# Combining Reclaimed PET with Bio-Based Monomers Enables Plastics Upcycling

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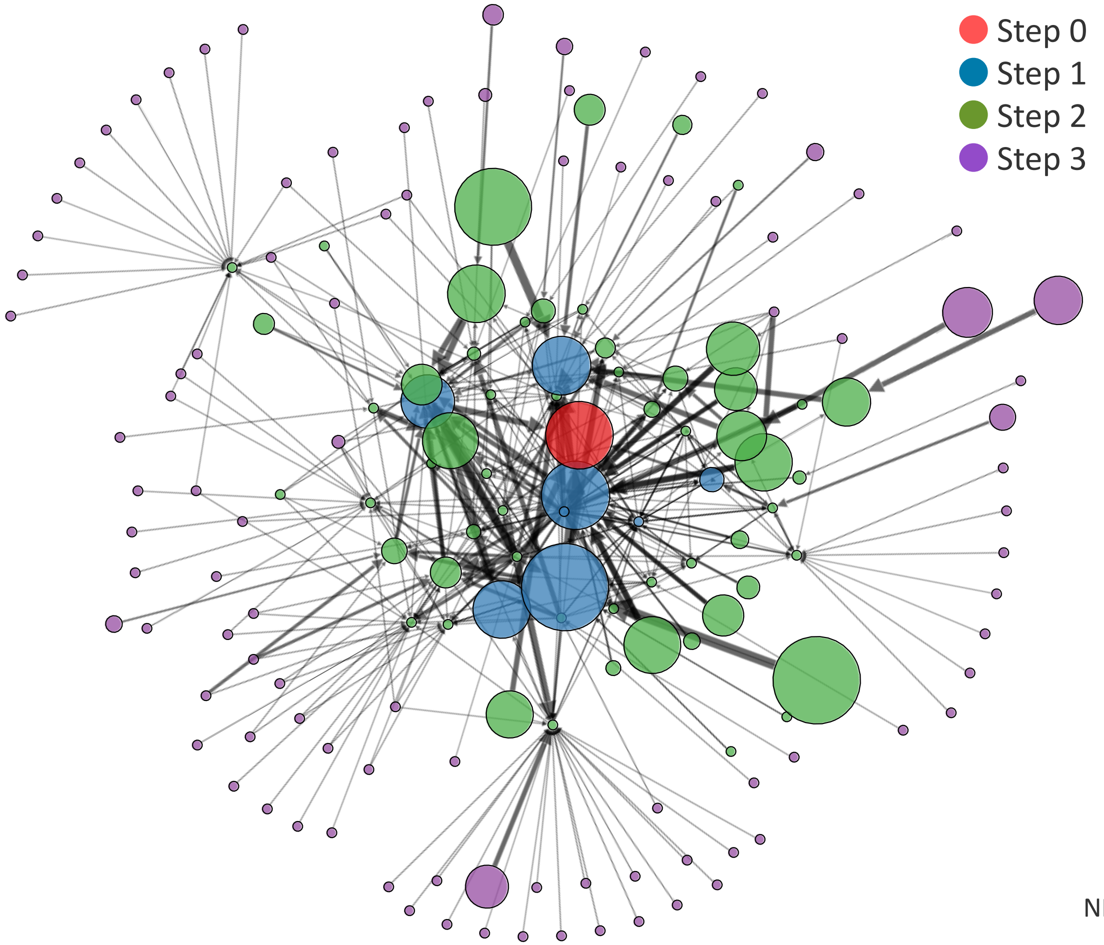
# The Materials Flows though Industry (MFI) Tool

*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](mfitool.nrel.gov)

