Manufacturing Process Developments to Ensure Olefin Circularity in Interiors

Chris Davis and Mark Wolfe
Core Engineering

SPE TPO Global Automotive Conference
Oct 3, 2025

October 3, 2024

Inteva at a Glance

100+
Customers

Inteva has a true global presence and reach, with engineering and production capabilities across the Americas, Asia and Europe.

30
Global Sites

From our headquarters in Troy - Michigan, we operate

30 global facilities.

8500+
Employees

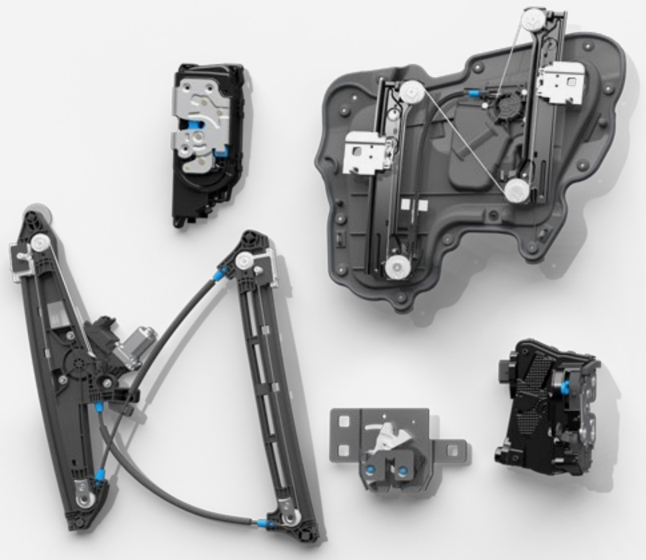
Our global team shares one common vision: ensuring that customers and partners recognize Inteva as a global leading company in innovation, sustainability, and products that enhance the consumer experience.

3
Areas of Excellence

Inteva combines a culture of continuous improvement with our advanced expertise in **Interior Systems, Closure Systems, and Motors & Electronics to provide world-class solutions to customer needs.**

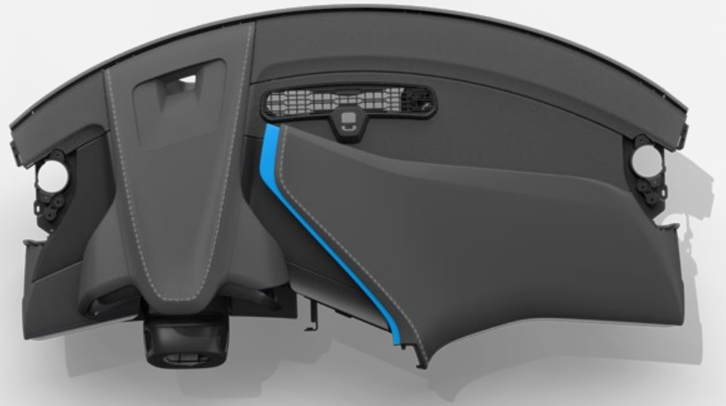
Global Footprint

Products



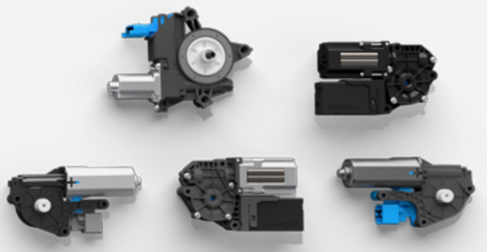
Closure Systems

- Latching Systems
- Window Regulators
- Door Modules
- Smart Actuators
- Smooth Motion Systems
- Actuators and Strikers



Interior Systems

Inteather™
Our **thermoplastic polyolefin (TPO)** family of automotive-grade materials that have been carefully engineered for post-industrial (PIR) and post-consumer (PCR) use.



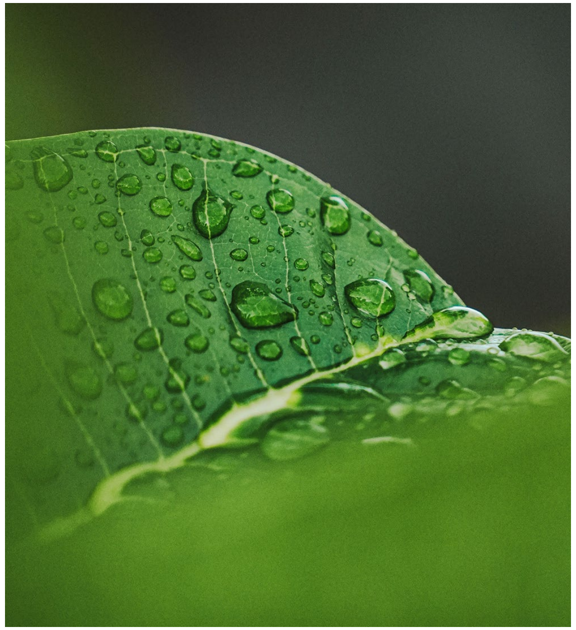
Motors & Electronics

- Window Motors
- Sunroof Motors
- Electronics

Global Mega Trends

Trends: Automotive Industry and Consumer Behavior

Sustainability

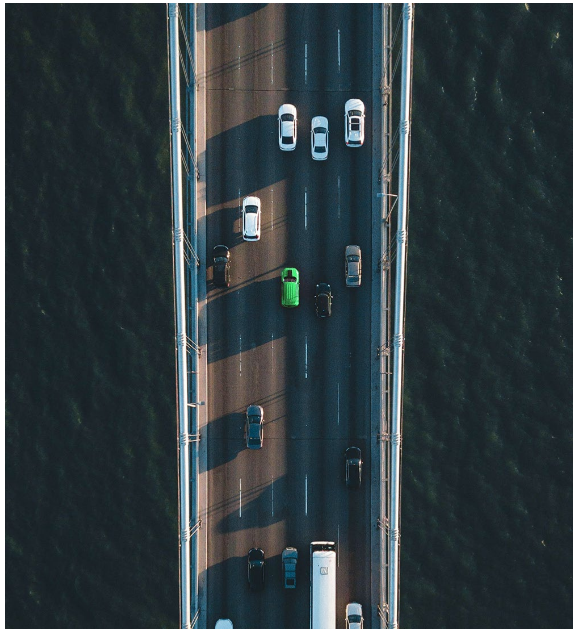


Environmentally friendly products, non-hazardous materials, and circularity initiatives

Environmental Impact

Increasing awareness of carbon footprint and consciousness about products having harmful materials.

