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Combining Reclaimed PET with Bio-Based Monomers Enables Plastics Upcycling

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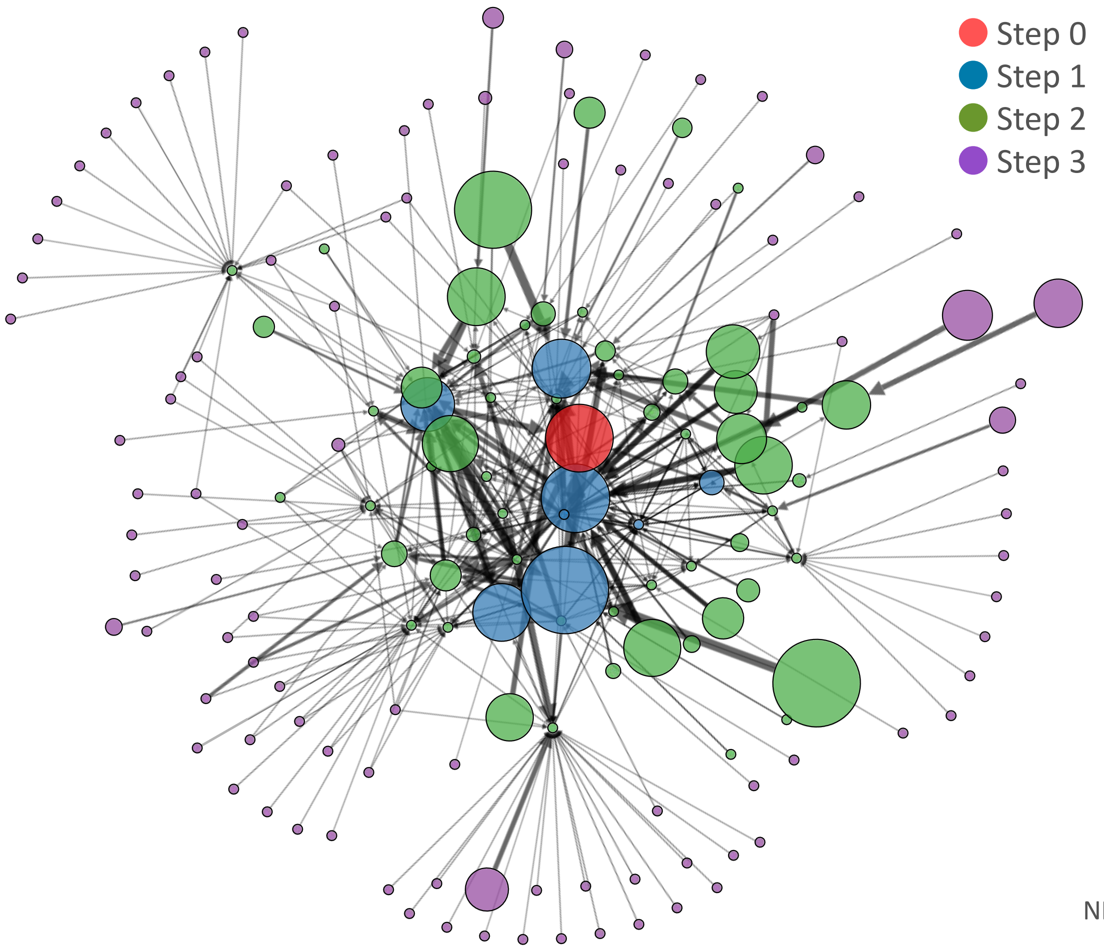
The Materials Flows though Industry (MFI) Tool

MFI is a supply chain modeling tool funded by the Advanced Manufacturing Office created to identify and analyze opportunities to reduce the energy and carbon intensities of the U.S. industrial sector.