**Glass Fiber Reinforced Plastic Supply Chain Network**



# PET Upcycling to Composites

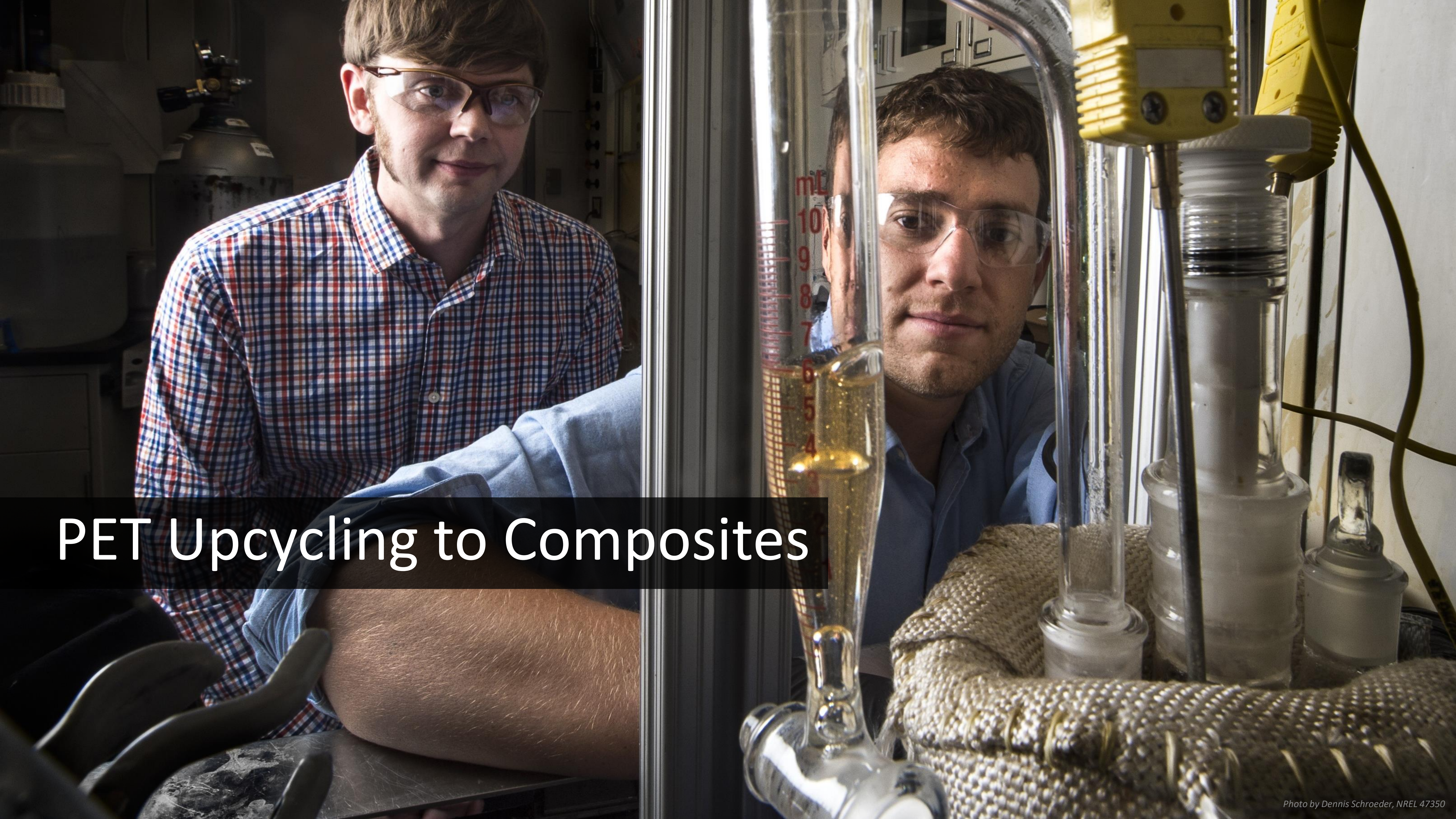



