

2023-2025

ADVANCE

ACCOMPANYING MEASURE FOR DISSEMINATION, VALORISATION
AND COLLABORATIVE EXPLOITATION OF CIRCULARITY
OF CONSTRUCTIONAL STEEL PRODUCTS



Funded by
the European Union

VTT

How to increase the reuse of steel structures in existing and new buildings?

Petr Hradil
Norsk Ståldag, 6.11.2025

10/11/2025 VTT – beyond the obvious

VTT provides growth with research and development

VTT is a visionary research, development and innovation partner for businesses and society and one of Europe's leading research institutions.

We bring together people, businesses, science and technology to solve the world's biggest challenges and create sustainable growth, jobs and well-being.

2,390

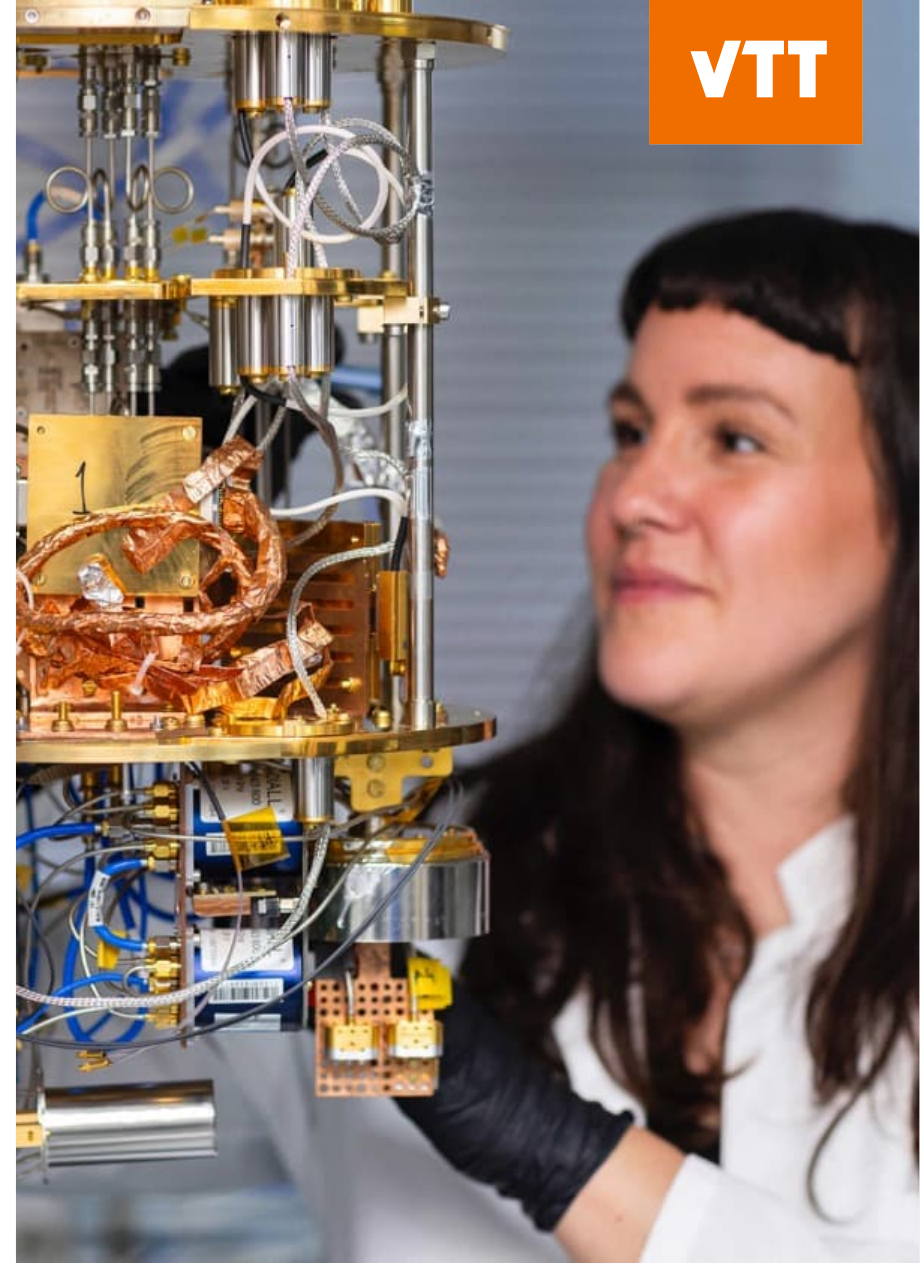
employees

1,100

customers

296 M€

operating income



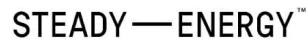
Working with us promotes sustainable renewal of business and industry



A powerhouse of over 50 spin-off companies

