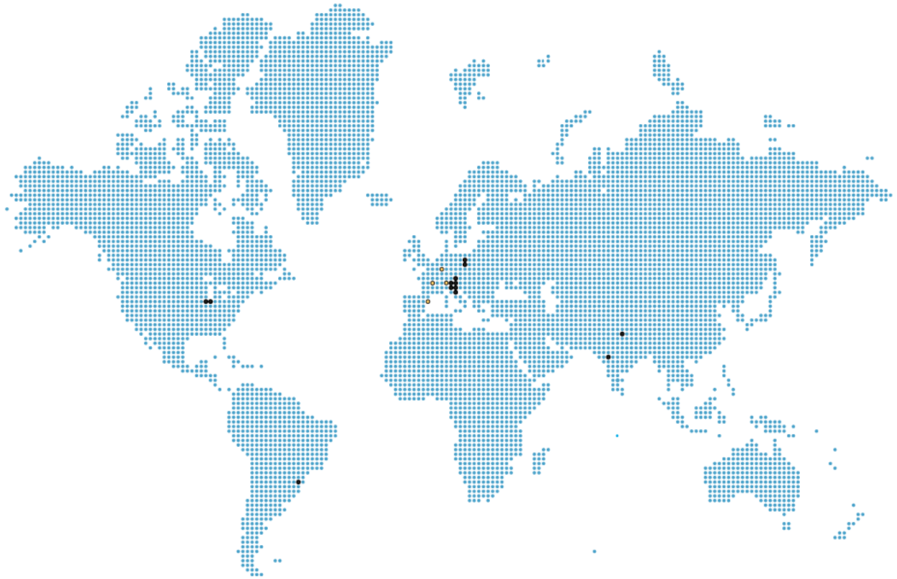
2025



Sustainable light weight solutions for interior applications in Talc filled and impact modified TPOs

Automotive Engineered Polyolefins Conference
29 September - 1 October 2025 - Troy, MI
SPE®TPO

Innovation Manager: Luca Gazzola

Agenda

- **Company overview**
- **Sirmax integrated process for recycled material production**
  - Waste streams in EU and US
  - Main challenges for r-PP upcycling
  - Green compounds production
- **Sustainable and lightweight PPT12 for interiors**
  - PCR content optimization
  - Impact resistance
  - Odor and Emission
  - Sustainability
- **Potential applications**
- **Conclusions**