Photo by Dennis Schroeder, NREL 47350

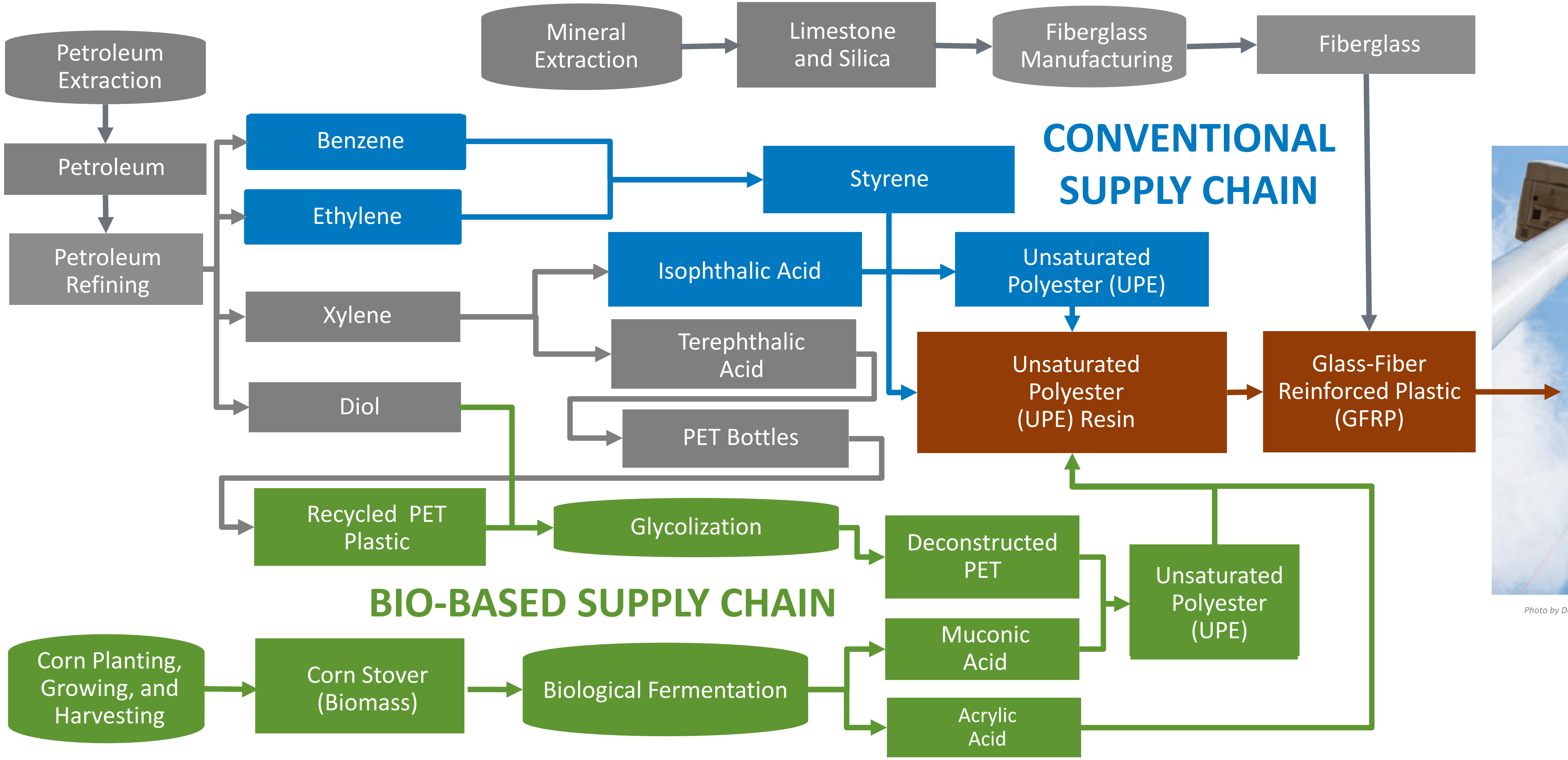
# rPET Upcycling Background & Motivation

