



SUSTAINABILITY IN THE LIFE CYCLE OF BODY SHOP ADHESIVE BONDING

NACHHALTIGE KUNSTSTOFFE IN KOMPLEXEN ANWENDUNGEN, OST BUCHS 27.9.2023
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BUILDING TRUST



SIKA GOALS ON NET ZERO

SCIENCE BASED TARGET INITIATIVE

MORE PERFORMANCE
MORE SUSTAINABLE

Sika's targets and way to net zero by 2050

Scope 1 and 2 Goals:

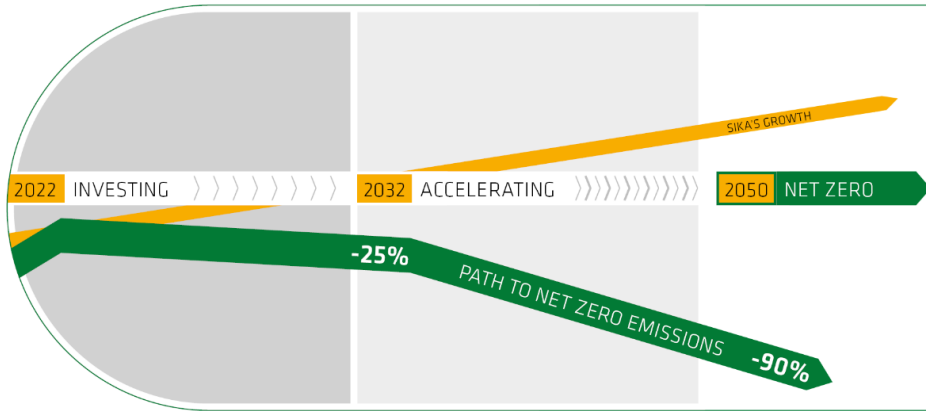
Scope 3 Goals:

-42% by 2032

-25% by 2032

-90% by 2050

-90% by 2050



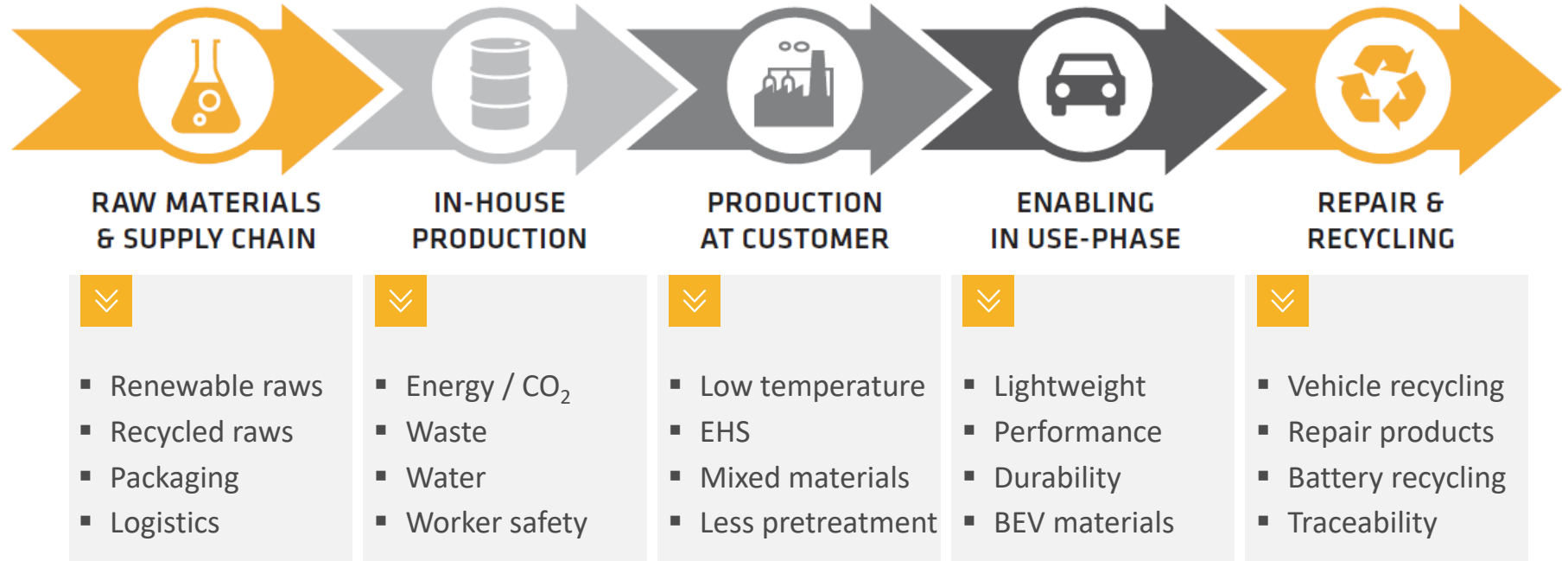
Impact on product development

Combine higher performance with additional sustainability benefits



LIFE CYCLE OF BODY SHOP ADHESIVE BONDING

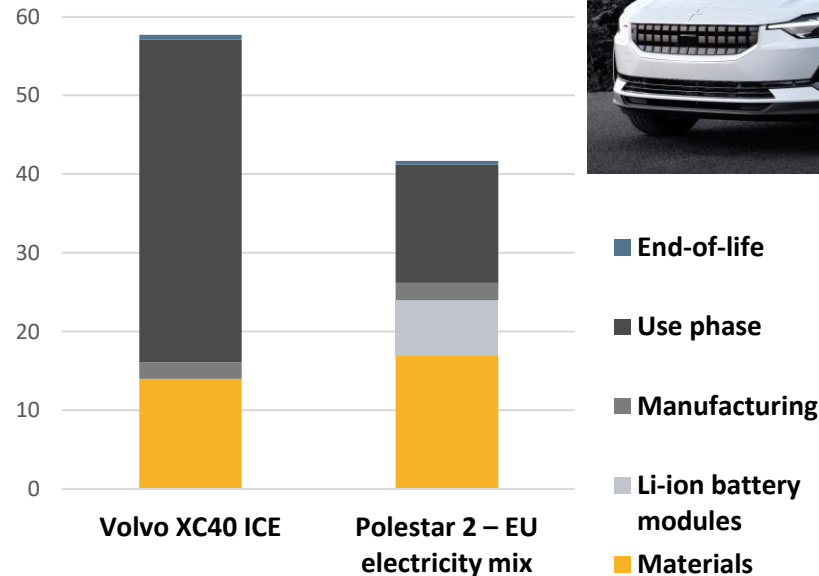
FROM CRADLE OF ADHESIVE TO GRAVE OF CAR AND BACK TO CRADLE



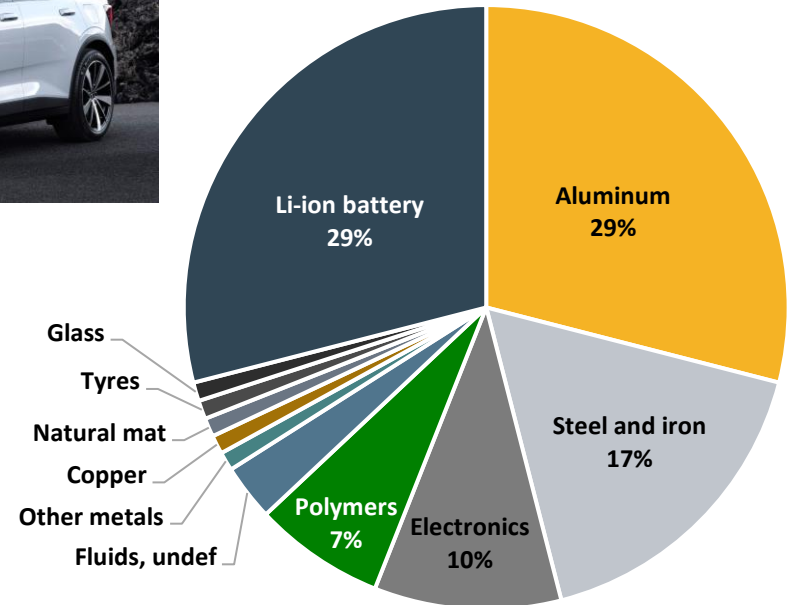
LIFE CYCLE ASSESSMENT OF A CAR CRADLE-TO-GRAVE