Company overview. Sirmax around the world

SIRMAX PROXIMITY COMPOUNDING

Europe

Sirmax S.p.A Headquarters
Cittadella, PD

PP and rPP Compounds, R&D

110M lb/yr

Sirmax S.p.A
San Vito al Tagliamento, PN

EPC and rEPC Compounds, R&D

51M lb/yr

Sirmax S.p.A
Isola Vicentina, VI

Logistics Hub

Sirmax S.p.A
Tombolo, PD

EPC and rEPC Compounds

77M lb/yr

Sirmax New Life S.r.l.
Salsomaggiore Terme, PR

rPP, rHDPE Polymers, R&D

77M lb/yr

Sirmax S.p.A.
Mellaredo di Pianiga, VE

Biocompounds, R&D

53M lb/yr

Sirmax Polska Sp. z o.o.
Kutno 1, Łódź

PP and rPP Compounds

187M lb/yr

Sirmax Polska Sp. z o.o.
Kutno 2, Łódź

PP, TPE, EPC and rTPE Compounds, R&D

66M lb/yr

Americas

Sirmax North America Inc.
Anderson, IN

PP and rPP Compounds, R&D

105M lb/yr

Sirmax North America Inc.
Anderson, IN

rPP Polymers

40M lb/yr

Sirmax do Brasil Ltda
São Paulo, Jundiaí

PP Compounds

33M lb/yr

Asia

Autotech-Sirmax India Pvt Ltd
Palwal, Haryana

PP Compounds

66M lb/yr

Autotech-Sirmax India Pvt Ltd
Valsad, Gujarat

PP, EPC Compounds, R&D

66M lb/yr

Autotech-Sirmax India Pvt Ltd
Hosur, Tamil Nadu

New plant by 2026

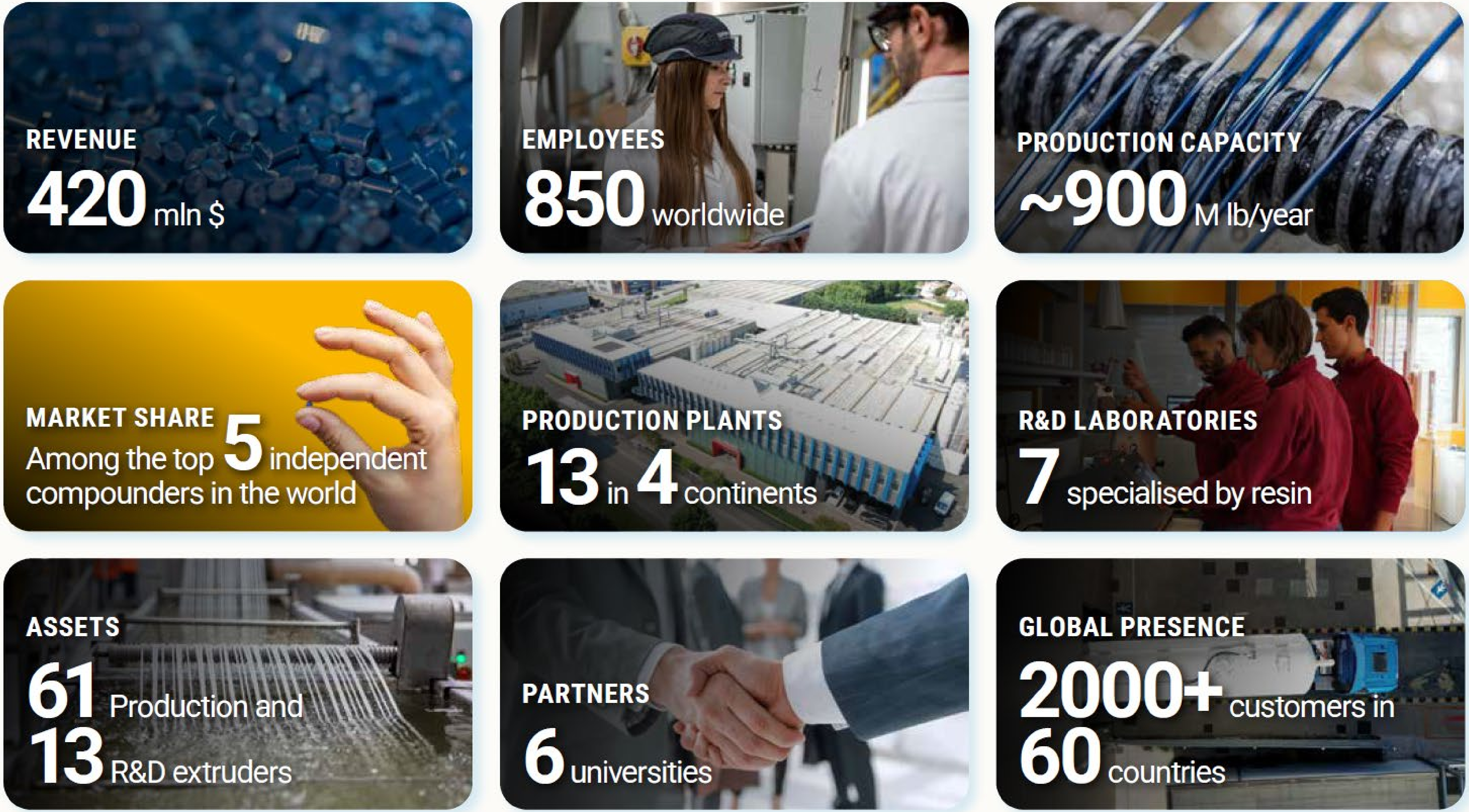
Green Materials Production Plant

Research & Development Centers

Production capacity

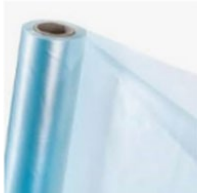
Company overview. A global company

SIRMAX
PROXIMITY COMPOUNDING



SIRMAX integrated process. Waste streams in EU and US

- Plastic-Recycling
  - Pre-Consumer Scrap
    - Production Scrap
      - Punch Grids
      - Films
      - Sprues
      - Start-up Waste
  - Post-Consumer Waste
    - Pure / Unmixed
      - Containers
      - Battery Cases
      - Bumpers
      - Bags
    - Mixed / Polluted
      - Waste Collectors
      - Shredder Plants
      - Scrapped Cars
      - Civic Amenity Site

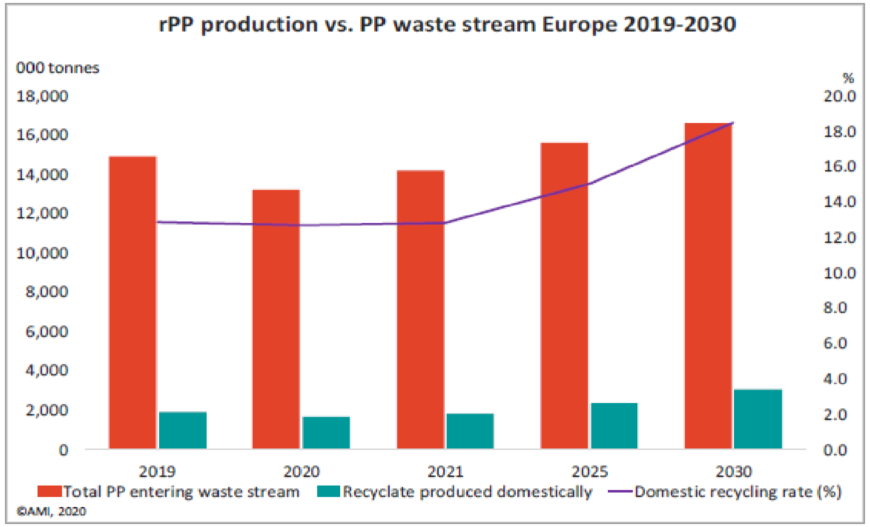




Different streams of scrap or waste can be selected but **good quality** usually **doesn’t match with high availability.**
An Optimized mechanical recycling process allows upcycling of **poor-quality waste**.

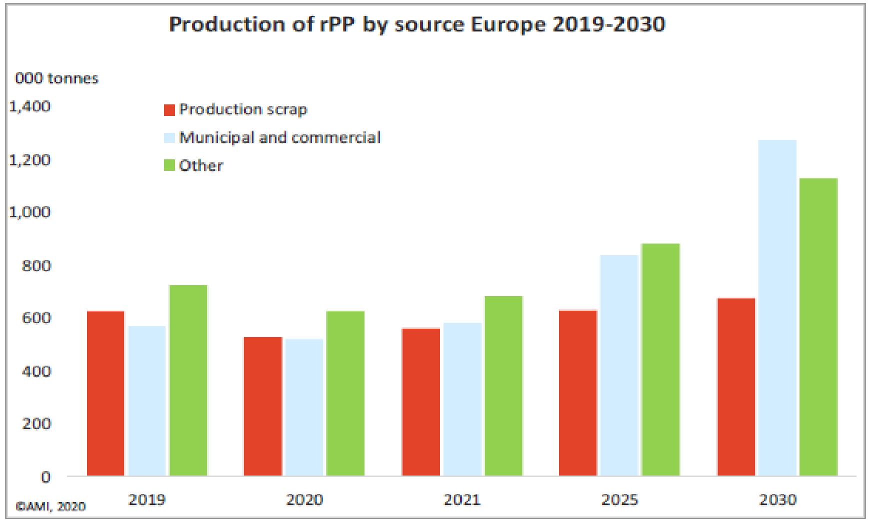
SIRMAX integrated process. Waste sources in EU

Availability of rPP from curbside collection, feedstock continues to grow - EU

Recycling rate



Waste stream %



15%

PP recycling rate equivalent to 2.4Mt in 2025 (18.5% or 3Mt in 2030)

35%

Urban waste share equivalent to 850Kt in 2025 (43% or 1.3 Mt in 2030)

