



Design to CO₂e

Reality Check

M. Rothbart, C. Sams, T. Schmid

Today's Presenters



Martin Rothbart

**Senior Product Manager
Energy & Sustainability**

23 years of experience in
automotive industry

4 years responsible for business
development und lifecycle
sustainability



Christoph Sams

**Lead Engineer Value Engineering
Cost & Supply Chain Management**

8 years of experience in total cost
of ownership and life cycle analysis

Lecturer at university on TCO and
LCA



Thomas Schmid

**Value Engineer
Cost & Supply Chain Management**

5 years of experience in
automotive industry

4 years of specialization in
life cycle assessments

Privacy Notice

This Webinar will be recorded and the recording is kept online on AVL's websites or partner websites as long as considered to serve the overall information and training purpose recorded for.

Please note that any communication or information you transmit during the webinar, such as voice, live instant messaging displaying names of those interacting, presentations etc. are available to the webinar audience and may also be included in the recording, which may be made available on-demand. As such, this information may be collected and used by other webinar participants or by viewers of the recordings. Please apply appropriate caution when disclosing any personally identifiable information or personally sensitive data.

For more information: www.avl.com/privacy-policy



Design to CO₂e: Reality check

About Us

AVL at a Glance



1948

Founded



26

Countries Represented



11,200

Employees Worldwide



11 %

Of Turnover Invested in Inhouse R&D

75

Years of Experience

45

Global Tech and Engineering Centers

68 %

Engineers and Scientists

2,200

Granted Patents in Force

Environmental Sustainability

We have already taken numerous actions to reach CO₂ neutrality at our headquarters.

- Global energy consumption and CO₂ monitoring
- 100 % renewable electricity
- Solar facility (>3,300 m²)
- System for infrastructure waste heat recovery
- >50 % electric or hybrid vehicles in our carpool

Certificates



ISO 14001

ISO 9001

ISO 27001

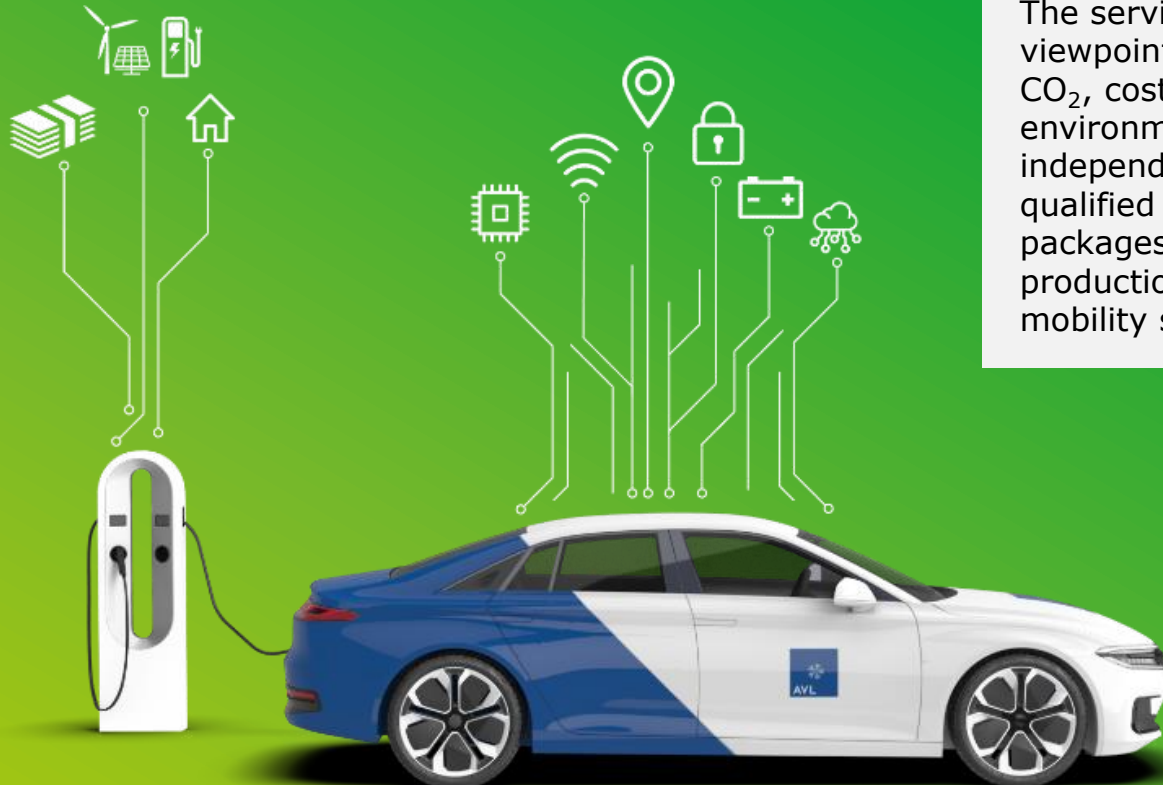
ISO 45001

ECOPROFIT®

Ford Q1 Award



Ecosystem



AVL Sustainability Engineering

The services tackle various viewpoints on technology, energy, CO₂, costs and the market environment. We provide independent recommendations for qualified and balanced solution packages at all interfaces of production, use and end-of-life for mobility solutions.

Packages

- Supply chain CO₂ footprint analysis
- Optimization of the CO₂ footprint
- Sustainable design of components and vehicle system
- CO₂ component benchmarking
- CO₂ supply chain audits and certification

