Transitioning Toward a

CIRCULAR ECONOMY

for Automotive Plastics and Polymer Composites

American Chemistry Council | Plastics Division

The transition toward a **circular economy** for industrial goods will require the automotive industry and its suppliers to rethink the ways that vehicles and their materials are designed, constructed, used, and handled at end of life.

We're starting the conversation *now*.

Principles of a Circular Economy

Reduce demand for finite raw materials

Design materials, products, and systems to be circular (e.g., design for disassembly and recovery)

Eliminate in-process scrap production

Reuse recovered materials in new products

Recover and recycle materials at the end of their usable life

Refurbish and remanufacture products to extend useful service lifecycles

$4.5 trillion
opportunity by 2030

$400–600 billion
of which could go to automotive companies and their suppliers

For automakers to take full advantage of all the benefits plastics and polymer composites offer, our materials need to be **highly circular**

GM

At least 50% of materials in vehicles sustainable by 2030

VOLVO

25% recycled plastics in cars starting in 2025

Ford

20% renewable and recycled plastics by 2025

BMW

"Replace materials in value chain with recycled and sustainable raw materials"
"Design for Recycling principle"

NISSAN

30% of raw materials used in car production will not depend on newly extracted resources by 2022

TOYOTA

"Eco-friendly materials"
"Auto part longevity"
"Recycling technologies"
"Manufacturing vehicles from end-of-life vehicles"