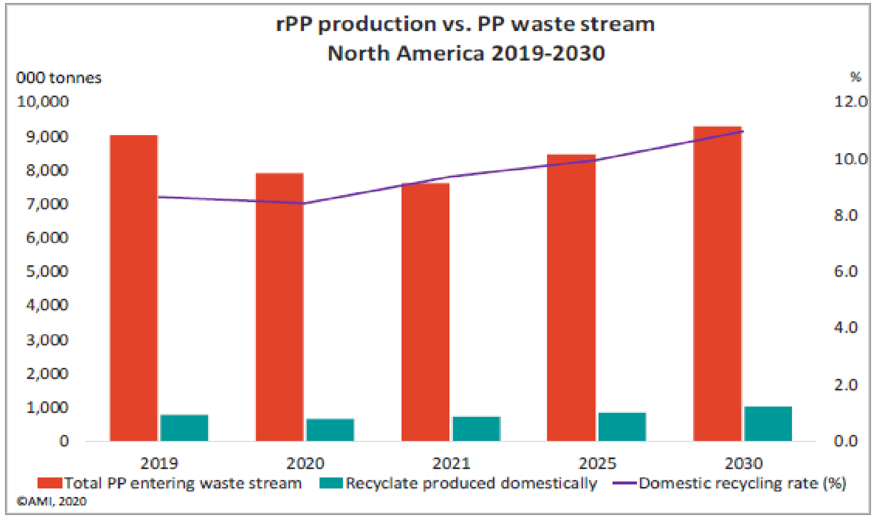
Source: AMI report 2020 The global mechanical plastics recycling industry

SIRMAX integrated process. Waste sources in US

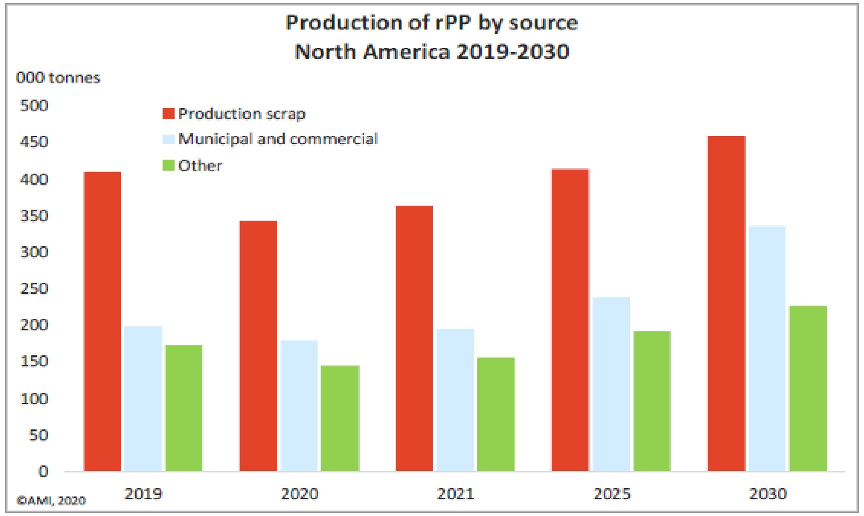
US has a lower recycling rate than EU, and most waste comes from industrial scrap.

SIRMAX
PROXIMITY COMPOUNDING

Recycling rate



Waste stream %



10%

PP recycling rate equivalent to 850Kt in 2025 (11% or 1Mt in 2030)

50%

Post industrial share equivalent to 420 Kt in 2025 (45% or 460Kt in 2030)

Source: AMI report 2020
The global mechanical plastics recycling industry

In US, the focus of Sirmax is post industrial scrap, but has the capability to transition quickly to reliable post-consumer scrap when it is available.

POST INDUSTRIAL (PRE CONSUMER)

The Anderson, IN recycling plant is currently designed to process polypropylene post-industrial scrap.

- Raffia
- Non-woven
- BOPP film
- Film bales
- Blocks and purge
- Regrinds

The waste streams are validated by continuous incoming **quality control checks** which are performed to ensure full consistency and traceability.

POST CONSUMER

Factors linked to post consumer availability

- Collection: Minimum content legislation is in force in certain US states (e.g. California, 25% recyclate for detergent bottles) but a **lack of federal legislation** is hindering recyclate volumes.
- Economics: Extremely low virgin PP prices make curbside collection not profitable without the presence of legislation supporting it.
- Oil price
- OEM pledge to have key brands recycled
- Legislation (ASR, EPR, etc.)

Material in scope:

- **PP –** Polypropylene
- **PE –** Polyethylene

SIRMAX integrated process. r-PP upcycling challenges

Household waste

High level and different types of contamination like:

- ✓ Polymers
- ✓ Organic (food, wood)
- ✓ Inks, glues, labels
- ✓ Metallic particles

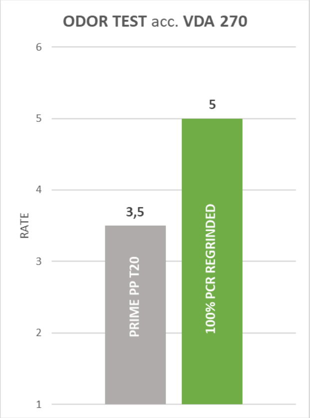
Start up waste

Potential impurities like:

- ✓ Polymers
- ✓ Additives, plasticizers
- ✓ Metals

Mechanical properties, aesthetics and odor of final green compound are negatively affected without proper upcycling.

Odor and Aesthetics

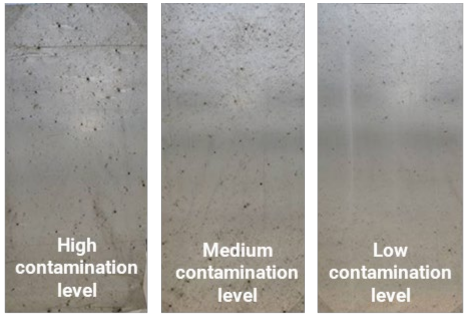


VDA 270. Prime PPT20 vs 100% regrind PP

Aesthetics

Silver streaks on part molded with green compound

Impact strength



100% regrinded r-PP

High contamination level | Medium contaminations level | Low contamination level

Multiaxial impact test acc. to ASTM D-3763 (2.2 m/s 23°C)

SIRMAX integrated process. Green compounds production

FROM WASTE TO A HIGH-VALUE RAW MATERIAL FOR DURABLE GOODS

Certified purchase of plastic waste

PCR Waste selection from national suppliers → Sorting, grinding, washing → Filtering and pelletizing → Compounding → Compound post-treatment

PIR Scrap selection from converters → Shredding, grinding, sorting → Filtering and pelletizing → Compounding → Compound post-treatment