Agenda

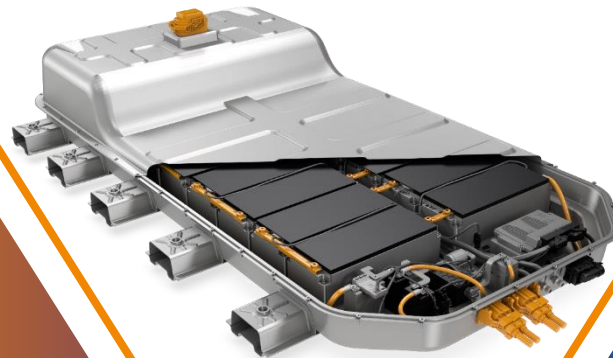
Design to CO₂e Reality Check

Introduction •

Motivation •

Methodology •

Example •



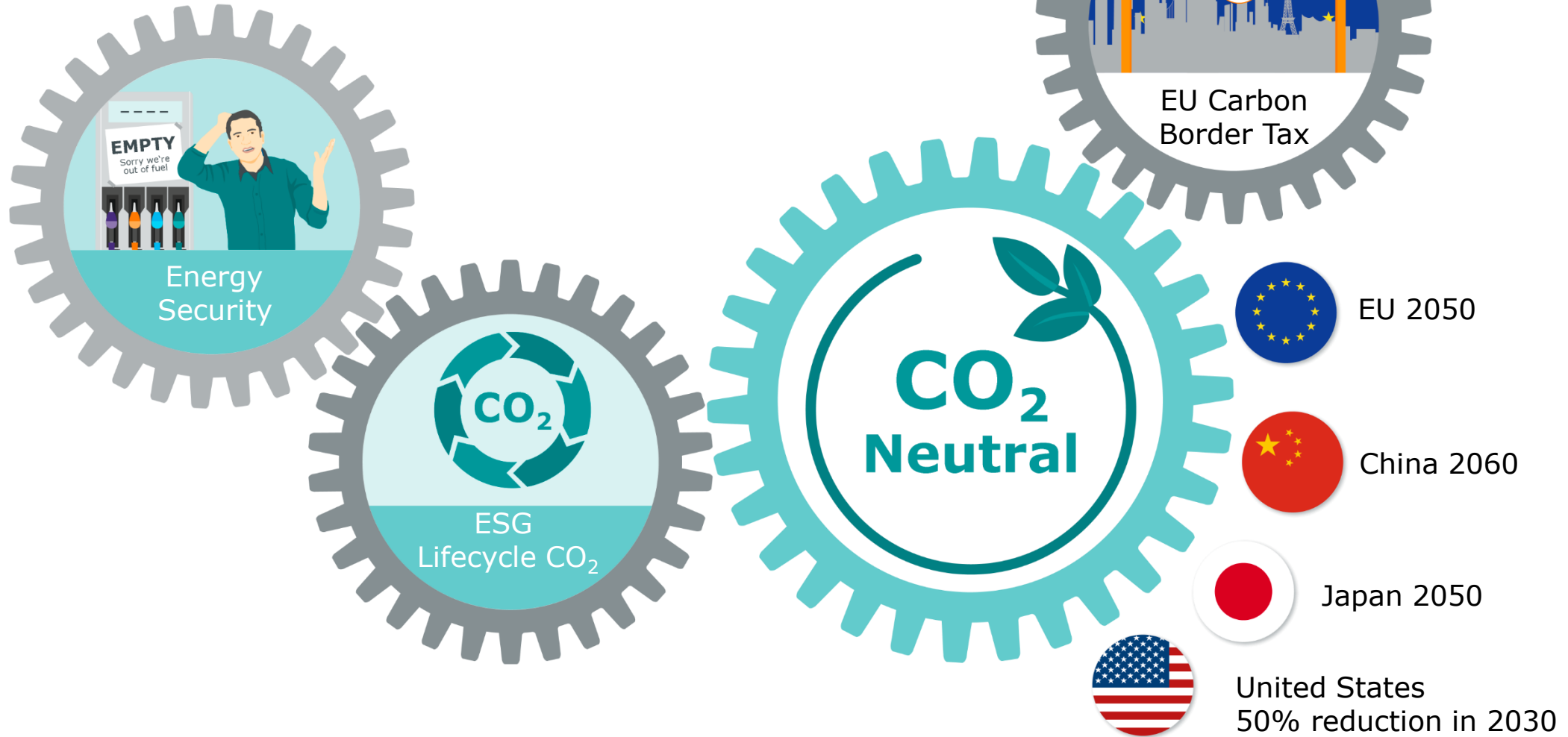
• Key Takeaways

• CO₂e Pricing

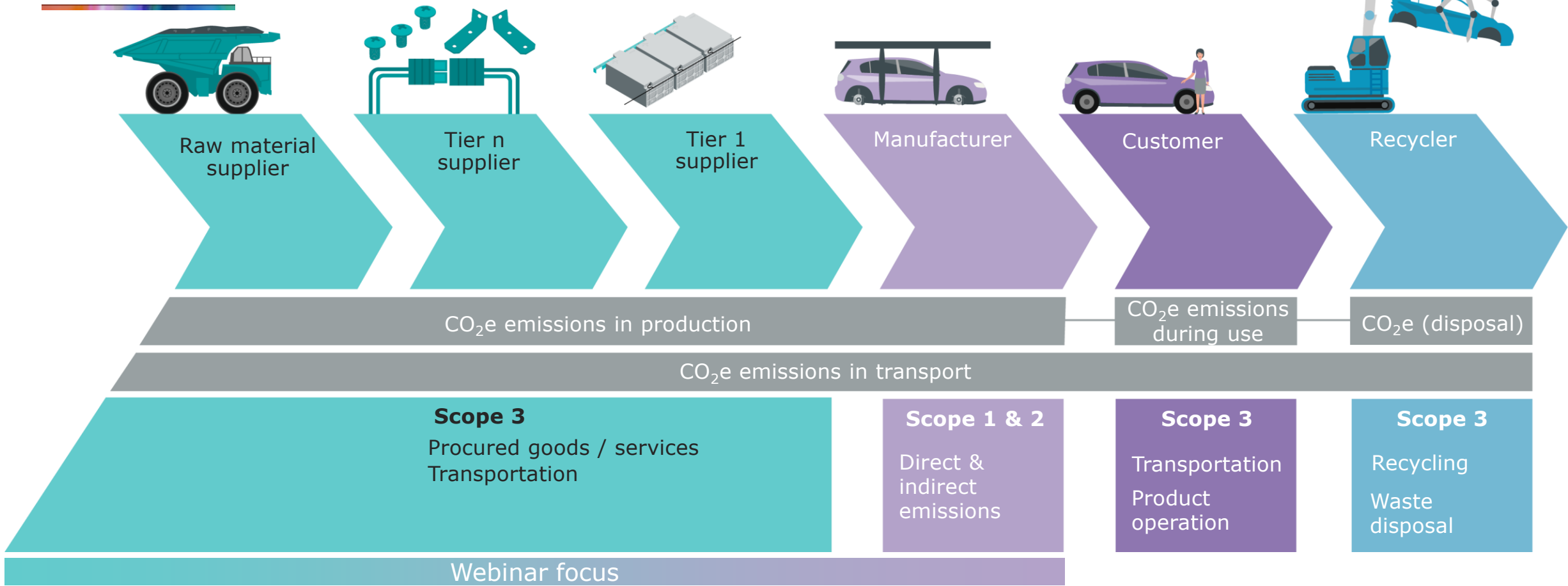
**• Development-
process guidelines**

• DfX Balancing

On the Roadmap to Carbon Neutrality

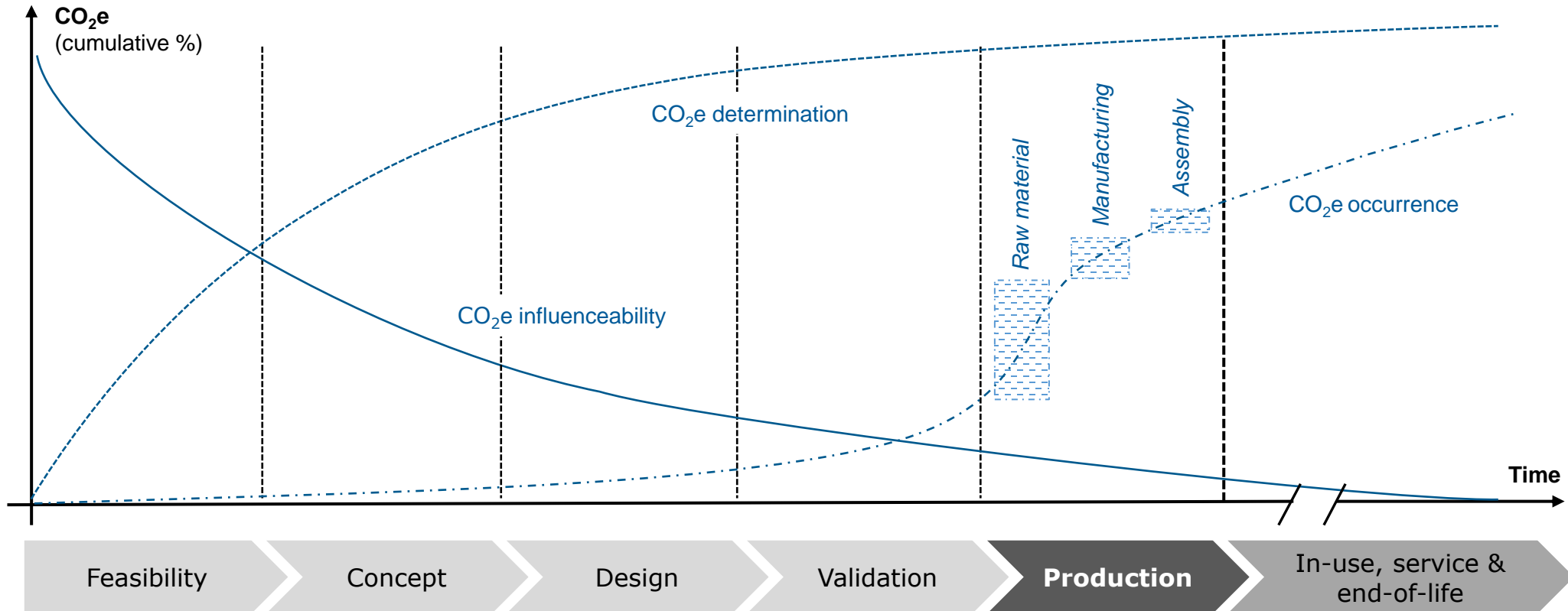


Emission Scopes can be mapped onto the different Stages of the Value Chain



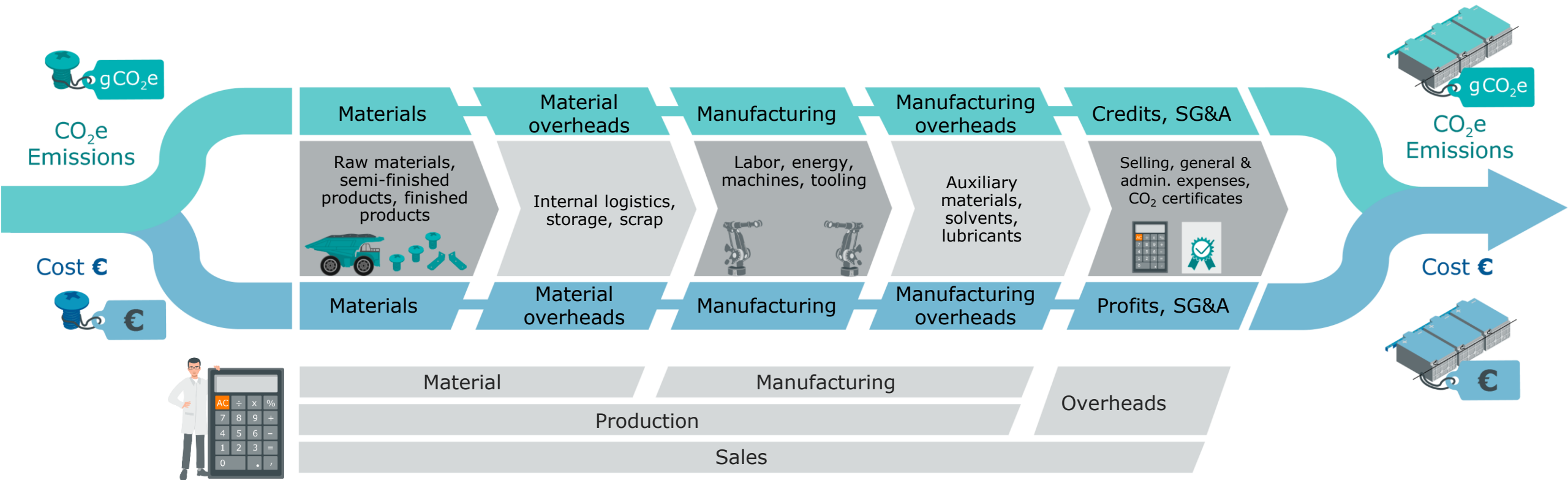
By far the largest share of emissions are assigned to Scope 3 and includes all upstream and downstream activities of a legal entity

Product Lifecycle Model with qualitative Patterns for CO₂e Influenceability, Determination and Occurrence



Significance of early development phase for lifecycle CO₂e

Simultaneous Assessment of Product Cost and CO₂e



Bottom-up calculation for optimized cost and CO₂e balancing in production

Reality Check: Battery Cover

Requirements:

Crash & Impact resistance

Cost

Carbon Footprint (CF)

Fire resistance

Weight

EMC Shielding

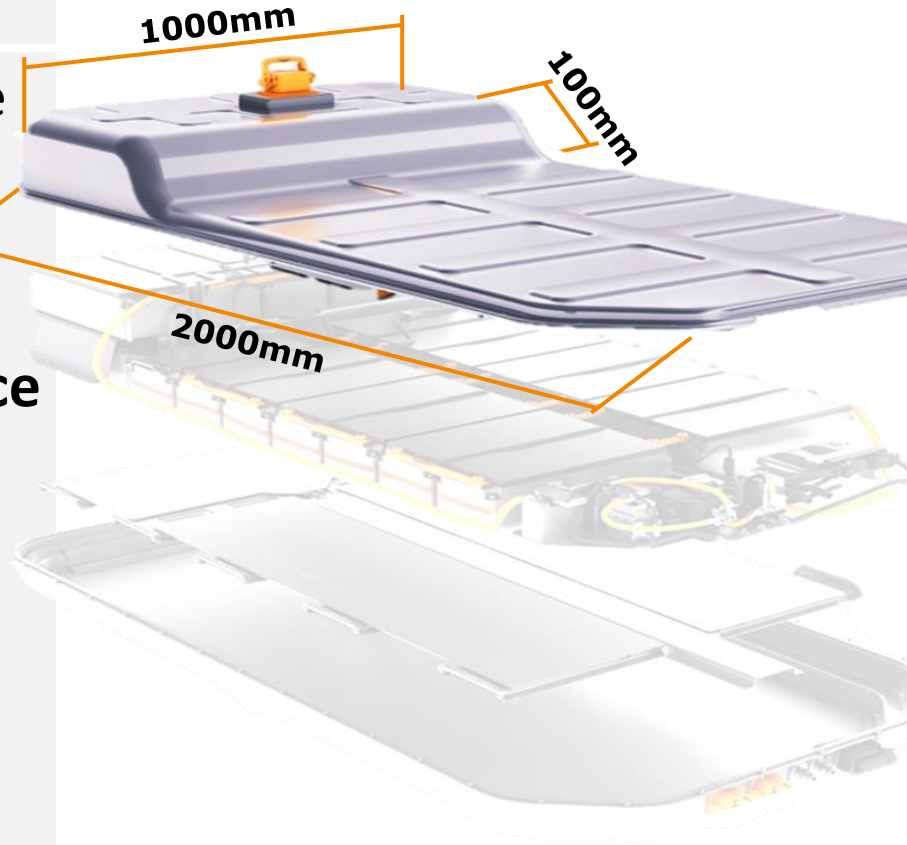
Allowable dimension

Stiffness

Serviceability

Recyclability

non-exhaustive list



Variant 1 - Steel

- 17.88 kg (cover only) / 1 mm thickness
- + Bolts
- + KTL coating

Variant 2 - Aluminium

- 7.26 kg (cover only) / 1.2 mm thickness
- + MICA
- + Bolts

Variant 3 - SMC

- 10.35 kg (cover only) / 2.5 mm thickness
- + MICA
- + EMC shielding
- + Paint
- + Glue

Reality Check: Battery Cover

Requirements:

Crash & Impact resistance

Cost

Carbon Footprint (CF)