- Most commercial polyethylene terephthalate (PET) plastic 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



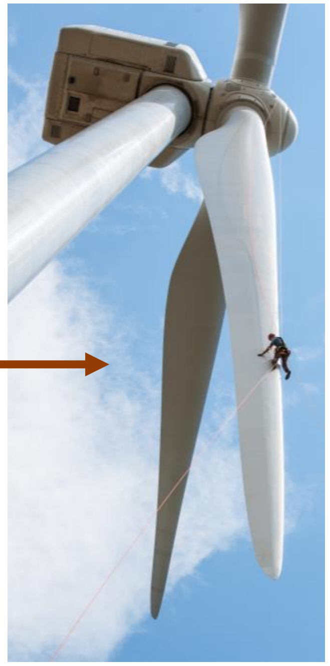
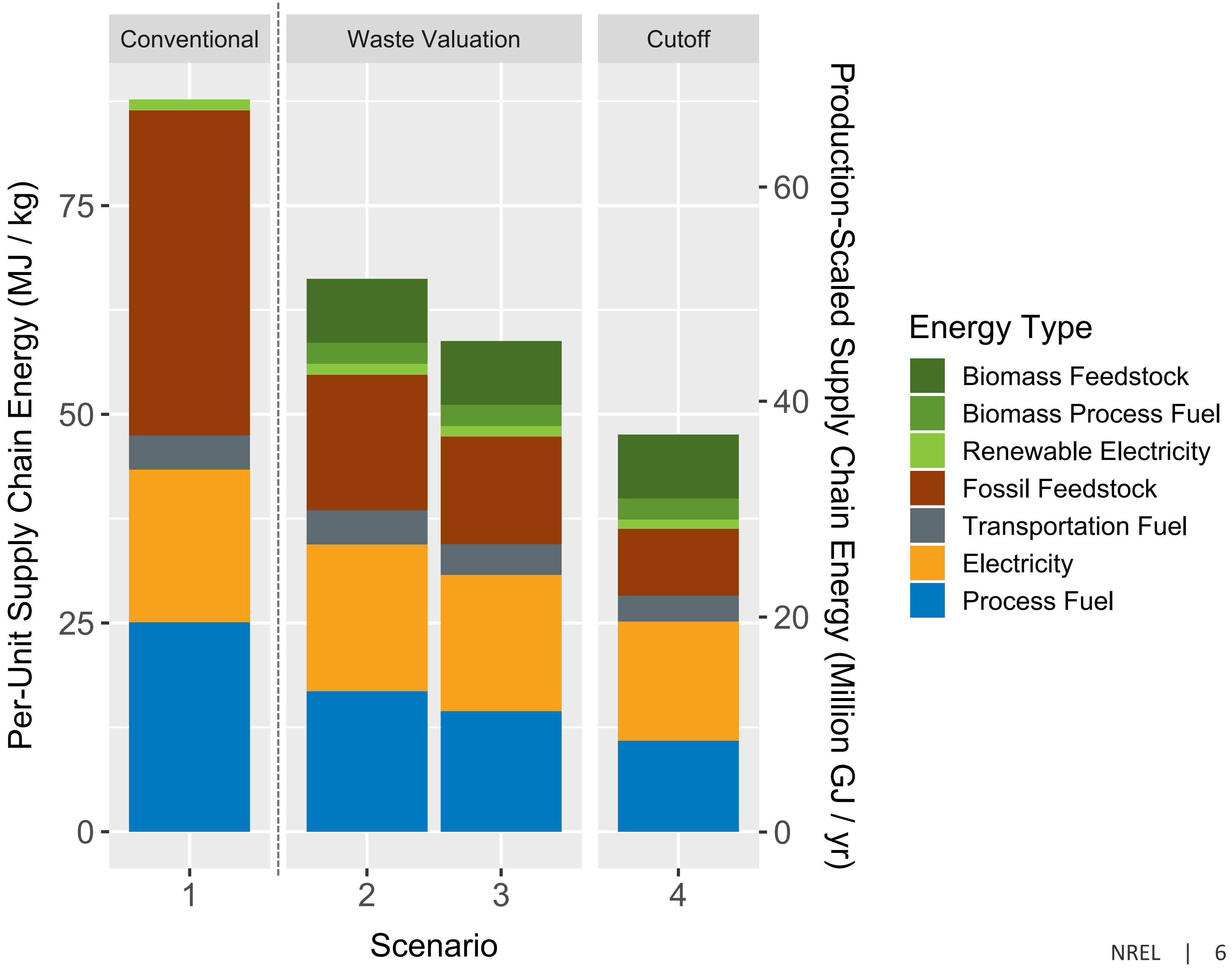