- Linear network model
- U.S.-based supply chains
- ~750 industrial, bulk commodities
- ~1300 recipes (unit processes)
- Mine-to-materials; does not include use-phase or end-of-life by default
- Outputs: Energy consumption and GHG emissions
- Web application now publicly available to try out: mfitool.nrel.gov

Glass Fiber Reinforced Plastic Supply Chain Network



PET Upcycling to Composites

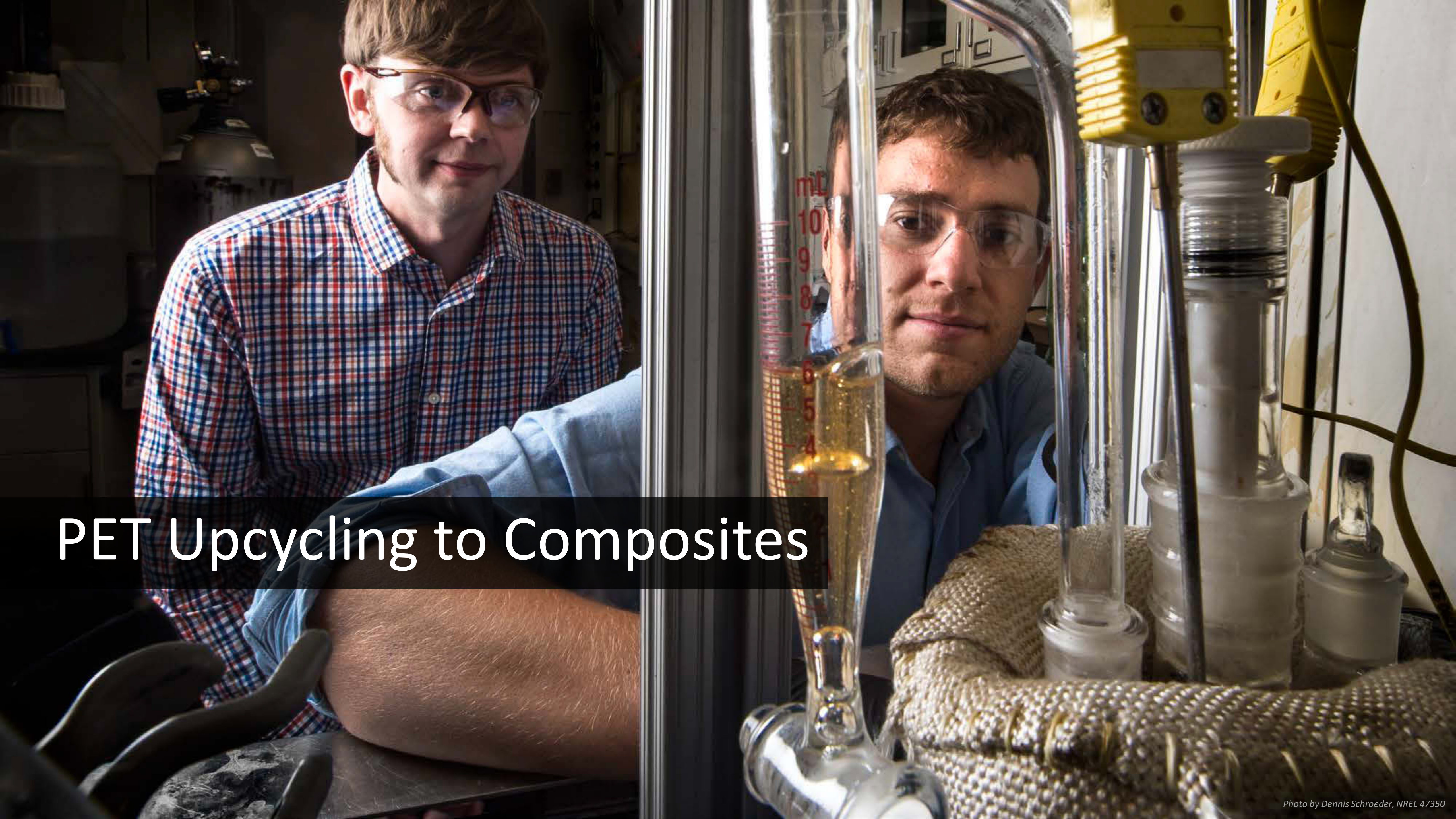


Photo by Dennis Schroeder, NREL 47350

rPET Upcycling Background & Motivation

- Most commercial PET recycling is mechanical
- Mechanical recycling leads to lower-grade plastic with fewer applications (carpet fiber, etc.)
- Chemical recycling of PET bottles back to its monomers is expensive
- What if we could make higher value glass fiber reinforced plastic with recycled PET?