Fire resistance

Weight

EMC Shielding

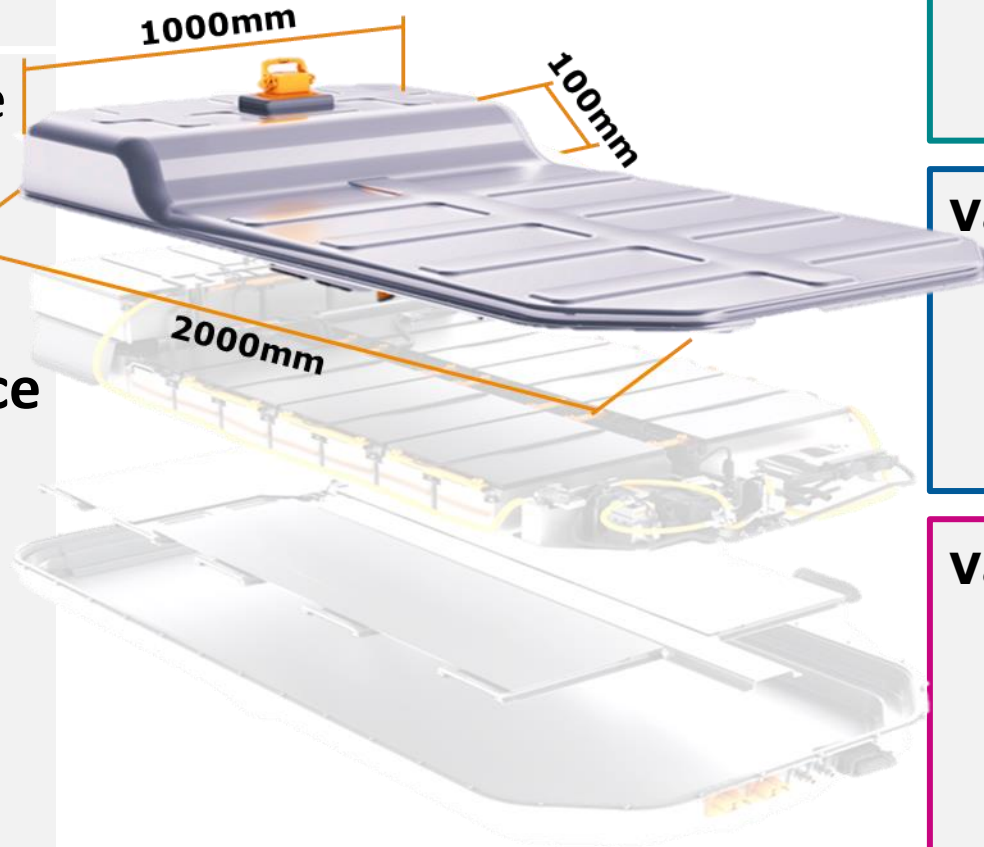
Allowable dimension

Stiffness

Serviceability

Recyclability

non-exhaustive list



Variant 1 - Steel

- 17.88 kg (cover only) / 1 mm thickness
- + Bolts
- + KTL coating

Variant 2 - Aluminium

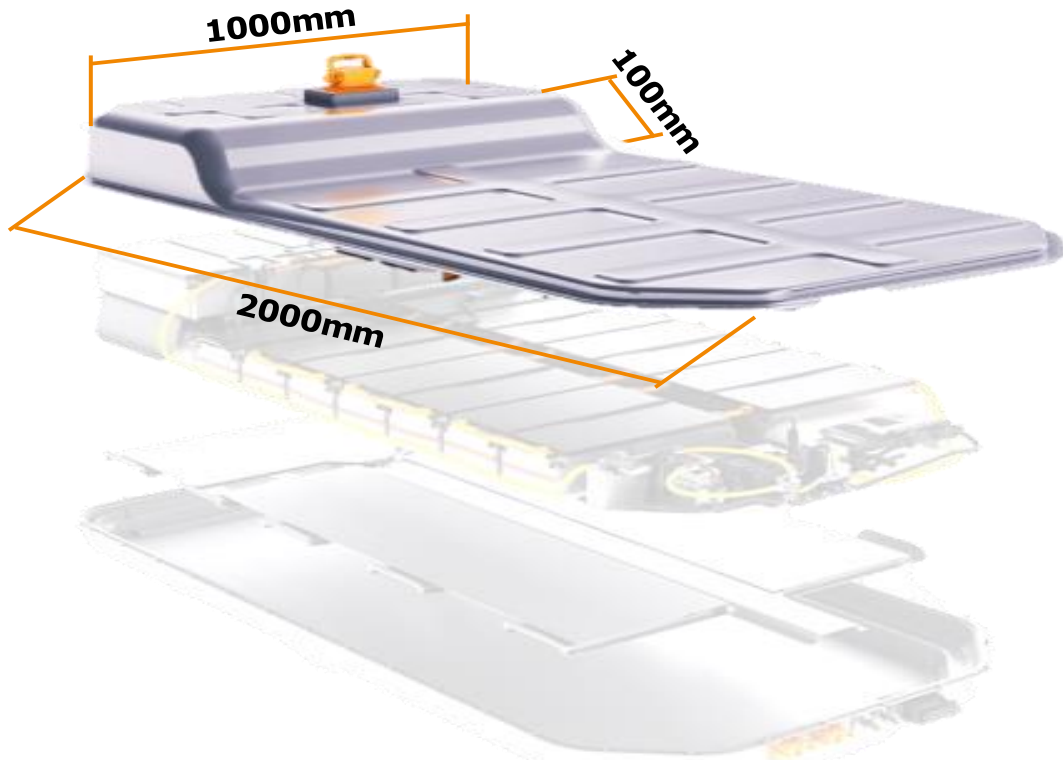
- 7.26 kg (cover only) / 1.2 mm thickness
- + MICA
- + Bolts

Variant 3 - SMC

- 10.35 kg (cover only) / 2.5 mm thickness
- + MICA
- + EMC shielding
- + Paint
- + Glue

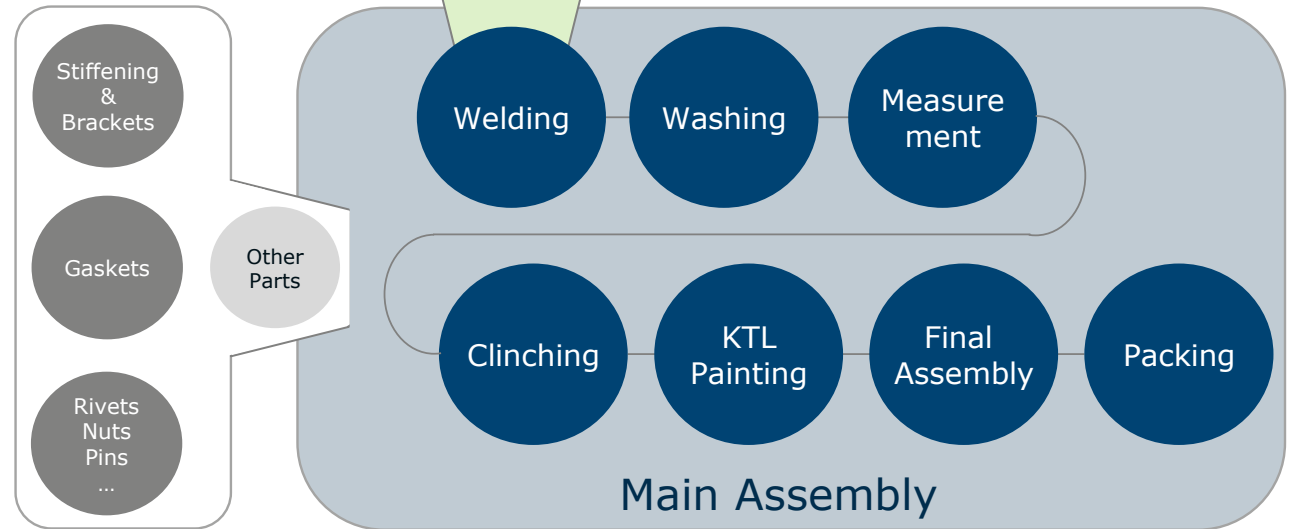
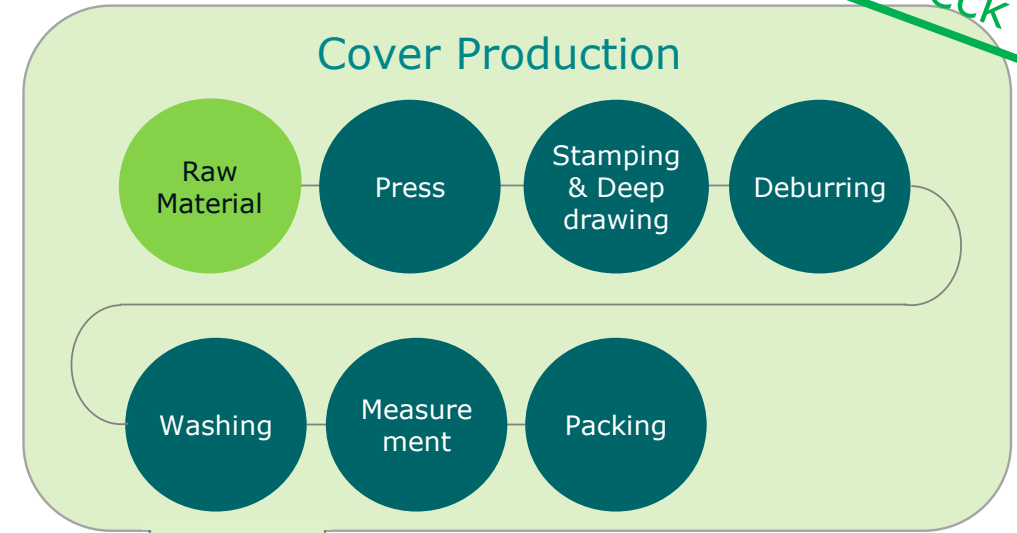
Battery Cover: Production Processes and Results

Reality Check

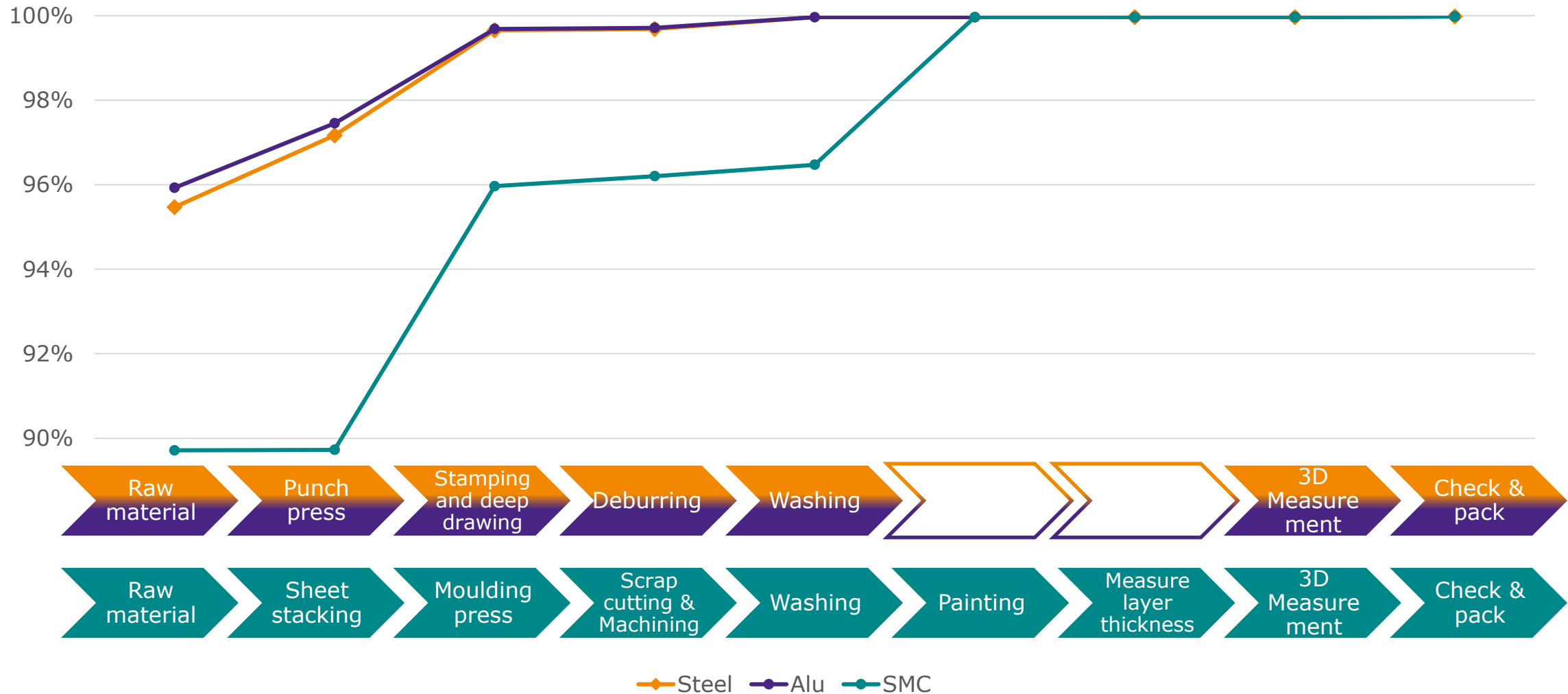
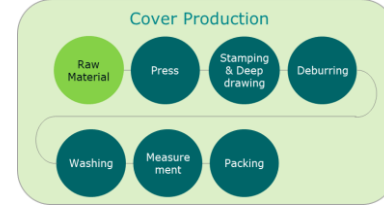


