



North American Pultrusion Conference

LCI Data and LCA Results for the Pultrusion Process

Melissa Huff

May 16, 2023



Introduction

- Franklin Associates, a Division of ERG
 - Founded by Bill Franklin, 1976
 - Part of Eastern Research Group, 2003

- Melissa Huff
 - Mentored by Bill Franklin
 - 31 years of experience doing LCA
 - Created Past Databases for ACMA and ACC Plastics



Introduction to Life Cycle Assessment

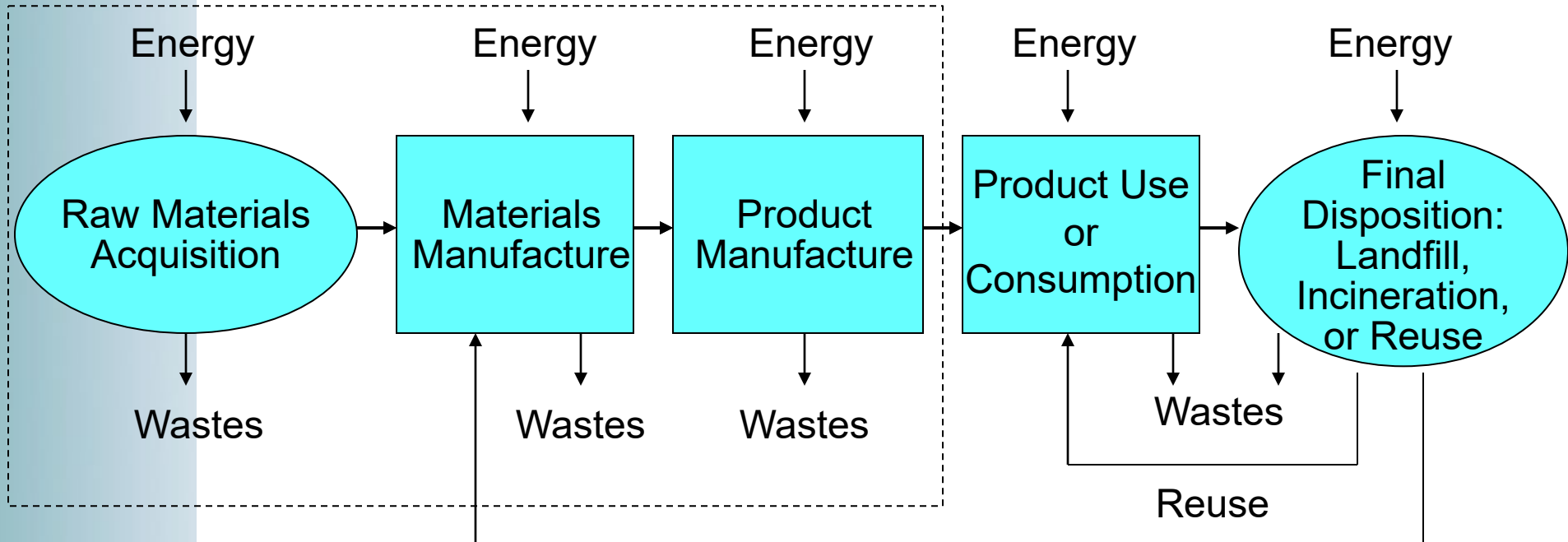
- ISO standards for Life Cycle Assessment (LCA) - ISO14040 (Principles & Framework), ISO14044 (Requirements & Guidelines), ISO14067 (Carbon Footprint)
- As defined in ISO 14040, a Life Cycle Assessment is the “compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle.”



Introduction to Life Cycle Assessment

- A complete LCA includes four phases:
 1. definition of goal & scope;
 2. inventory analysis;
 3. impact assessment; and
 4. interpretation of results

LCA Boundaries






Introduction to ACMA LCI/LCA Work

- 2012 LCI plus Global Warming study
 - E-glass, Unsaturated Polyester
 - Open Molding, Compression Molding, Vacuum Infusion, Open Mold Casting, Secondary Bonding
- 2022 LCA study
 - Vinyl Ester Resin
 - Pultrusion
 - Polyurethane Precursors



ACMA Goals for 2022-2023 LCA

- Collect data from and provide ACMA members with average North American LCA results for vinyl ester resin and the pultrusion process in a report format. Polyurethane precursors will also be discussed in the LCA report.
- Provide ACMA with averaged LCI data for vinyl ester resin and pultrusion suitable for submission to the US LCI Database.