Photo from pxhere.com

Are there energy savings associated with rPET–based GFRP production?

Conventional and Bio-Based GFRP Production

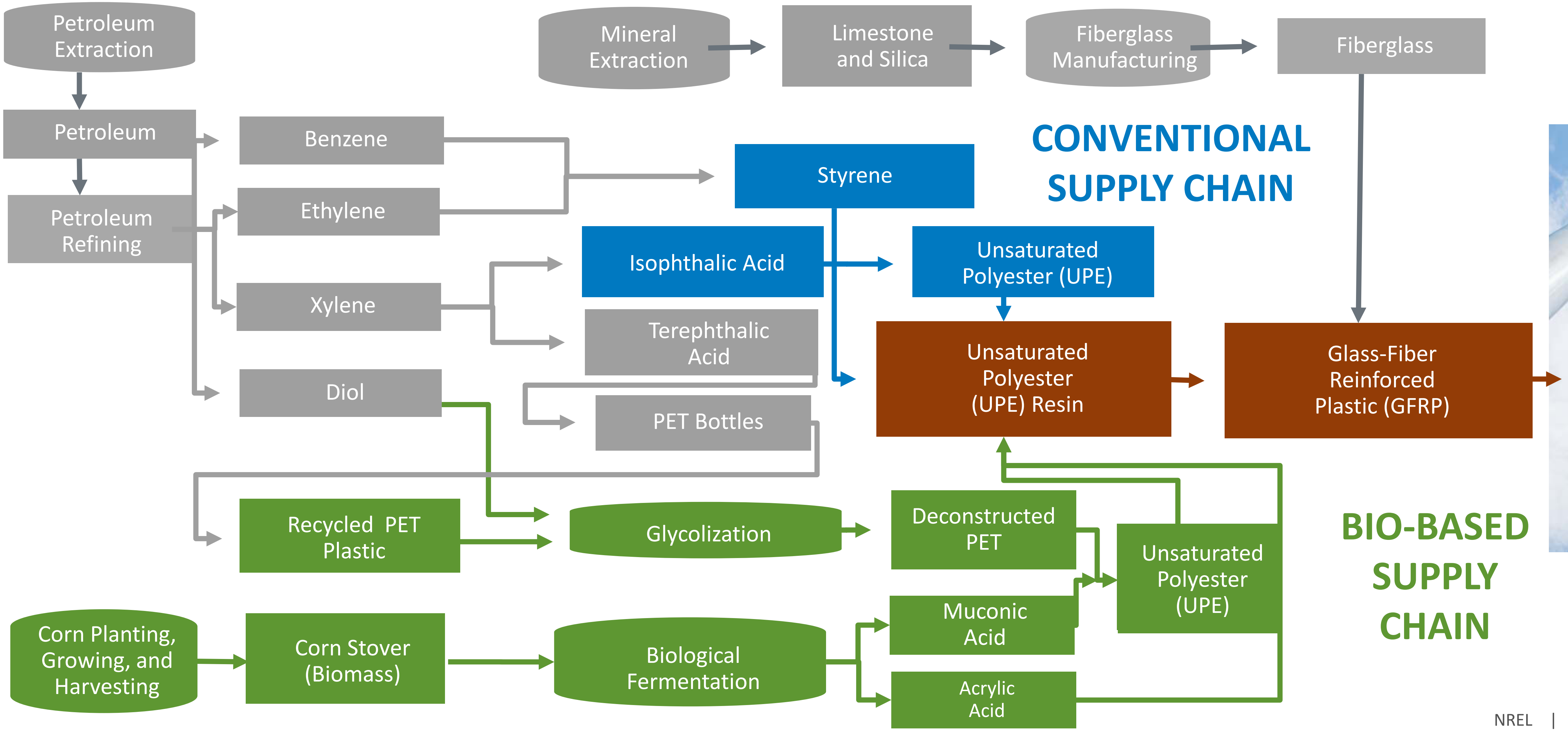
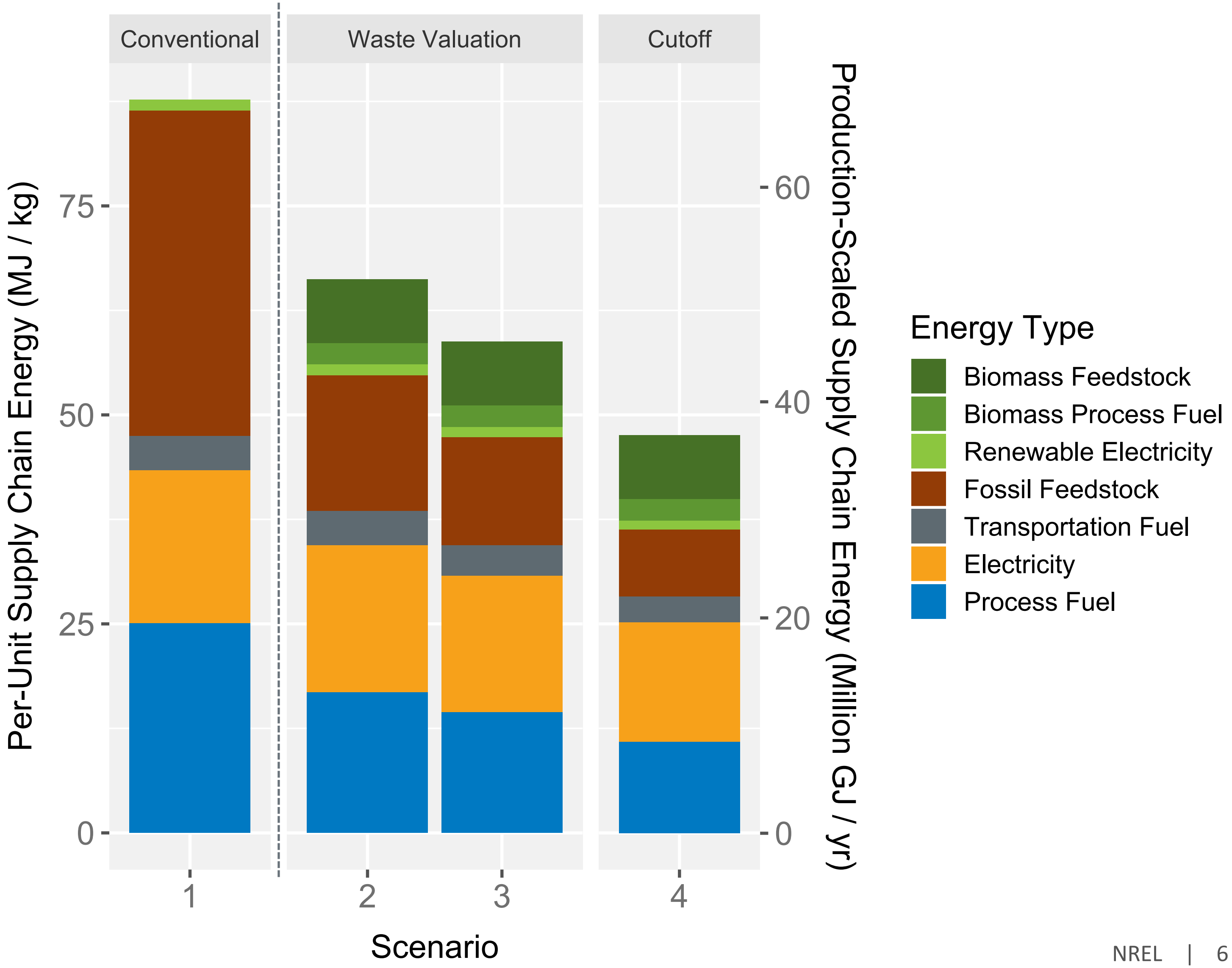


Photo by De

Comparison of Supply Chain Energy Requirements for GFRP from Conventional vs Upcycled rPET

Depending on the allocation method, supply chain fossil energy reductions range from **37% to 58%**.