Variant	Cost [€]	CF [kg CO ₂ e]	Weight [kg]
Steel	70 ▲	66 ●	18 ◆
Aluminium	117 ▲	85 ●	7 ◆
SMC	147 ▲	67 ●	10 ◆

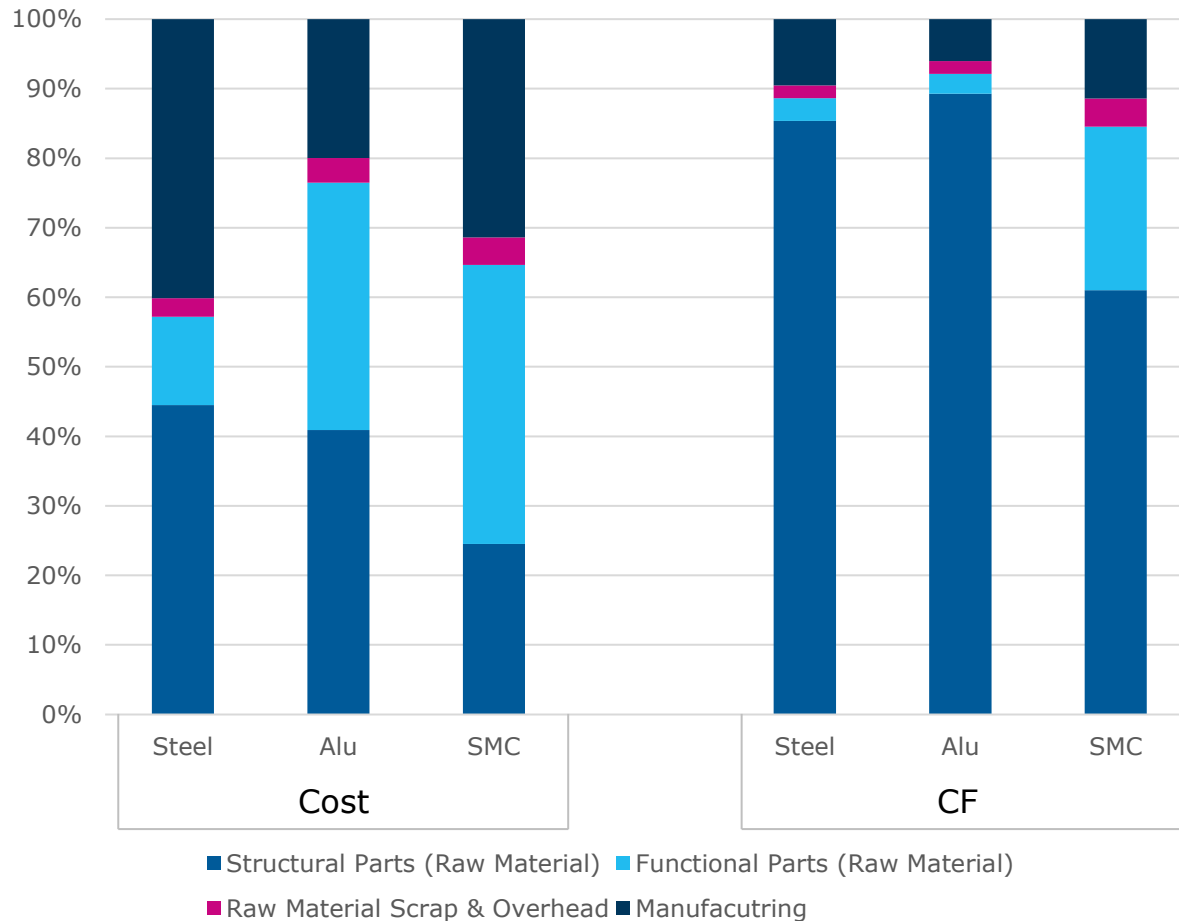
rounded to the nearest whole number



Production Carbon Footprint Comparison: Cover Production

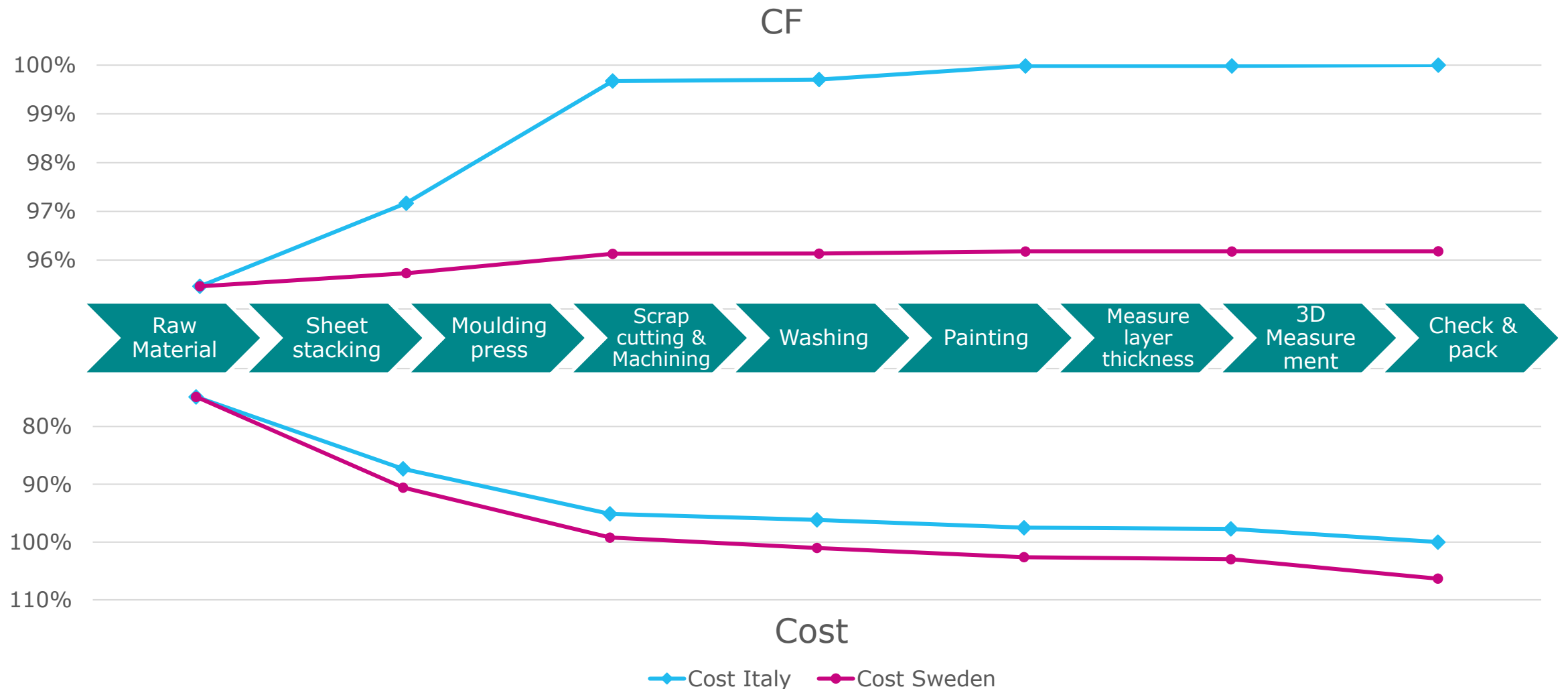


Production Cost and Carbon Footprint Comparison: Cover Assembly



Name	Steel	Alu	SMC
Cover Assembly			
Consist of.			
Cover	1	1	1
Stiffening & Brackets	2	2	2
Rivets, Nuts and Pins	34	34	2
Gaskets	2	2	-
Glue	-	-	2
MICA	-	9	9
EMC Shielding	-	-	1
KTL Coating	0.25	-	-
Paint	-	-	0.63
Scrap & OH			
Assembly			
Assembly Sub Parts			

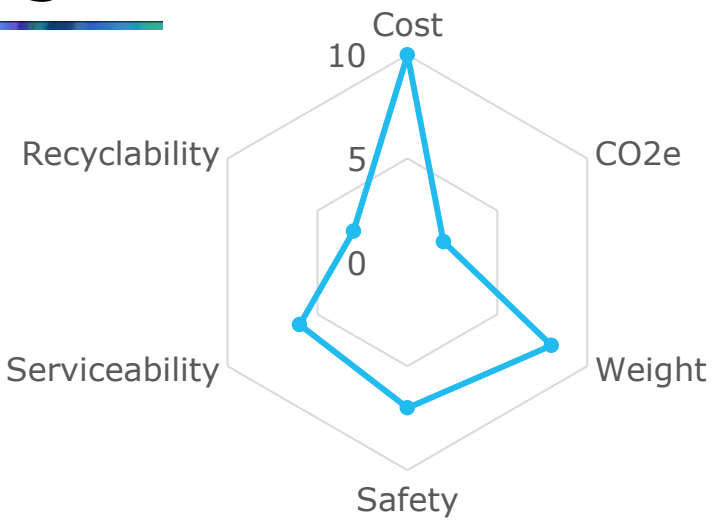
Production Cost and Carbon Footprint: Steel Variant Comparison: Production Site Variation