Current 2022-2023 study

- Data collection commenced at the end of 2022
- Vinyl ester resin and pultrusion average LCI data are currently draft
- Results for vinyl ester resin and pultrusion process are currently draft
- Report to be completed by end of June 2023

Pultrusion Unit Process LCI Average

Unit Process Data for the Pultrusion of 1000 Pounds of Product

	<u>1,000 lb</u>	<u>1,000 kg</u>
Material Inputs		
E-glass (representing various types)	741 lb	741 kg
Vinyl ester resin	45.9 lb	45.9 kg
Polyether polyol	12.1 lb	12.1 kg
Isocyanate	19.0 lb	19.0 kg
Unsaturated Polyester	172 lb	172 kg
Styrene	8.9 lb	8.9 kg
Kaolin Clay	22.6 lb	22.6 kg
Energy		
<i>Process Energy</i>		
Electricity from grid	368 kWh	811 kWh
Electricity from Renewable Sources	22.9 kWh	50.4 kWh
Diesel	0.031 gal	0.26 l
Propane (as LPG)	0.52 gal	4.33 l
<i>Transportation Energy</i>		
Ocean freighter	397 ton-mi	1,277 tonne-km
Truck	336 ton-mi	1,082 tonne-km

Pultrusion Unit Process LCI Average

Unit Process Data for the Pultrusion of 1000 Pounds of Product

	<u>1,000 lb</u>	<u>1,000 kg</u>	
Environmental Emissions			
<i>Atmospheric Emissions</i>			
VOC, unspecified origin	1.02 lb	1.02 kg	
Particulates, unspecified	1.0E-04 lb	1.0E-04 kg	*
Styrene	1.81 lb	1.81 kg	
Methylmethacrylate (MMA)	1.0E-03 lb	1.0E-03 kg	*
<i>Waterborne Releases (none)</i>			
Solid Wastes			
Solid waste, process to landfill	57.9 lb	57.9 kg	
Solid Waste Sold for Recycling or Reuse	17.1 lb	17.1 kg	
Hazardous waste to landfill	4.17 lb	4.17 kg	
Water Consumption	4.1E-05 gal	3.4E-04 l	

* To indicate known emissions while protecting the confidentiality of individual company responses, the emission is reported only by the order of magnitude of the average.