Regulatory



Stricter emissions standards, EV adoption incentives, and changing policy targets

Automotive Transformation

Ramping up Recycled Content

Automotive Recyclability Push

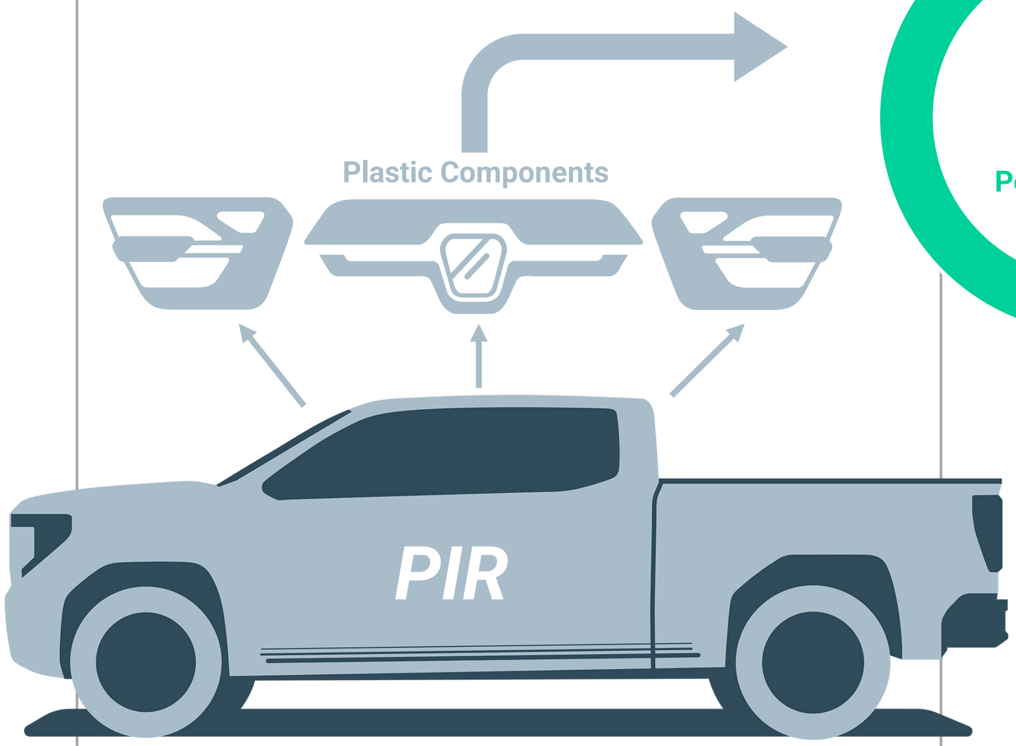
NEWS

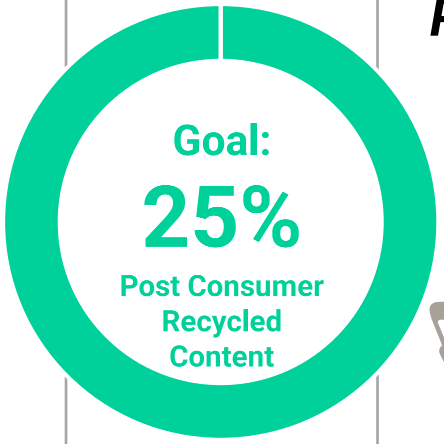
*"European Commission proposes setting a recycled content target of **25%** for post-consumer plastics into new cars as of **2030**."*

Automotive Plastic Recycling

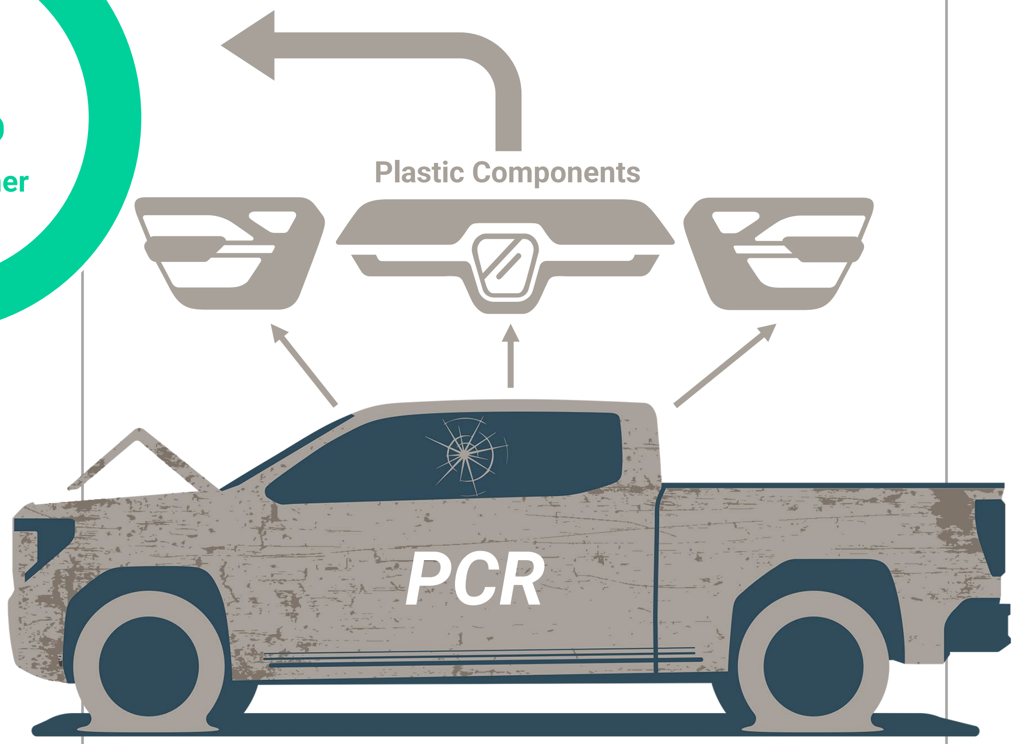
Two Strategies to promote circularity

Post Industrial Recycling (PIR)





Post Consumer Recycling (PCR)



PIR (Post-Industrial Recycled)

Definition:

- PIR materials are scraps, trimmings, or defective products generated during manufacturing that are recycled back into the production process.

Examples:

- Plastic trimmings from injection molding
- Paper scraps from printing operations

Pros:

- High quality and consistency
- Easier to collect and process
- Often cheaper than PCR

Cons:

- Doesn’t reduce consumer waste
- Sometimes considered 'downcycling'

PCR (Post-Consumer Recycled)

Definition:

- PCR materials come from products that have been used and discarded by consumers, collected through recycling programs.