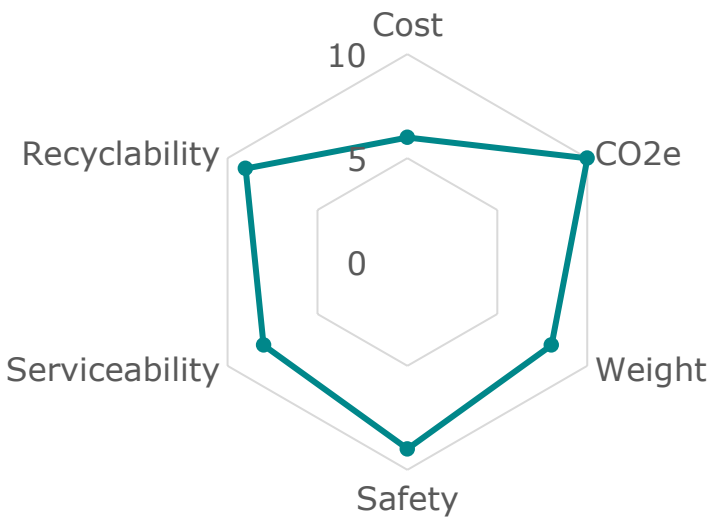
Reality Check

Design for X – DfX Balanced Product

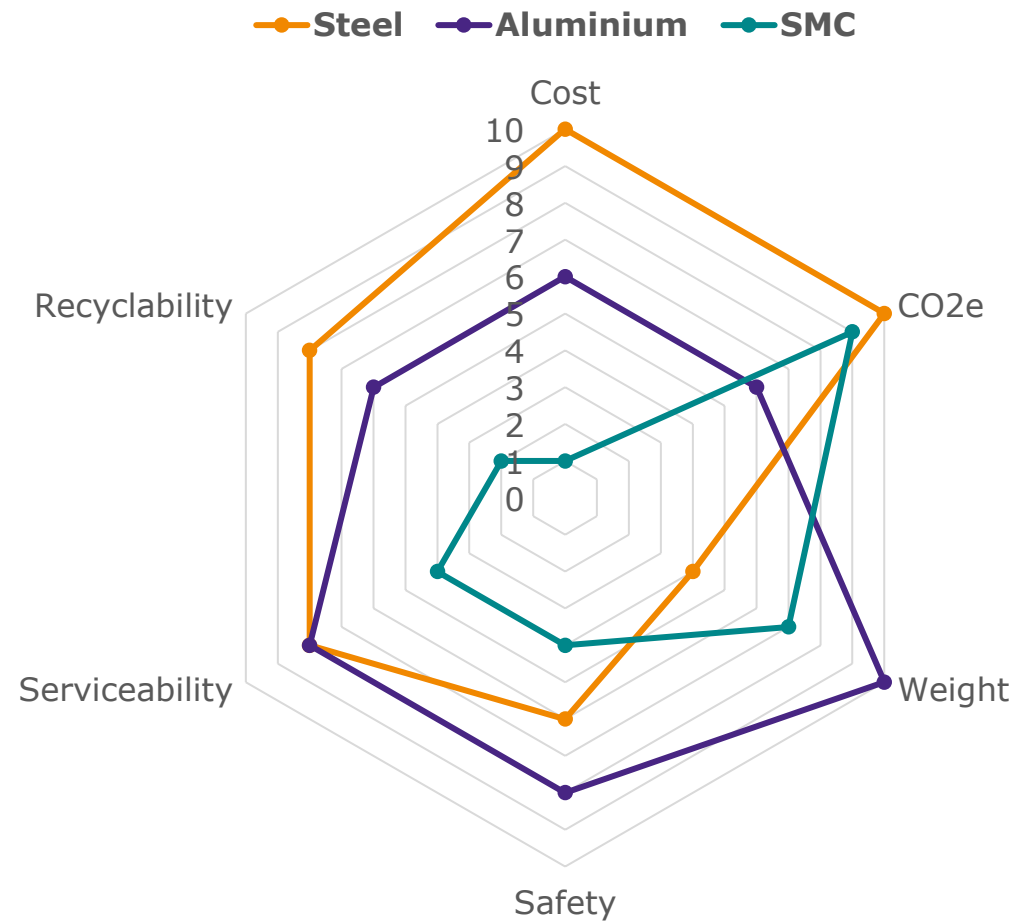
Traditional view:
focus on **Cost**



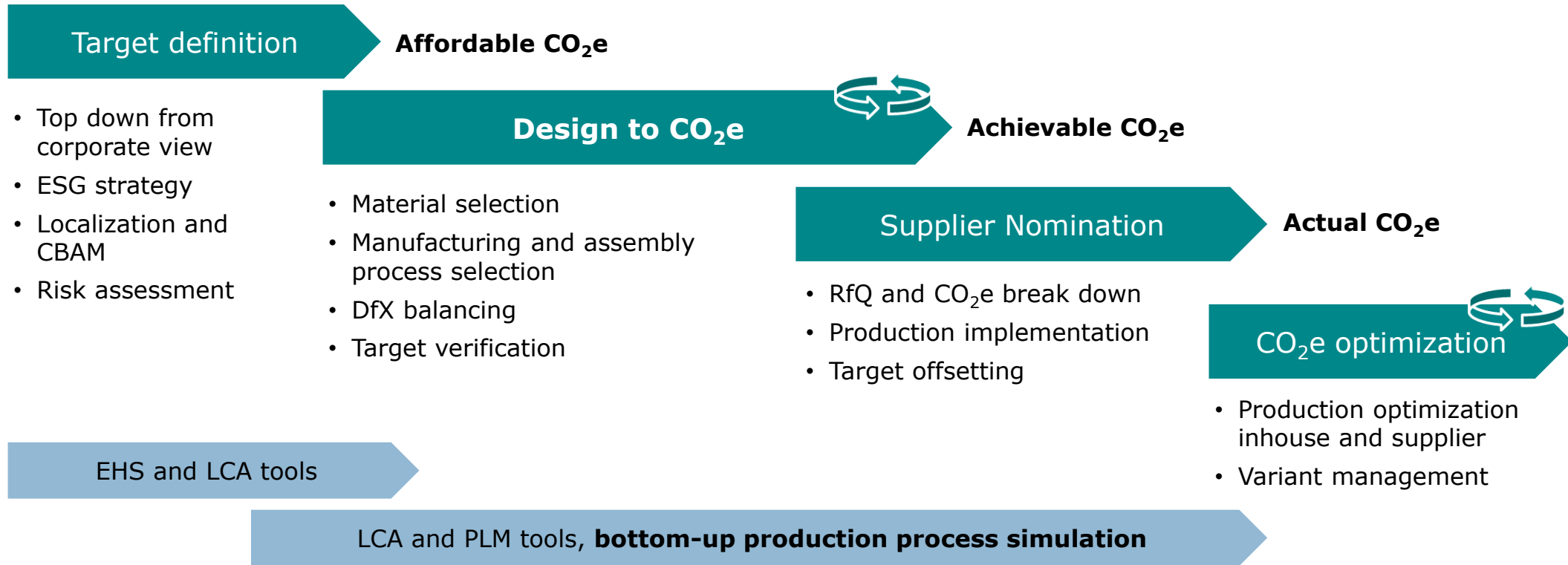
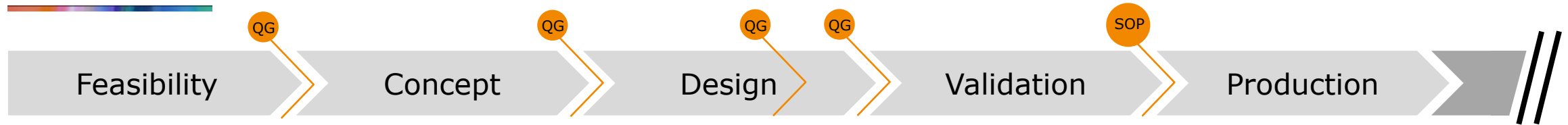
2023 view:
focus on **Lifecycle**



Battery cover



Design to CO₂e in Product Development



Secondary data

Primary data

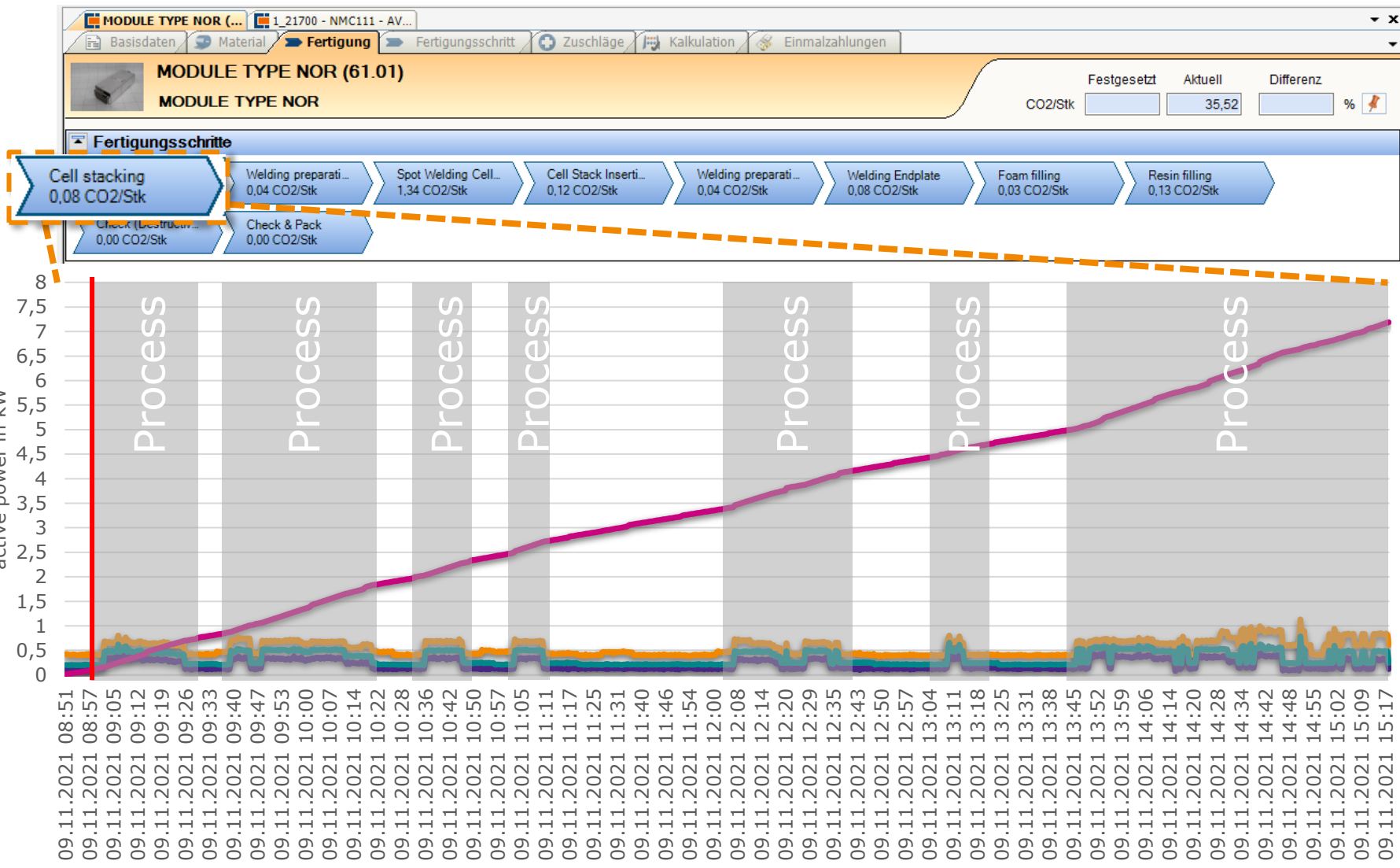
* QG... Quality Gate; ESG... Environmental, Social, Governance; CBAM... Carbon Border Adjustment Mechanism; EHS... Environment, Health, Safety; PLM... Product Lifecycle Management, RfQ... Request for Quotation