Customized service

Through Smart Mold

SMART MOLD

The correct trade-off between performance / value / sustainability must be carefully considered in each step of the value chain to ultimately achieve:

- > **Minimum required performance** on eco-designed systems
- > **Best property balance** considering rheology, thermomechanical, and emissions properties

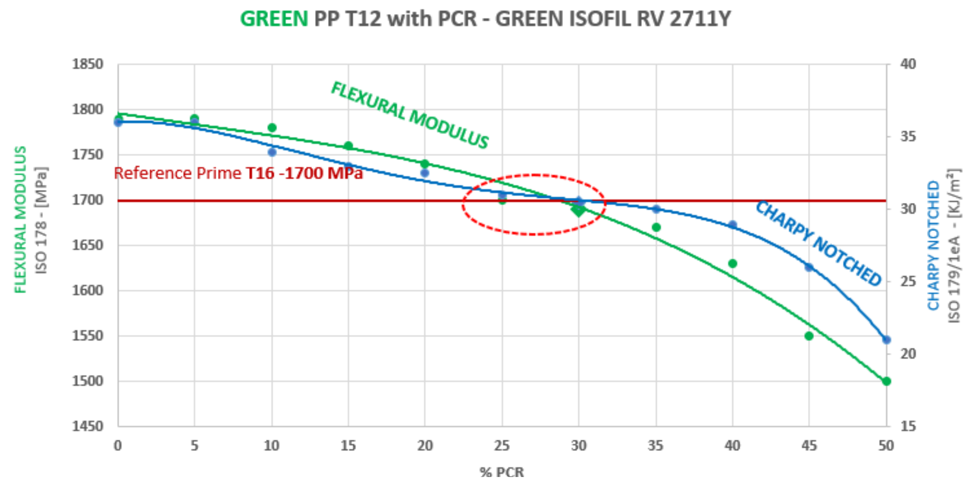
Sustainable and lightweight PPT12 for interiors.

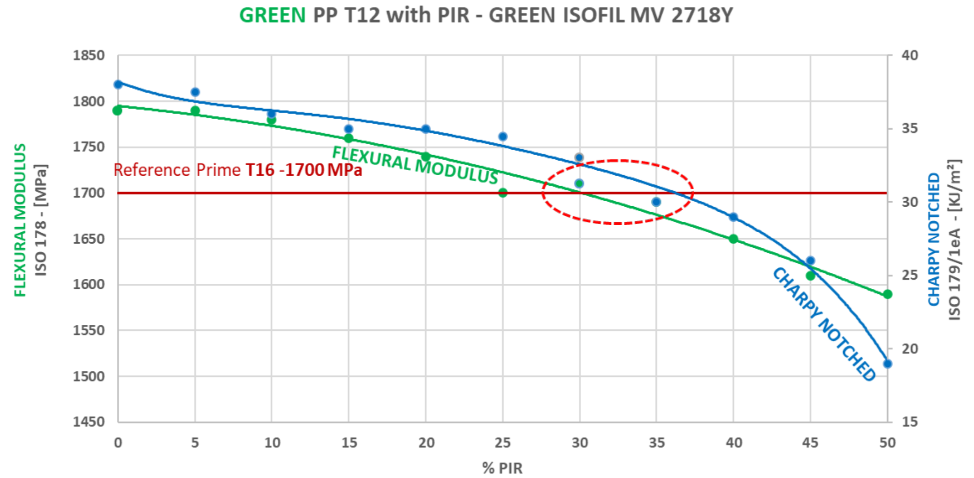
The goal of the study is to develop a **sustainable compound fulfilling VW TL52388-E** for interior, but **with lower filler content** to match **sustainability and lightweighting targets.**

	Test Method	Norm VW TL52388 - E	ISOFIL MF 3604Y	GREEN ISOFIL RV 2711Y	GREEN ISOFIL MV 2718Y
Post-consumer content [%]	-	-		30%	
Pre-consumer content [%]	-	-			30%
Melt Flow Rate (230°C - 2,16 Kg) [g/10']	ISO 1133	-	15	15	16
Density [g/cm³]	ISO 1183-1	-	1,02	0,98	0,98
Filler (0,5h, 750°C) [%]	ISO 1172	16 ± 2	16	12	12
Flexural Modulus (23°C - 2 mm/min) [MPa]	ISO 178	≥ 1100	1700	1690	1710
Charpy notched impact (23°C) [kJ/m²]	ISO 179-1/1eA	≥ 25	35	30	33
Charpy notched impact (-30°C) [kJ/m²]	ISO 179-1/1eA	-	3,8	3,5	3,8
Tensile Stress at yield (50 mm/min, 23°C) [MPa]	ISO 527-2	≥ 15	21	20	21
Tensile Elong. at yield (50 mm/min, 23°C) [%]	ISO 527-2	≥ 4	5,8	8	4,5
HDT, A (1,80 MPa) [°C]	ISO 75/Af	-	50	55	56

25% to 30% r-PP from post consumer source affords the **best compromise** between **impact and stiffness properties.**

Similar targets can be achieved **with r-PP from pre-consumer (PIR)** sources by selecting specific waste streams. This will also yield **Better impact strength retention** compared to PCR.





Sustainable and lightweight PPT12 for interiors.