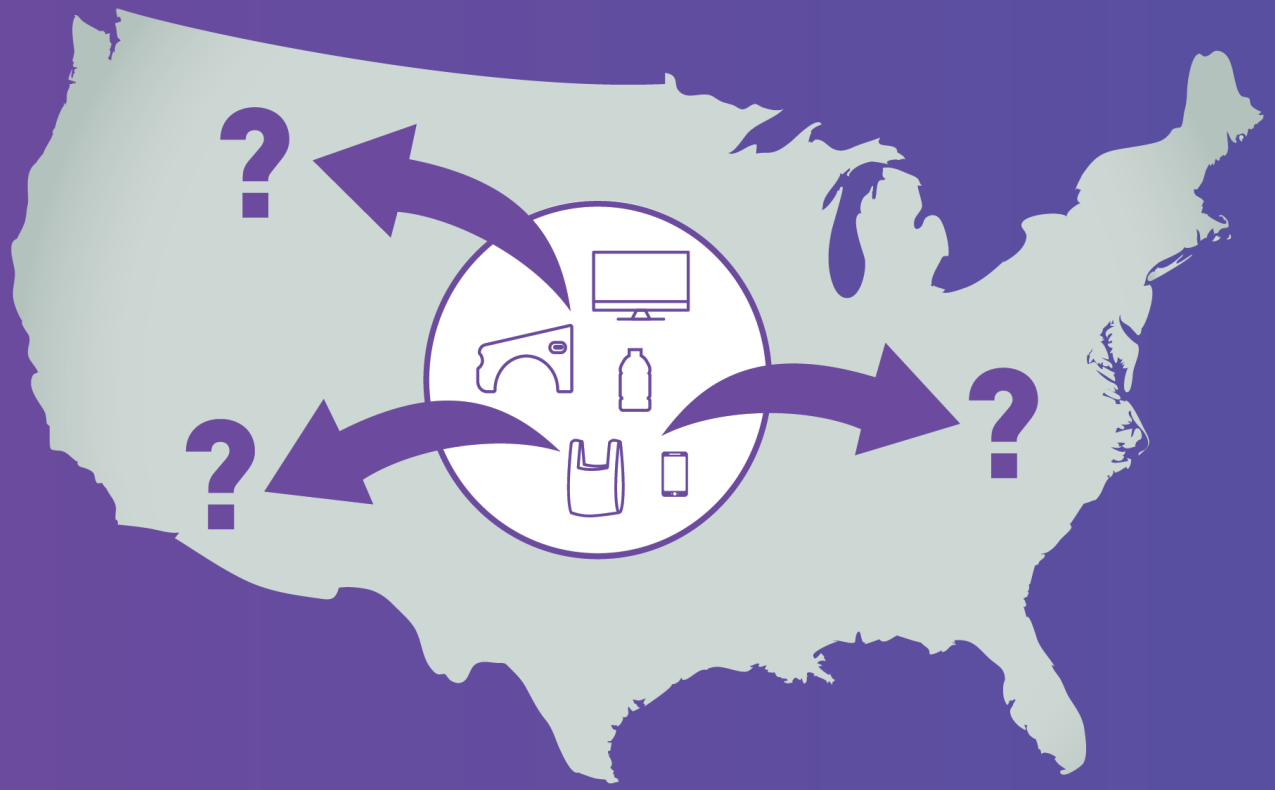
EU Legislation/Initiatives

- End-of-Life Vehicles Directive (2000/53/EC)
- Motor Vehicle Reusability, Recyclability, and Recoverability Directive (2005/64/EC)
- Circular Economy Action Plan (EU)

U.S. State Legislation

- California: Circular Economy and Plastic Pollution Reduction Act 2019-2020 (introduced)
- Maine: Resolve, To Support Municipal Recycling Programs (introduced)

Decreasing capacity for handling materials at end of life



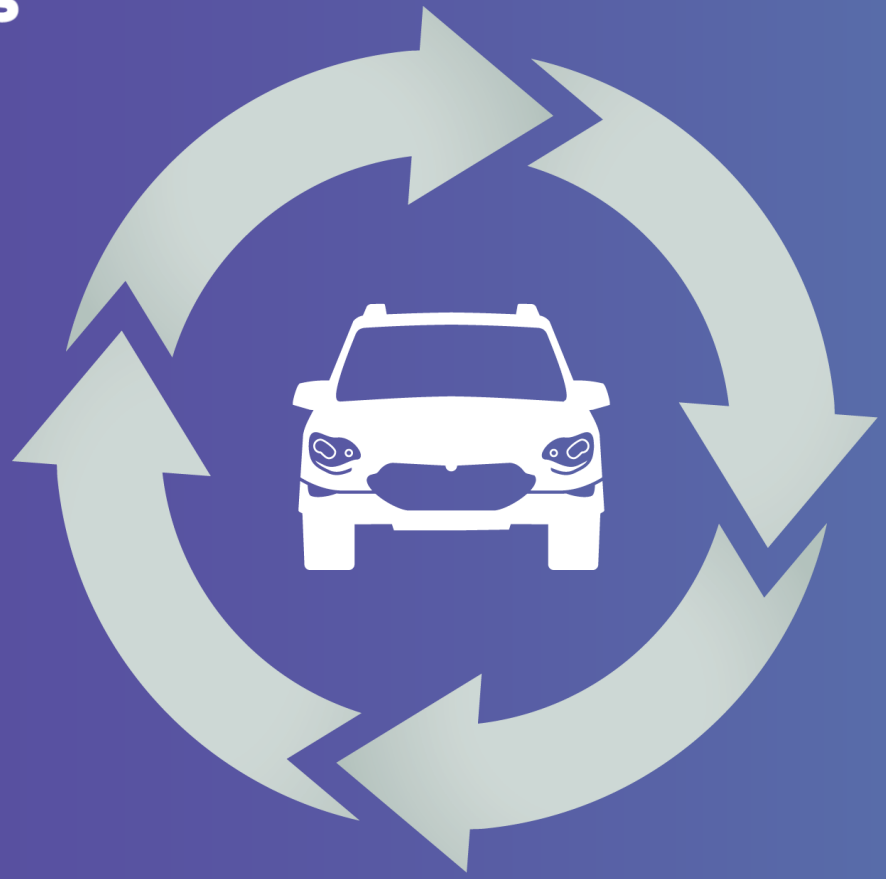
China National Sword Policy

Decreasing landfill capacity

Increasing landfill tipping fees

Challenges facing traditional automotive recycling

- Traditional shredding and sorting **does not allow for valuable materials to be harvested** for reprocessing and contaminates others
- Dismantlers and shredders are **regionally siloed** throughout the country
- Online part sales are creating **more competition and higher customer expectations**