*Photo by Dennis Schroeder, NREL 27204*

# 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%**.

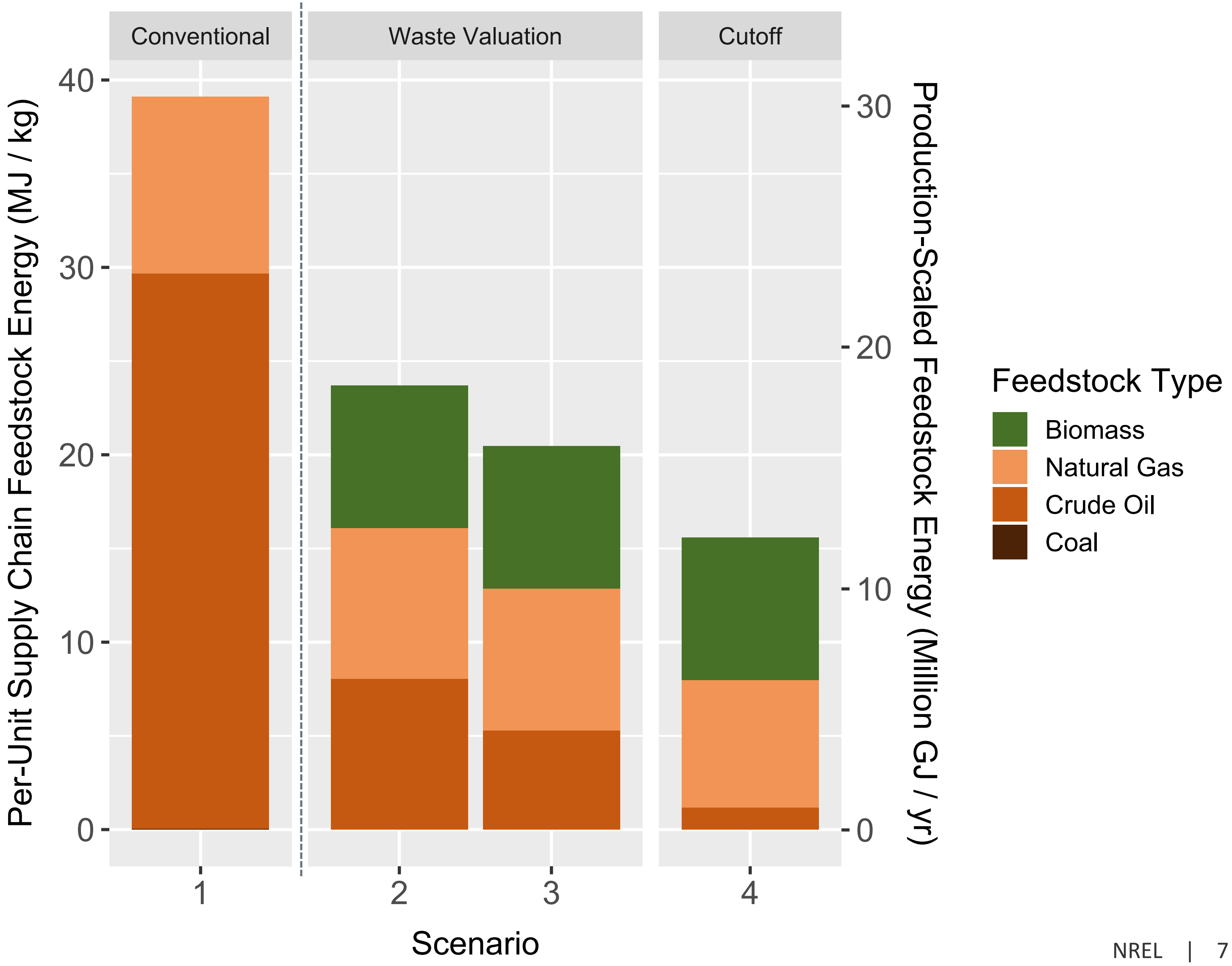
| Scenario | Name | PET Bottle (First Life) Allocation |
|---|---|---|
| 1 | Conventional GFRP | N/A (No rPET Used) |
| 2 | Waste Valuation; Reclaimed Clear rPET  | ≈54% (Economic) |
| 3 | Waste Valuation; Reclaimed Green rPET  | ≈32% (Economic) |
| 4 | Reclaimed rPET - Cutoff | 0% |