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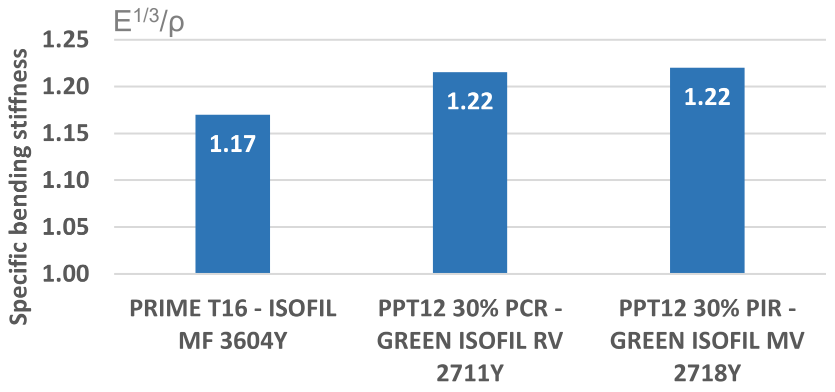
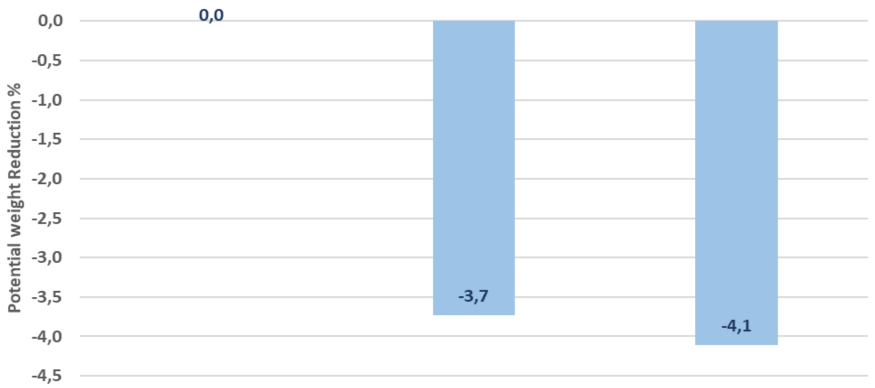
Post-consumer content [%]	-	-		30%	
Pre-consumer content [%]	-	-			30%
Melt Flow Rate (230°C - 2,16 Kg) [g/10']	ISO 1133	-	15	15	16
Density [g/cm³]	ISO 1183-1	-	1,02	0,98	0,98
Filler (0,5h, 750°C) [%]	ISO 1172	16 ± 2	16	12	12
Flexural Modulus (23°C - 2 mm/min) [MPa]	ISO 178	≥ 1100	1700	1690	1710
Charpy notched impact (23°C) [kJ/m²]	ISO 179-1/1eA	≥ 25	35	30	33
Charpy notched impact (-30°C) [kJ/m²]	ISO 179-1/1eA	-	3,8	3,5	3,8
Tensile Stress at yield (50 mm/min, 23°C) [MPa]	ISO 527-2	≥ 15	21	20	21
Tensile Elong. at yield (50 mm/min, 23°C) [%]	ISO 527-2	≥ 4	5,8	8	6,4
HDT, A (1,80 MPa) [°C]	ISO 75/Af	-	50	55	56





4% potential weight saving can be achieved by replacing PPT16 prime with a sustainable compound with lower filler content and 30% recycled content.

Sustainable and lightweight PPT12 for interiors. Impact resistance

SIRMAX PROXIMITY COMPOUNDING

The goal of the study is to develop a **sustainable compound fullfilling VW TL52388-E** for interior, but **with lower filler content** to match **sustainability and lightweighting targets.**

	Test Method	Norm VW TL52388 - E	ISOFIL MF 3604Y	GREEN ISOFIL RV 2711Y	GREEN ISOFIL MV 2718Y
Post-consumer content (%)	-	-		30%	
Pre-consumer content (%)	-	-			30%
Ball Drop Test (h=400mm, -30°C)	PV3905	No Fracture	No Fracture	No Fracture	No Fracture
Multiaxial impact test FRACTURE TYPE* (3mm thickness, 4,4 m/s, 23°C)	ISO 6603-2	-	YD	YD	YD
Multiaxial impact test FRACTURE TYPE* (3mm thickness, 4,4 m/s, -30°C)	ISO 6603-2	-			

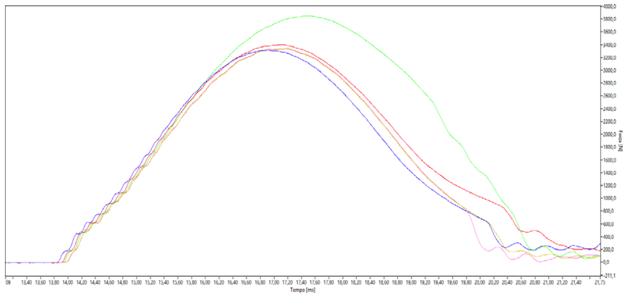
***FRACTURE TYPE**:
YD: Yielding w/h deep drawing (100% ductile) | YS: Yielding w/h STABLE crack
YU: Yielding w/h UNSTABLE crack | NY: no yielding

Both post-consumer and post-industrial r-PP can be introduced into the formulation at a percentage of 30% while maintaining ductility at 23°C.

MULTIAXIAL IMPACT @ 23°C

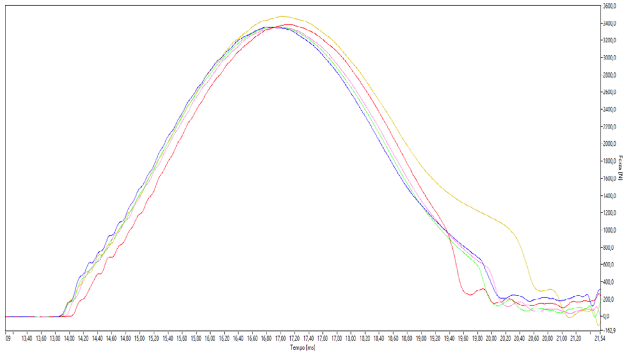
ISOFIL MF 3604Y
PRIME T16

YD
100% DUCTILE



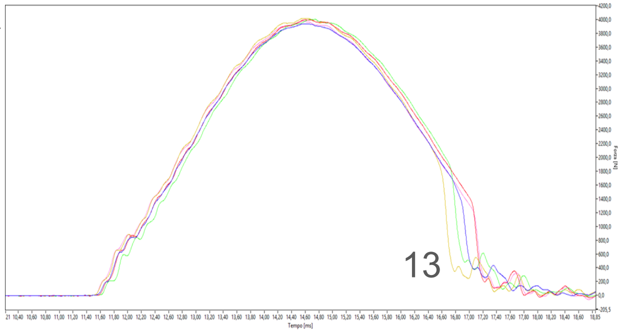
GREEN ISOFIL RV 2711Y
GREEN T12 – **30% PCR**

YD
100% DUCTILE



GREEN ISOFIL MV 2718Y
GREEN T12 – **30% PIR**

YD
100% DUCTILE



Sustainable and lightweight PPT12 for interiors. Impact resistance

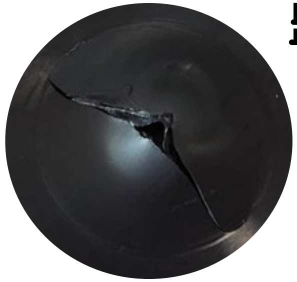
The goal of the study is to develop a **sustainable compound fullfilling VW TL52388-E** for interior, but **with lower filler content** to match **sustainability and lightweighting targets.**