Growing demand for mobility as a service

Nearly $54 billion in 2016 across China, Europe, and the United States

Expected to grow by 28% annually from 2015 to 2030

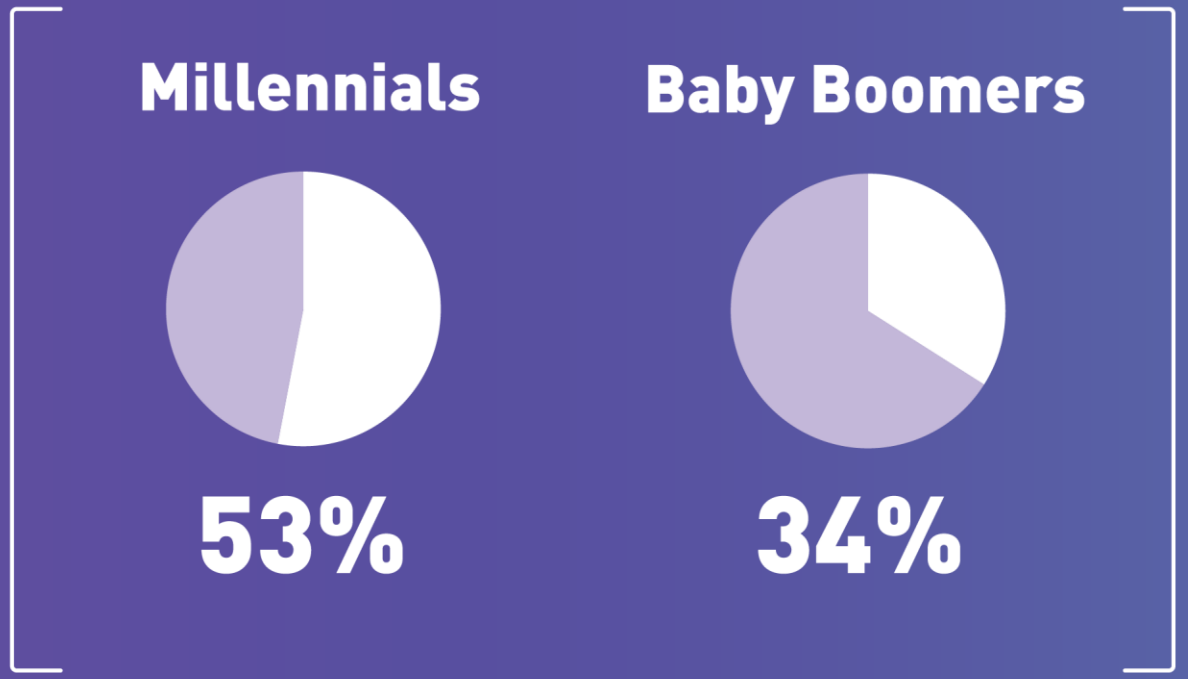
Through 2030 **roughly 1/3** of the expected increase in vehicle sales from urbanization and macroeconomic growth likely **will not happen** because of shared mobility

Shift to a consumer electronics mindset

- → Integrating take back programs
- → Designing for disassembly
- → Incorporating parts that can be revised, upgraded, and recovered

Growing consumer sentiment against single-use plastics

Percentage of people **willing to forgo a brand** in order to buy products that are **environmentally friendly**



Without highly circular plastics and polymer composites, automakers may find themselves with no choice but to turn to other material solutions.