Reality Check

Usage of Primary Data in Product Development Process



- Integration of measured values in CO₂e modeling
- Digital-twin for energy-based control & scheduling of production



EU Carbon Border Adjustment Mechanism (CBAM)

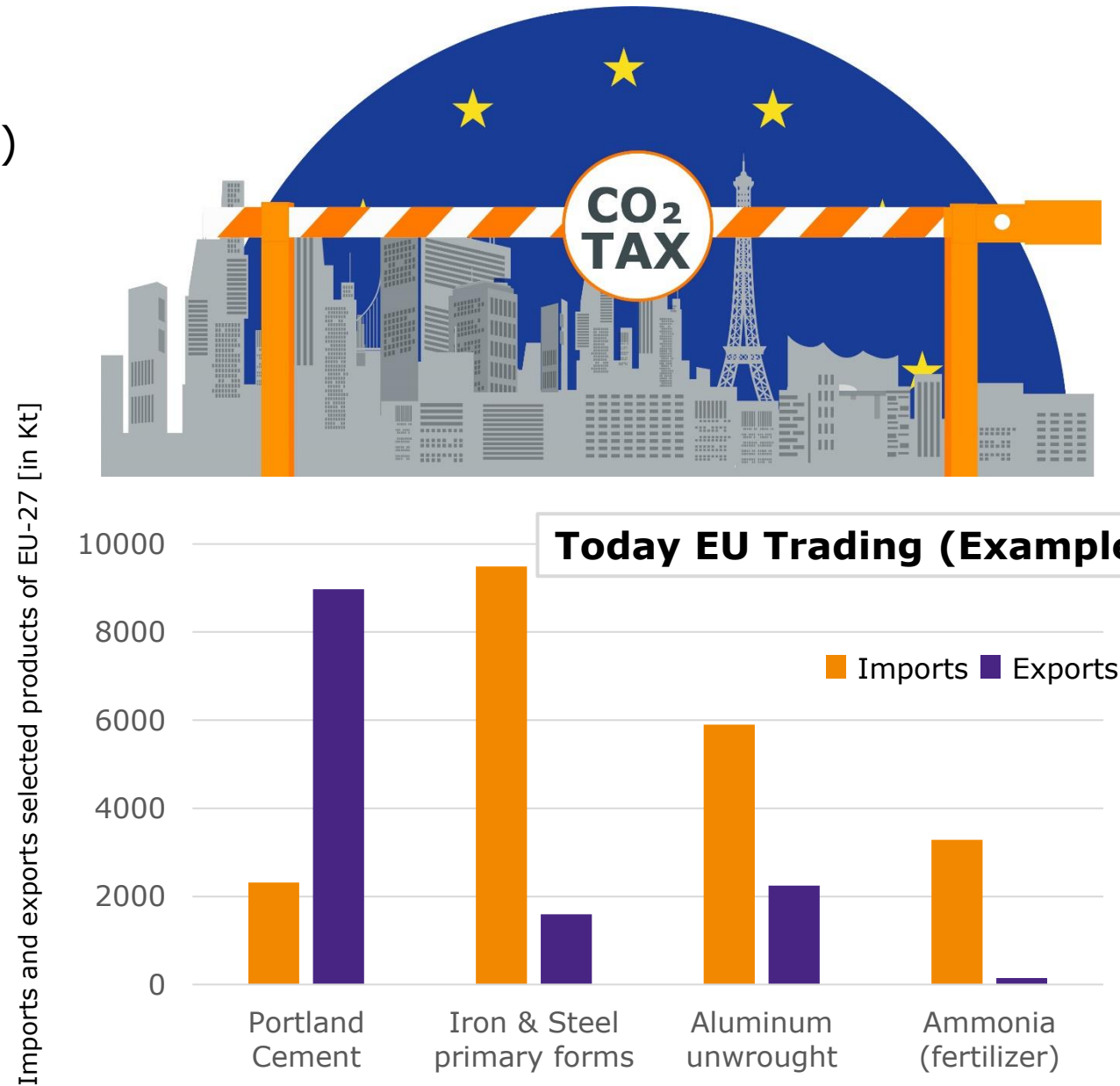
Carbon Import tax for all Carbon intense products imported into EU:

- Focus on global emissions decline
- Equalization of carbon price of domestic products
- Effective from 2026

Applicable Products



Hydrogen was added in a later draft of the regulation
Pricing on EU Emission Trading System allowances, today ~ 90 €/t CO₂



Source: EU green taxation, 2022, [Link](#)

EU Carbon Border Adjustment Mechanism (CBAM)

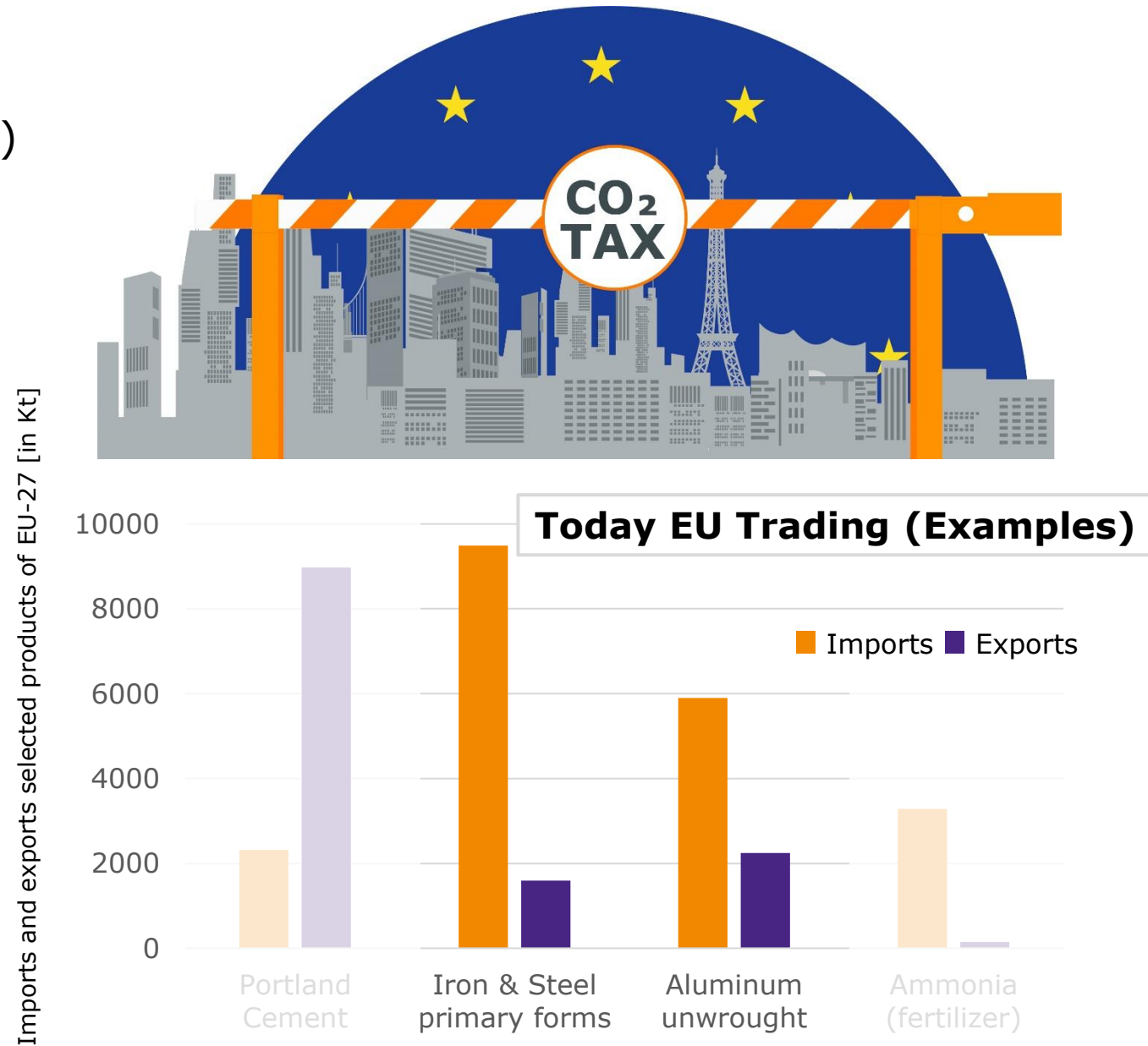
Carbon Import tax for all Carbon intense products imported into EU:

- Focus on global emissions decline
- Equalization of carbon price of domestic products
- Effective from 2026

Applicable Products

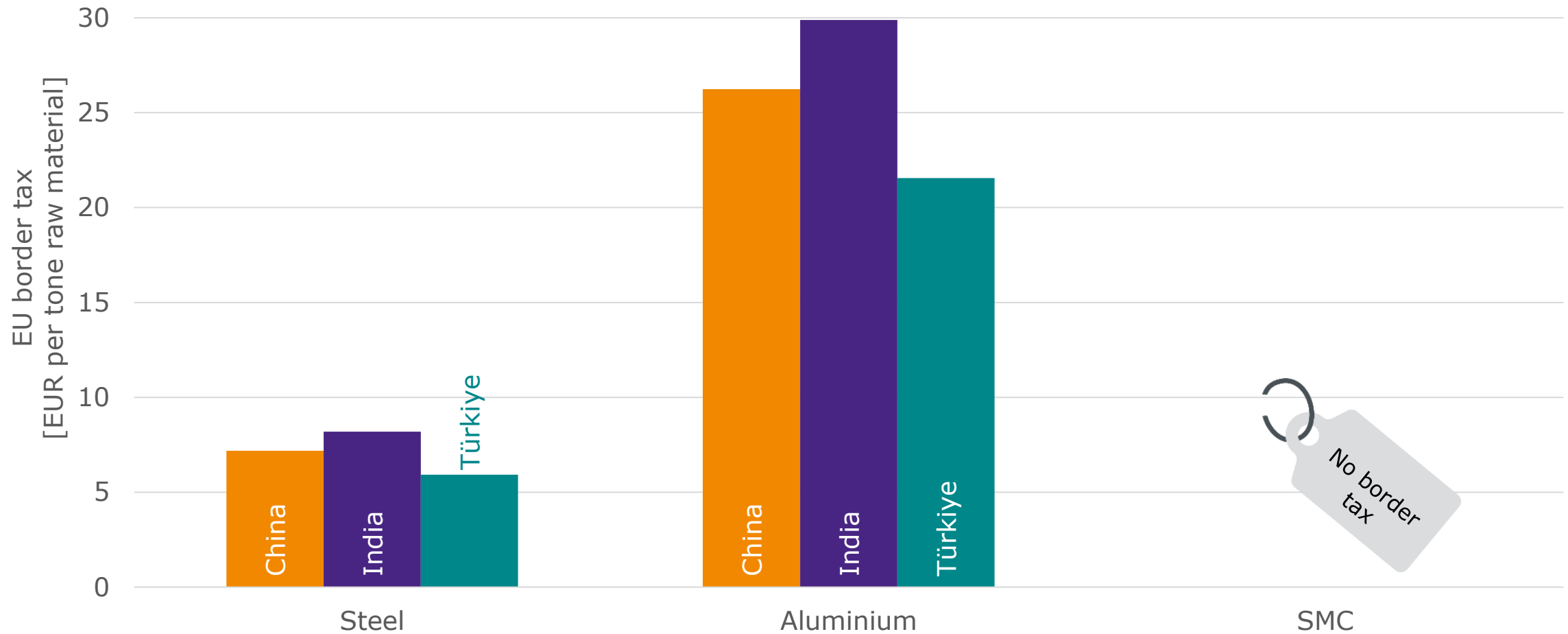


Hydrogen was added in a later draft of the regulation
Pricing on EU Emission Trading System allowances, today ~ 90 €/t CO₂