Scenario	Name	PET Bottle (First Life) Allocation
1	Conventional GFRP	N/A (No rPET Used)
2	Waste Valuation; Reclaimed Clear rPET 	≈54% (Economic)
3	Waste Valuation; Reclaimed Green rPET 	≈32% (Economic)
4	Reclaimed rPET - Cutoff	0%



Supply Chain Feedstock Energy Requirements for GFRP from Upcycled PET

Overall, supply chain fossil feedstock energy reductions range from **58% to 79%**

Scenario	Name	PET Bottle (First Life) Allocation
1	Conventional GFRP	N/A (No rPET Used)
2	Waste Valuation; Reclaimed Clear rPET 	≈54% (Economic)
3	Waste Valuation; Reclaimed Green rPET 	≈32% (Economic)
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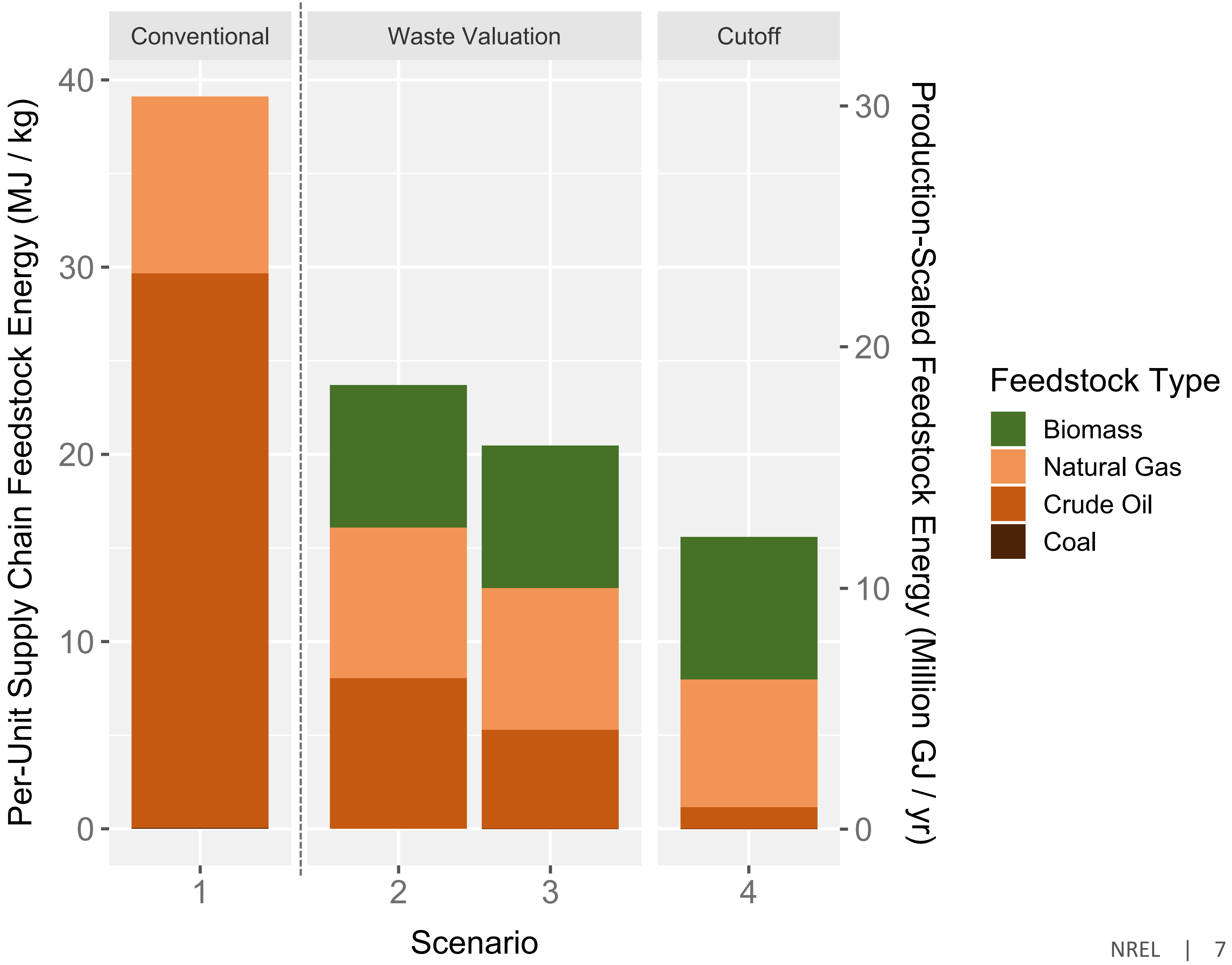