VTT LaunchPad is a business incubator that commercializes VTT's research and technology into spin-off companies.

The incubator brings together VTT's researchers and IPR offering, the best business expertise and investors.

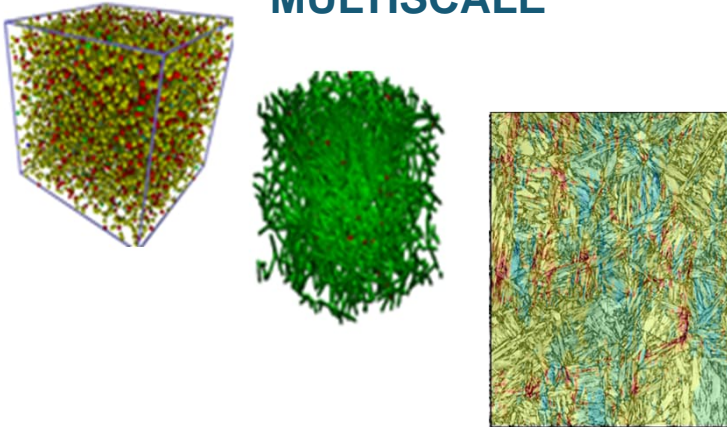


From the material design ...

VTT ProperTune®

VTT ProperTune is a toolset, a collection of software libraries and tools for solving multiscale materials and multiphysical modeling problems. It enables one to efficiently and rapidly set up novel modeling workflows and solvers to address materials modeling and simulation challenges.

MULTISCALE

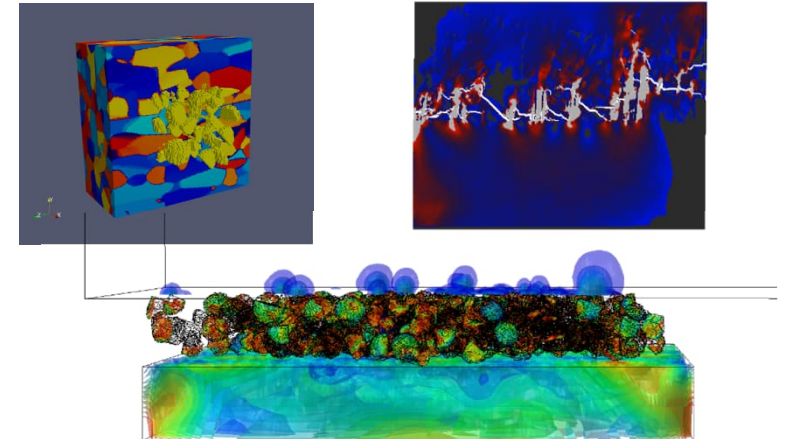


From atomistic to microstructural and to product performance and lifetime

Couplings,
concurrencies,
interfaces and data
across scales and
physics



MULTIPHYSICAL



Material properties, manufacturing processes, solidification processes, damage and failure, thermodynamics and kinetics, chemical reactivity, electrochemistry, transport phenomena, electromagnetism, dynamics, process models etc.