# 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) |
| 4 | Reclaimed rPET - Cutoff | 0% |



# 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-$CO_2$e offsets; Equivalent to taking **150,000 - 200,000 cars** off the road

| Scenario | Name | PET Bottle (First Life) Allocation |
|---|---|---|
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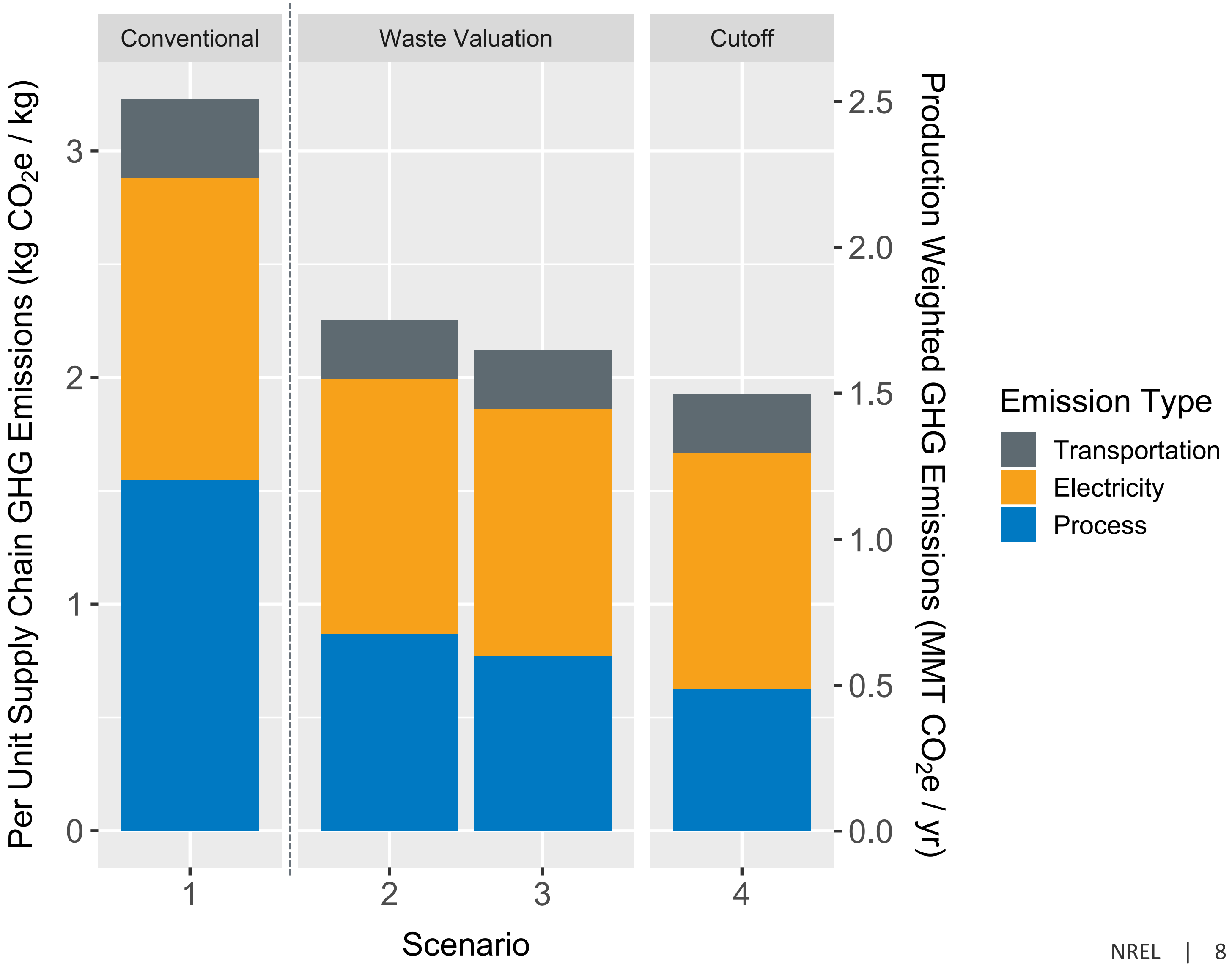