EXAMPLES VOLVO XC40 ICE AND POLESTAR 2 BEV

Carbon footprint per vehicle
in tons CO₂-equivalent
(200'000 km lifetime range):



Contribution of different materials
to the footprint of Polestar 2:

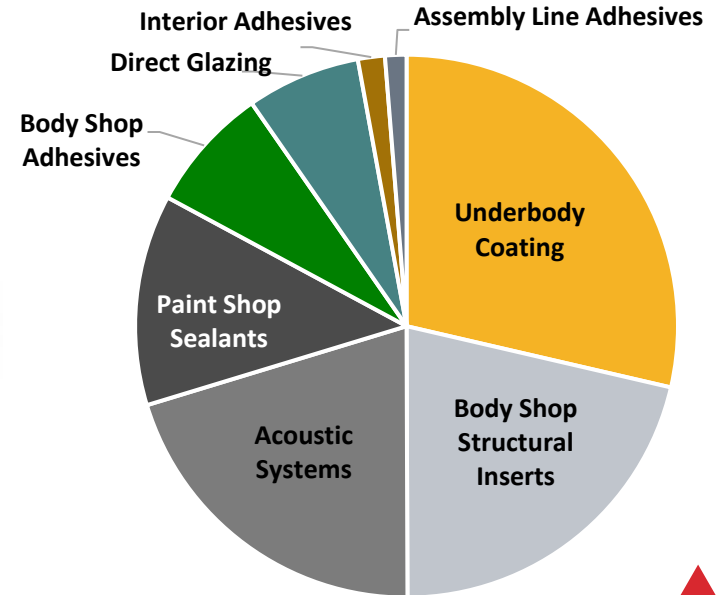
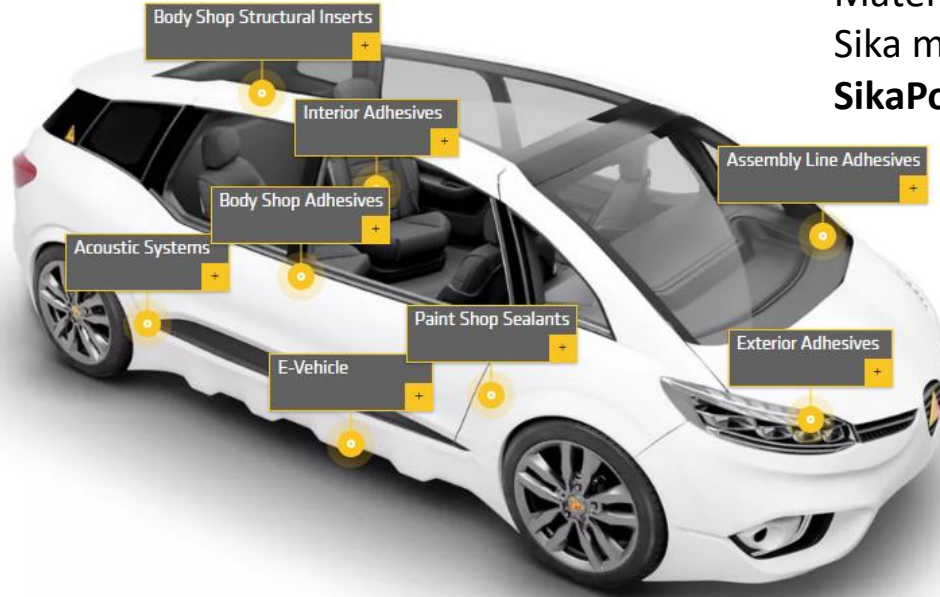


