From Linear to Circular Economy RaaS®

Bernd Sparenberg

FROM LINEAR TO CIRCULAR ECONOMY – RaaS®
AGENDA

- Introduction
- Open Loop Recycling by ALBIS & WIPAG
  - ALTECH ECO Near-to-Prime®
  - ALTECH IQ, WIPAFLEX, WIPELAST
- Closed Loop Recycling by WIPAG
  - Bumper-to-bumper recycling
  - Dashboard-to-dashboard recycling
- Recycling-as-a-Service (RaaS)® by WIPAG
  - RaaS® - new opportunities
- Summary

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INTRODUCTION

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INTRODUCTION
ALBIS PROFILE

- **>13,000 active Customers globally**
- >200 People in Business Development, Application Development & Sales
- **>10,000 (Bulk)-Products/ Formulations** available, global Product Specifications
- **130 people in Product Development / Laboratory** (DE, UK, CN, US)
- **>1,000 Product Developments per year**
- 45 years Experience & Know-how in Compounding
- **>11,000 Production Orders per year**
- 8 Production Sites, **63 Compounding-Lines, globally**
- IATF 16949, ISO 50001:2011 certified

➡ **WE love complexity and we can handle it.**

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Feedstock
- SLF (shredder-light-fraction)
- Bumper, coated
- Dashboard stamp-out
- Spoiler, coated
- Mirror housing, coated
- Trim-parts, coated
- a.o.

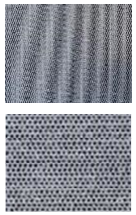
- PP
- PP+EPDM
- ABS
- PC
- PC+ABS
- PA

Patented Processes
- Composite (2-3K) Separation
- De-Coating
- Carbon Fiber-Recycling

Shredder Technology

Separation Processes
- Density
- Optics / Color
- De-Metallization
- Electro-Statics

Regranulation & Compounding
- Melt-Filtration (80,120,200µm)



OPEN LOOP

CLOSED LOOP

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OPEN LOOP RECYCLING

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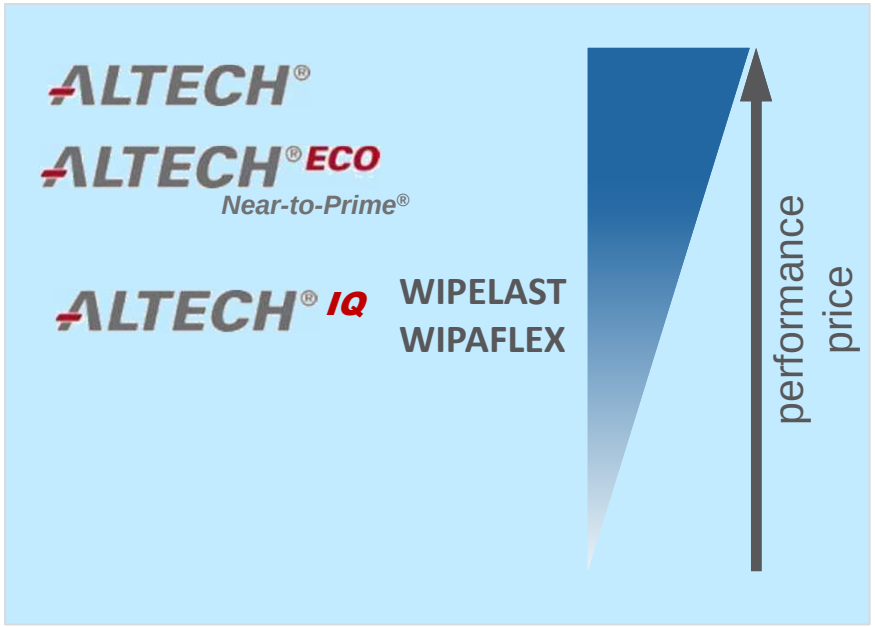
ALBIS & WIPAG – OPEN LOOP RECYCLING
PRODUCT POSITIONING & BRANDING

ALTECH – PA6/66, PP, ABS, PC, PC-Blends
- Prime polymer, filler, additive, color customized
- Ultimate performance/ quality/ portfolio

ALTECH ECO – PA6/66, PP, PC
- PIR-polymer, filler, additive, colors
- ECO = Near-to-Prime® performance/ quality

ALTECH IQ – PA6/66, PP, ABS, PC-Blends
- PIR/PCR-polymer/ regrind, filler, additive, blk
- IQ = Industrial Quality level