Supply Chain Combustion GHG Emissions for GFRP from Upcycled PET

- Overall, supply chain GHG emissions reductions range from **30% to 40%**
- 0.7 – 1.0 MMT-CO_2e offsets; Equivalent to taking **150,000 - 200,000 cars** off the road

Scenario	Name	PET Bottle (First Life) Allocation
1	Conventional GFRP	N/A (No rPET Used)
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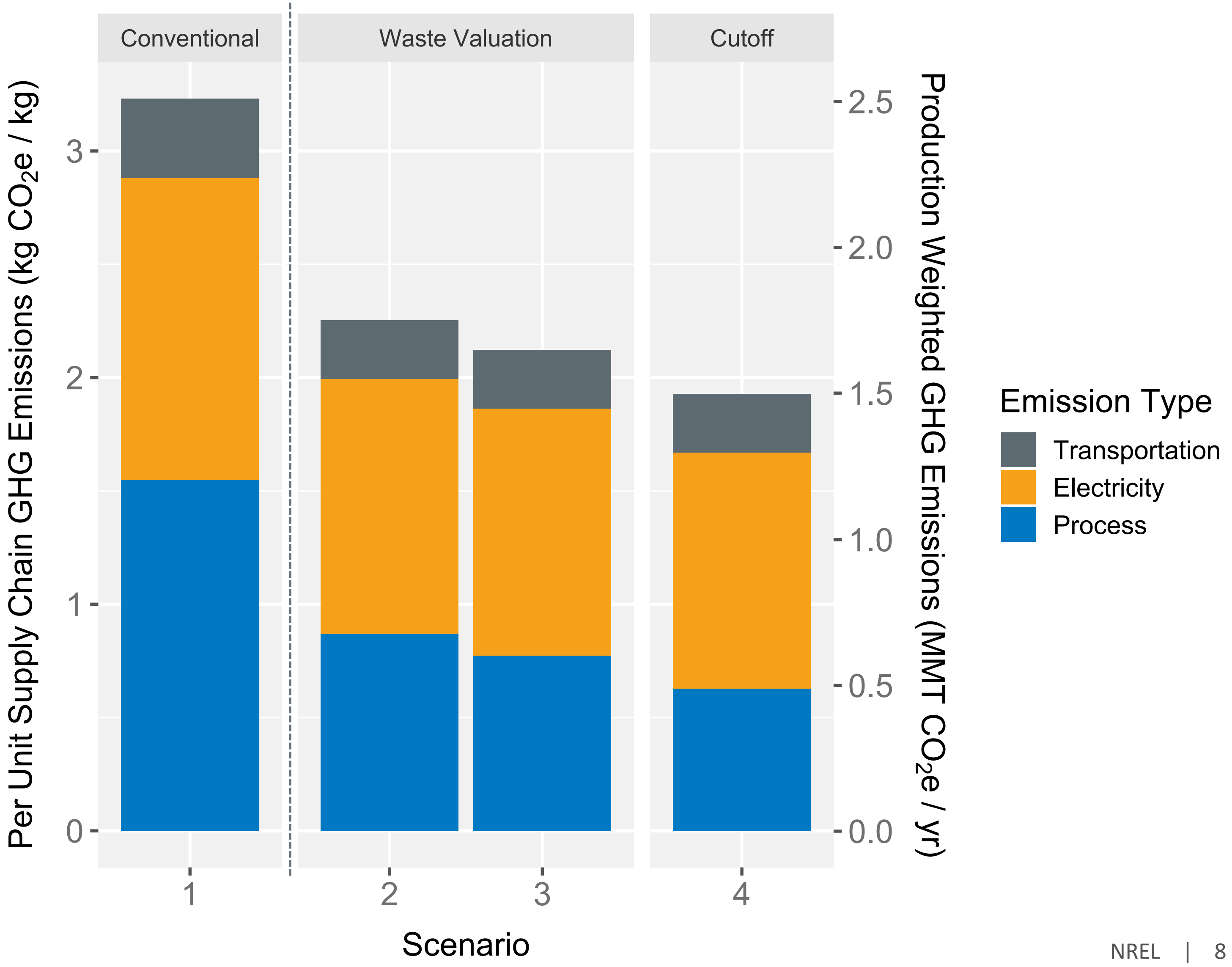
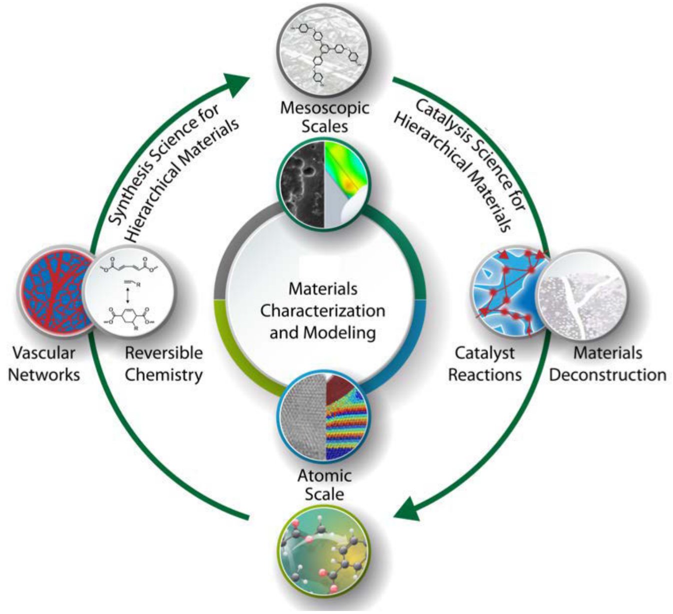