VTT ProperTune® reference cases

Use case type: Optimize a material solution (microstructure)

CATERPILLAR

- Optimization of protective composite coatings



Outcome: performance +40%, TTM -60%, what-if-capability

Use case type: New steel grade design

The ArcelorMittal logo, featuring a stylized orange 'A' shape above the company name 'ArcelorMittal' in a black sans-serif font.

- Discovery and design of new high performance steel grade



Outcome: durability +200-250%, TTM & R&D cost -50%, material & mfg cost: unchanged

Use case type: New material discovery for extreme conditions

The U.S. Department of Energy logo, featuring a circular seal with an eagle and the text 'U.S. DEPARTMENT OF ENERGY' and 'ENERGY' in large green letters.

- Novel materials for the first wall of fusion reactors



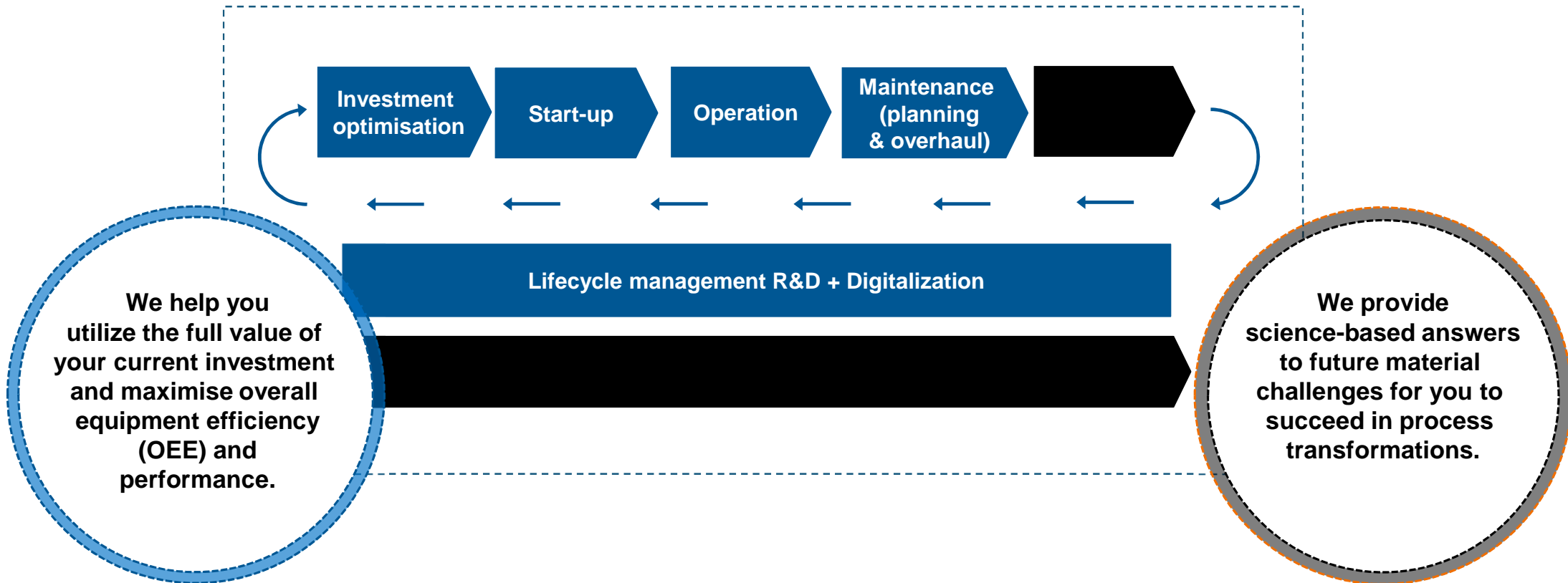
ARPA-E (Advanced Research Projects Agency – Energy) research program ([press release](#))

VTT ProperTune® has been developed together with our industrial partners and applied to their materials and products.

