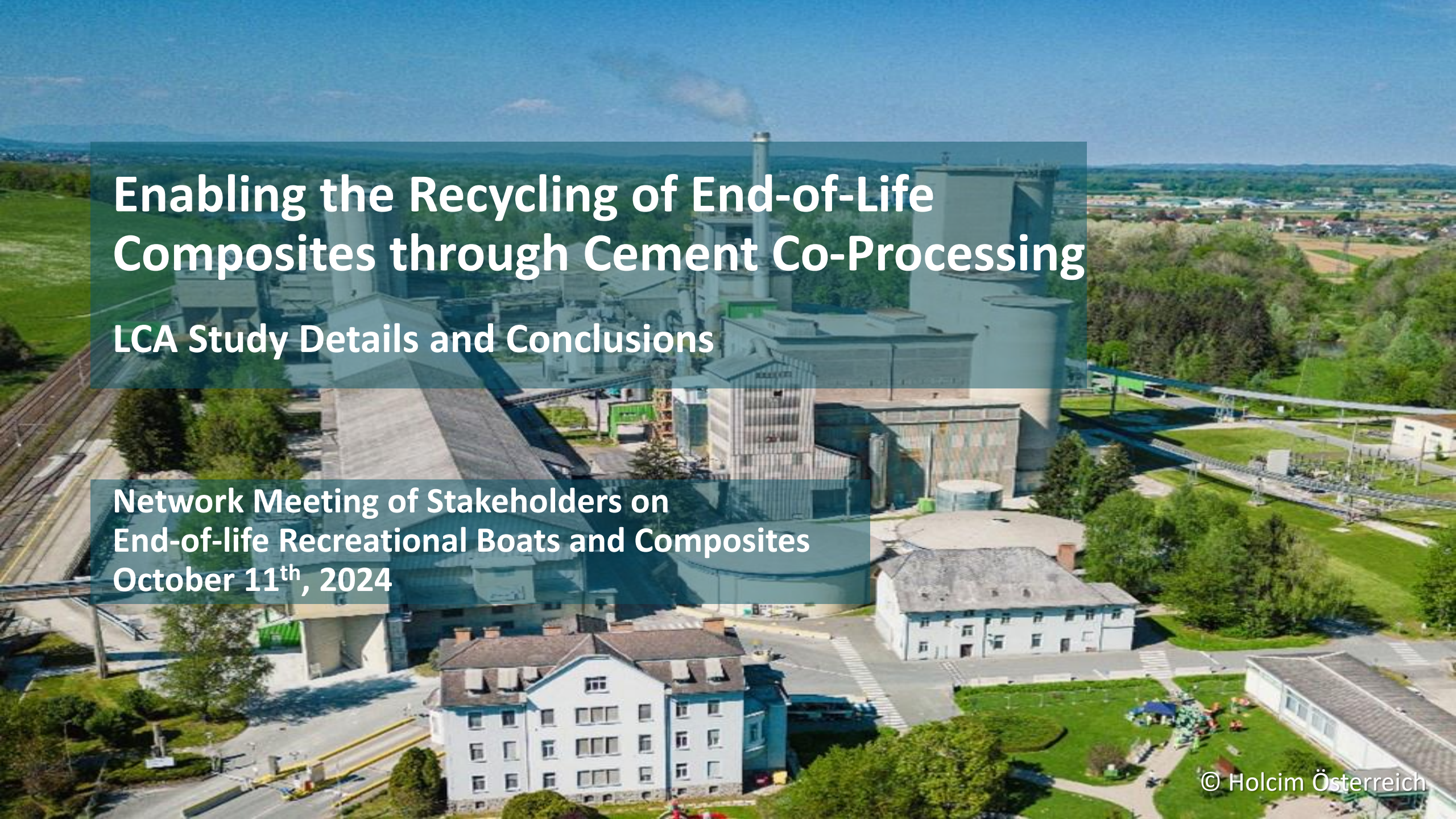