- WIPELAST – PP/EPDM
- WIPAFLEX – PP/PE/EPDM



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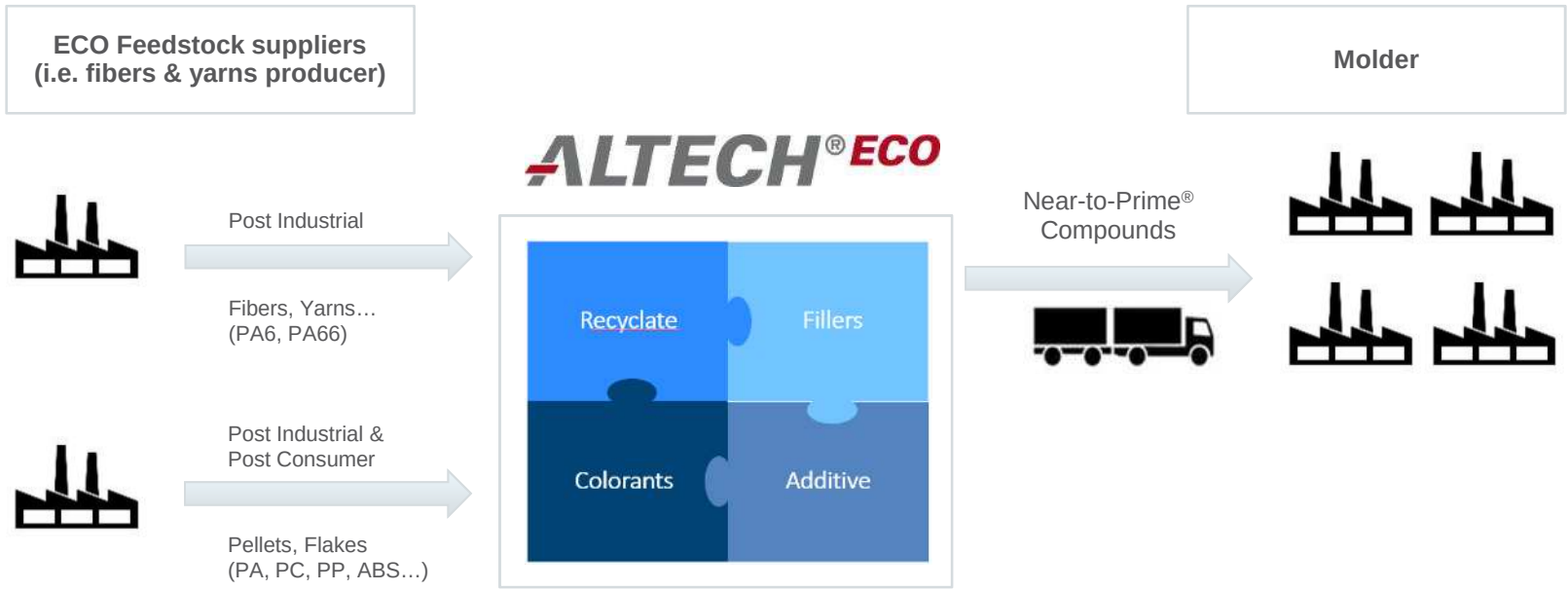
ALBIS & WIPAG – OPEN LOOP RECYCLING
ALTECH ECO >> VALUE-CHAIN



➡ **PIR fiber/ yarn feedstock is top-quality polymer.**

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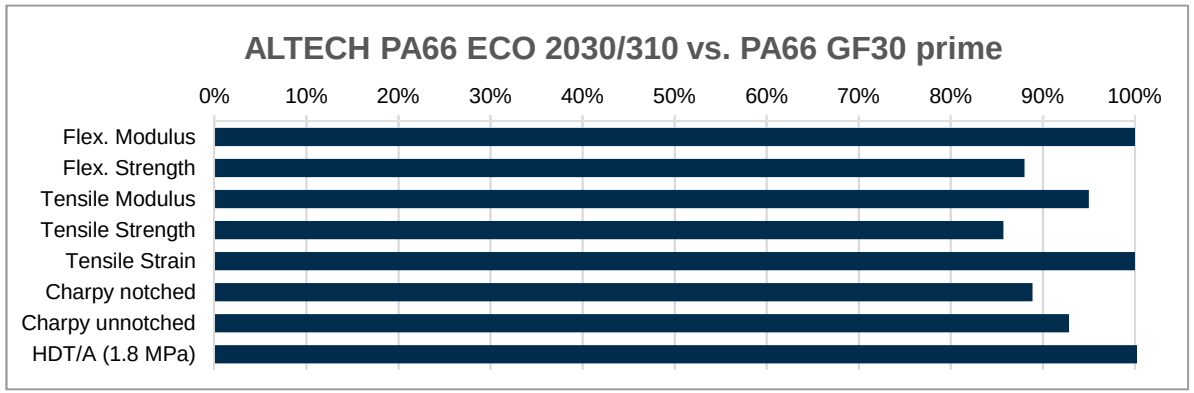
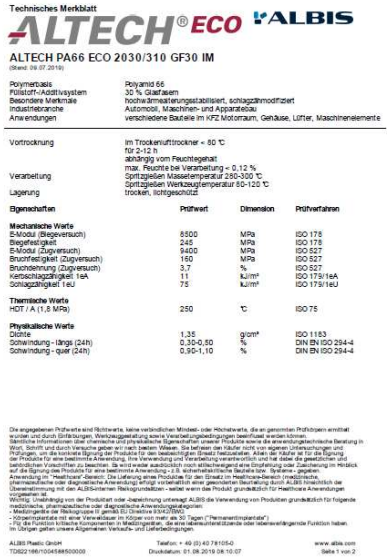
ALBIS & WIPAG – OPEN LOOP RECYCLING
ALTECH ECO >> NEAR-TO-PRIME® PERFORMANCE

ALTECH® ECO

Compounds provide excellent Cost/Performance ratio and can match demanding Auto and E&E application.