The plastics and polymer composites industry is already taking steps to transition **toward a circular economy**

Repurposing plastic waste and recyclates into automotive materials and parts

BMW

CFRP production scraps for **roofs and rear seat structure**

BASF

Nypel® 6030G HS BK resin from PIW; **Petra® 7010** from PCW

Braskem

I'm green™ recycled PP from PCW

Jaguar Land Rover

Recycled feedstock for **front-end carrier** prototypes

LANXESS

Pocan® ECO reinforced with glass fiber and up to 30% PCW

Ford

Molded engine components with recycled nylon carpet

Renault

Textile from textile scraps, safety belts, and plastic bottle recycling

SABIC

CYCOLOY™ C8080REC resin system from recycled PC and ABS

Using renewable feedstock in plastics and polymer composites

BASF

Elastoflex® E 3496/102 foam system based on renewable raw materials

CONTOURA™ pre-preg composite combines resins with a variety of natural, recycled, or synthetic fibers

Braskem

I'm green™ PE and EVA from sugarcane

Celanese

Application for Ford using composites that combinine cellulose fiber from trees with long-glass fiber in a PP matrix

Covestro/Neste

High-performance plastic made from Neste-supplied renewable hydrocarbons

Ford

Soy-based **PU foam**

Wheat straw **PP composites**

PP compound with rice hulls

Kenaf fiber in **PP door bolsters**

LANXESS

Bio-based PBT using butanediol made from sugars

SABIC

TRUCIRCLE™ Certified Renewable PC plastic made from 60% renewable feedstock

Advancing materials separation and cleaning

Advanced separation technology that **extracts and fully recycles polyolefins and PS** from e-scrap, car shredder residues, and incinerated bottom ash (Ad Rem)

Cleaning technology for **painted TPO and PC/ABS plastics** (Geo-Tech)

Cleaning and sorting technology for **heavily contaminated PE film** (FVH Folienveredelung Hamburg GmbH & Co. KG)

Cleaning technology for **recycled PP and PE** (Quality Circular Polymers)

Designing plastics and systems for longevity, recyclability, and disassembly

UV stabilizers to extend lifetime of polyolefin plastic parts (Solvay)

RETAIN and VERSIFY resin technologies that enable recyclability and incorporation of recycled content (Dow)

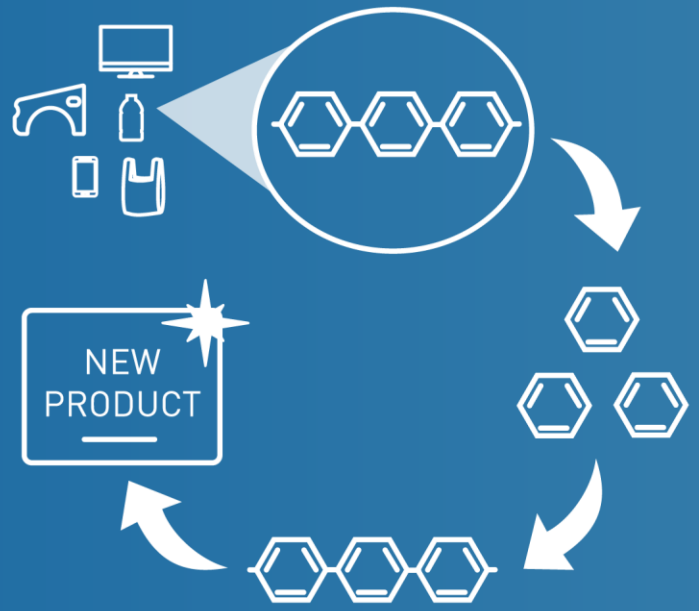
Vistamaxx™ performance polymers that compatibilize PE and PP (Exxon Mobil)

REMADE **design for remanufacturing rules** (RIT, Caterpillar, RIC)

REMADE Value Retention Processes (VRP)

