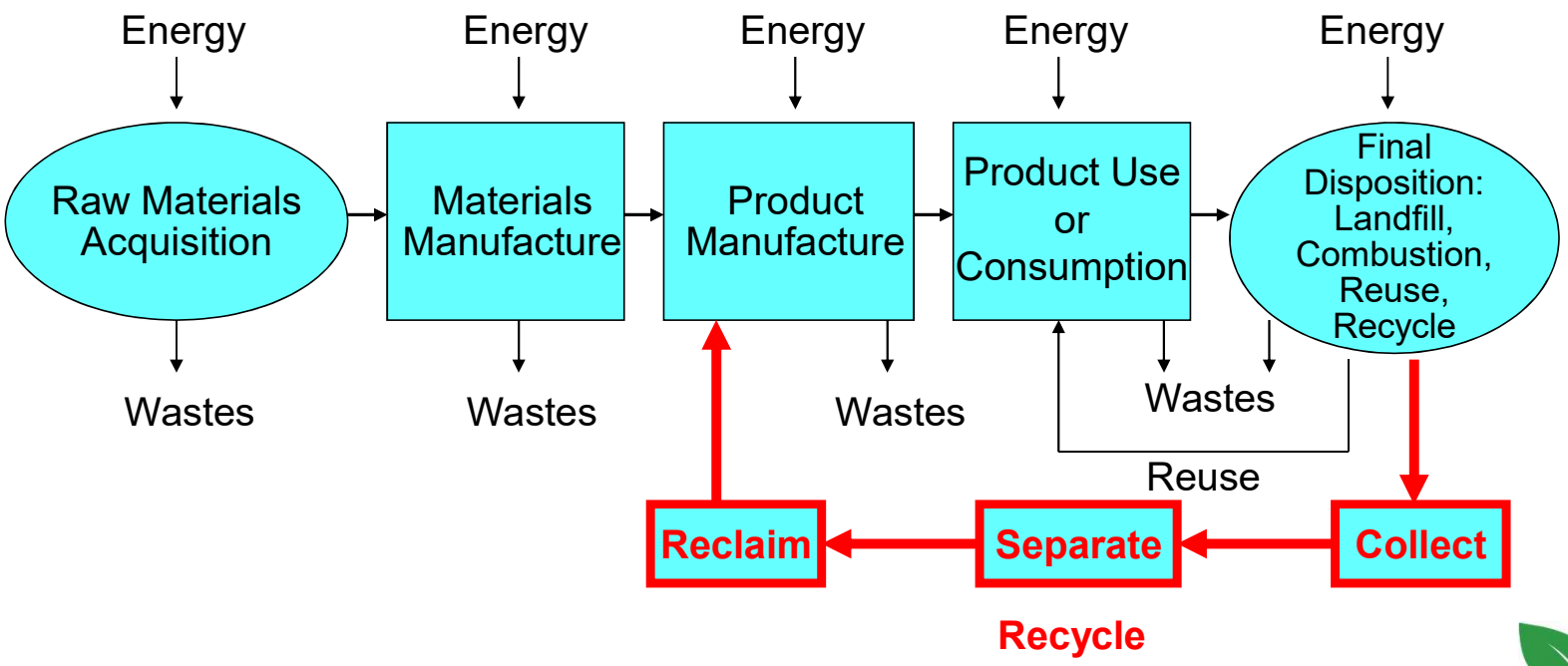
General Life Cycle Flow Diagram for a Product



Focus of Recycled Resin Project



Recycling Unit Processes



Data Developed for Recycled Resin Project

1. Sourcing and collection of postconsumer plastic
2. Sorting/separation of collected material
3. Processing steps by reclaimers to convert postconsumer material into recycled resin ready for use in a product

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1. Postconsumer Resin Collection

Collection of postconsumer plastic includes:

- Residential curbside programs
- Drop-off programs
- Deposit systems
  - California deposit system CRV (California refund value).
  - Recovery from other deposit states shown separately from CRV
- Commercial collection programs.

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1. Collection Data Sources

- Percent of PET, HDPE, and PP recovery through the various sources was determined using data from reliable published sources, including:
  - EPA's *Advancing Sustainable Materials Management* report
  - ACC and NAPCOR annual reports
  - California CRV reports
  - Governmental Advisory Associates, Inc. 2016-2017 MRF database

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Summary

Collection Systems for the Recovery of PET, HDPE, and PP Bottles and Containers						
	Curbside	Drop-off	Deposit States other than CA*	CRV**	Commercial	
					through MRF	other
PET	48%	5%	20%	19%	2%	6%
HDPE***	45%	5%	23%	11%	14%	2%
PP	95%	5%		<0.1%		

*Includes deposit recovery and curbside recovery

**California refund value

***Excludes HDPE film packaging.

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1. Average Collection Data Sets

- Transportation and fuel use developed for collecting 1000 lb postconsumer material from each source
- Weighted average collection data set compiled for each resin based on % of postconsumer supply from each source
- Main changes since 2010 study:
  - Significant increase in single stream collection
  - Added use of natural-gas fueled collection vehicles.