Technisches Merkblatt

ALTECH® ECO ALBIS

ALTECH PA66 ECO 2030/310 GF30 IM

Polymerbasis	Polyamid 66
Füllstoff-/Additivsystem	30 % Glasfasern
Besondere Merkmale	hochwärmealterungsstabilisiert, schlagzähmodifiziert
Industriebranche	Automobil, Maschinen- und Apparatebau
Anwendungen	verschiedene Bauteile im KFZ Motorraum, Gehäuse, Lüfter, Maschinenelemente

Vortrocknung	im Trockenlufttrockner < 80 °C für 2-12 h abhängig vom Feuchtegehalt
Verarbeitung	max. Feuchte bei Verarbeitung < 0,12 % Spritzgießen Massetemperatur 280-300 °C Spritzgießen Werkzeugtemperatur 80-120 °C
Lagerung	trocken, lichtgeschützt

Eigenschaften	Prüfwert	Dimension	Prüfverfahren
Mechanische Werte			
E-Modul (Biegeversuch)	8500	MPa	ISO 178
Biegefestigkeit	245	MPa	ISO 178
E-Modul (Zugversuch)	9400	MPa	ISO 527
Bruchfestigkeit (Zugversuch)	160	MPa	ISO 527
Bruchdehnung (Zugversuch)	3,7	%	ISO 527
Kerbschlagzähigkeit 1eA	11	kJ/m²	ISO 179/1eA
Schlagzähigkeit 1eU	75	kJ/m²	ISO 179/1eU
Thermische Werte			
HDT / A (1,8 MPa)	250	°C	ISO 75
Physikalische Werte			
Dichte	1,35	g/cm³	ISO 1183
Schwindung - längs (24h)	0,30-0,50	%	DIN EN ISO 294-4
Schwindung - quer (24h)	0,90-1,10	%	DIN EN ISO 294-4

Die angegebenen Prüfwerte sind Richtwerte, keine verbindlichen Mindest- oder Höchstwerte, die an genormten Prüfkörpern ermittelt wurden und durch Einflüsse wie Werkzeuggestaltung sowie Verarbeitungsbedingungen beeinflusst werden können. Sämtliche Informationen über chemische und physikalische Eigenschaften unserer Produkte sowie die anwendungstechnische Beratung in Wort, Schrift und durch Versuche geben wir nach bestem Wissen. Sie befreien den Käufer nicht von eigenen Untersuchungen und Prüfungen, um die konkrete Eignung der Produkte für den beabsichtigten Einsatz festzustellen. Allein der Käufer ist für die Eignung unserer Produkte für die beabsichtigten Verfahren und Zwecke verantwortlich. Er hat die Einhaltung aller gesetzlichen und behördlichen Vorschriften zu beachten. Es wird weiter ausdrücklich nach allfälligerweise eine Einstellung oder Zulassung im Hinblick auf die Eignung des Produkts für eine bestimmte Anwendung - z.B. sicherheitstechnische Bauteile bzw. Systeme - gegeben. Anwendung im "Healthcare"-Bereich: Die Lieferung eines Produktes für den Einsatz im Healthcare-Bereich (medizinische, pharmazeutische oder diagnostische Anwendung) erfolgt vorbehaltlich einer gesonderten Beurteilung durch ALBIS hinsichtlich der Übereinstimmung mit den ALBIS-internen Rekognitionsdaten - selbst wenn das Produkt grundsätzlich für Healthcare-Anwendungen freigegeben ist.
Wichtig: Unabhängig von der Produktart oder -bezeichnung untersagt ALBIS die Verwendung von Produkten grundsätzlich für folgende medizinische, pharmazeutische oder diagnostische Anwendungskategorien:
- Medizingeräte der Risikogruppe III gemäß EU Directive 93/42/EWG
- Körperimplantate mit einer Verweildauer im Körper von mehr als 30 Tagen ("Permanentimplantate")
- PSI, die Funktion kritische Komponenten in Medizingeräten, die eine lebenserhaltende/-stützende oder lebensverlängernde Funktion haben.
Im Übrigen gelten unsere Allgemeinen Verkaufs- und Lieferbedingungen.

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➡ **ALTECH ECO recycling grades can replace prime counter-grades.**

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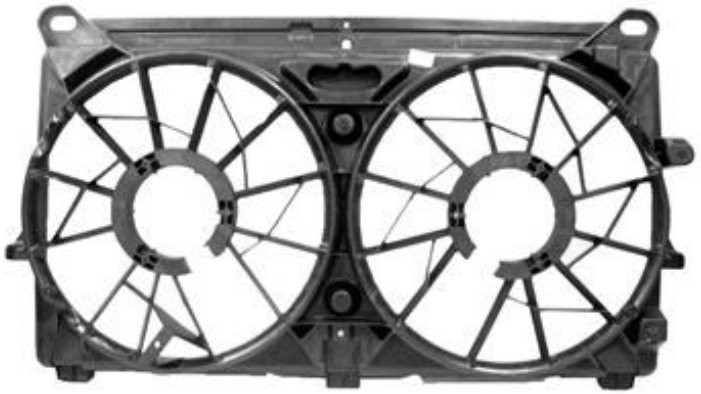
ALBIS & WIPAG – OPEN LOOP RECYCLING
ALTECH ECO >> CASE STUDY (1/2)