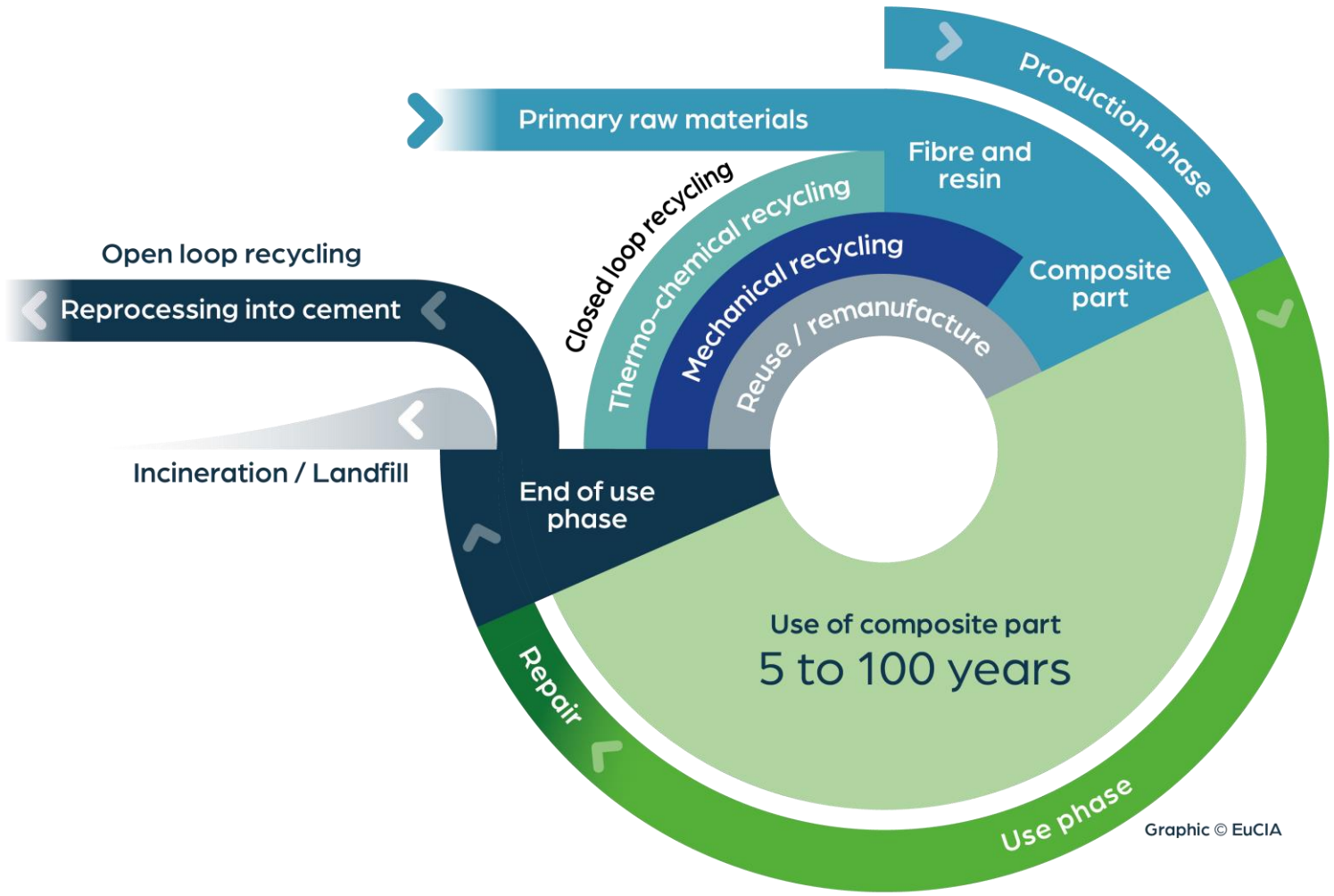