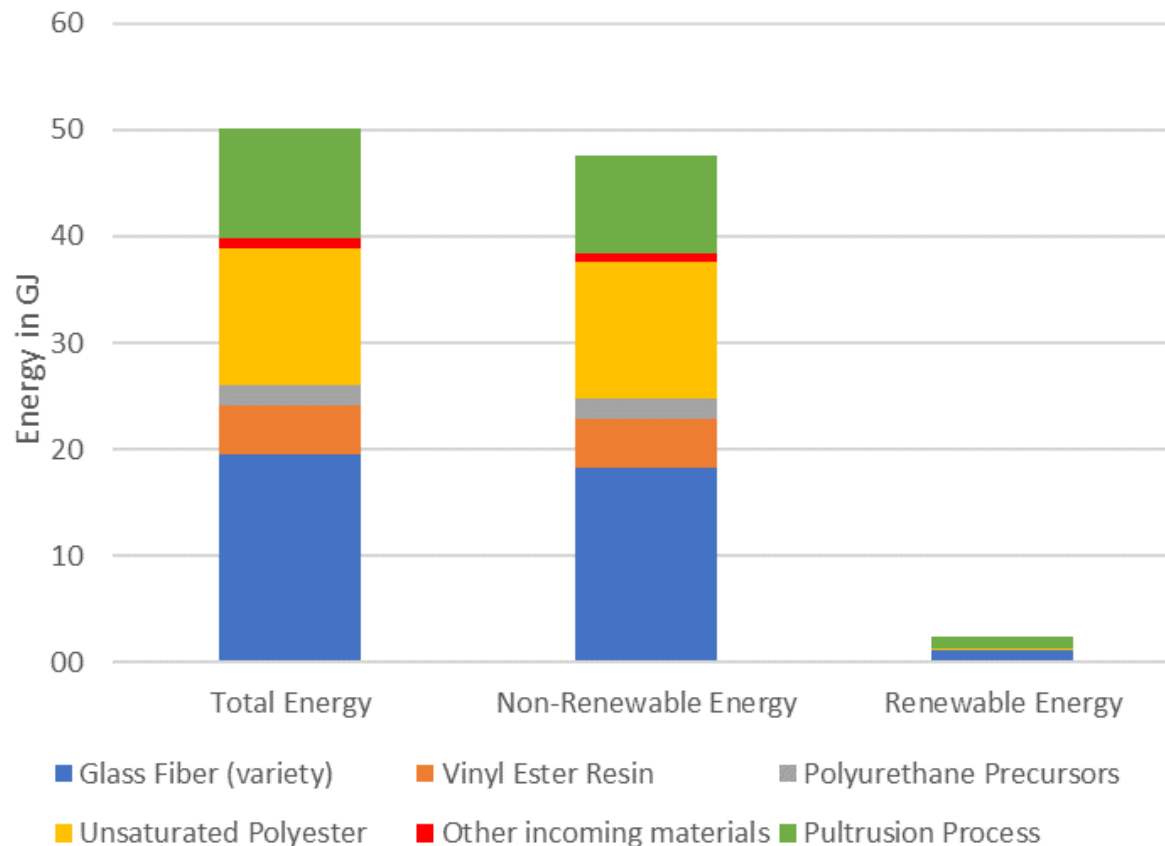
Pultrusion LCI Results

	1000 kilograms of Pultruded Products				
	<i>LCI Results</i>				
	Total Energy	Non-Renewable Energy	Renewable Energy	Total Solid Waste	Water Consumption
	<i>GJ</i>	<i>GJ</i>	<i>GJ</i>	<i>kg</i>	<i>Liters</i>
Glass Fiber (variety)	19.5	18.3	1.14	358	9,824
Vinyl Ester Resin	4.57	4.49	0.073	5.71	852
Polyurethane Precursors	1.94	1.91	0.032	2.29	720
Unsaturated Polyester	12.9	12.8	0.14	15.0	1,415
Other incoming materials	0.86	0.85	0.008	17.4	93
Pultrusion Process	10.3	9.23	1.08	110	5,696
Total	50.1	47.6	2.47	508	18,601