Source: 'Polestar Life cycle assessment', L. Bolin 2020

CARBON FOOTPRINT OF MATERIALS

CASE STUDY OF SIKA MATERIALS IN A VIRTUAL CAR

Material footprint in Polestar 2: 17'000 kg CO₂-eq
 Sika materials in case study*: 63 kg CO₂-eq – 0.37 %
SikaPower® BIW adhesives: 5 kg CO₂-eq – 0.03 %



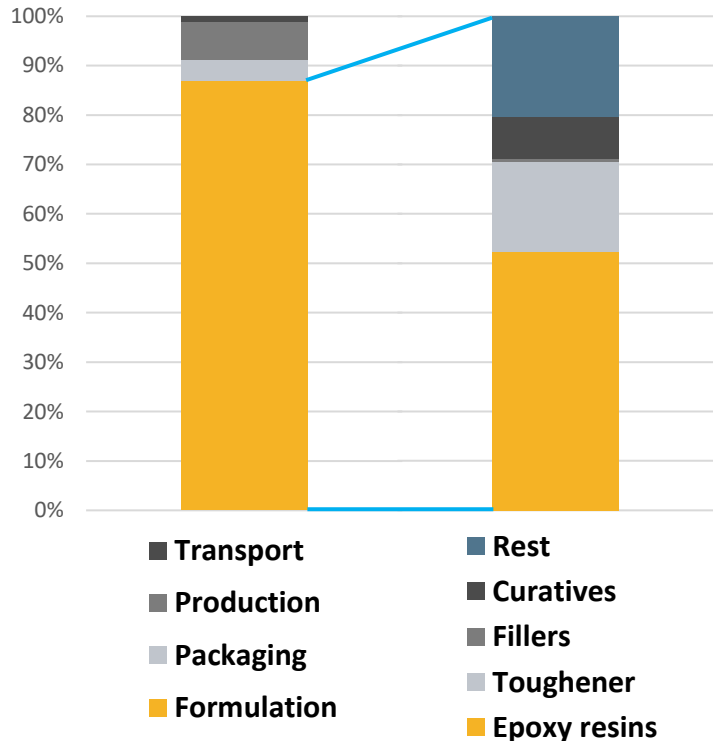
* Based on average usage of Sika materials in mid class cars
 Raw materials only (production, packaging, transport, end-of-life not considered)
 Battery and anti-flutter materials not included

LCA OF A BODY SHOP ADHESIVE CRADLE-TO-GATE

FOCUS ON RENEWABLE AND RECYCLED RAW MATERIALS



Global Warming Potential SikaPower®



- Factories with 100% renewable purchased electricity
- Local plants in Europe, Asia, North and South America
- Main impact is formulation
- Technology projects with positive initial results
 - Bio-based epoxy resins
 - Bio-based polymers and other reactants
 - Natural fillers / additives
 - Recycles as fillers / additives
- Challenges: Availability and stable material quality

About the Life Cycle Assessment:

Databases: Sphera CUP 2022.2, ecoinvent 3.8

Production, transportation (RMs) and packaging modelled in GaBi 10 Software

Standard value of 1000 km transport distance assumed for all raw materials

Methodology: ISO 14040/44

REDUCING CLIMATE IMPACT OF DRUMS

RAW MATERIALS & SUPPLY CHAIN



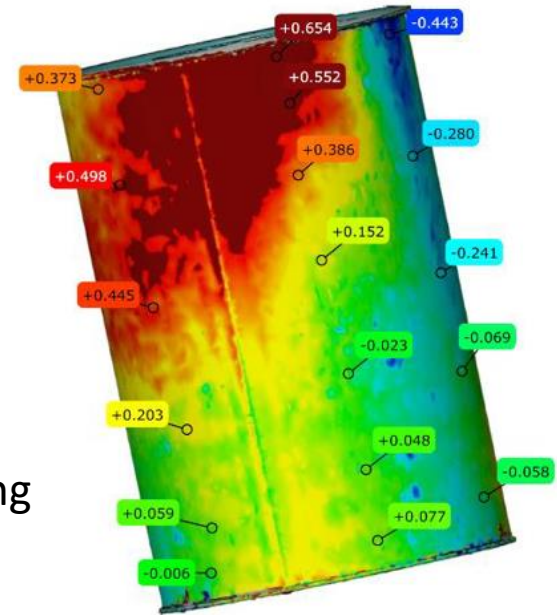
Open cycle reuse concept

- Using **refurbished/reconditioned** drums
 - Drums can be picked up and refurbished by third party
- **Multiple use** of drums possible
 - Drum deformation over multiple use measured