**... to material service life
management ...**

VTT ProperScan

Understanding tomorrow's materials



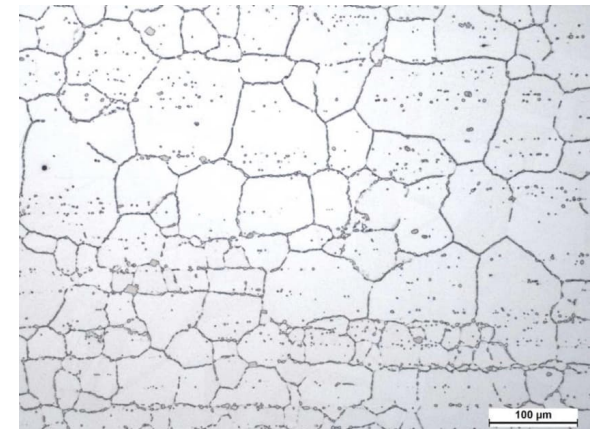
VTT ProperScan

Rejuvenation treatment of gas turbine inner casing material

Challenge: Gas turbine service life is approaching the manufacturer recommended limit with no rejuvenation option. The power plant is facing an expensive replacement investment.

Solution:

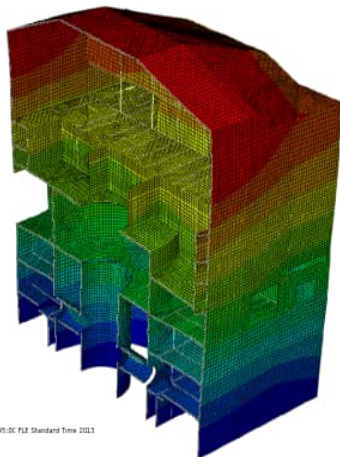
- VTT carried out metallographic analysis and mechanical testing of heat-treated material samples
- The results confirm that heat treatment of casing will offer sufficient rejuvenation potential of the material properties to facilitate the targeted service life extension
- Helen proceeded with the heat treatment and brings the gas turbine casing back in operational use in summer '22



Structural Materials

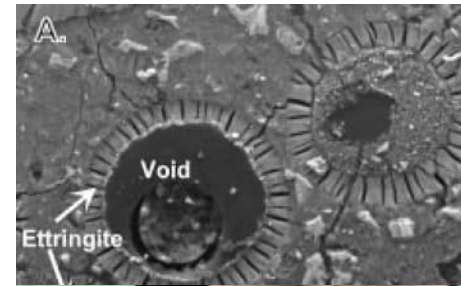
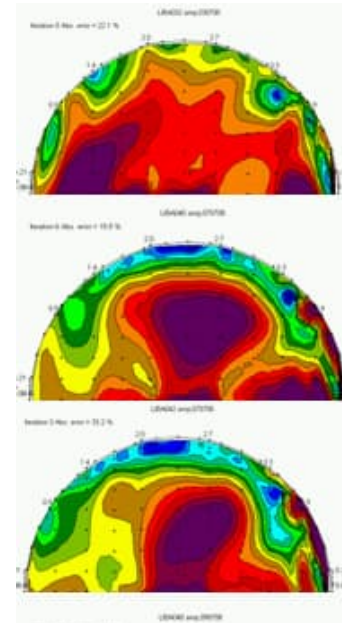


- Developing solutions for the construction sector to achieve **net zero carbon emissions** by 2035 through **building material innovations**
- Enable **full circularity of building materials** through new re-processing, re-cycling and re-use concepts
- Increase structures, components and materials **resilience and safety** through **digitalisation** and **ageing management** solutions