Examples:

- Recycled plastic bottles
- Used cardboard boxes
- Old electronics

Pros:

- Diverts waste from landfills
- Reduces demand for virgin materials
- Supports circularity goals

Cons:

- More variability in quality
- Requires more processing and cleaning
- Can be more expensive

INTEVA

Circularity

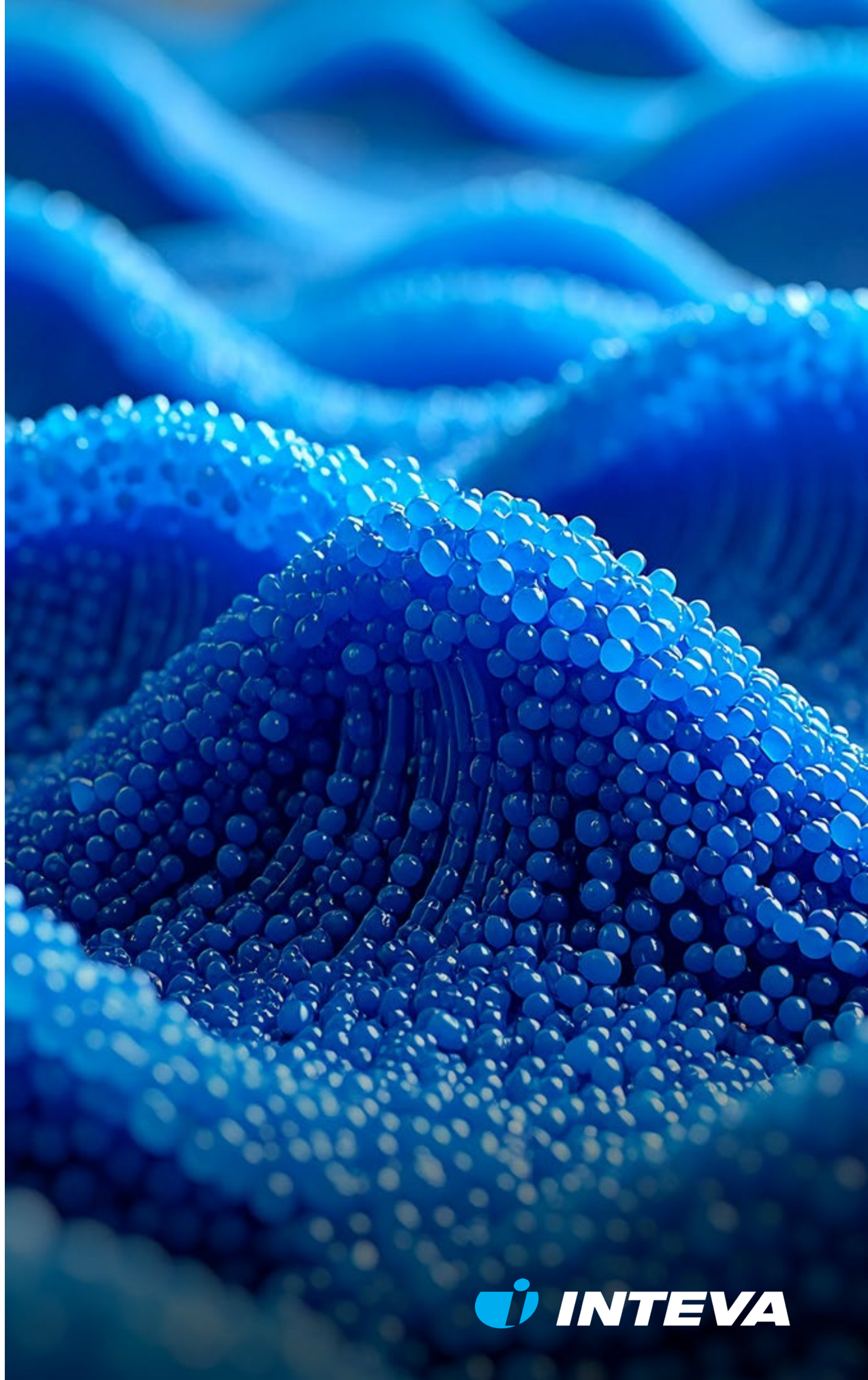
Definition:

- Circularity is a systemic approach to economic development designed to benefit businesses, society, and the environment. It aims to keep materials, products, and resources in use for as long as possible.

Key Principles:

- Design out waste and pollution
- Keep products and materials in use
- Regenerate natural systems

In practice, circularity includes reuse, repair, remanufacturing, and recycling.



Summary Comparison

Feature	*PIR*	*PCR*	*Circularity*
Source	Manufacturing waste	Consumer-used products	System-wide approach
Goal	Reduce industrial scrap	Divert consumer waste	Eliminate waste, regenerate
Environmental Impact	High and consistent	Variable, needs processing	Varies by strategy
Cost	Lower	Higher	Long-term savings

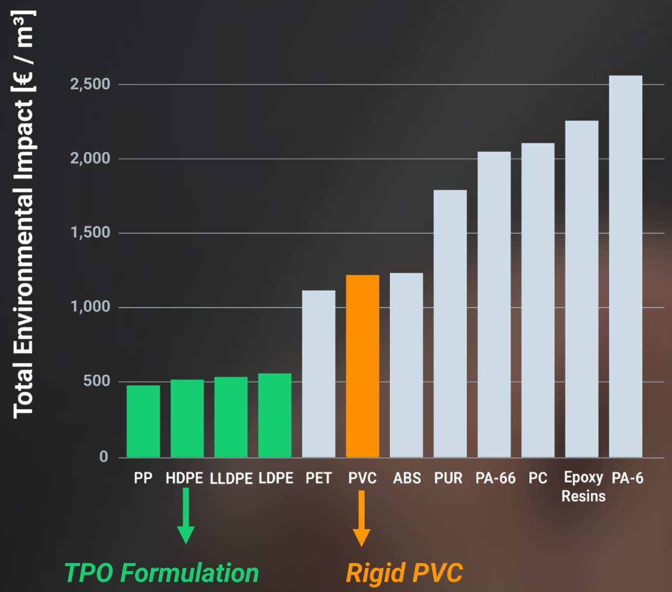
One Inteva circularity solution:

Thermoplastic Polyolefins (TPOs)

Why TPOs?

1. Low Impact

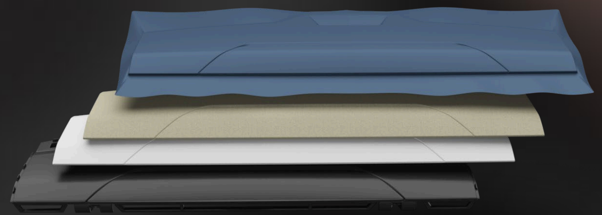
Production & Incineration



A.E. Schwarz, T.N. Ligthart, D. Godoi Bizarro, P. De Wild, B. Vreugdenhil, T. van Harmelen, Plastic recycling in a circular economy; determining environmental performance through an LCA matrix model approach, Waste Management, Volume 121, 2021, Pages 331-342

2. Versatile

- TPO sheets
- TPO fabrics
- TPO adhesives
- TPO foams
- TPO substrates



3. Robust & Recyclable

Offering a unique combination of strength, impact, thermal stability, chemical resistance, and recyclability.