- Automotive
- Fan Shroud
- ALTECH PA6 ECO 2025/509 BK14-950 (PA6 GF25)
- Benefits
  - High heat deflection temperature
  - High stiffness and strength
  - Stable material properties/ quality, near-to-prime
  - Attractive cost/ performance ratio
  - Sustainability due to recycled material ca. 8kg lower CO2 footprint vs. comparable prime compound



➡ **Customized recycling compound with improved CO2 footprint.**

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ALBIS & WIPAG – OPEN LOOP RECYCLING
ALTECH ECO >> CASE STUDY (2/2)

- Automotive
- Engine „beauty“ cover
- ALTECH PA6 ECO 7010/100
  (PA6 rCF10)
- Benefits
  - Light-weight (Density 1,17 g/cm³)
  - High heat deflection temperature + good impact resistance
  - Top surface quality/ appearance
  - Cost reduction based on volume/part- price
  - Sustainability due to recycling materials (polymer/ carbon fiber)
    ca. 12kg lower CO2 footprint vs. comparable prime compounds

➡ Weight -15% vs. PA6-MR/GF, CO2 footprint ca. 12kg lower.

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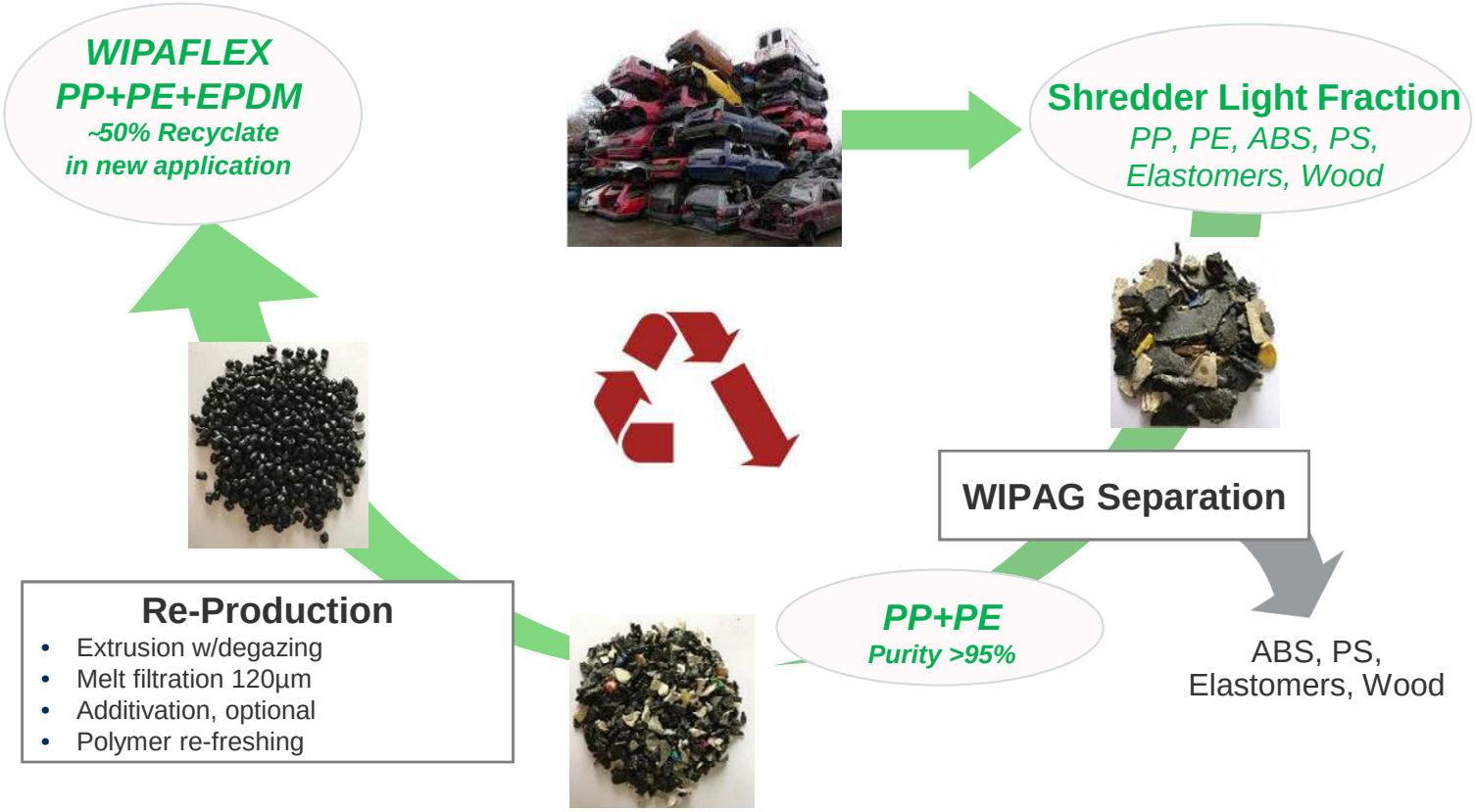
WIPAFLEX >> VALUE-CHAIN