1-45:00 P12 Standard Time 2033

the obvious

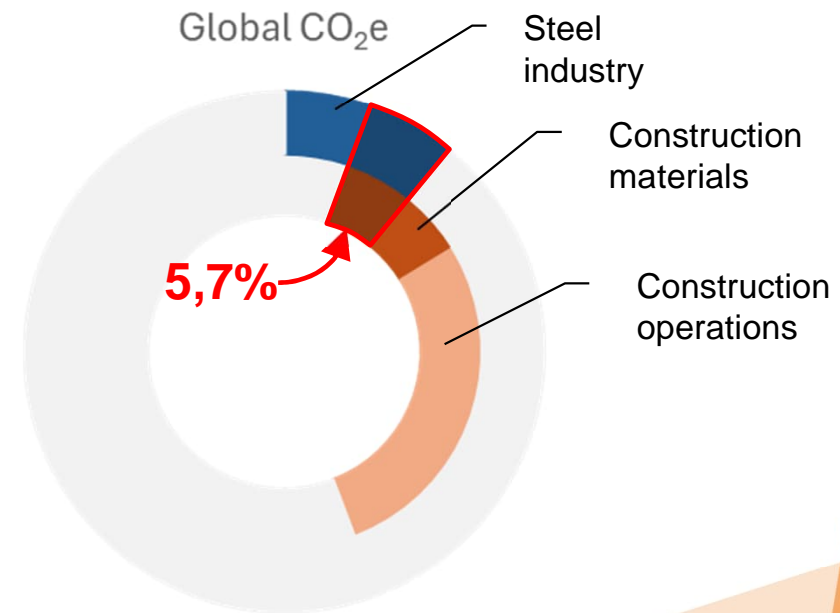


**... to solutions beyond
the service life boundaries**

Constructional steel ...

... causes significant CO₂e impact globally

- Construction industry is responsible for ~39% of global CO₂ (11% materials, 28% operations)
- Steel industry is responsible for ~8% of global GHG emissions
~11% of global CO₂
- Constructional steel share is ~52% of total steel production



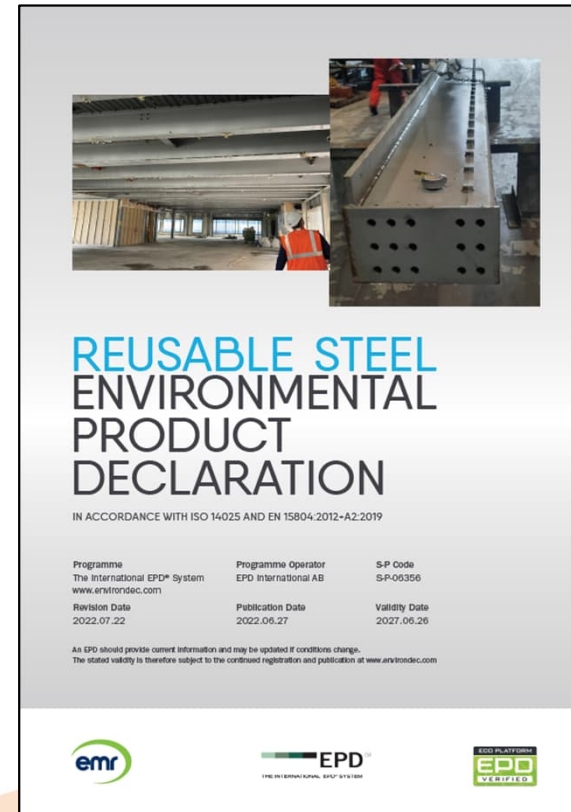
Constructional steel offers significant CO₂ saving when reused



product stage
333 kgCO₂e/t

**86%
reduction**

product stage
47 kgCO₂e/t



2017-2020

PROGRESS

PROVISIONS FOR GREATER REUSE OF STEEL STRUCTURES



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■ Protocols

- Pre-deconstruction audit protocol
- Material testing protocol
- Deconstruction protocol

■ Guides

- Existing buildings
- New buildings

■ Assessment methods

- LCA & LCCA for reused steel
- Reusability index

■ Case studies

- 11 factsheets

■ Other results

- Definition of product and waste
- Connections for envelopes
- 3D scanning with drones
- Deconstruction techniques

Circular standardization

EN 1090-1

- CE marking of reused steel constituents

TS 1090-201

- testing protocol for reused steel

CEN/TC250/SC3/AHG

- design rules for reused steel

EN 17662

- PCR for steel (including reuse)