INTEVA

Inteva Eco Process

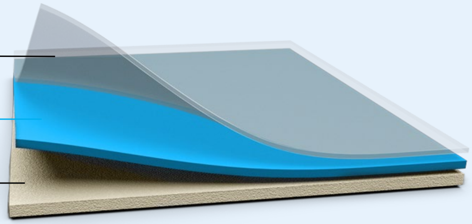
PIR in Action

100% Prime

Special Coating

Virgin TPO (0.7mm)

XLPP Foam



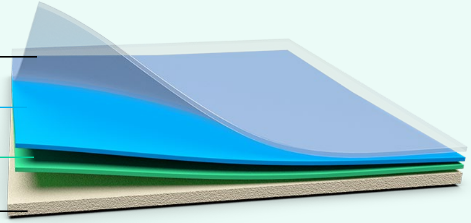
Eco Grade

Special Coating

Color-Matched TPO (0.35mm)

ECO TPO (0.35mm)

XLPP Foam



Application

***FIRST** in automotive industry to recycle TPO bilaminate scrap into an ECO TPO and reuse in interior trim applications.*

IN PRODUCTION
since mid-2020 on Chevrolet Silverado and GMC Sierra

LESS WASTE
~93% of thermoforming process scrap is saved from the landfill.

REDUCED IMPACT
Using less prime TPO resin reduces fossil usage and lowers the carbon footprint