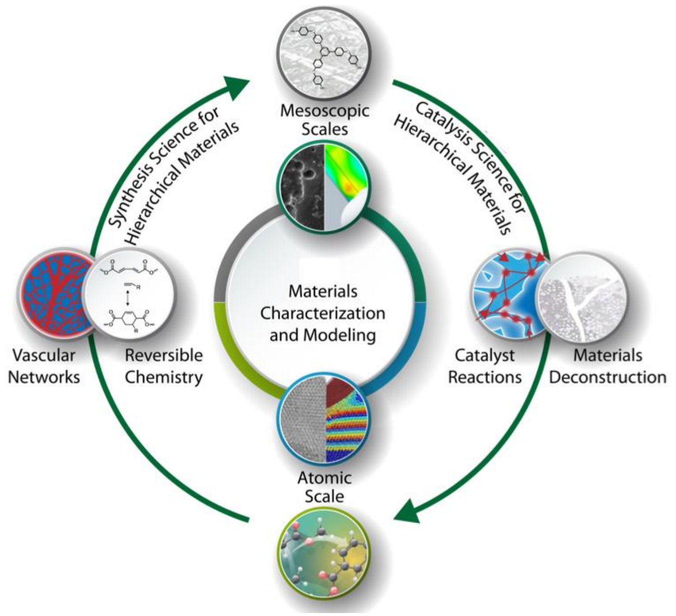


# The Plastics Upcycling Consortium

Slides courtesy of Gregg T. Beckham
National Renewable Energy Laboratory

# Vision and Mission

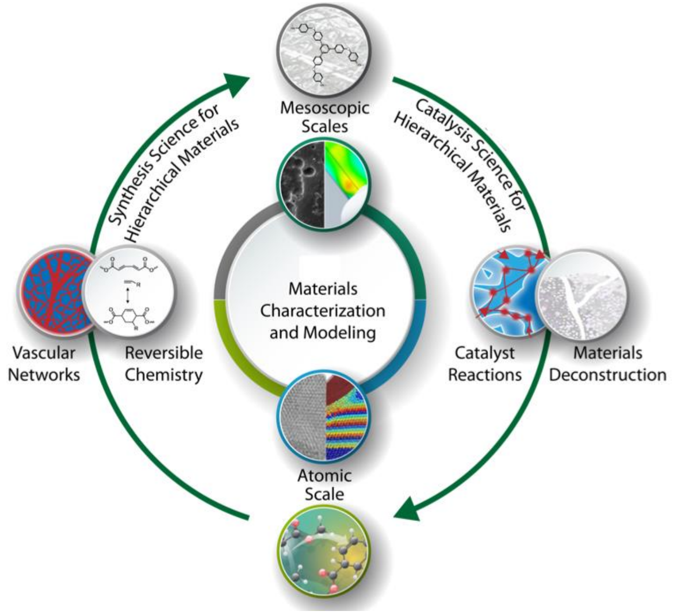
The **vision** for the **Plastics Upcycling Consortium** is to deliver technologies that will incentivize reclamation of waste plastics to enable a circular plastics economy