Enabling the Recycling of End-of-Life Composites through Cement Co-Processing

LCA Study Details and Conclusions

Network Meeting of Stakeholders on
End-of-life Recreational Boats and Composites
October 11th, 2024

Composites are Circular



Cement co-processing is both commercially and technically proven for treating end-of-life glass reinforced composite materials and can immediately be deployed at large scale

Cement co-processing could pave the way for other composites recycling technologies at various Technology Readiness Levels (TRL)

Glass Fibers Used as Raw Materials for Cement Clinker

- **Recycling materials**
  - Reducing use of conventional raw materials (i.e. limestone, bauxite, silicium oxide) in cement manufacturing
  - Up to **70 %** of composite weight (glass fiber and mineral filler) is used to replace virgin raw materials
- **Energy recovery**
  - Mitigating climate change contributions, replacing fossil energy sources (e.g. coal)
  - **30 %** of composite weight (resin matrix) is used as energy recovery

LCA Analysis done by SGS Intron
Peer-reviewed by NIBE

Performed by internationally well-recognized consultancy for LCA analysis studies with broad experience in calculating eco-footprint of cement manufacturing operations

(including experience in application of alternative fuels)

Analysis according to the core PCR document for construction products EN 15804:2019+A2

(Based on ISO 14044: "Environmental management – Life Cycle Assessment – requirements and guidelines")*

LCA-calculations done with SimaPro software, using Ecoinvent 3.8 [3] as the LCA database for background data

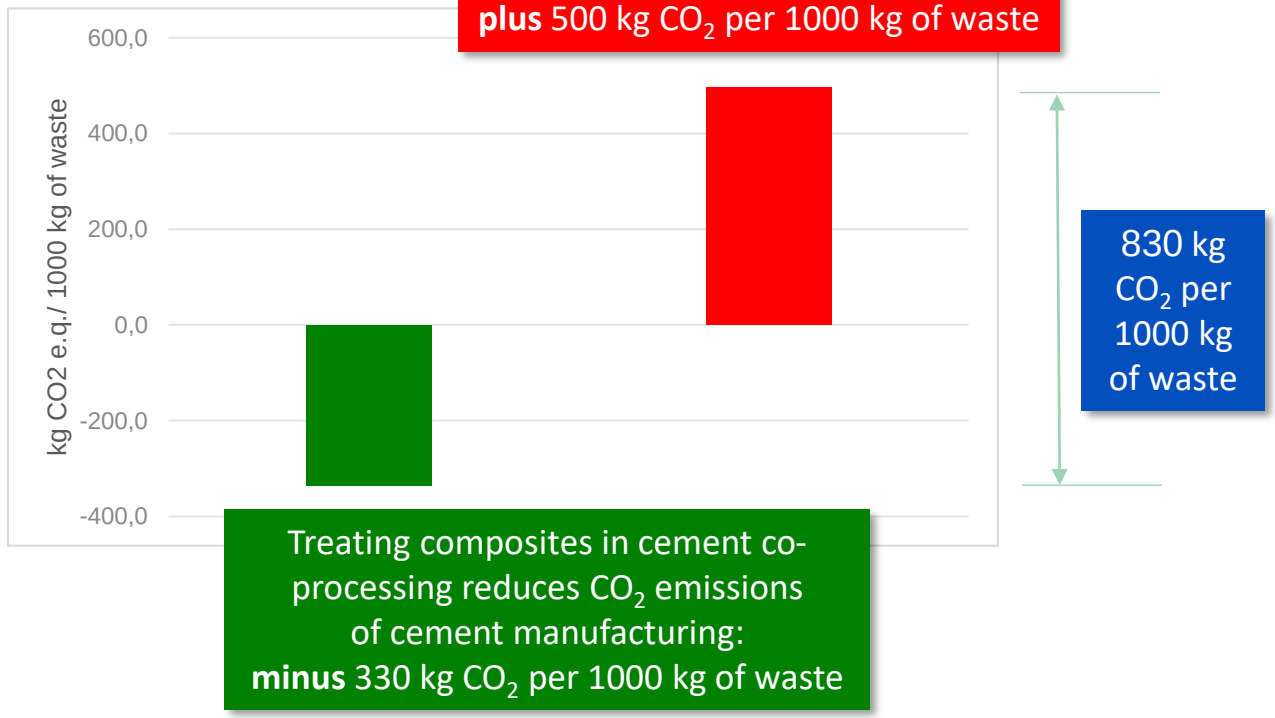
Peer review for ensuring LCA study accuracy and correctness