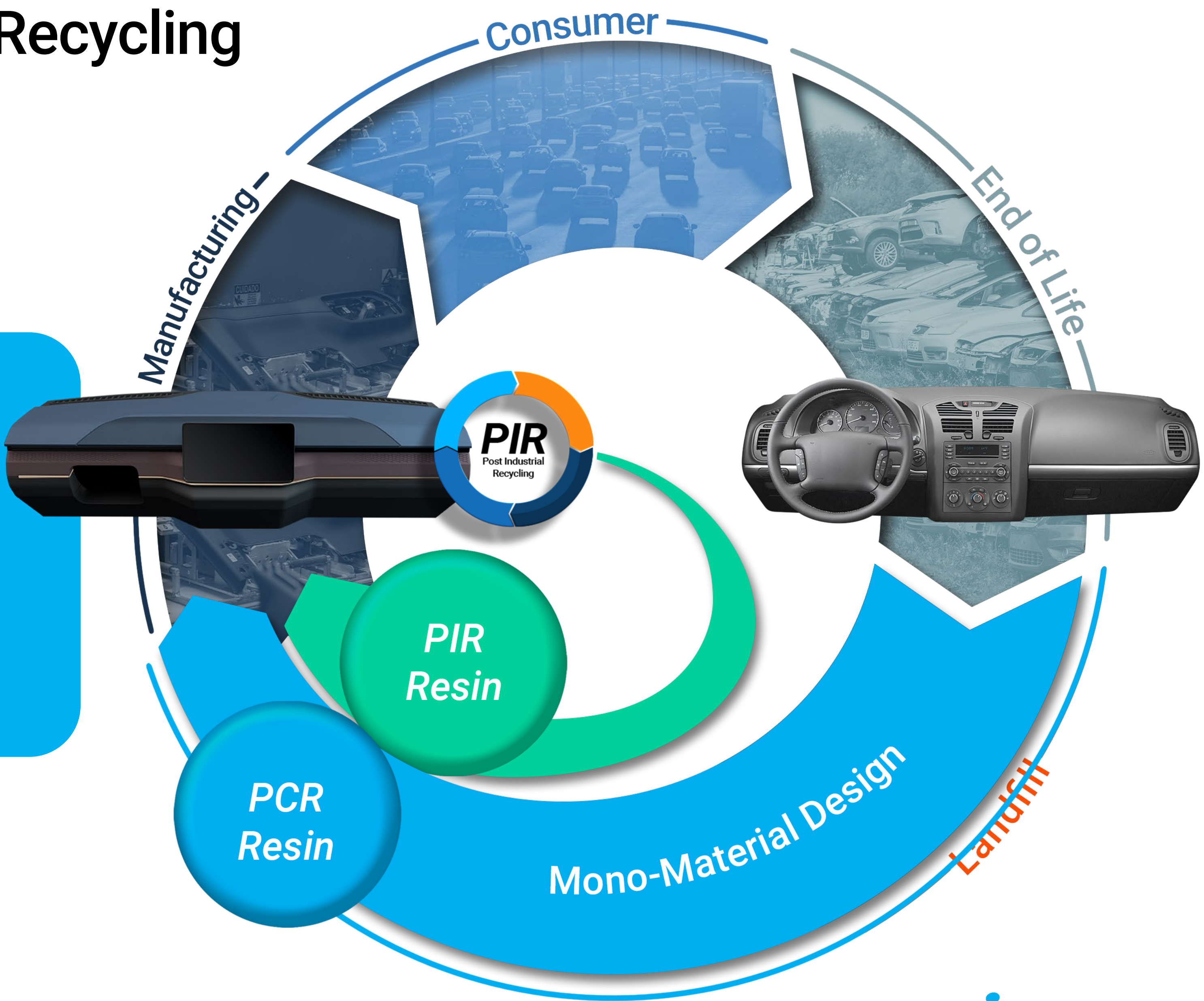
Mono-Material Design for Circularity

Closing the PCR Loop with Olefins

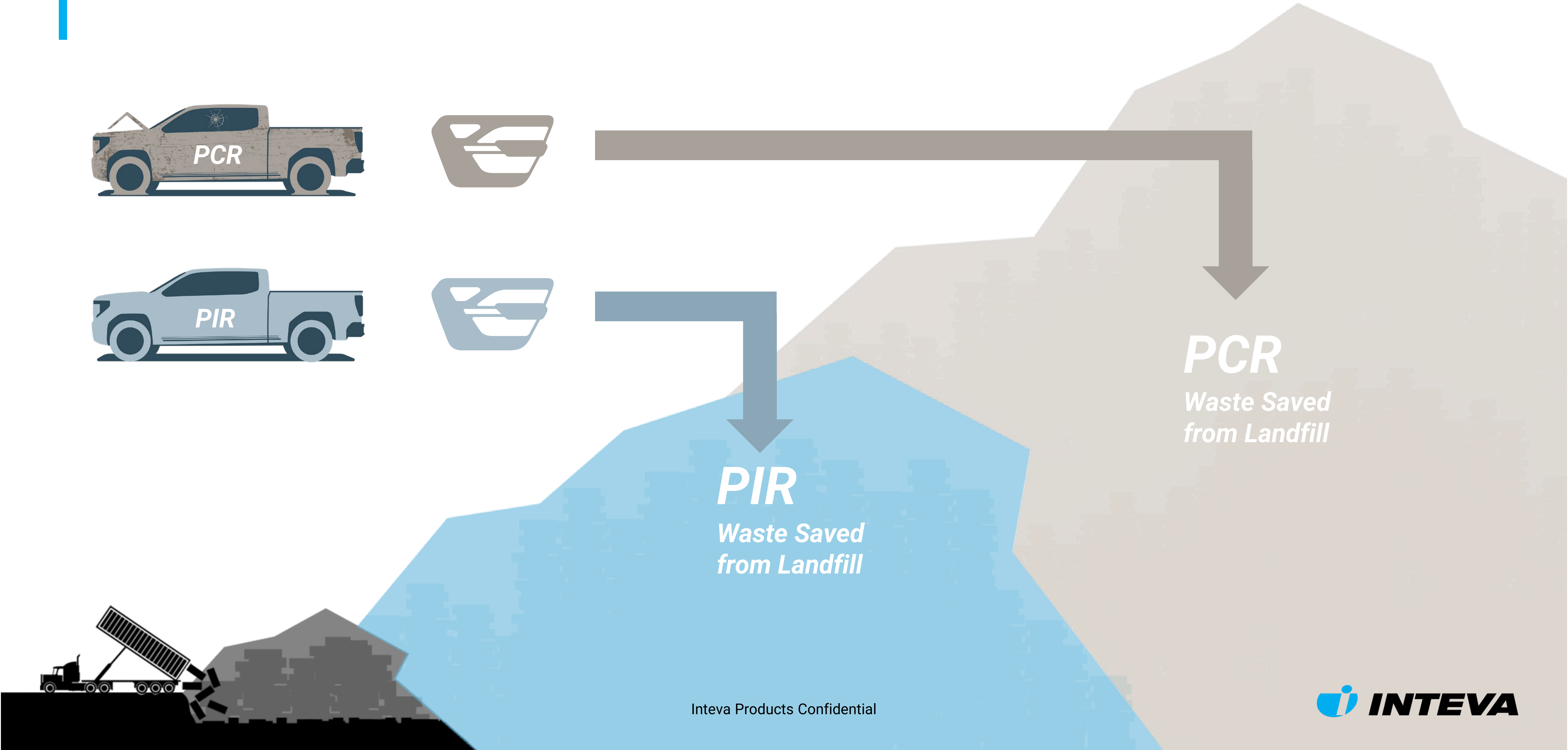
Enabling Post Consumer Recycling

PCR Circularity Requires

- Material suppliers
- Tier supply base
- OEMs (design, material specs, etc.)
- Material collection
- Recyclers (ASR)
- Government regulations



End-of-Life Process Waste

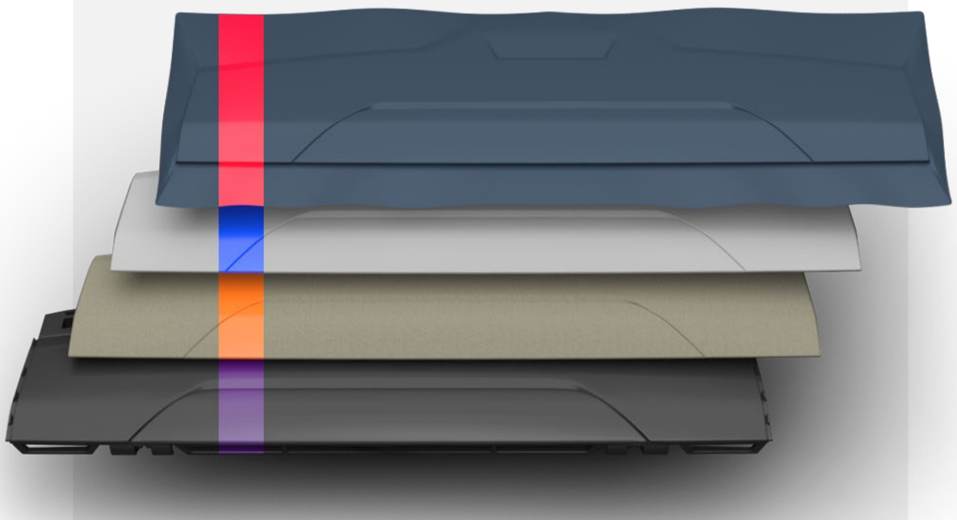


INTEVA

What is Next: Mono-Material Design Utilizing Olefins

Automotive Parallel

Current / Common Construction



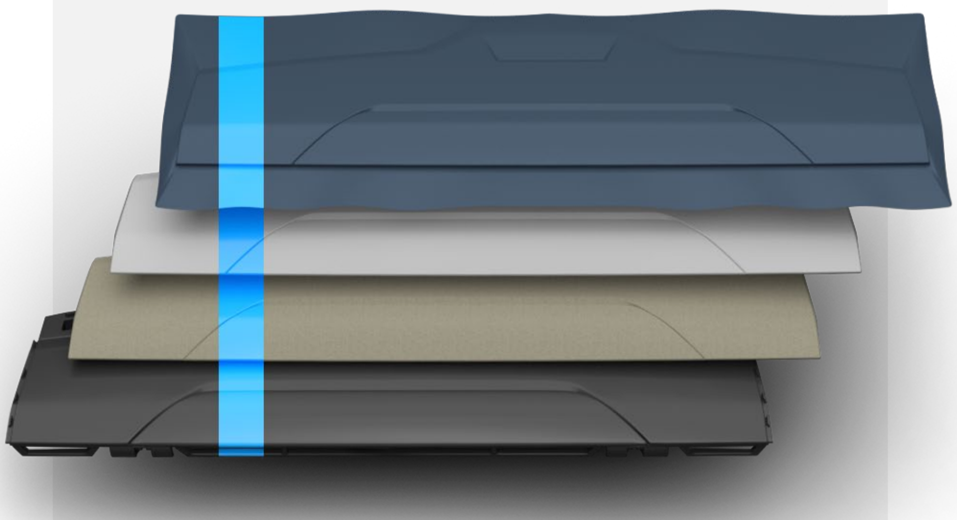
PVC (sheet)

PUR /PET (foam) / Spacer

PUR (Adhesive)

PC/ABS (substrate)

Mono-Material Construction



TPO (sheet)

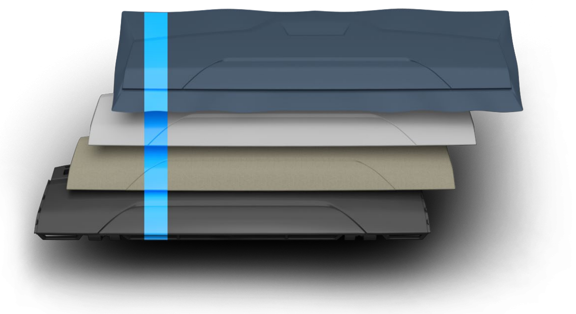
TPO (foam/fabric)