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ALBIS & WIPAG – OPEN LOOP RECYCLING
WIPAFLEX >> CASE STUDY

IN TOUCH WITH PLASTICS

- Volkswagen, Passat/ Tiguan
- Wheel Arch Liner
- WIPAFLEX TV10 BLK
  (PP/PE/EPDM TV10)
- Benefits
  - Sufficient mechanical performance & constant quality
  - Cost effective solution vs. prime compounds
  - Sustainable material based on end of life recycling (PCR/SLF)
  - CO2 footprint ca. 9kg/ pro kg compound lower
    vs. comparable prime compounds

➡ Cost efficient recycling solution with ca. 9kg lower CO2 footprint.

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ALBIS & WIPAG – OPEN LOOP RECYCLING
WIPELAST >> CASE STUDY

- Automotive / various OEMs
- Under Body Panel
- WIPELAST TV30 BK, typical usage 40-100% (PP/EPDM TV30)
- Benefits
  - Sufficient mechanical performance & constant quality
  - Lower cost solution vs. prime compounds
  - Sustainable material based on PCR/PIR feedstock
  - CO2 footprint ca. 8kg/ pro kg compound lower vs. comparable prime compounds

➡ Cost efficient recycling solution with ca. 8kg lower CO2 footprint.

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ALBIS & WIPAG – OPEN LOOP RECYCLING
WIPELAST >> CASE STUDY

- Automotive / various OEMs
- Rocker Panel
- WIPELAST TV20-30 BK, typical usage 40-100% (PP/EPDM TV20-30)
- Benefits
  - Sufficient mechanical performance & constant quality
  - No influence on painting process
  - Lower cost solution vs. prime compounds
  - Sustainable material based on PCR/PIR feedstock
  - CO2 footprint ca. 8kg/ pro kg compound vs. comparable prime compounds

➡ Cost efficient recycling solution with ca. 8kg lower CO2 footprint.

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ALBIS & WIPAG – OPEN LOOP RECYCLING
CO2 SAVINGS

Products	ALTECH ECO PA6	ALTECH ECO PA66	ALTECH ECO PA6 rCF10	ALTECH IQ GF20	WIC PP rCF15	WIPELAST PP/EPDM TV20
Energy Demand Prime Compounds [kWh/kg]			40,85	19,08	30,91	18,04
Energy Source			German Energy Mix (2017): 0,486 kgCO_2/kWh			
Energy Demand Recycling Compounds [kWh/kg]			16,48	0,581	19,14	1,29
Energy Source			Energy Mix WIPAG/ALBIS	100% Hydro-Power, WIPAG: 0,013 kgCO2/kWh		
CO2 Savings in kg per 1 kg Compound	10.91	11.03	12.1	9.2	6.0	8.7

➡ **With every kg recycling compound you buy from ALBIS/ WIPAG you help to reduce CO2 emissions & lower your carbon footprint.**

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CLOSED LOOP RECYCLING

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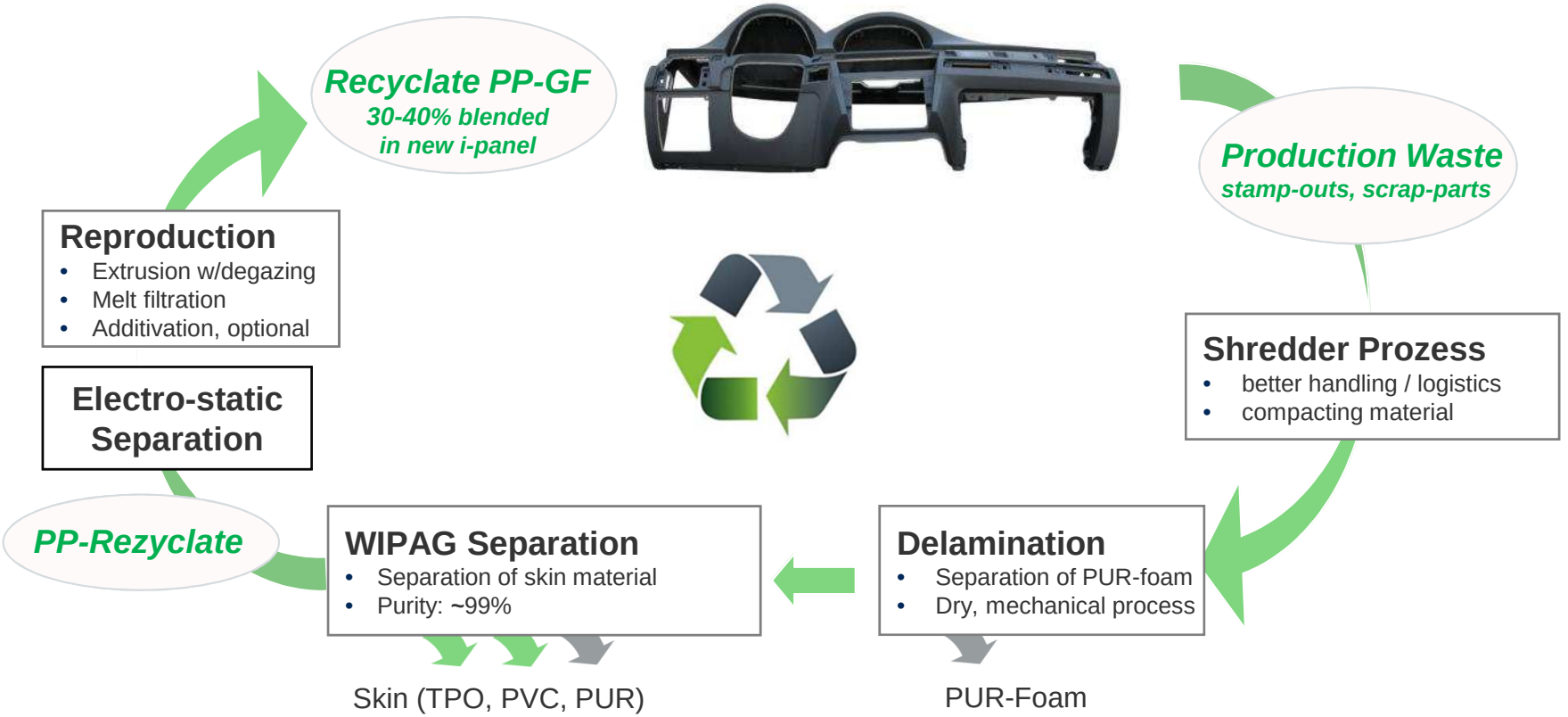
WIPAG – CLOSED LOOP RECYCLING
VALUE CHAIN >> DASHBOARDS-TO-DASHBOARD (1/2)