* Ensures that the results may be applied in LCA-studies resulting in EPDs

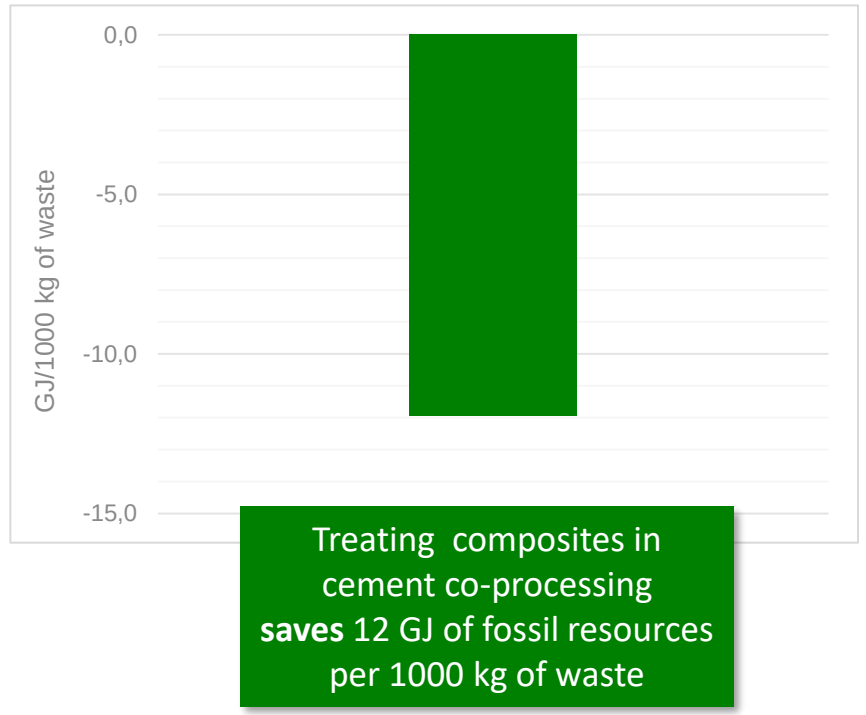
Cement Co-processing Makes Sense for Treating End-of-life Composites

Each ton of composite waste treated by co-processing in cement saves ~830 kg CO_2 vs. incineration*

Greenhouse warming potential (GWP)



Abiotic resource depletion (ADP, fossil)



* Comparing composite waste vs. traditional cement raw materials and fuels (in this calculation: coal)

Three Composites Material Profiles Used

Together Representing 95+ % of Glass Filled Composites Market Volume

Key material profiles for Marine

GF50

50 % glass fiber, 50 % resin

Conversion processes
Hand Lay-up, Spray-up, Filament Winding, Continuous lamination