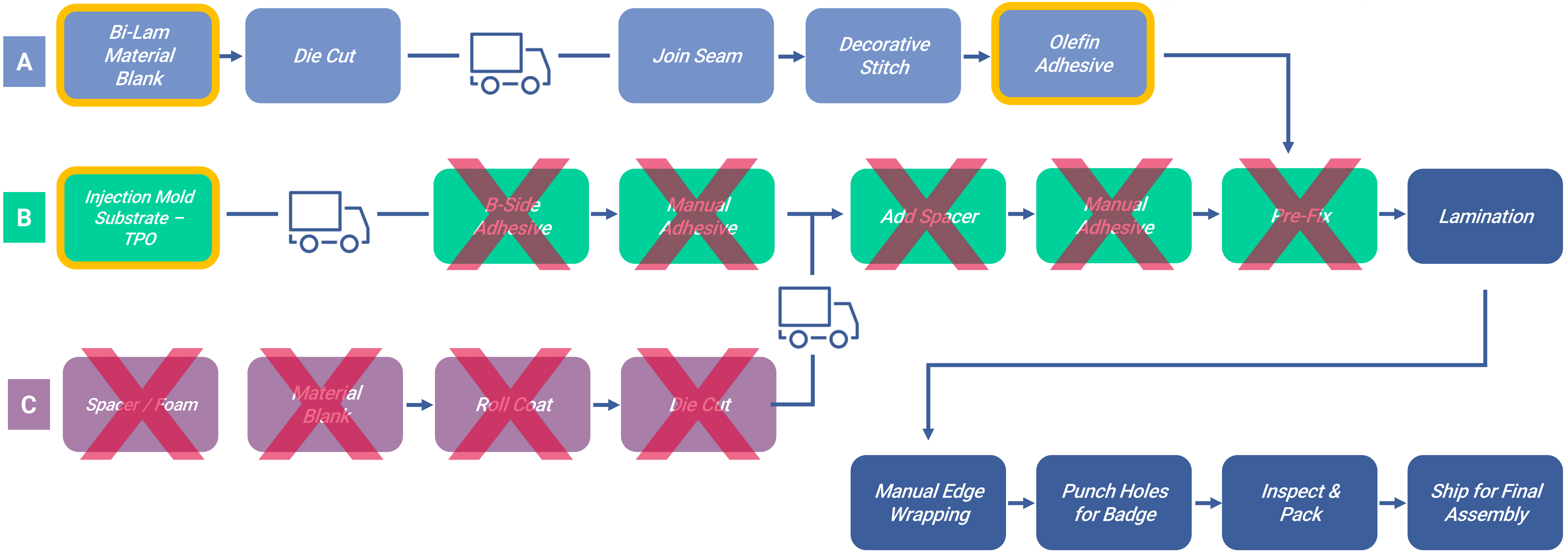
TPO (adhesive)

TPO (substrate)

Mono-Material Design

Efficient Manufacturing

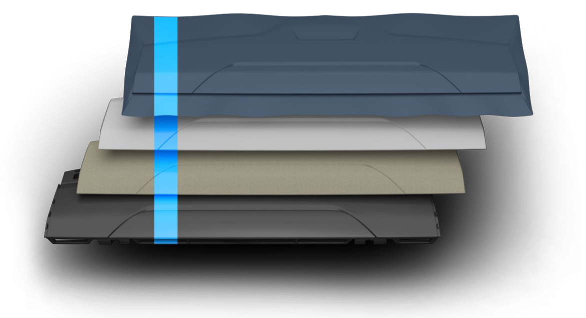


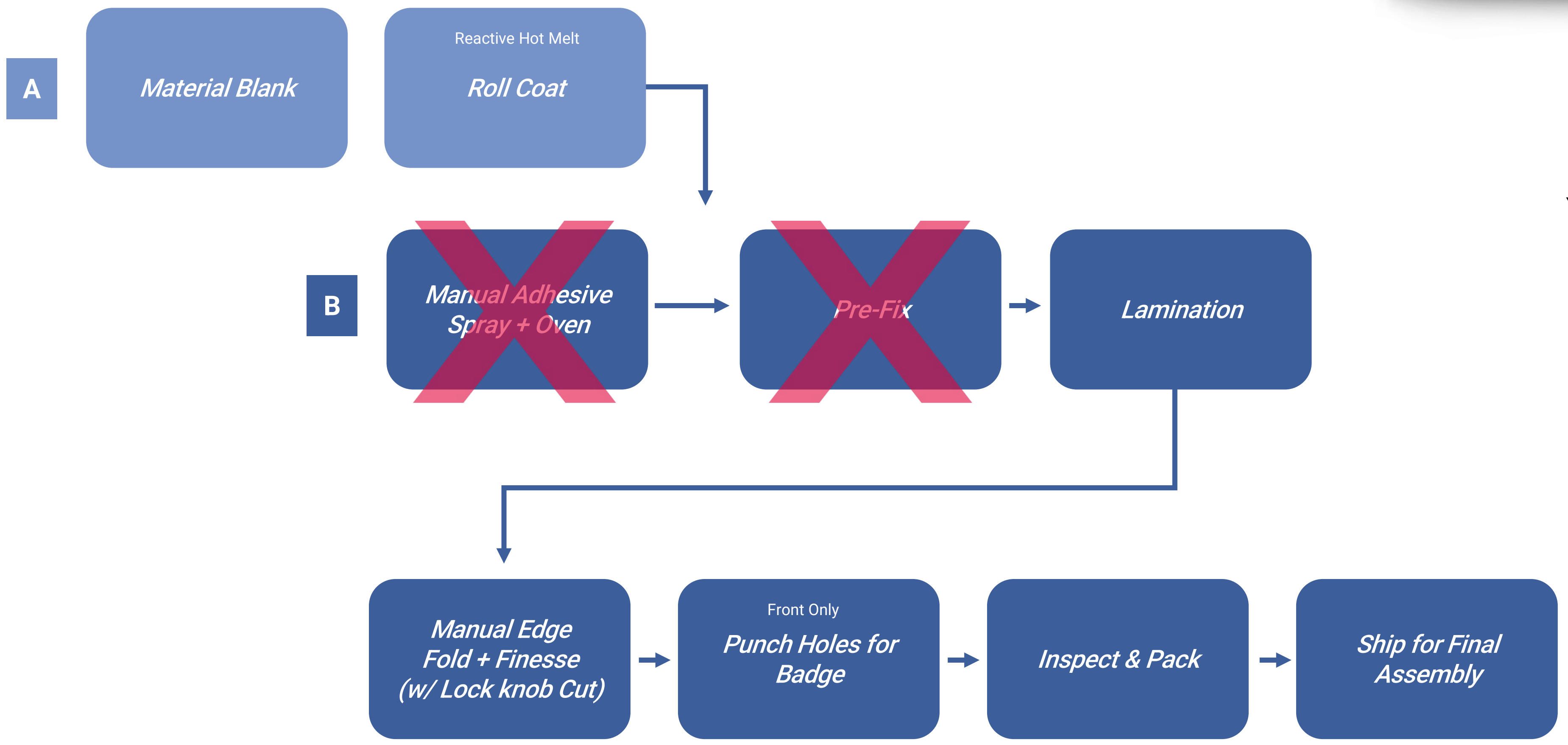


October 3, 2024

Mono-Material Design

Efficient Manufacturing





NEED TO EXPAND ON YELLOW HIGHLIGHTED

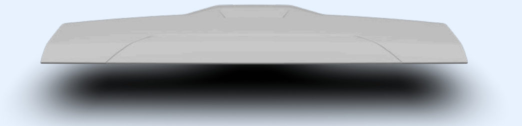
Notes:

- Seam types require feasibility study
- Single Bi-Lam skin, No loose Spacer
- Less Sharp Radii around the perimeter
- Leather is not feasible

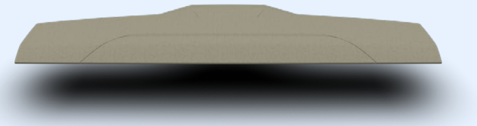
INTEVA

Manufacturing Considerations for Olefin Circularity

Skin
- Thermoformable TPO Bi-Laminate
  - Cost effective premium soft feel with PIR content
- Cut/Sew/Wrap Scrim Backed TPO
  - Potential to replace standard PE scrim with PP scrim



Spacer
- Typically PU Foam or a PET Spacer
  - Replace with PP spacer or PE/PP closed cell foam (IMG/IMGL) or open cell XLPP



Adhesive
- POR or APAO Hot Melt
  - Seam types require feasibility study
  - Best for automated wrapping solutions
  - Not optimal for true cut, sew, wrap applications
- Typically PUD
  - Bets option for hand wrapping constructions
  - Would require flame or other treatment when pared with Olefins
  - Would act as a filler material during recycling process
  - Lessens the circularity goal

Substrate
- Typically made from ABS or PC/ABS
  - Replace with PP, TPO (Olefins)
  - Key enablers: shrink rate understood, crash worthiness for side impact (doors), dimensional stability

Manufacturing Impacts

PUD Cut Sew Wrap Construction vs. All Olefin Construction

Benefits:

10-15% Reduction in overall labor for CSW Door Components

- Majority of reduction due to switch from separate foam spacer and skin to pre-laminated foam backed skin in the CSW parts
- Additional savings from single hot melt glue application vs multiple PUD adhesive applications between component layers
- Slighter higher Injection Molding cycle times expected with PP vs ABS
- Higher lamination cycle times are offset by fewer operations when compared to traditional CSW processes with PUD

Challenges:

- Larger radii required (when using a bi-laminate construction)
- Some limitations to functional and decorative seam
- Higher initial equipment investment – Automation

Material Impacts

PUD Cut Sew Wrap Construction vs. All Olefin Construction

C/S/W Upper Bolster:

25% decrease in material cost

- Olefin construction requires 1 adhesive application vs 4 with PUD construction
  - Fewer adhesive applications offsets higher adhesive material cost
- Lower substrate cost – PP vs PC/ABS
- Bi-Laminate skin is marginally lower cost than separate skin and spacer

Challenges:

- Fewer material combination options when aiming for full circularity
- POR/APAOs require unique application and lamination methods compared to PUDs

INTEVA

Challenges Ahead

Going to a circularity future requires understanding from the customers and the suppliers relative to investment, material cost, labor costs, and influence on the design which may occur due to limitations of adhesive types.

PCR and PIR impacts within a plant is easier to comprehend and currently being done to various degrees. End of life PCR is much further away.

The larger picture for EOL vehicles is not easy to comprehend and will create new value streams that don't exist today:

- Organized collection and distribution of the end of life vehicles.
- Sorting plastics by polymer type at dismantling stage.
- Closed-loop recycling to produce high-quality feedstock for new vehicles
- Collaborative ecosystems involving OEMs, chemical companies, and recycler in order to reintroduce into future vehicles

Enablers: Friendly part designs with minimal die locks, stitching not locating into ditches (or ditches in die draw), no need to hand wrap, no 105C at temp peel requirement, higher capital investment, hand spray not feasible.

Looking Beyond the Parts

What industries could sprout from a circularity approach?

Vehicle Disassembly & Material Recovery Services

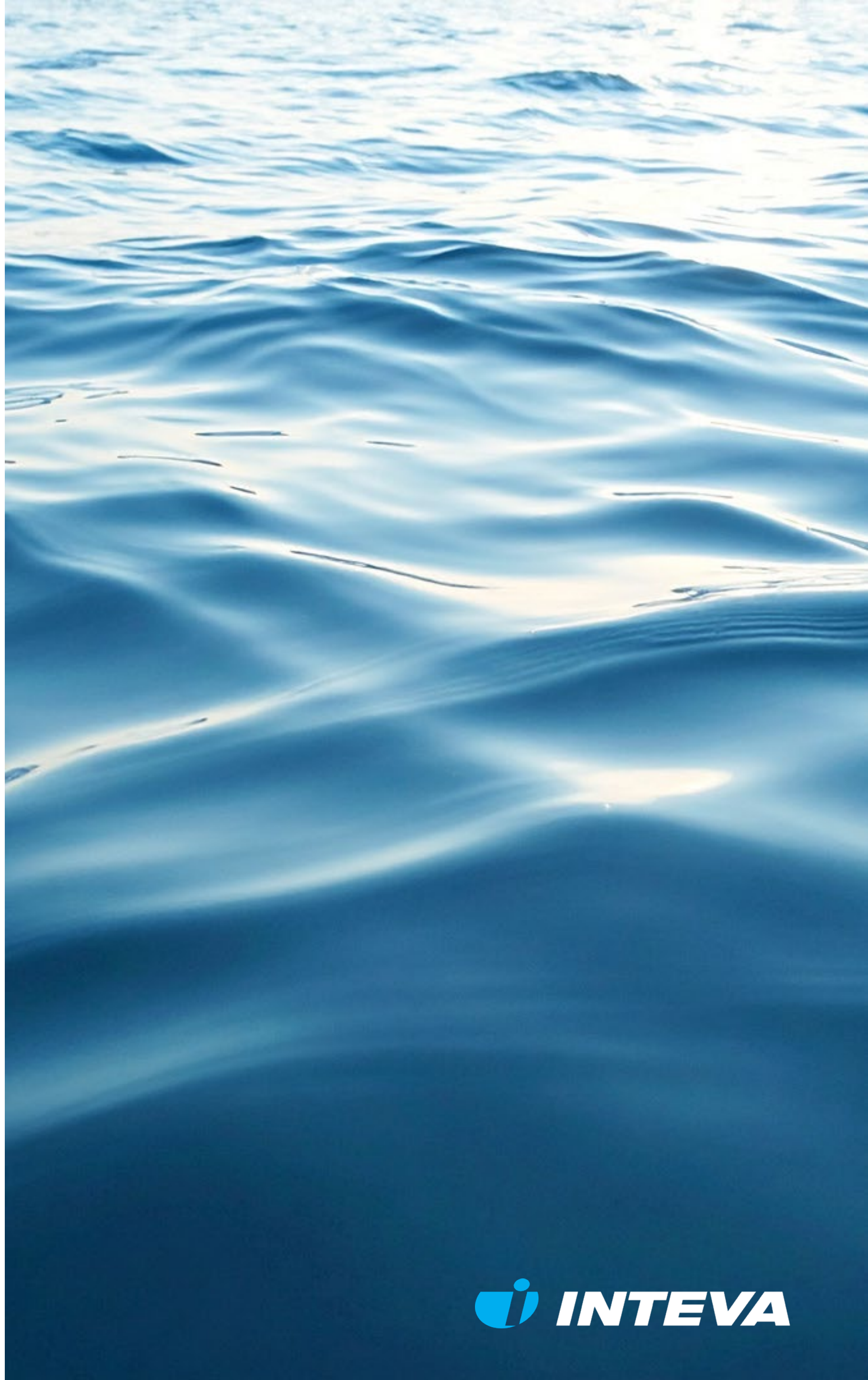
- Industry Focus: Specialized facilities for automated, AI-guided disassembly of vehicles to recover high-value materials (e.g., rare earths, aluminum, carbon fiber).
- Innovation Drivers: Robotics, machine vision, and digital twins.
- Business Model: Subscription-based recovery services for OEMs or fleet operators.