Closed cycle reuse concept

- Special **returned + refilled drums** with follower plate staying inside drum in use for specific customers since years

Drums with lower CO₂ impact steel under investigation



Deformation in cm
after 4 times used

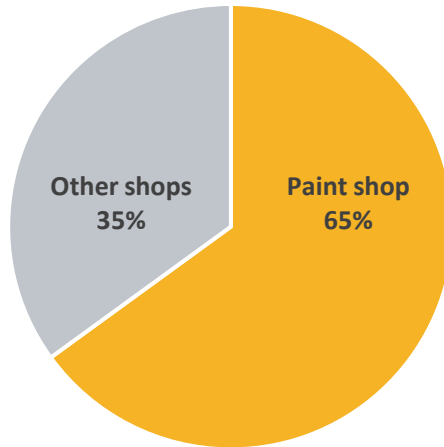
ENERGY SAVINGS THROUGH OVEN TEMPERATURE REDUCTION

CAR PRODUCTION

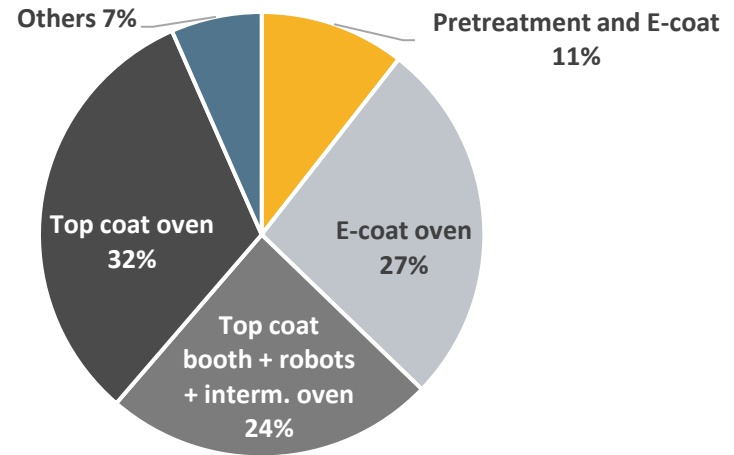


- Reducing energy for ovens is key focus of most OEMs to reduce CO₂ emission
- Reduce no. of ovens (e.g. '4 on wet') / shorter time / lower temperature
E-coat: Target min. bake temperature (at metal) 140°C or lower vs. currently typically 160°C

Plant breakdown (CO₂ emission)



Paint shop breakdown (kWh/car)



Source: 'Stellantis' answer to CO₂ challenge', Strategies in Car Body Painting 2022

LOW BAKE BODY SHOP ADHESIVES

CAR PRODUCTION



SikaPower® LowBake structural adhesives

- Curing: 10 min 140°C
- Structural/semi-crash, high modulus
- In serial use at first customer