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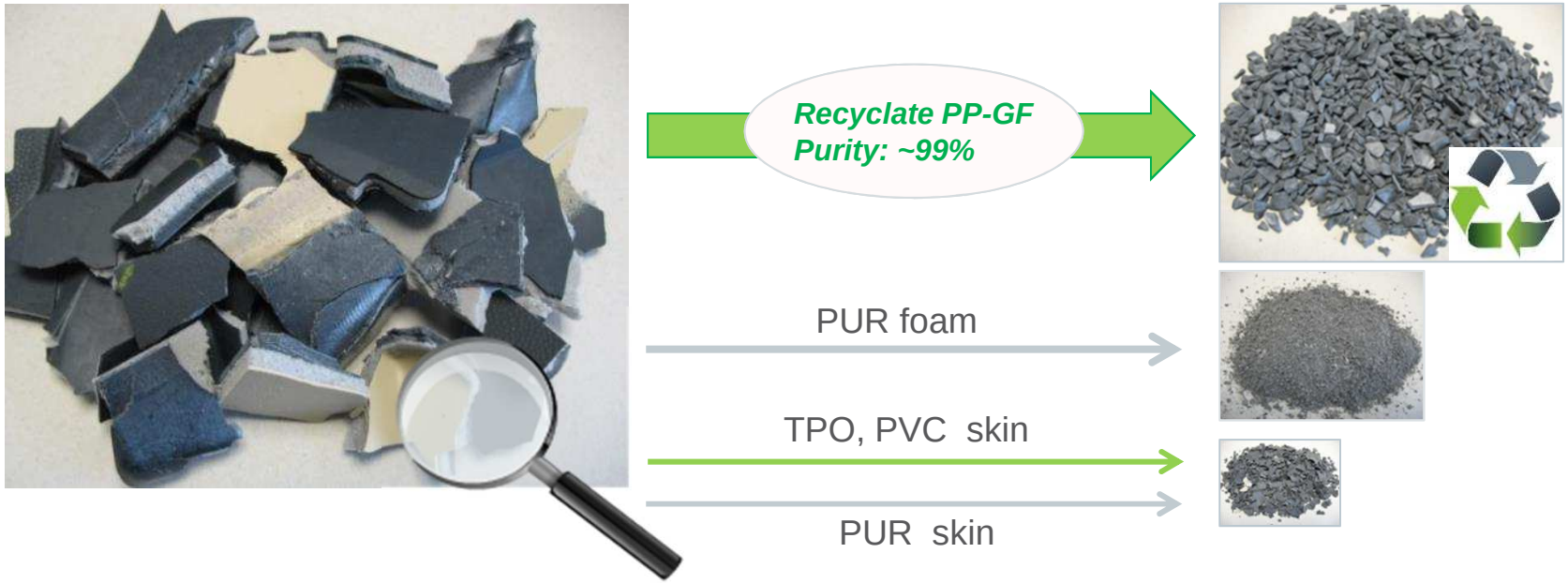
WIPAG – CLOSED LOOP RECYCLING
VALUE CHAIN >> DASHBOARDS-TO-DASHBOARD (2/2)