Circular Supply Chain Platforms

- Industry Focus: Digital marketplaces for trading refurbished parts, recycled materials, and remanufactured components.
- Innovation Drivers: Blockchain for traceability, AI for demand forecasting.
- Business Model: B2B platforms connecting OEMs, recyclers, and remanufacturers

Automotive Material Re-processors

- Industry Focus: Advanced chemical recycling of plastics, composites, and textiles from vehicles.
- Innovation Drivers: Enzymatic recycling, pyrolysis, solvent-based recovery.
- Business Model: Material-as-a-service for OEMs and Tier 2 suppliers.



Looking Beyond the Parts

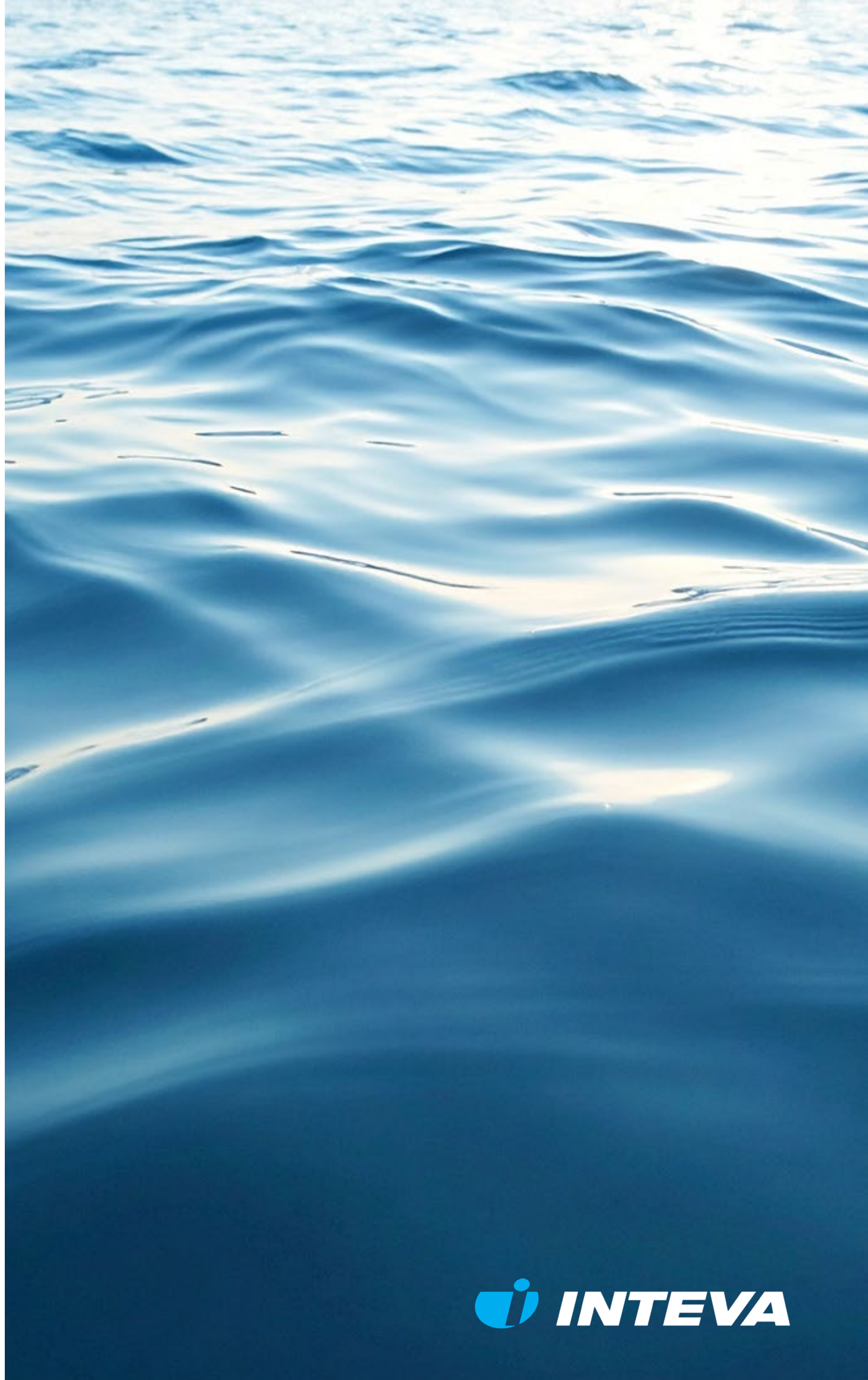
What industries could sprout from a circularity approach?

Battery Circularity Ecosystems

- Industry Focus: Closed-loop systems for EV battery reuse, repurposing (e.g., grid storage), and material recovery.
- Innovation Drivers: AI-driven diagnostics, second-life battery analytics.
- Business Model: Leasing, buy-back, and energy-as-a-service models.

Modular Vehicle Platforms

- Industry Focus: Vehicles built from interchangeable modules that can be upgraded, reused, or recycled.
- Innovation Drivers: Standardized interfaces, plug-and-play architecture.
- Business Model: Subscription or pay-per-mile modular upgrades.



INTEVA