The Plastics Upcycling Consortium

Slides courtesy of Gregg T. Beckham
National Renewable Energy Laboratory

Vision and Mission

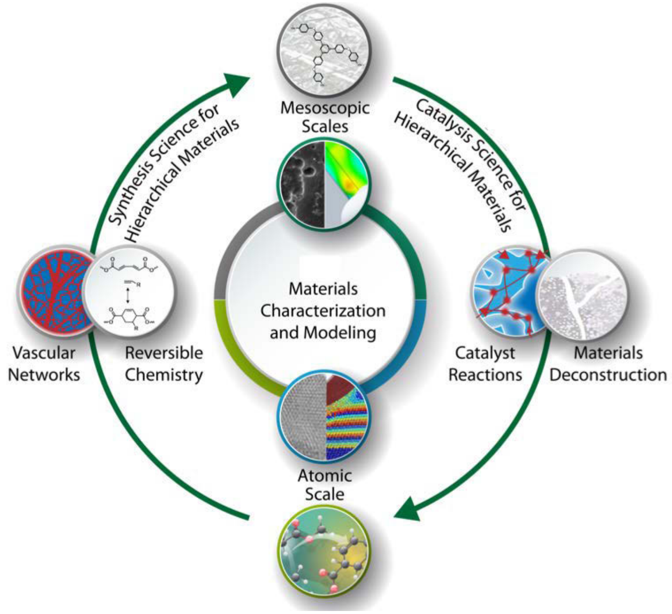
The **vision** for the **Plastics Upcycling Consortium** is to deliver technologies that will incentivize reclamation of waste plastics to enable a circular plastics economy