	Test Method	Norm VW TL52388 - E	ISOFIL MF 3604Y	GREEN ISOFIL RV 2711Y	GREEN ISOFIL MV 2718Y
Post-consumer content (%)	-	-		30%	
Pre-consumer content (%)	-	-			30%
Ball Drop Test (h=400mm, -30°C)	PV3905	No Fracture	No Fracture	No Fracture	No Fracture
Multiaxial impact test FRACTURE TYPE* (3mm thickness, 4,4 m/s, 23°C)	ISO 6603-2	-	YD	YD	YD
Multiaxial impact test FRACTURE TYPE* (3mm thickness, 4,4 m/s, -30°C)	ISO 6603-2	-	YS	YU	YS

***FRACTURE TYPE**:
YD: Yielding w/h deep drawing (100% ductile) | YS: Yielding w/h STABLE crack
YU: Yielding w/h UNSTABLE crack | NY: no yielding

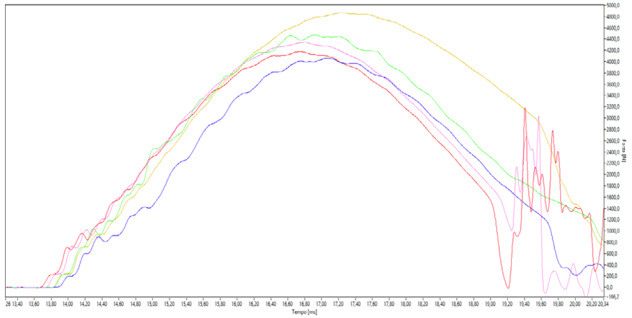
Impact resistance at low temperature is not 100% ductile, but is in line with the prime material used as a reference. Some cracks are observed but is still stable with yielding.

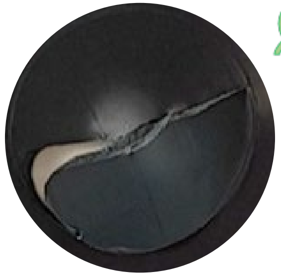
MULTIAXIAL IMPACT @ -30°C



ISOFIL MF 3604Y PRIME T16

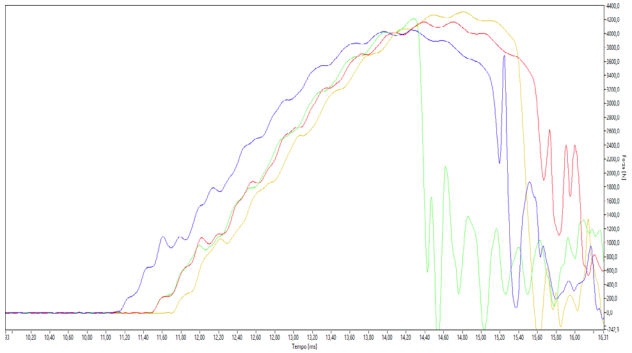
YS
Yielding w/h **STABLE** crack

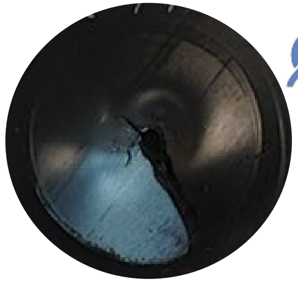




GREEN ISOFIL RV 2711Y
GREEN T12 – **30% PCR**

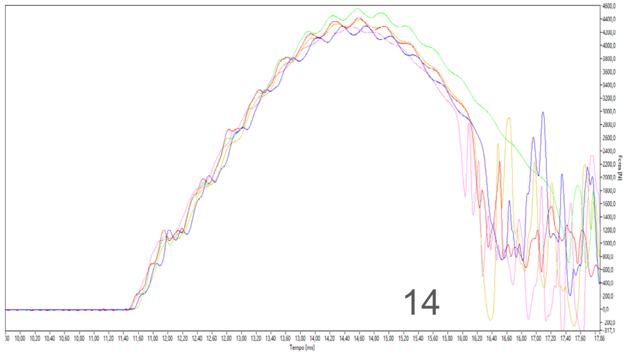
YU
Yielding w/h **UNSTABLE** crack





GREEN ISOFIL MV 2718Y
GREEN T12 – **30% PIR**

YS
Yielding w/h **UNSTABLE** crack

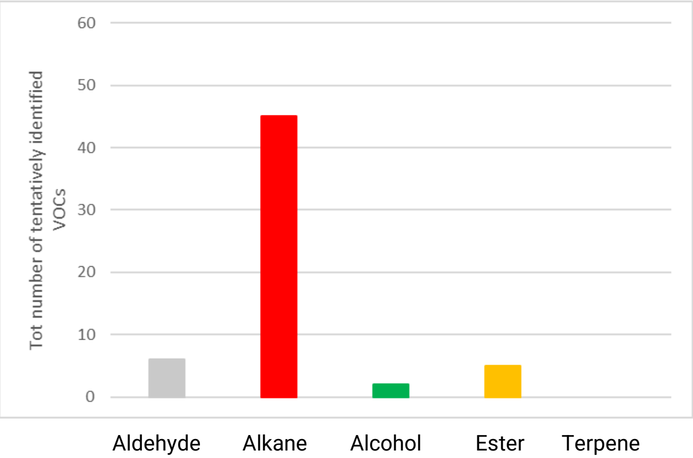


Sustainable and lightweight PPT12 for interiors. Odor and emission.