Resin mix
50 % Ortho, 10 % Iso, 35 % DCPD, 5 % Vinyl Ester

EU market volume share
~33 %

GF70

70 % glass fiber, 30 % resin

Conversion processes
Infusion, RTM, Pultrusion

Resin mix
50 % Ortho, 10 % Iso, 30 % DCPD, 5 % Vinyl Ester, 5 % Epoxy

EU market volume share
~38 %

SMC

28 % glass fiber, 25 % resin, 47 % $CaCO_3$ filler

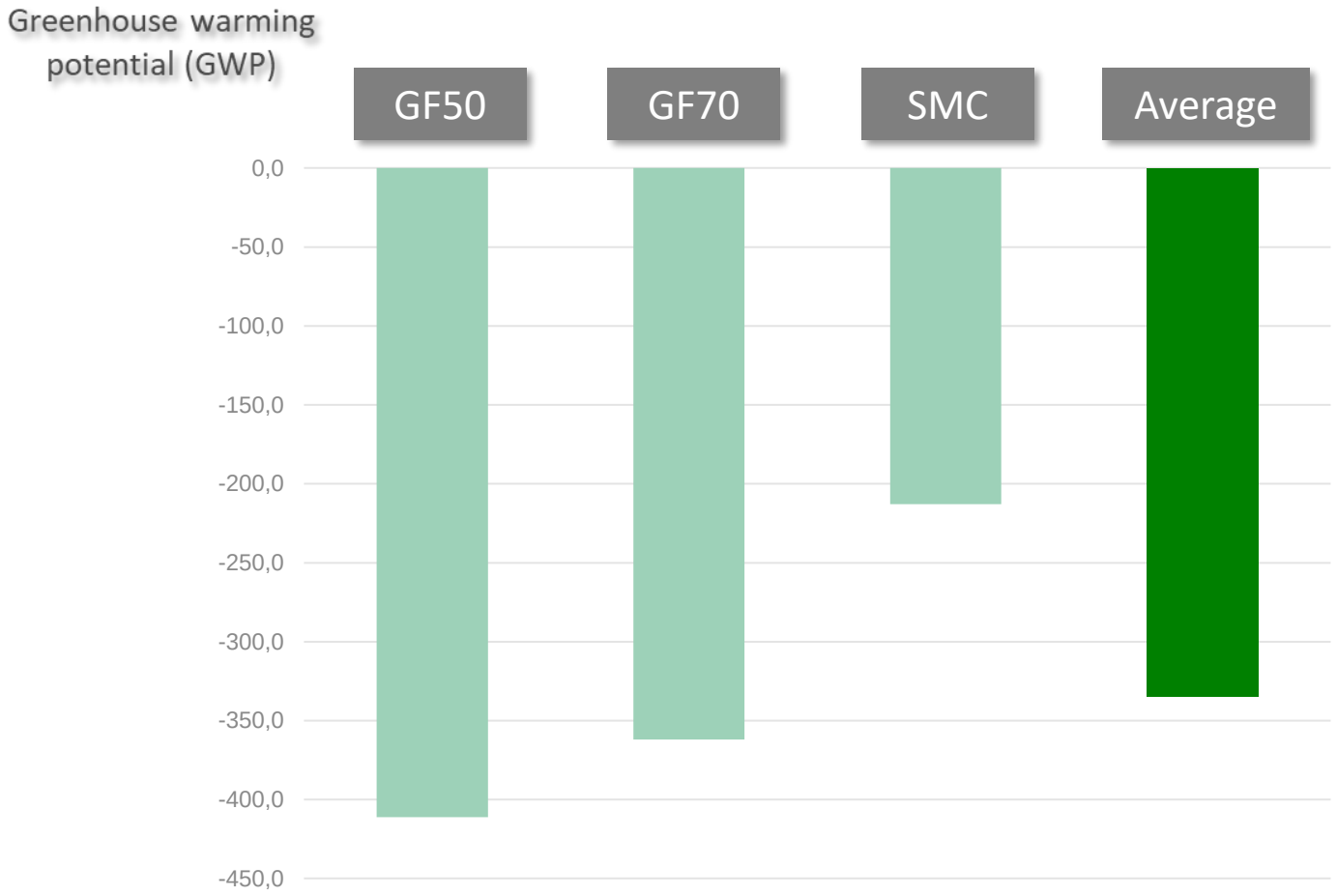
Conversion processes
SMC, BMC

Resin mix
50 % Ortho, 50 % Maleic

EU market volume share
~29 %

Sources:
Composite material profiles, resin mix: Cefic UP/VE, Epoxy Europe, EuCIA
EU market volumes: AVK, The European Market for Fibre Reinforced Plastics and Composites (2022)

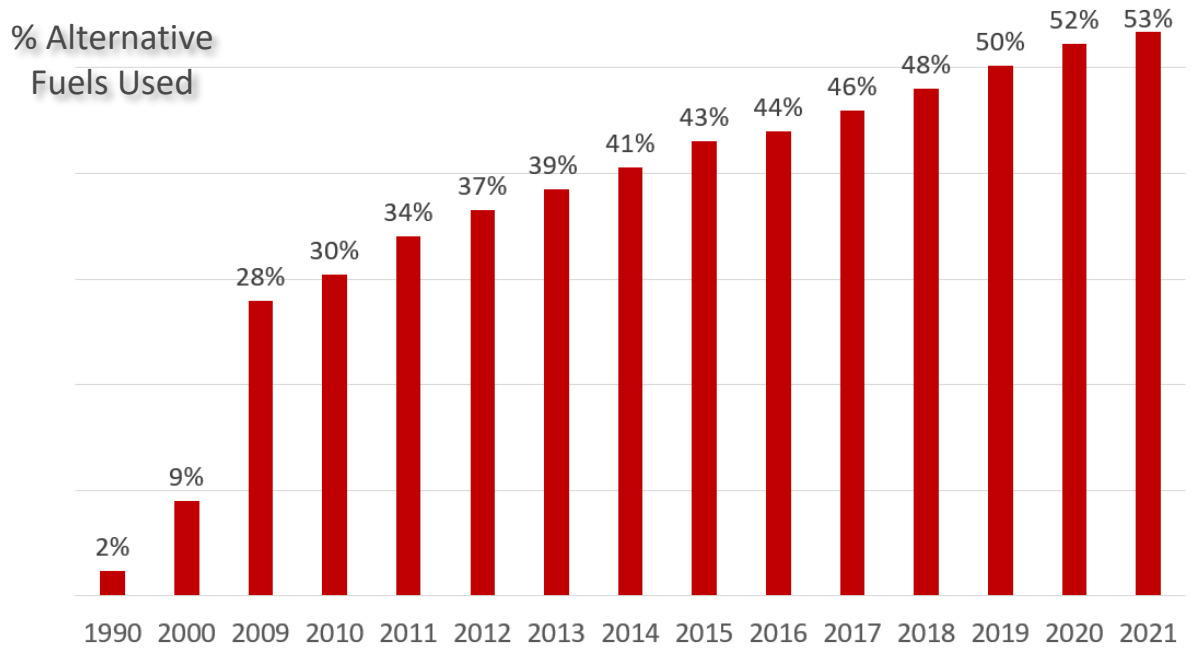
Reduced GWP is Confirmed for All Composites Material Profiles