The **mission** of the **Plastics Upcycling Consortium** is to:
(1) develop robust processes to upcycle existing waste plastics, and
(2) develop new plastics and processes that are recyclable-by-design

Goals

- Develop **selective, scalable processes** to deconstruct and upcycle **commodity thermoplastics** that are discarded in large quantities today including PE, PP, PS, PET, nylons, and polyurethanes
- Work with industry to catalyze a new upcycling paradigm for plastics



- Design new chemistries and associated processes for direct chemical recycling of future plastics and composites that are recyclable-by-design
- Leverage AMO, BETO, and DOE investments in process development, biological and chemical catalysis, analysis-driven R&D

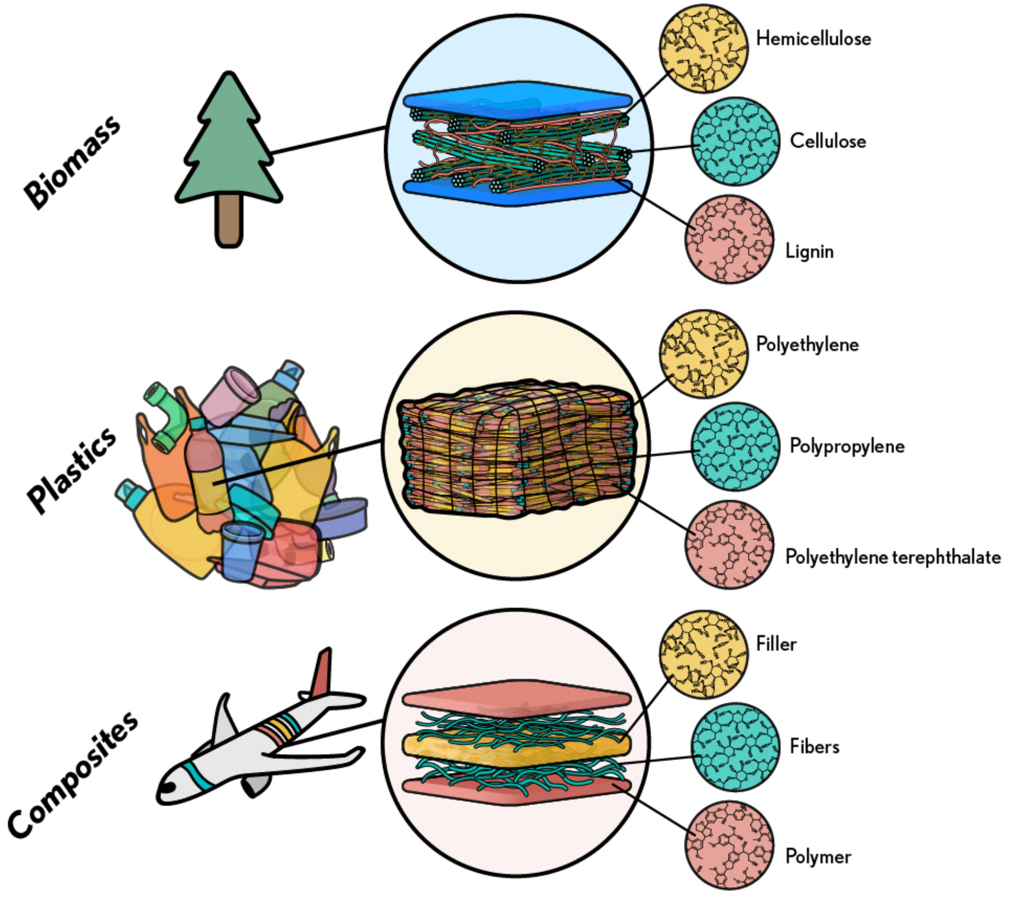
What this consortium is…

A consortium leveraging AMO and BETO investments in…

Applied R&D for waste polymers to valuable products through biological and catalytic processes

Analysis-guided R&D that can leverage and expand existing analysis tools

A consortium that could immediately engage industry and industry groups



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MFI Web App Link:
mfitool.nrel.gov

Thank you

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