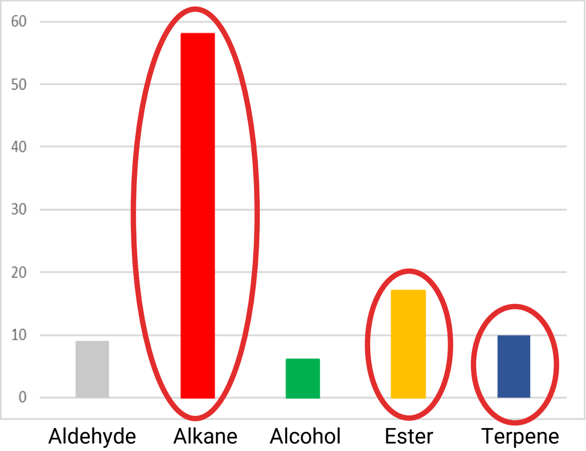
	Test Method	Norm VW50180 (2019)	Other targets	ISOFIL MF 3604Y	GREEN ISOFIL RV 2711Y	GREEN ISOFIL MV 2718Y
VOC [µg/g]	VDA 278	**-**	**250**	**58**	**100**	**71**
FOG [µg/g]	VDA 278	**-**	**500**	**355**	**402**	**395**
FOG [µg C/g]	PV3341	**< 50**	**-**	**21**	**26**	**23**
ODOR [Rate]	PV3900	**≤ 4**	**-**	**3**	**4**	**3,5**
FOGGING [mg/10g]	PV3015	**-**	**1,2**	**0,52**	**0,76**	**0,64**

Emission and odor properties of green compounds were investigated and optimized by process configuration both on mechanical recycling and compounding phase.

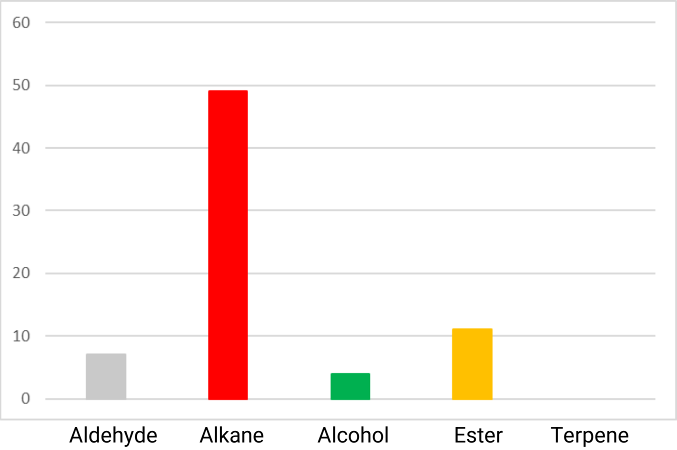
ISOFIL MF 3604Y
PRIME T16



GREEN ISOFIL RV 2711Y
GREEN T12 – **30% PCR**



GREEN ISOFIL MV 2718Y
GREEN T12 – **30% PIR**

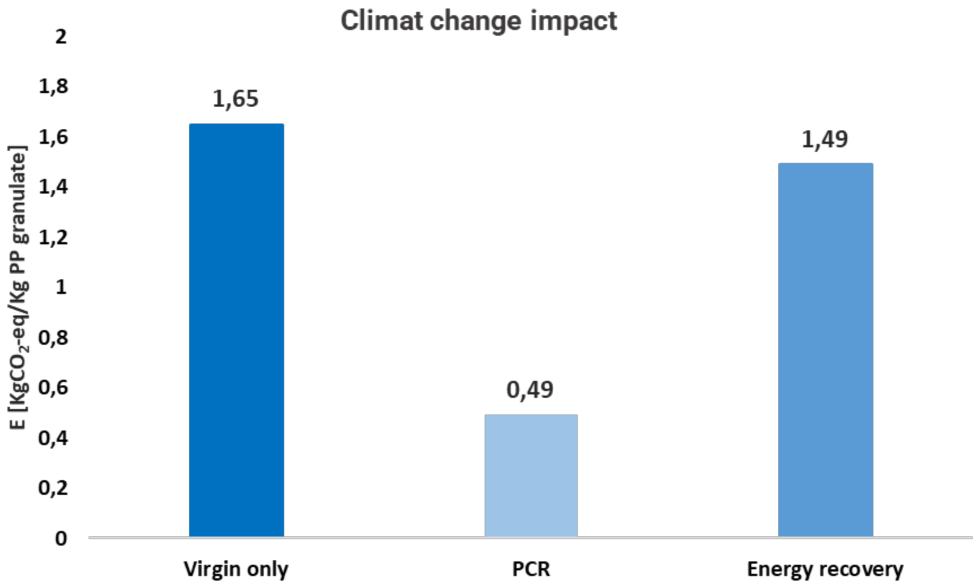


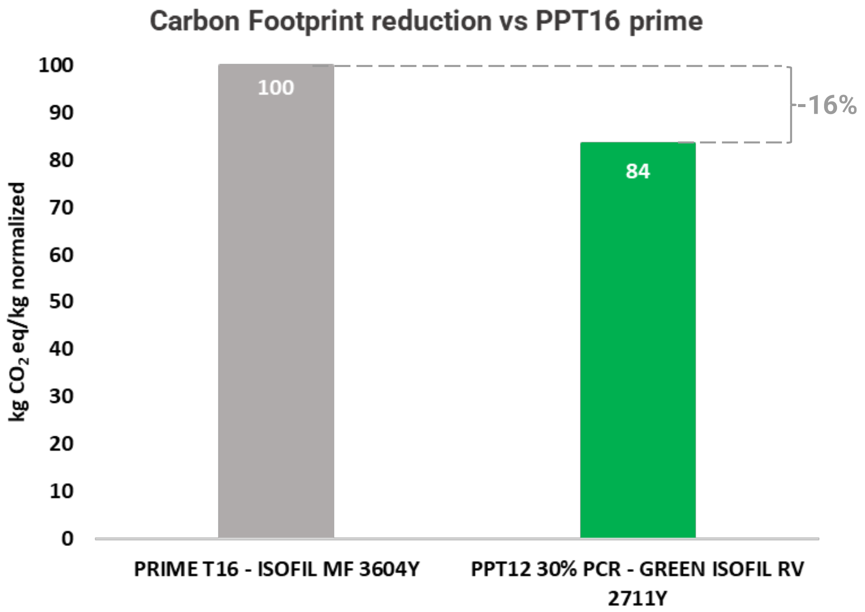
Chemical substances classification from VOC screening highlights that **esters, aldehydes, alcohols and terpenes content are increased by the presence of PCR.** These molecules are usually **odor active substances affecting final compound odor**.

- **Pre-consumer** r-PP has **good performance on emission and odor,** quite close to the prime material. There is a low amount of oxidation molecules.
- When **r-PP from post-consumer** sources is used, **emission and odor are affected** and need to be **controlled along the production process**.

Sustainable and lightweight PPT12 for interiors. Sustainability.

Environmental impact of post-consumer (PCR) recycled materials on green compounds.