➡ **Even complex material laminates can be separated / re-used.**

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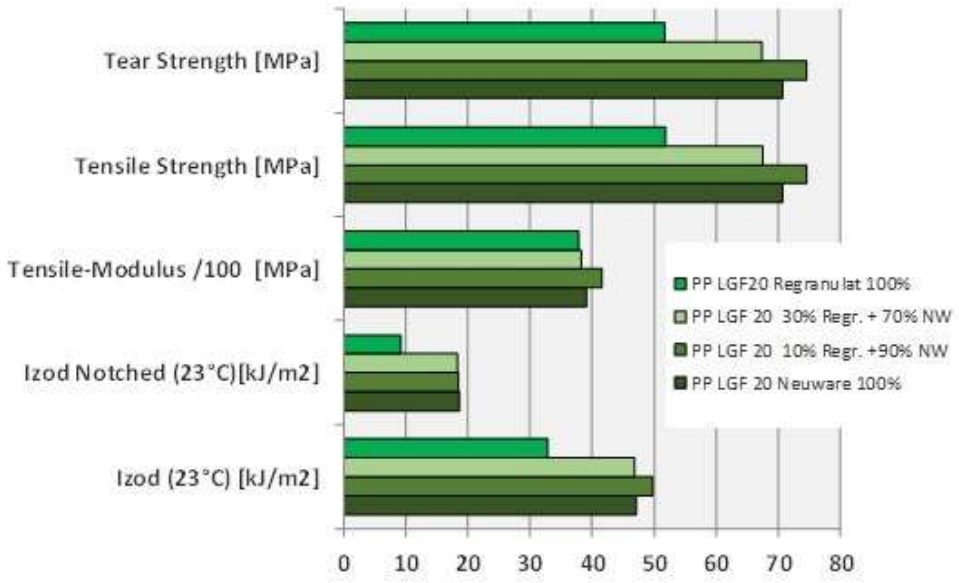
WIPAG – CLOSED LOOP RECYCLING
RECYCLATE PERFORMANCE VS. PRIME



➡ **Prime-like performance at 30-40% recyclate ratio.**

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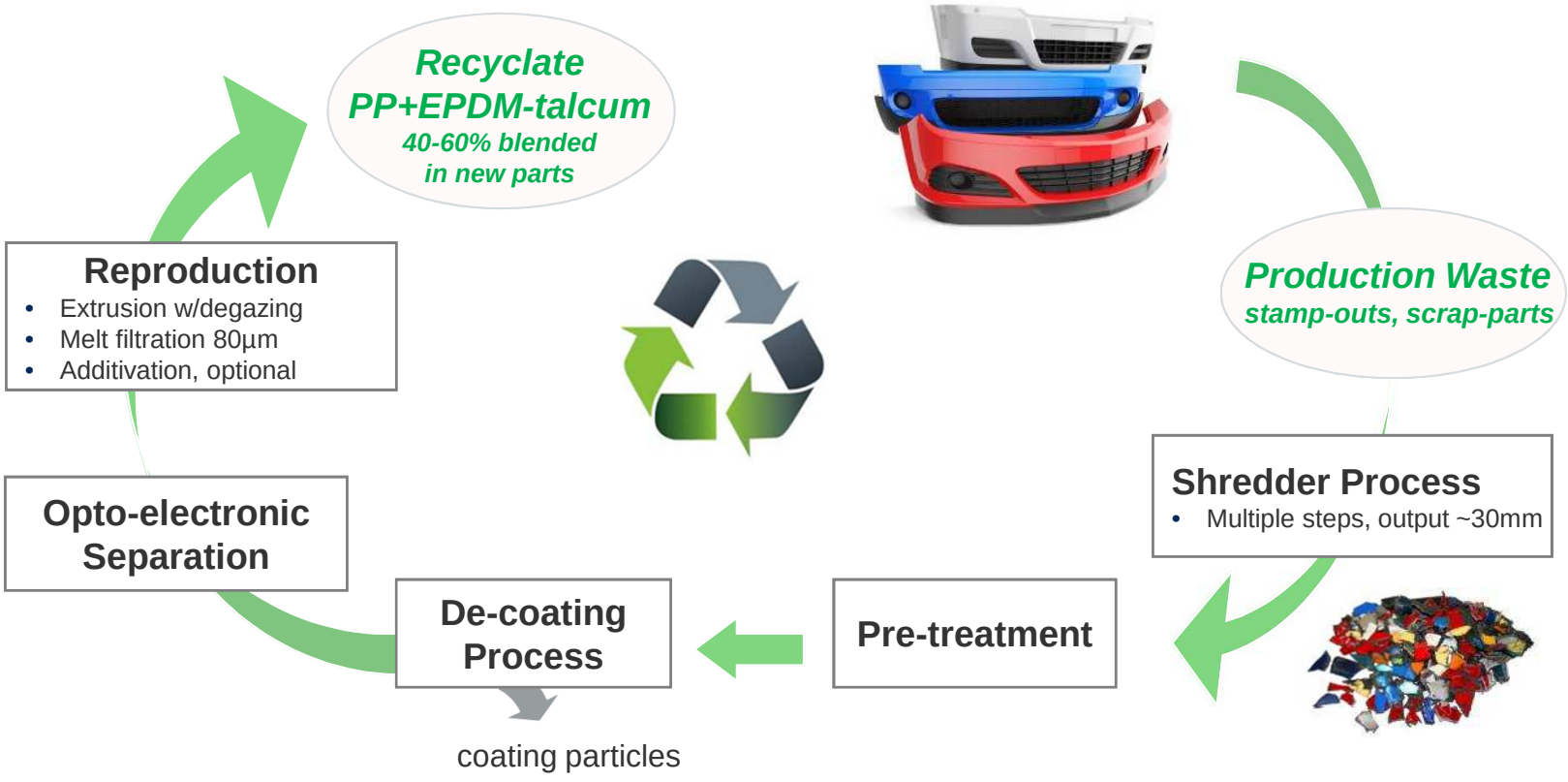
WIPAG – CLOSED LOOP RECYCLING
VALUE CHAIN >> BUMPER TO BUMPER (PIR)