Source: EU green taxation, 2022, [Link](#)

Carbon Border Adjustment Mechanism 2026 CBAM Phase-in 2.5%

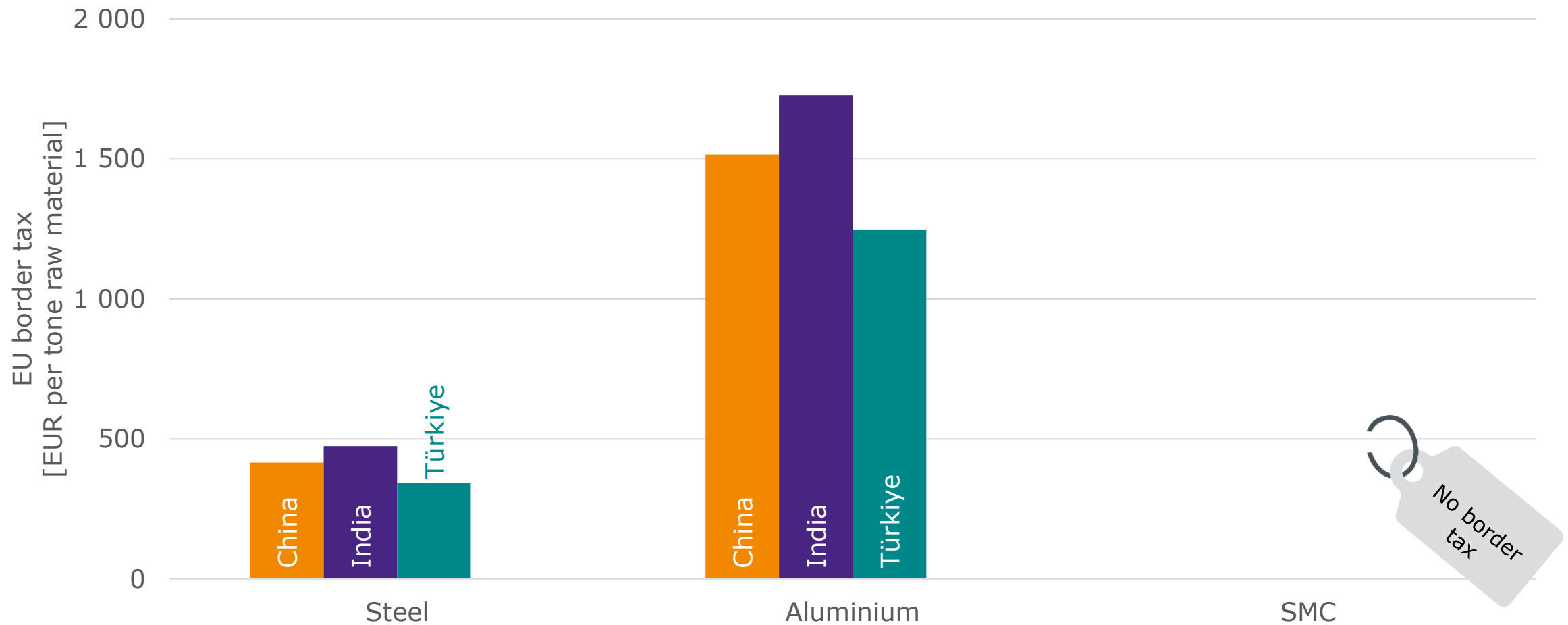


Assumptions: ETS price 90 €/tCO₂e |

China: 3.2 tCO₂e/t steel | India: 3.6 tCO₂e/t steel | Türkiye: 2.6 tCO₂e/t steel | China: 11.7 tCO₂e/t aluminium | India: 13.3 tCO₂e/t aluminium | Türkiye: 9.6 tCO₂e/t aluminium

Source: G. Petrowitsch, „Welche Auswirkungen hat Carbon Border Adjustment Mechanism auf die europäische Autoindustrie und wie könnte sich CBAM in Zukunft entwickeln?“, 2023

Carbon Border Adjustment Mechanism 2034 CBAM 100%



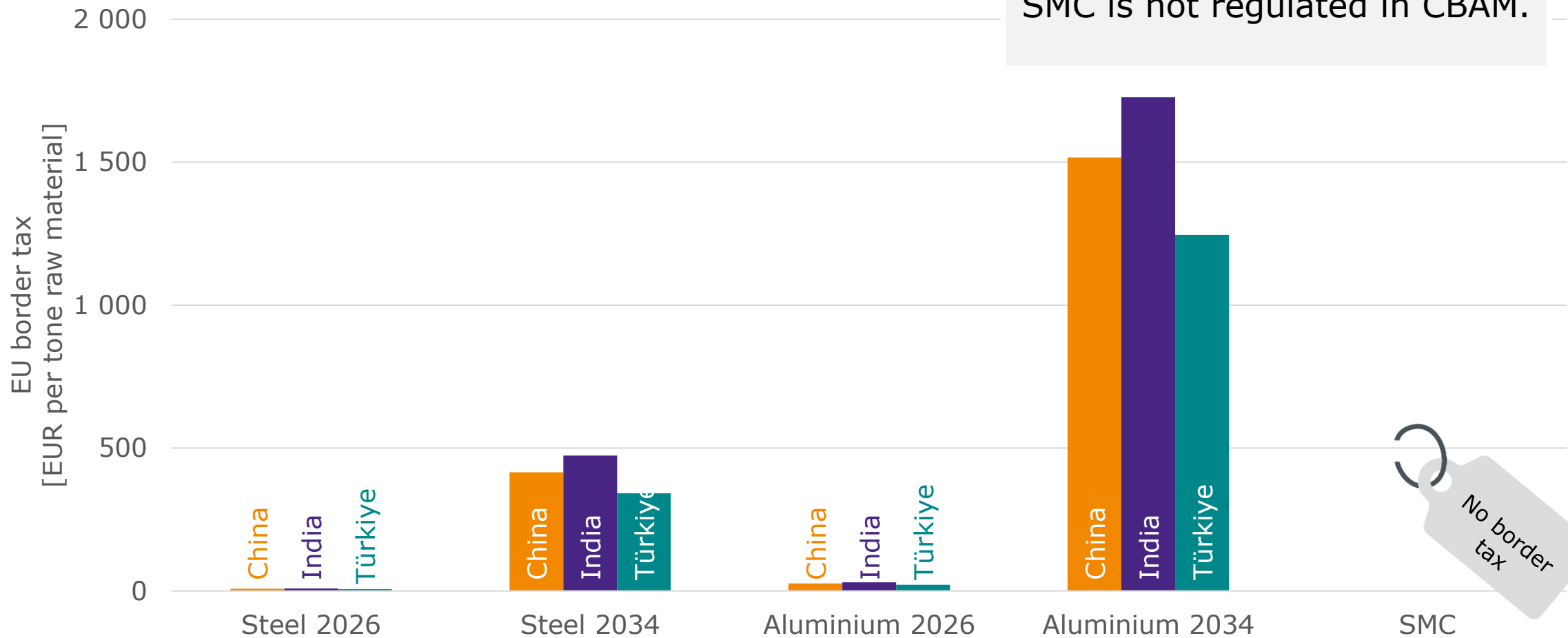
Assumptions: ETS price 90 €/tCO₂e |

China: 3.2 tCO₂e/t steel | India: 3.6 tCO₂e/t steel | Türkiye: 2.6 tCO₂e/t steel | China: 11.7 tCO₂e/t aluminium | India: 13.3 tCO₂e/t aluminium | Türkiye: 9.6 tCO₂e/t aluminium

Source: G. Petrowitsch, „Welche Auswirkungen hat Carbon Border Adjustment Mechanism auf die europäische Autoindustrie und wie könnte sich CBAM in Zukunft entwickeln?“, 2023

Carbon Border Adjustment Mechanism 2026 2.5% | 2034 100%

Significant additional costs for imported steel and aluminium from 2034 onwards.
SMC is not regulated in CBAM.

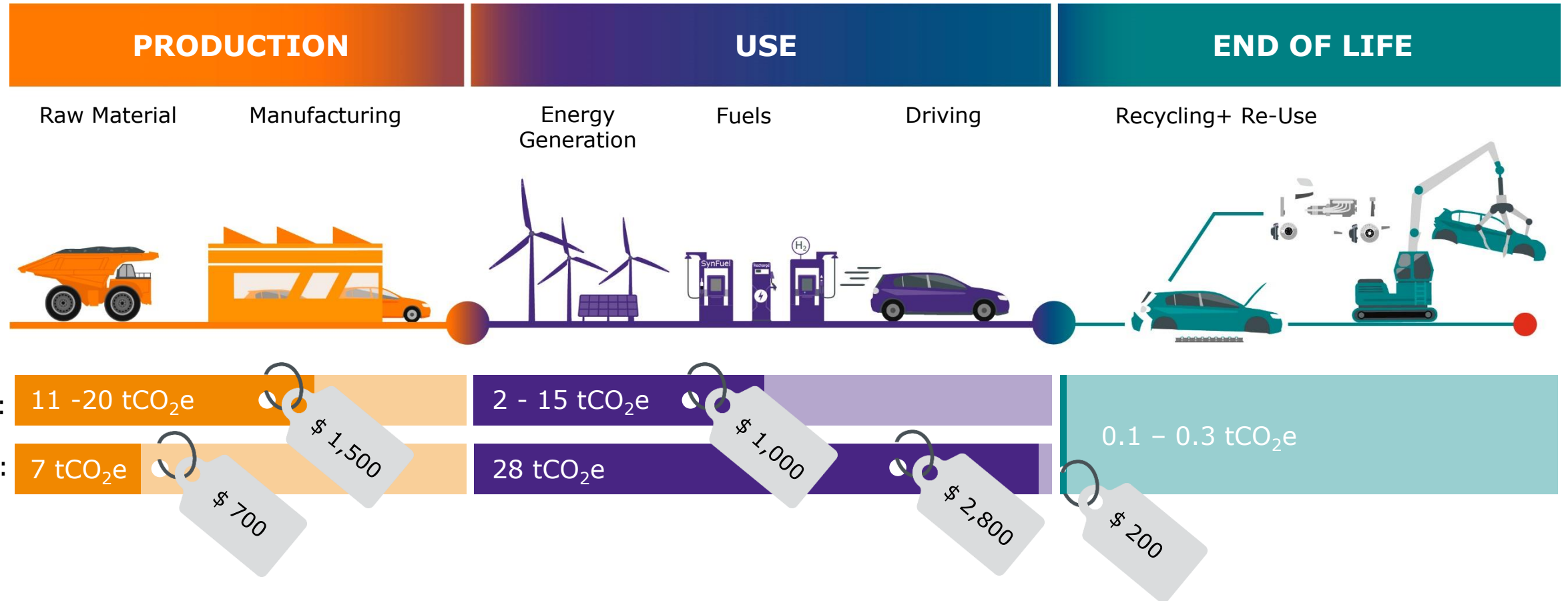


Assumptions: ETS price 90 €/tCO₂e |

China: 3.2 tCO₂e/t steel | India: 3.6 tCO₂e/t steel | Türkiye: 2.6 tCO₂e/t steel | China: 11.7 tCO₂e/t aluminium | India: 13.3 tCO₂e/t aluminium | Türkiye: 9.6 tCO₂e/t aluminium