Average all composites material profiles is **minus** 330 kg CO_2/ 1000 kg of waste

Fossil-based Fuels are Still the Reference for This LCA

(i.e. Coal, Lignite, Petcoke)



Source: Global Cement & Concrete Association (GCCA)

Large share of fuels used in EU cement production is still fossil-based

Using composite waste can help to further increase use of alternative fuels

Recognize Cement Co-processing as a Recycling Process


EN Official Journal of the European Union

DIRECTIVE (EU) 2018/851 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL
of 30 May 2018
amending Directive 2008/98/EC on waste
(Text with EEA relevance)

- **Waste Framework Directive 2018/851/EC**

  Article 11(7): "[…] The Commission shall assess co-processing technology that allows the incorporation of minerals in the co- incineration process of municipal waste. Where a reliable methodology can be found, as part of this review, the Commission shall consider whether such minerals may be counted towards recycling targets.'"

- **New ISO standard - May 2024**

"*Determination of the **Recycling Index for co-processing***"
ISO Technical Committee 300 / Solid Recovered Fuels (SRF) / ISO DIS 4349

Calling for Five Steps to Unlock Waste Collection and Industrial-scale Recycling

- **Revise the List of Waste** to create dedicated waste codes for composite material waste from decommissioned wind turbine rotor blades and boats.
- **Revise the Waste Framework Directive** to set progressive targets for the reuse and recycling of composite material waste from decommissioned wind turbine rotor blades and boats
- **Develop an EU-wide model for separate waste collection** of composite material waste from decommissioned wind turbine rotor blades and boats.
- **Revise the Landfill Directive** to set a landfill ban on composite material waste from decommissioned wind turbine rotor blades and boats
- **Revise the Waste Shipment Regulation** ensure composite material waste from decommissioned wind turbine rotor blades and boats is subject to the Green control procedure of the Basel Convention

Summary

- Composites are circular and can be recycled
  - Treating End-of-life composites in cement Co-processing makes sense
  - Saving 830 kg of CO_2 per tone of waste vs. incineration
- Paving the way for other composites recycling technologies
- Calling for recognition of co-processing as recycling technology for composites
- Industry and legislators should focus on facilitating waste collection and industrial recycling

Support for Doing Your Own LCA

- If you would like to perform a cradle-to-grave LCA, the dataset of the Co-processing LCA will become available for you to use

- Data for all output categories can be easily uploaded into your LCA software and is provided in a convenient .CSV format

- Please contact EuCIA (through raphael.pleynet@eucia.eu) if you would like to receive a copy

Industry Associations Supporting this LCA Study

GLASS FIBRE EUROPE	**Glass Fibre Europe:** Founded in 1987, is the voice of the European continuous filament glass fibre industry. The continuous filament glass fibre industry is the cornerstone of the glass-based composite materials and technical textiles value-chains. www.glassfibreeurope.eu
EBI European Boating Industry	**EBI**, the European Boat Industry represents the recreational boating and nautical tourism industry in Europe. It encompasses all related sectors, such as manufacturing, services, infrastructure and tourism. www.europeanboatingindustry.eu
Wind EUROPE	**WindEurope** is the voice of the wind industry representing over 500 organizations from across the whole value chain of wind energy. www.windeurope.org
TECH-FAB Europe	TECH-FAB Europe is an association made up of the main European Technical Textile producers. Our products are high-performing engineered textiles that bring lightweight, strength and many other benefits to our everyday lives. www.tech-fab-europe.eu
CEMBUREAU The European Cement Association	**CEMBUREAU**, the European Cement Association is the representative organization of the cement industry in Europe. Currently, its Full Members are 23 national cement industry associations and cement companies of the European Union plus Norway, Switzerland and the UK. www.cembureau.eu