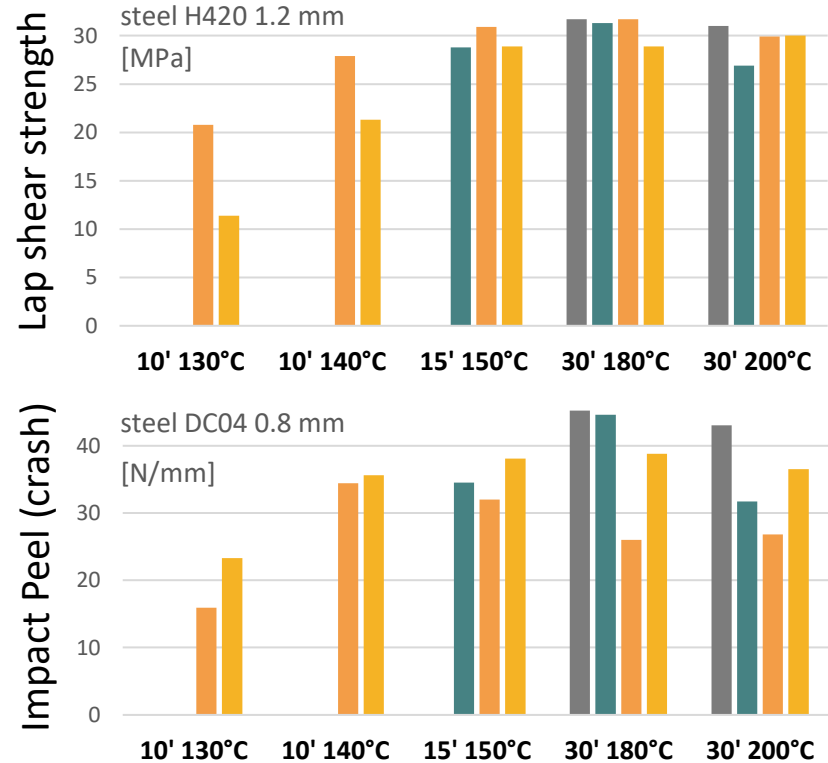
SikaPower® LowBake crash adhesives

- Curing: 15 min 150°C / 20 min 140°C
- Crash resistant, high strength
- Approved by first customers

SikaPower® UltraLowBake under development

- Curing: 10 min 130 - 140°C
- Technology development finalized mid 2023
- Main challenges: Crash, corrosion, shelf life

Standard SP vs. LowBake and UltraLowBake



REDUCED FUEL CONSUMPTION THROUGH LIGHTWEIGHTING ENABLING IN USE PHASE



Case study based on series model

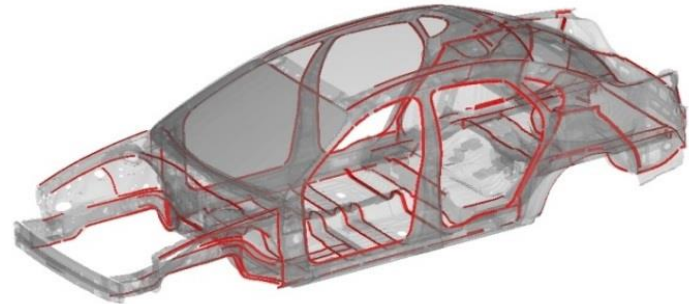
Impact:

Footprint of joining ¹: **24 kg CO₂-eq.**
thereof SikaPower 5 kg CO₂-eq.

Advantage:

434 kg CO₂-eq. emission avoided ²
over lifetime 150'000 km through reduced
fuel consumption (365 kg) and less steel (69 kg)

- Use of structural SikaPower®
- 30 kg weight reduction through use of thinner steel sheets
- Maintaining stiffness and crash performance
- Resulting in 0.09 l/100 km fuel saving ³



¹ Adhesive + application + spot welding

(acc. 'Bewertungsmethodik für Fertigungsverfahren im Karosseriebau aus Sicht des betrieblichen Umweltschutzes', H. Stephan 2007)