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Curbside Collection Summary

Curbside Collection Profile by Weight					
	Single stream collection		Dual stream collection		Curbside sort
Percent of Material Collected	65.5%		23.1%		11.4%
	19.7%	45.7%	17.3%	5.9%	11.4%
Truck type	Manual	Fully/semi-automated	Manual	Fully/semi-automated	Manual

2. Sorting/Separation of Collected Material

- In original study, collected primary data for:
  - 4 Material Recovery Facilities (MRFs)
  - 1 Plastic Recycling Facility (PRF)
  - Data from individual MRFs were normalized to basis of 1000 lb of output from the facility, and composite MRF processing data set compiled based on each facility's share of total output
- No participating MRFs/PRFs in the update
- MRF composite updated to reflect the share of material processed at each type of MRF, using data from the 2016-2017 MRF database.

3. Reclaimer Operations

- Data collected represent:
  - 7 PET reclaimers (180,000 tons),
  - 5 HDPE reclaimer facilities (213,000 tons), and
  - 3 PP reclaimers (71,000 tons)
- Compare to 2010 study:
  - 4 PET reclaimers (127,000 tons)
  - 6 HDPE reclaimer facilities (228,000 tons)

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3. Reclaimer Operations

- Participating reclaimers provided data on:
  - Incoming material sources & distances
  - Output of recycled resin
  - Other saleable material recovered from incoming bales
  - Water and chemical use for washing operations
  - Energy for washing and pelletizing operations
  - Solid wastes (waste in incoming bales, wastes generated during recycling processes, including wastewater treatment sludge)
  - Atmospheric emissions
  - Waterborne emissions

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3. Reclaimer Operations

- For each facility, operating data are normalized to basis of 1000 lb output
- Putting data from each reclaimer on a common basis helps identify data gaps and outliers for follow up
- Individual reclaimer data sets are then aggregated, weighting each data set according to the facility's contribution to the total output of postconsumer recycled resin reported by all participating reclaimers for that resin

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PET Updates

Compared to 2010 study, participating PET reclaimers in 2018 study reported:

- Less material from PRFs
- Similar incoming transportation distance
- More non-PET saleable material recovered from incoming bales
- More detail on chemical usage
- Similar process energy to 2010; more reclaimers reported energy for converting flake to solid stated food grade pellet
- Higher water use
- More solid waste per 1000 lb recycled PET

HDPE Updates

Compared to 2010 study, participating HDPE reclaimers in 2018 study reported:

- Less material from PRFs, more from deposit
- Similar incoming transportation distance
- Minimal recovery of non-HDPE saleable material recovered from incoming bales (consistent with original study)
- More detail on chemical usage/composition
- Similar process energy to 2010; more reclaimers split out energy for converting flake to pellet
- Higher water use
- More solid waste per 1000 lb recycled HDPE

New Data on PP

- Majority from curbside collection with some dropoff/commercial
- No reported recovery of non-PP saleable material from incoming bales
- Little chemical usage reported
- Process energy and solid waste similar to HDPE

Steps to Completion

- Finish follow up with reclaimers to resolve last remaining questions
- Add washing chemicals to models
- Generate final results
- Compare results for each recycled resin with corresponding virgin resin results

Preliminary* Greenhouse Gas Savings Compared to Virgin Resins

Reduction in CO2 eq compared to virgin resin:

- Solid-stated PET pellet: Approximately 50% reduction
- HDPE & PP pellet: 65-70% reduction

Majority of greenhouse gas impacts are associated with reclaimer operations

- Solid-stated PET pellet: Almost 90%
- HDPE & PP pellet: 70-75%

*Results may change to some degree with addition of washing chemicals and final clarifications from reclaimers

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More Results Categories in Updated Report

Original Report:

- Energy
- Solid waste
- Water consumption
- Greenhouse gas (CO2 eq)
- Inventory of other atmospheric and waterborne emissions (process and fuel-related) for collection through reclaimer processing

Updated Report: Add life cycle impact categories reflecting the potential contributions of the atmospheric and waterborne emissions on:

- Acidification
- Eutrophication
- Smog
- Ozone Depletion

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Important Uses of Recycled Resin Data

- **Reclaimers:** Understand and communicate benefits of recycled resin relative to virgin resin, increase demand for recycled resin
- **Manufacturers:** Communicate benefits of recycled content products to customers
- **Corporations:** Understand potential for recycled content to help meet GHG reduction targets, quantify progress toward sustainability goals
- **Consumers:** Understand importance of recycling in reducing environmental impacts; motivate increased recycling

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Final Step: Put Updated Unit Process Data Sets in U.S. LCI Database

- Database containing detailed environmental data on processes, fuels, and materials
- Data for US/North America
- Publicly available free of charge
- Data presented on unit process level for transparency and flexibility in modeling
- Can be used by any interested party to construct LCIs and LCAs of plastic products with recycled content

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