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WIPAG – CLOSED LOOP RECYCLING
VALUE CHAIN >> BUMPER TO BUMPER (PCR)

PCR Bumper

Shredder Process
output ~30cm

De-Metallization

Metals

Shredder Process
output ~25mm

Density Separation

Contaminations

De-Coating Prozess

Coating particles

De-Metallization

Re-Production
- Extrusion w/degazing
- Melt filtration 80µm
- Additivation, optional

Recyclate PP+EPDM-talcum
40-100% blended in new parts

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WIPAG – CLOSED LOOP RECYCLING
BUMPER TO BUMPER >> CASE STUDY

- Automotive / various OEMs
- Bumper
- PP/EPDM TV10-20, typical usage 40-100%
- Benefits
  - Sufficient mechanical performance & constant quality
  - No influence on painting process
  - Lower cost solution vs. prime compounds
  - Sustainable material based on PCR/PIR feedstock
  - CO2 footprint ca. 9kg/ pro kg compound lower vs. comparable prime-based compounds

➡ Cost efficient recycling solution with ca. 9kg lower CO2 footprint.

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WIPAG – CLOSED LOOP RECYCLING
RECYCLATE PERFORMANCE VS. PRIME

Properties	Test method	Unit	Prime PP+EPDM TV20	Re-Compound PP+EPDM TV20
Color			Black	Black
MVR (230°C/2,16kg)	ISO 1133	[cm³/10 min]	13	14
Ash	ISO 3451-1	[%]	20	20
Tensile Modulus	ISO 527	[MPa]	1450	1600
Tensile Strength	ISO 527	[MPa]	15	16
Tensile Strength at Break	ISO 527	[MPa]	12	13
Elongation at Break	ISO 527	[%]	50	40
Charpy Impact Strength (23°C) 1eU	ISO 179	[kJ/m²]	NB	NB
Charpy Notched Impact (23°C) 1eA	ISO 179	[kJ/m²]	53	48

➡ **100% PP/EPDM recyclate shows almost prime-like performance.**

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RECYCLING as a SERVICE (RaaS)®

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WIPAG – RECYCLING-AS-A-SERVICE (RaaS)®
A CIRCULAR ECONOMY CONCEPT

What does it mean, Recycling as a Service (RaaS)® ?

input	material	❶ Logistic Service	❷ Shredding & De-Metallization	❸ Density Separation	❹ Paint Removal	❺ Composite Separation	❻ Electrostatic Separation	❼ Repelletization	❽ Compounding	❾ Melt-Filtration	❿ Drying	⓫ Homogenization	⓬ Packaging	⓭ Testing	⓮ Logistic Service	closed loop
Bumper post-industrial	PP+EPDM talcum	x	x		x			x	x	x	x		x	x	x	new Bumper

- WIPAG can offer a broad range of recovery/recycle-processes, which can be modular combined/ added as needed.
- Depending on systematic scrap characteristics/ quality (min. 10MT/lot, tbd) and individual customer application requirements a taylor-made solution can be developed, i.e. from an application back into the same application – „cradle-to-cradle“.
- Customers keep material ownership and WIPAG will charge agreed recycling services/ fees only.

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WIPAG – RECYCLING-AS-A-SERVICE (RaaS)®
NEW OPPORTUNITIES

Automotive Parts/ Components tbd

- Interior Trim Parts – coated ABS / PC+ABS
- Door Panel – PP-GF, ABS-GF
- Coated Head-Lamps – hard-coated PC
- Mirror Housing – coated ABS
- Rocker Panel – coated PP/EPDM TV
- Spoiler – ABS, PC+ABS
- Engine Cam Cover – PA66 GF
- Noice damping baffle – PA66
- …

➡ **Pls challenge us, if you want to save money, go circular/ close the loop and do something good for the environment.**

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SUMMARY

- **Recycling of Plastics**, especially concepts addressing circular economy, i.e. re-using lost resources/ waste streams, **are becoming more important in the future, especially when a CO2 tax comes into play.**
- **ALBIS/ WIPAG have a clear commitment offering & developing resource-caring, cost-effective and high quality Recycling Compounds**; we save already today >200kT CO2 per year by producing/ selling our Recycling products instead of prime equivalents.

- Given the market reach and coverage of >10,000 buying customers **ALBIS/ WIPAG are well positioned to promote and establish Recycling-as-a-Service (RaaS)®** and explore new Recycling opportunities for turning waste streams into useful resources.

➡ **We are looking forward to working with you.**

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YOUR RECYCLING CONTACTS @ WIPAG & ALBIS

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