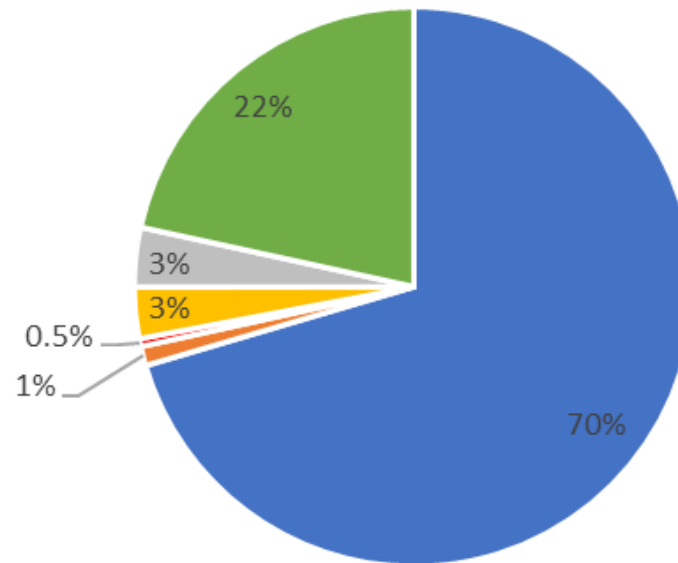
Pultrusion LCIA Results

1000 kilograms of Pultruded Products					
<i>LCIA Results</i>					
	Global Warming	Eutrophication	Smog Formation	Ozone Depletion	Acidification
	<i>kg CO₂ eq</i>	<i>kg N eq</i>	<i>kg O₃ eq</i>	<i>kg CFC-11 eq</i>	<i>kg SO₂ eq</i>
Glass Fiber (variety)	1,416	0.12	66.3	9.5E-07	4.25
Vinyl Ester Resin	188	0.14	12.1	3.3E-07	0.66
Polyurethane Precursors	72.7	0.032	4.41	1.7E-07	0.20
Unsaturated Polyester	453	0.24	27.0	5.7E-06	1.15
Other incoming materials	29.9	0.0035	1.56	5.9E-08	0.066
Pultrusion Process	575	0.091	57.2	4.3E-07	3.08
Total	2,734	0.63	169	7.6E-06	9.41

Pultrusion Energy Results (1000 kg of Pultruded Products)

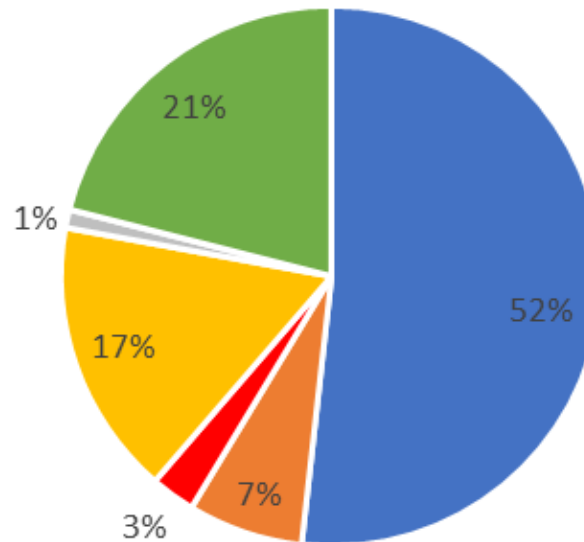


Pultrusion Solid Waste Results (1000 kg of Pultruded Products)



- Glass Fiber (variety)
- Vinyl Ester Resin
- Polyurethane Precursors
- Unsaturated Polyester
- Other incoming materials
- Pultrusion Process

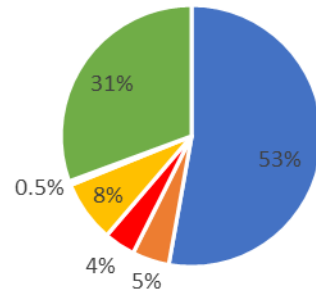
Pultrusion Global Warming Results (1000 kg of Pultruded Products)



- Glass Fiber (variety)
- Vinyl Ester Resin
- Polyurethane Precursors
- Unsaturated Polyester
- Other incoming materials
- Pultrusion Process

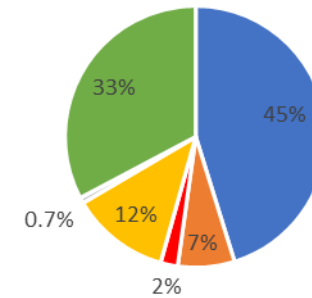
Pultrusion Other LCA Results (1000 kg of Pultruded Products)

Water Consumption



- Glass Fiber (variety)
- Vinyl Ester Resin
- Polyurethane Precursors
- Unsaturation Polyester
- Other incoming materials
- Pultrusion Process

Acidification Potential



- Glass Fiber (variety)
- Vinyl Ester Resin
- Polyurethane Precursors
- Unsaturation Polyester
- Other incoming materials
- Pultrusion Process



Average Pultrusion Data Use

- Available within the ACMA report
- Available within the US LCI Database
 - Use by practitioners who have no pultrusion data available
 - Use by your customers—unless you have company-specific LCA results to provide to them.



Increased Demand for Environmental Information

- Due to the increased interest in Global Warming Potential (carbon footprint) over the past 10 years in this country, you either have or will be asked by a customer what the carbon footprint of your product is.
- Environmental Product Declarations (EPD)



Questions?