Developing advanced recycling technologies

At least 60 organizations are currently working to scale up depolymerization, pyrolysis, and other emerging plastic processing methods



North American market for products could top **$120 billion annually**

$4.8 billion in cumulative recycling investments have been announced in the U.S. since January 2018

Investing in **260 new facilities** using advanced recycling could → produce **$9.9 billion** in economic output; → generate **38,000+ jobs** in local U.S. communities

Optimizing manufacturing processes

Thin wall instrument panels

SABIC's STAMAX™ resin helps decrease instrument panel wall thickness to **less than 2mm thick** and delivered **15% weight savings**

Blow-molded air ducts

ExxonMobil's Santoprene™ TPVs was used to produce a Subaru blow-molded air duct in a **single process step** with a **30-40% reduction in weight** and **25-35% cost savings**

Mono-material headlamps

Covestro's Makrolon® polycarbonate-based headlamp uses **more than 10 fewer parts** and **fewer manufacturing steps**, and **saves 1.8kg in weight** per lamp

Investigating the viability of automotive plastics recovery models

Plastics recovery from bumper fascia (e.g., Plastics Industry Association project to explore technical and market feasibility of end-of-life bumper recovery)

Plastics recovery from battery cases is a closed loop model—more than 95% of battery cases are recycled and sent to manufacturers to create new cases

Participating in the supply "web" to make connections and reimagine supply chains (e.g., Materials Marketplace with 1,500 businesses)

Funding R&D for circular economy solutions

ALLIANCE TO END PLASTIC WASTE

50 companies and supporters have committed to invest **$1.5 billion** toward solutions

THE COMPOSITES iacmi INSTITUTE

Funding **several projects** on circularity and the recyclability of fiber-reinforced plastic composites

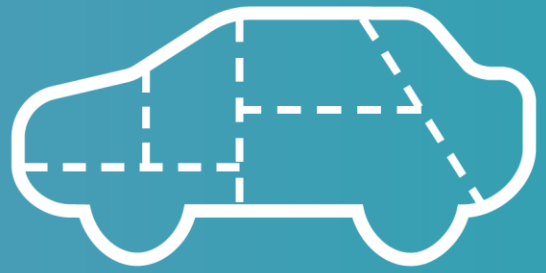
U.S. DEPARTMENT OF ENERGY

Approximately **$35 million** through REMADE, **$25 million** through BOTTLE, and other opportunities

But there is **more to be done**...

Continue to develop advanced recycling and recovery technologies

Invest in a robust and coordinated recycling infrastructure



Design high-quality automotive plastics for easier disassembly, refurbishment/ reuse, and recycling

Conduct rigorous lifecycle assessments of circular plastics and polymer composites

Explore new business models that enable profitable circularity

The **automotive plastics and polymer composites industry stands ready to help rethink** the ways that vehicles and their materials are designed, constructed, used, and handled at end of life.

1. **Encourage innovation within your organization** to position plastics and polymer composites as a key enabler for circularity in the automotive industry
2. **Support and participate in industry-wide efforts to advance circular design** of polymer materials and automotive components/systems
3. Support and, where possible, **lead efforts to improve supply chain circularity** with your automotive partners and suppliers
4. **Continue to educate the automotive supply chain** about the circularity potential of polymer-based materials
5. **Contribute to building the workforce** with skills and capabilities needed to shift toward a circular economy
6. **Advocate for R&D support** from state and federal governments to help fund technology development and demonstration
7. **Participate in standards processes** to ensure circularity standards take into account the needs and requirements of plastics and polymer composites
8. Work with the automotive value chain to **develop essential and robust automotive recycling infrastructure**
9. Partner with automotive value chain to **drive designs and processes for vehicle disassembly**
10. **Identify and apply lessons learned from other industries** working to improve circularity (e.g., packaging, wind, aerospace)

View the Full Report at www.automotiveplastics.com

Questions?

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