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

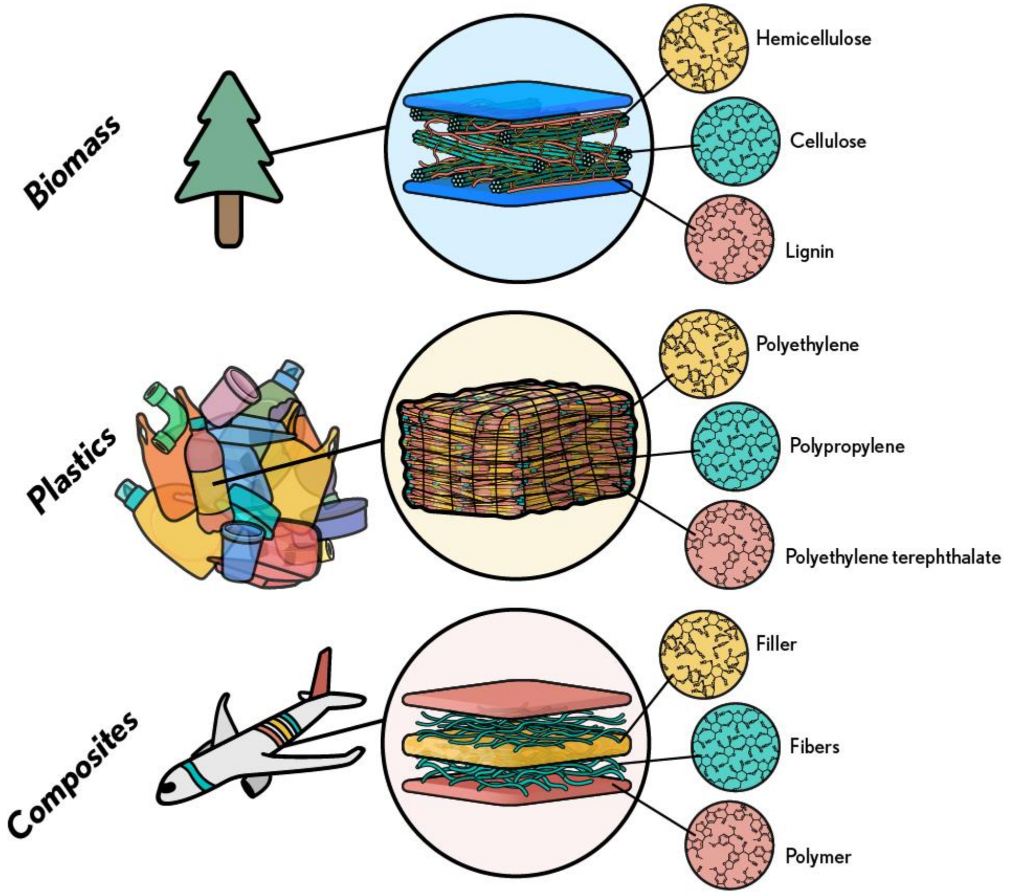
# What this consortium is…

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



# Thank you

**www.nrel.gov**

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MFI Web App Link:
mfitool.nrel.gov

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