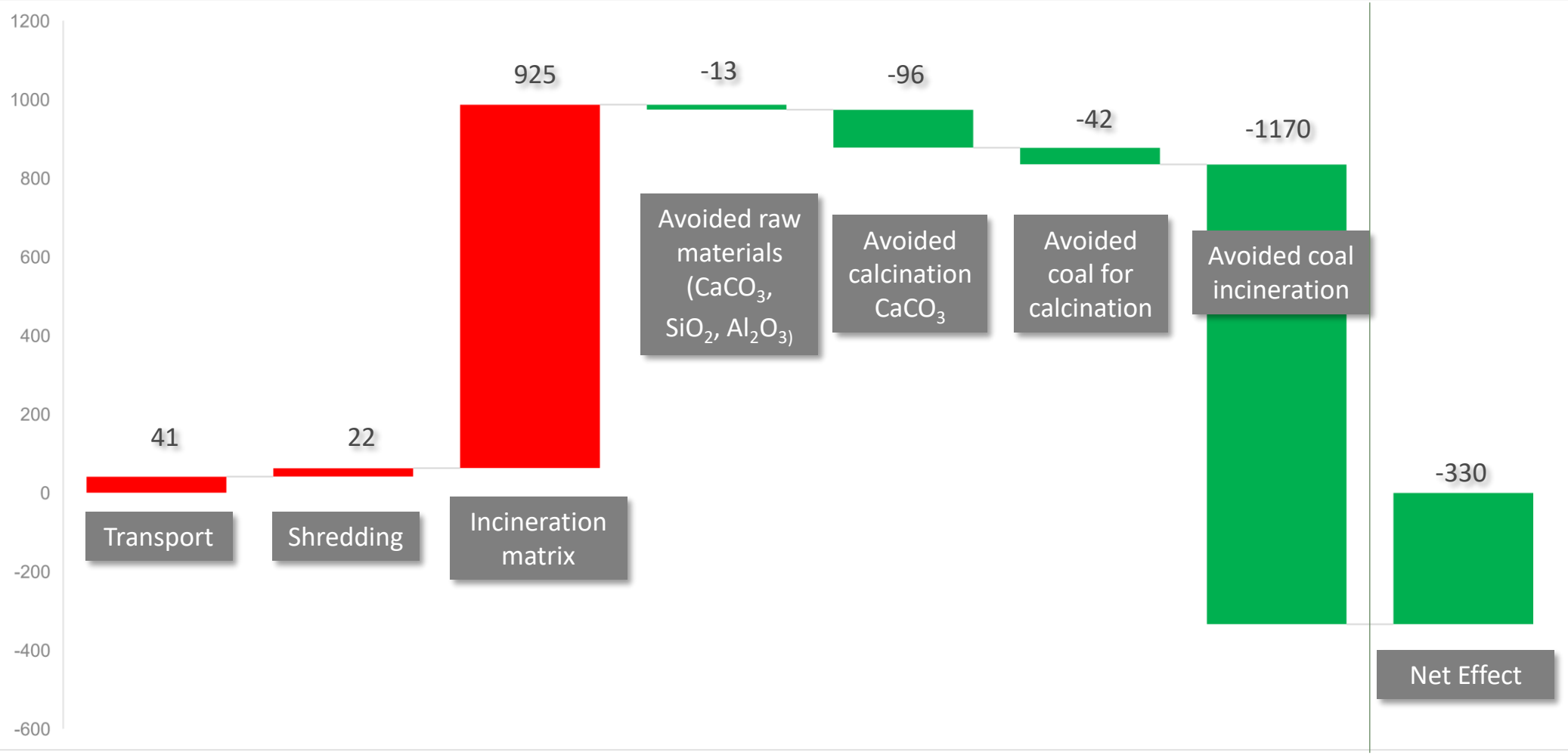
EuCIA The European Voice of Composites	**EuCia,** the European Composites Industry Association is composed by European national composites associations and industry-sector groups. 10,000 companies and 150,000 employees. www.eucia.eu
SMC BMC DRIVE COMPOSITE INNOVATION	**European Alliance for SMC BMC** is an industry association of European companies promoting the benefits of SMC BMC composite solutions. https://smcbmc-europe.org/
UP/VE Unsaturated Polyester & Vinyl Ester Resins	The **UPR/VE Resin Association**, a Cefic Sector group, represents unsaturated polyester (UPR) and Vinyl Ester (VE) resins producers of Europe. www.upresins.org
EPOXY Tomorrow's technology, today	**EPOXY EUROPE**, a Cefic sector group, represents the interests of the major European epoxy resins manufacturers since the early 1980s. www.epoxy-europe.eu
cefic	**Cefic**, the European Chemical Industry Council, was founded in 1972, and is the voice of large, medium and small chemical companies across Europe, which provide 1.2 million jobs and account for 16% of world chemicals production. www.cefic.org