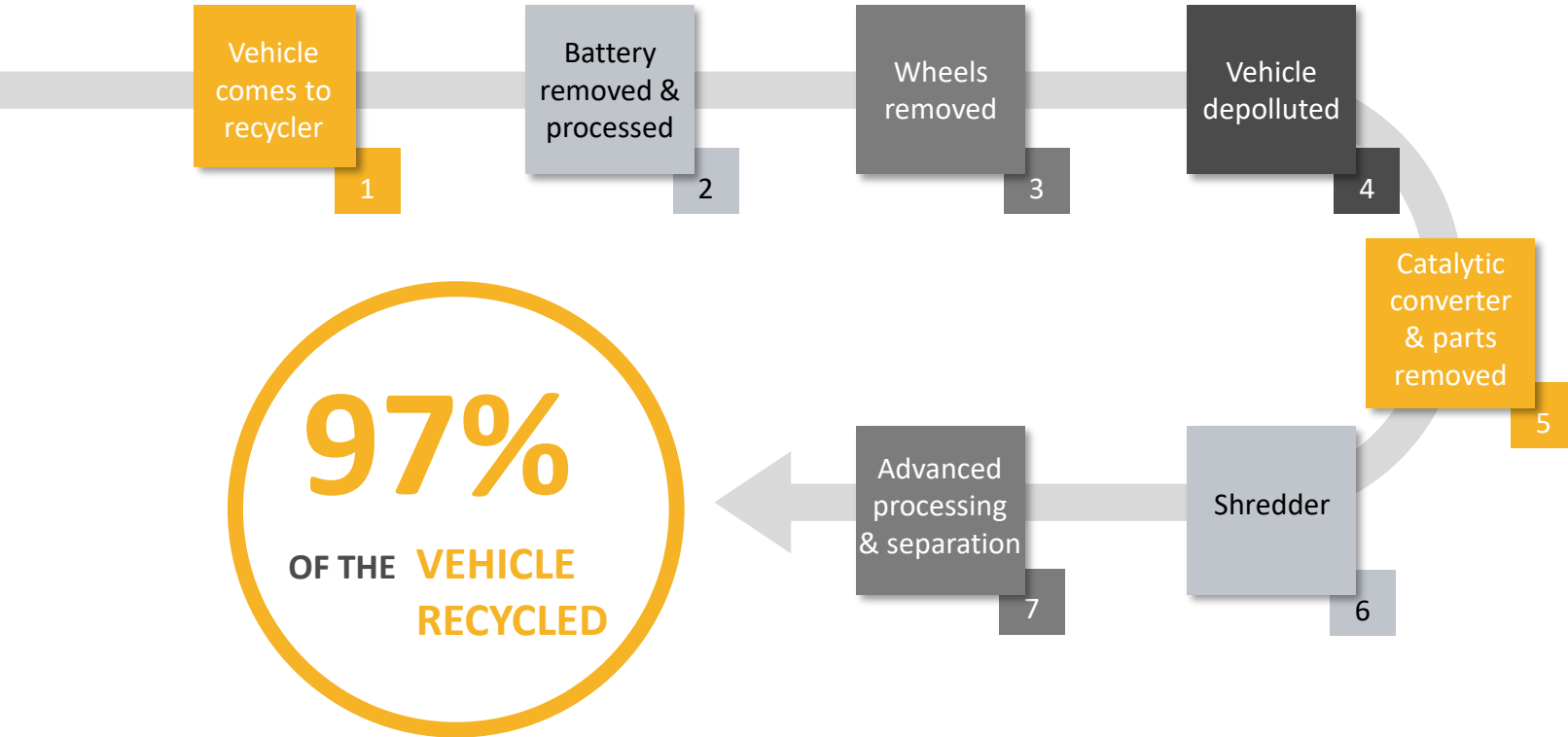
² 150'000 km x 0.09 l/100 km x 2.70 kg CO₂-eq. / l diesel (UK Government GHG conversion factors 2022)

30 kg x 2.3 kg CO₂-eq. / kg steel (voestalpine 'greentec steel' HDG)

³ Calculated acc: 'Research Needs & Future Trends in Lightweight Design', S. Gies 2009