Source: G. Petrowitsch, „Welche Auswirkungen hat Carbon Border Adjustment Mechanism auf die europäische Autoindustrie und wie könnte sich CBAM in Zukunft entwickeln?“, 2023

Future Vision: All Industries pay the same Price per ton CO₂e

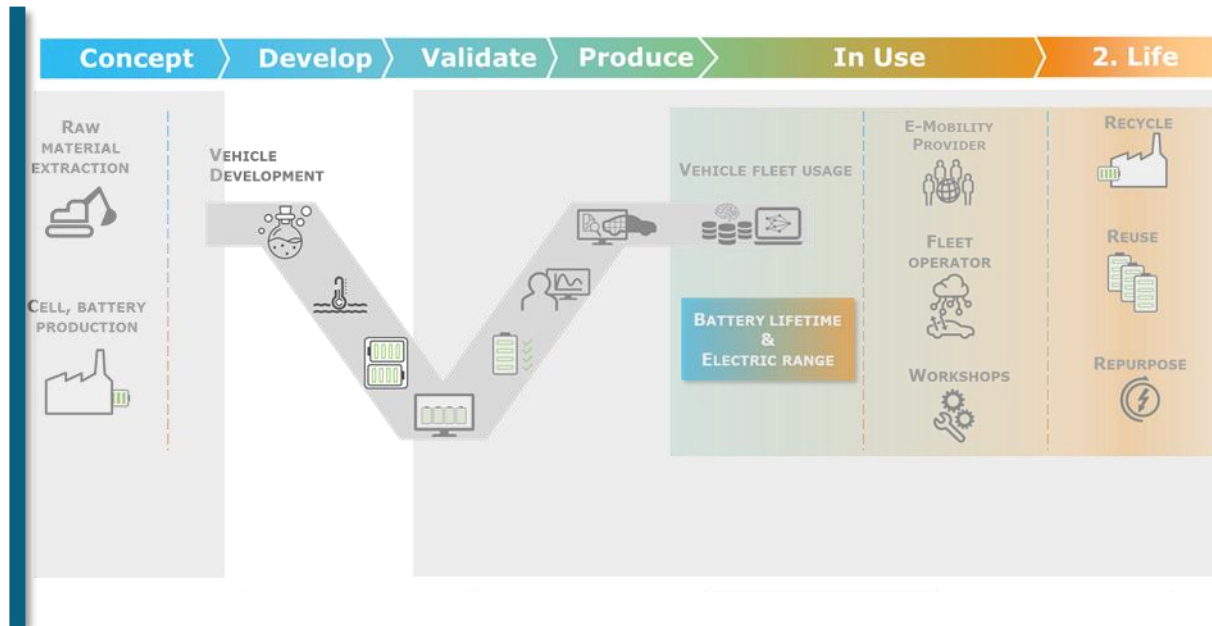


Additional CO₂ costs per phase | Assumption on future CO₂ costs: 100\$ / tCO₂
no additional penalties beside CO₂ pricing considered

Assumptions: C-segment | HEV: Propulsion 110 kW, Gasoline 85 kW, Battery 1.2 kWh, 42 MPG, 20% CO₂ from WtT, Fossil Fuel | BEV: Propulsion 150 kW, Battery 60 kWh (205 mi. range) | lifetime 110,000 mi.
Electricity mix for production & in-use phase ranges from 105 gCO₂e (France) to 980 gCO₂e (Poland)

Reference Projects

CO₂ Supply-Chain Audit

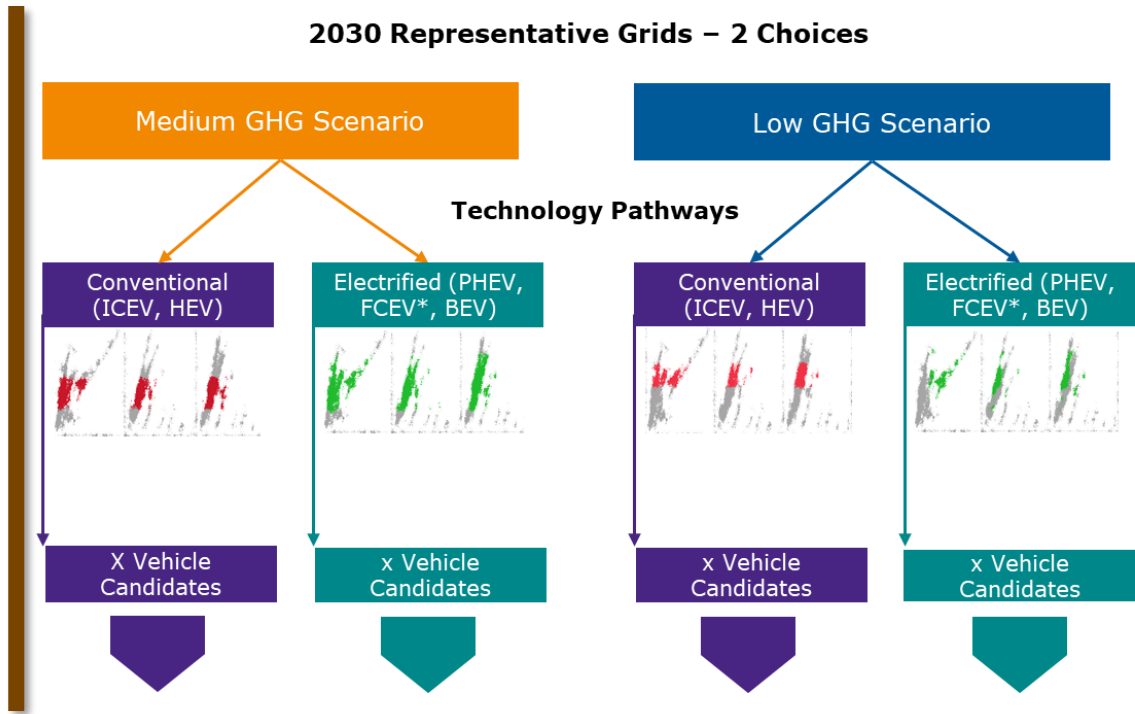


Identification of the relevant environmental factors in the battery life cycle

- Evaluation of the implication factors
- Improvement potential in the next 5 years
- Independent second opinion on the environmental aspects

Reference Projects

US Fleet Simulation comprising TCO and LCA



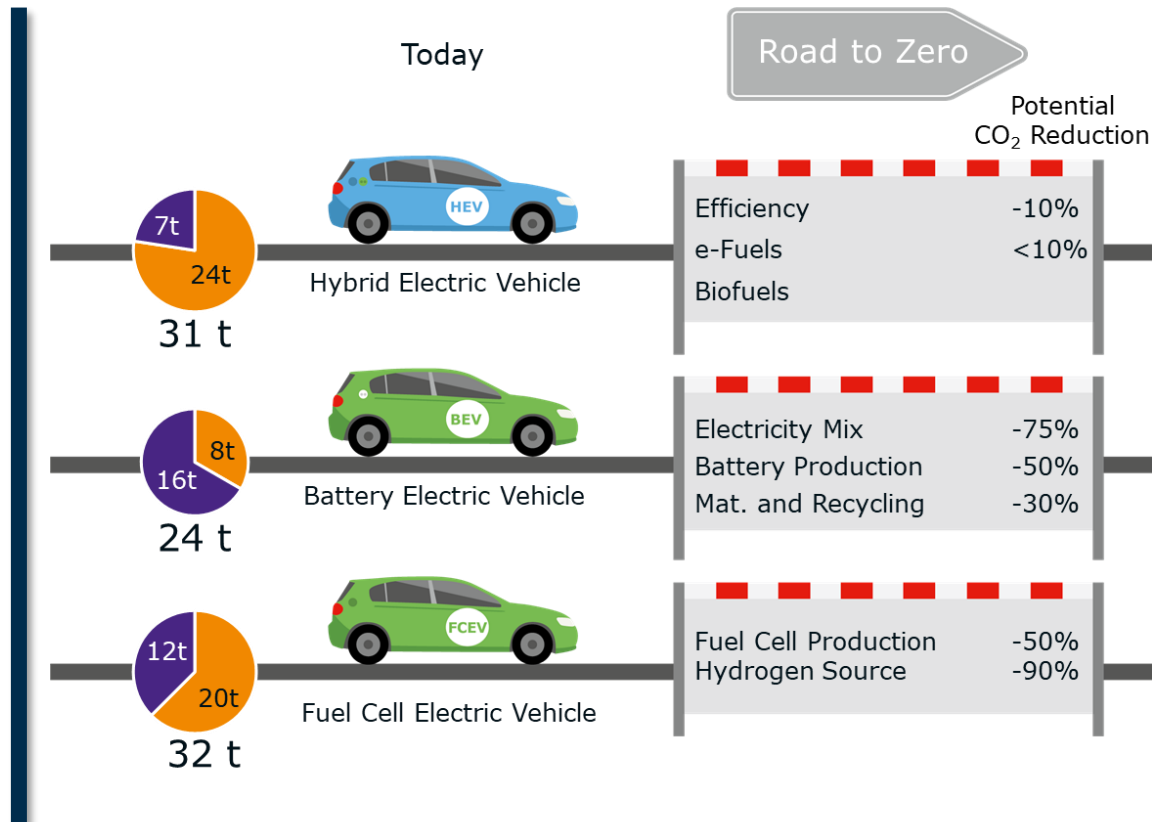
Optimize US pass car fleet penetration with EV for CO₂e target at minimum TCO

Sensitivity analysis considering:

- fuel type and cost
- charging efficiencies
- electric ranges
- incentive schemes

Reference Projects

Cost and CO₂e Analysis for Production and Supply Chain



Assessment of carbon footprint for different powertrain and vehicle technologies

- Analysis of supplier and customer production processes
- Assessment of investments for CO₂e reduction
- CO₂e as target parameter considered in all design steps

Key Takeaways



Early development phase defines lifecycle carbon footprint



CO₂e to be considered in development process & design guidelines



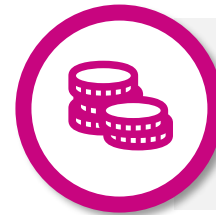
CO₂e lever in supply chain is larger than at the OEM



CO₂e measurements will enrich environmental impact data models



A balanced product needs to add CO₂e in the DfX evaluation



Future CO₂e taxation affects import of selected raw materials



Design to CO₂: Reality check

Q&A

Contact



LOCATION

AVL List GmbH
Hans-List-Platz 1
8020 Graz
Austria



PHONE

+43 316 787 4169
+43 316 787 5164
+43 316 787 1031



EMAIL

martin.rothbart@avl.com
christoph.sams@avl.com
thomas.schmid@avl.com



WEBSITE

www.avl.com/energy

Thank you



www.avl.com