Backup Slides

October 2024

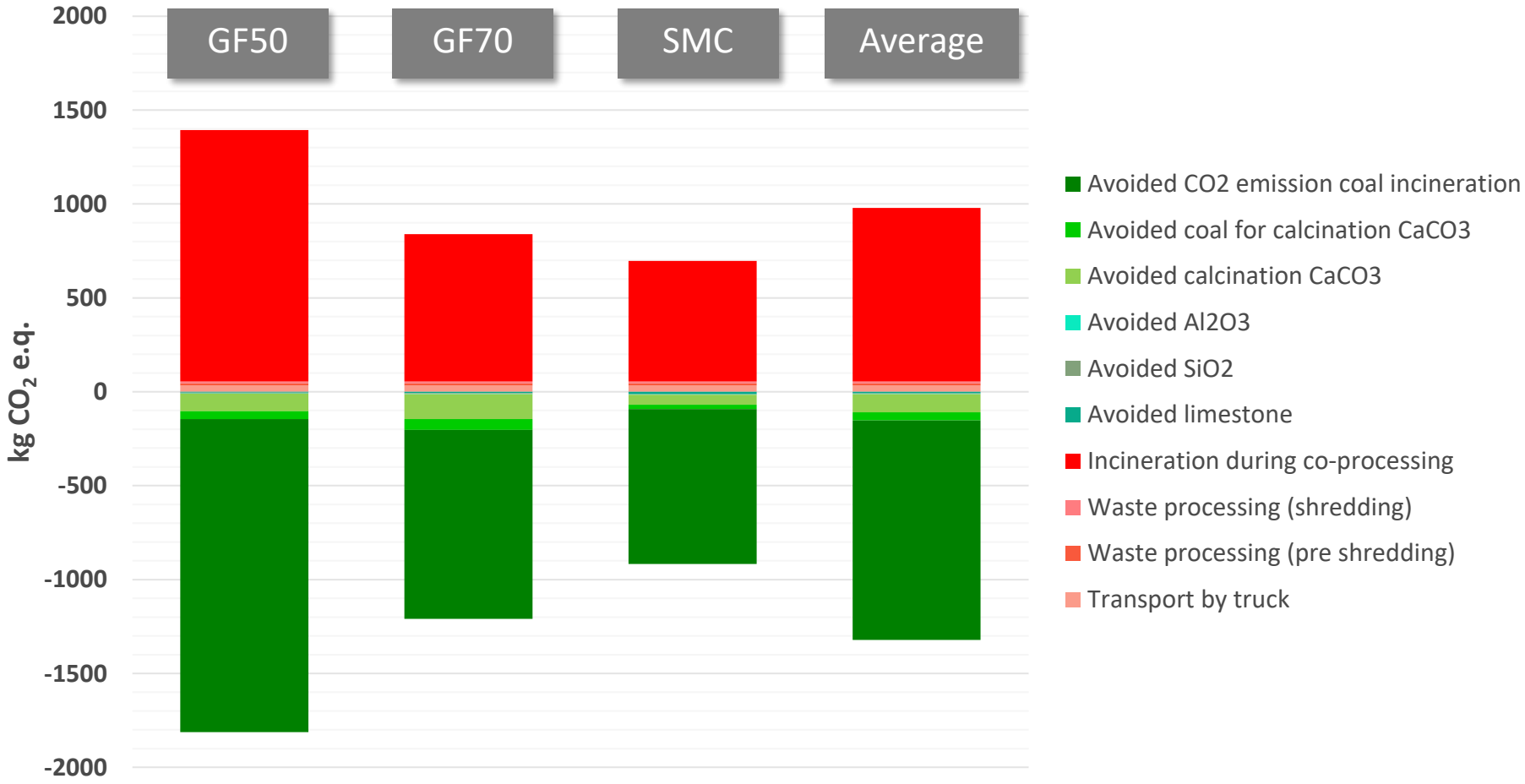
Contribution Details of Different Items

Average Values Across Material Profiles



Contribution Details of Different Items

CO_2 reductions outweigh CO_2 required for recycling



CO_2 Emission Reduction Confirmed of Using Composite for All Fossil-based Fuels

(Using the GF50 profile as baseline)