END OF LIFE CAR RECYCLING PROCESS

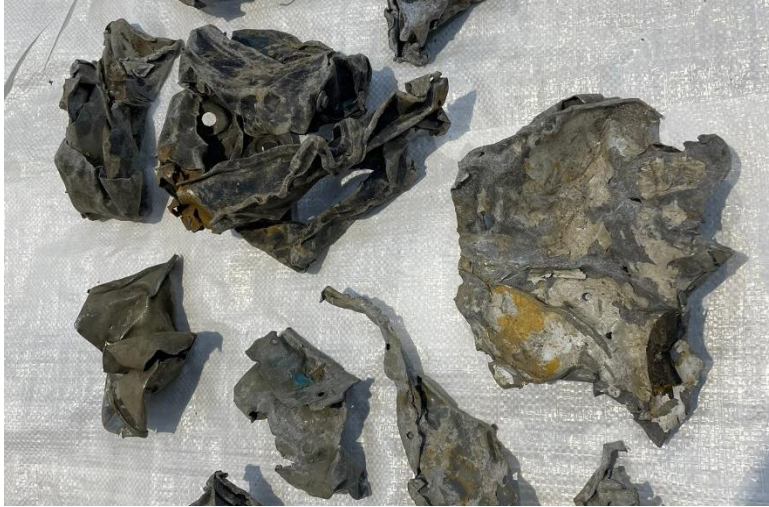
STATE-OF-THE-ART



Source: 'European Metal Recycling' EMR, UK

END OF LIFE CAR RECYCLING PROCESS

STATE-OF-THE-ART



- Depolluted vehicle structure chopped in **large industrial shredder** (processing 2 cars/min) resulting in fist sized chunks
- Metal heavily hammered and sheared apart, thin adhesive layer typically sheared and **left attached** to either side of the joint
- Steel pulled out during primary separation stage and melted in furnace. Subsequently used as a low carbon cheaper alternative to virgin ores
- Remaining adhesive causes negligible contamination, shown in data as slightly increased volatiles or carbon content causing no issue
- All body shop adhesives on the body structure account for only $< 0.5\%$ of the total mass



DEBONDING-ON-DEMAND

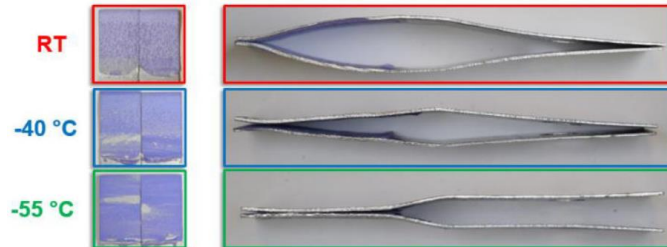
CURRENT OPTIONS AND FUTURE TECHNOLOGIES



Debonding current body shop adhesives

- Used in car body repair
- Weld spots / rivets to be drilled out first
- Mechanical separation, due to very high strength and toughness under application of:
 - Heat above 120°C (T_g) → Adhesive softening
 - Cooling below -40°C → Adhesive embrittling

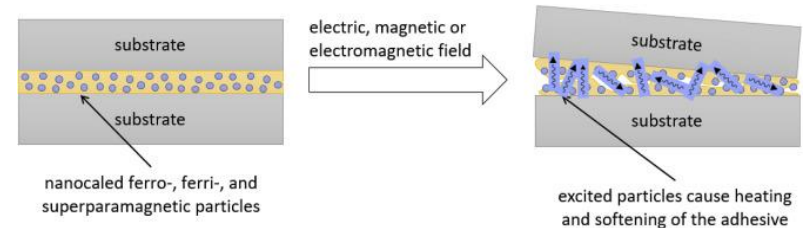
Reduced metal deformation i.e. decreasing energy for separation with lower temperature (impact wedge test):



Source: 'Bauteilschonendes Entfügen struktureller Klebverbindungen durch Kälte', adhäsion Kleben & Dichten, N. Chudalla 2022

Future technologies






- Focus on recycling / reuse, suitable for repair
- Elementary bonding preferred to avoid addl. operation for separation and part damage
- New technologies with various debonding triggers under research and development:
 - Temperature
 - Electricity
 - Microwave
 - Ultrasound
 - Magnetic fields
 - Light / UV
 - Solvents
 - etc.



Source: 'Adhesives for debonding-on-demand: Triggered release mechanisms and typical applications', Int J Adhes Adhes, C. Bandl 2020

CONCLUSIONS

CIRCULARITY FOR BODY SHOP ADHESIVES

-  Renewable raw materials and packaging concepts under investigation
-  Renewable electricity used in adhesive production
-  New adhesive technology for lower oven temperature available
-  Modern body shop adhesives enable lightweighting for CO₂ reduction
-  No issue with body shop adhesives for current end-of-life vehicle recycling

CONTACT AT SIKA

Thank you very much for your attention.
Should you have questions, please use this opportunity.



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