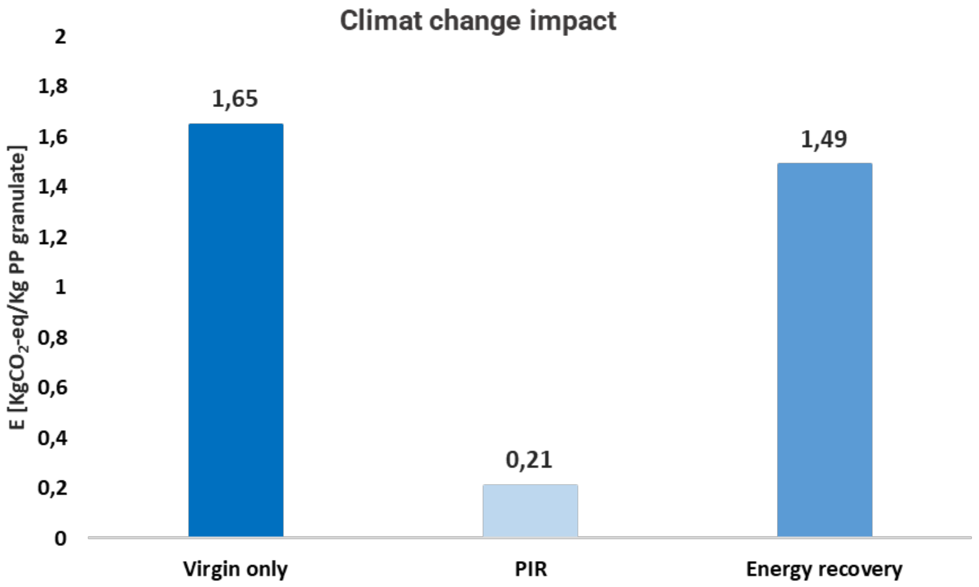
Carbon footprint evaluation according to ISO 14040 on a cradle to gate perspective.

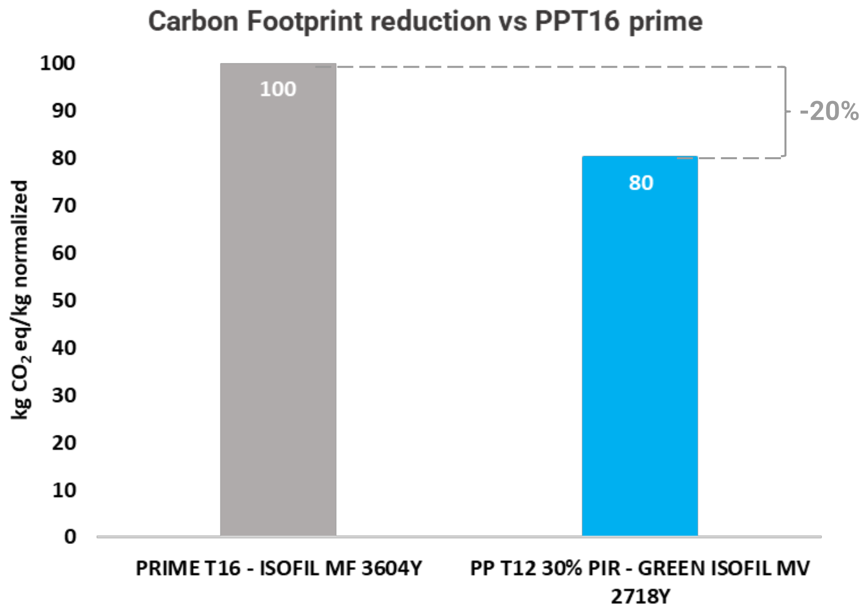
LCA evaluation on PP waste, recovered through the **mechanical recycling process** as an alternative to energy recovery, leads to **greenhouse gas (GHG) savings with PCR**.

- **With 30% PCR content,** we can achieve a **16% CO_2 reduction** on PPT12 compared **to prime PPT16.**

Sustainable and lightweight PPT12 for interiors. Sustainability.

Environmental impact of pre-consumer (PIR) recycled materials on green compounds.





Carbon footprint evaluation according to ISO 14040 on a cradle to gate perspective.

LCA evaluation on PP waste, recovered through the **mechanical recycling process** as an alternative to energy recovery, leads to **greenhouse gas (GHG) savings with PIR**.

- **With 30% PIR content,** we can achieve a **20% CO_2 reduction** on PPT12 produced in US (Anderson plant) **compared to prime PPT16.**
- **Today, PIR** might look **better than PCR on GHG reduction from the LCA** calculation, but the **LCA evaluation doesn't account for availability**. PIR is limited by the industrial production processes, while PCR depends on consumer behavior and the availability of efficient waste collection systems. **PCR ultimately has a higher potential to increase in availability, unlike PIR whose availability might not be enough to satisfy all future needs.**

Potential applications

CENTER CONSOLE

DOOR PANEL

PILLAR TRIM

SEAT TRIM

...among many others!

Conclusions

SIRMAX® PROXIMITY COMPOUNDING

- Sirmax approaches **sustainability by** being present in the market, offering **circular compounds** based on **mechanical recycling or biopolymer raw materials**.

- **Sirmax's goal** is to use **PP waste from post-consumer** sources in both the **EU** and the **US. PIR will be used in addition to PCR until a sufficient stream of PCR waste is developed and accepted by OEM's in North America.**

- Sirmax can maximize final compound sustainability by utilizing our integrated **r-PP mechanical recycling, and by choosing the best sources regionally, whether PCR or PIR**.

- It is possible to increase the **PCR or PIR PP content to 30% on a PP 12% talc filled compound** intended for interior applications **without significantly compromising** critical properties like **impact strength, odor, or emissions, when compared** to the prime incumbent 16% talc filled material. In addition we **optimized stiffness resistance** which opened the window to **lightweighting solutions (4%).**

- **GREEN ISOFIL RV 2711Y or GREEN ISOFIL MV 2718Y can be viable sustainable solutions** for prime material replacement on interior applications.

- **When comparing the incumbent** PP T16 **with 2711Y and 2718Y, we achieved the following improvements: Reduced carbon footprint (16% or 21% depending on the comparison material),** and the possibility to **reduce part weight** thanks to a material with **lower density**.

SIRMAX GROUP

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Mobile: +39 3423433069

Thank you!

Find out more
SIRMAX.COM