CEN/TC350/SC1/WG5

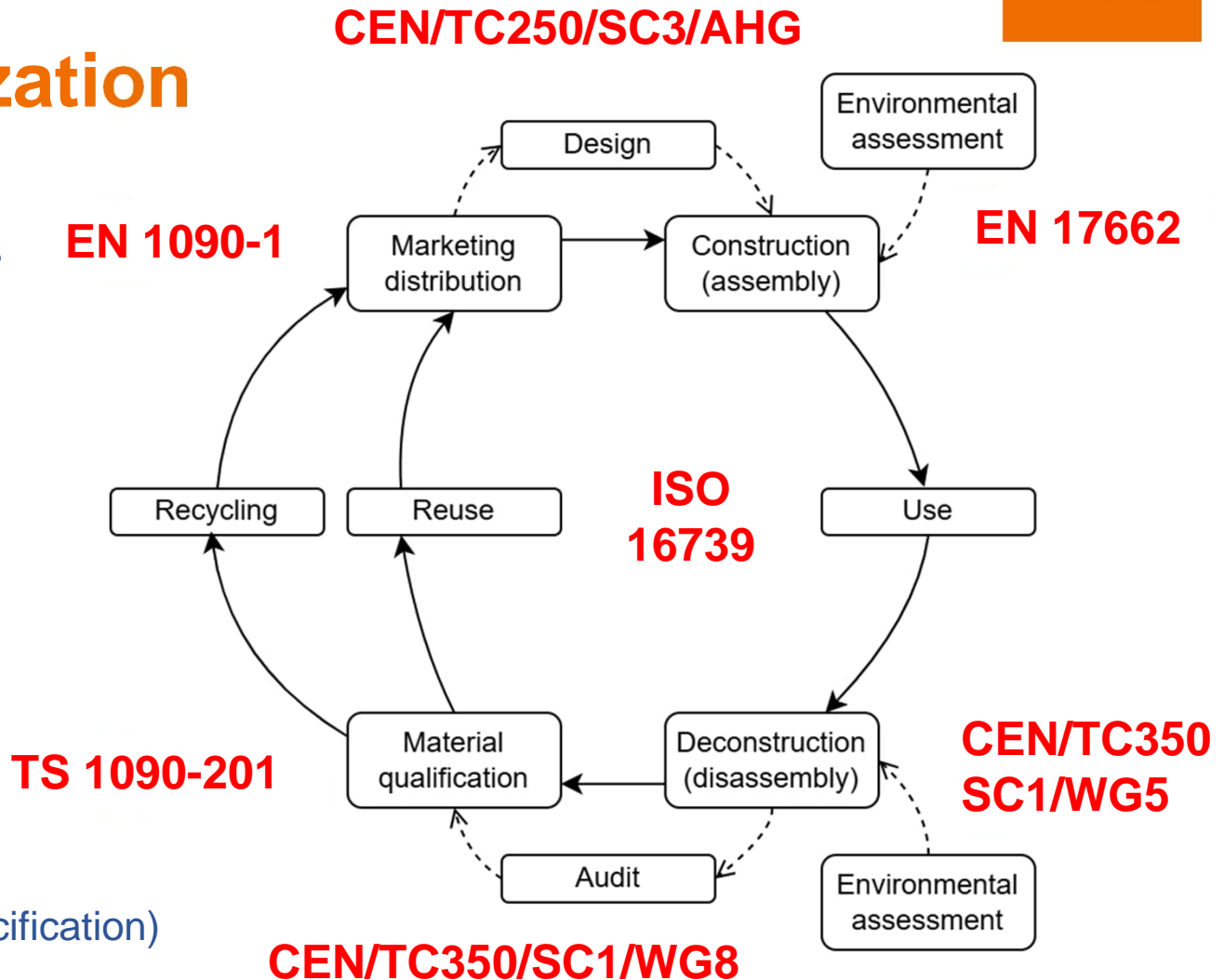
- circularity assessment

CEN/TC350/SC1/WG8

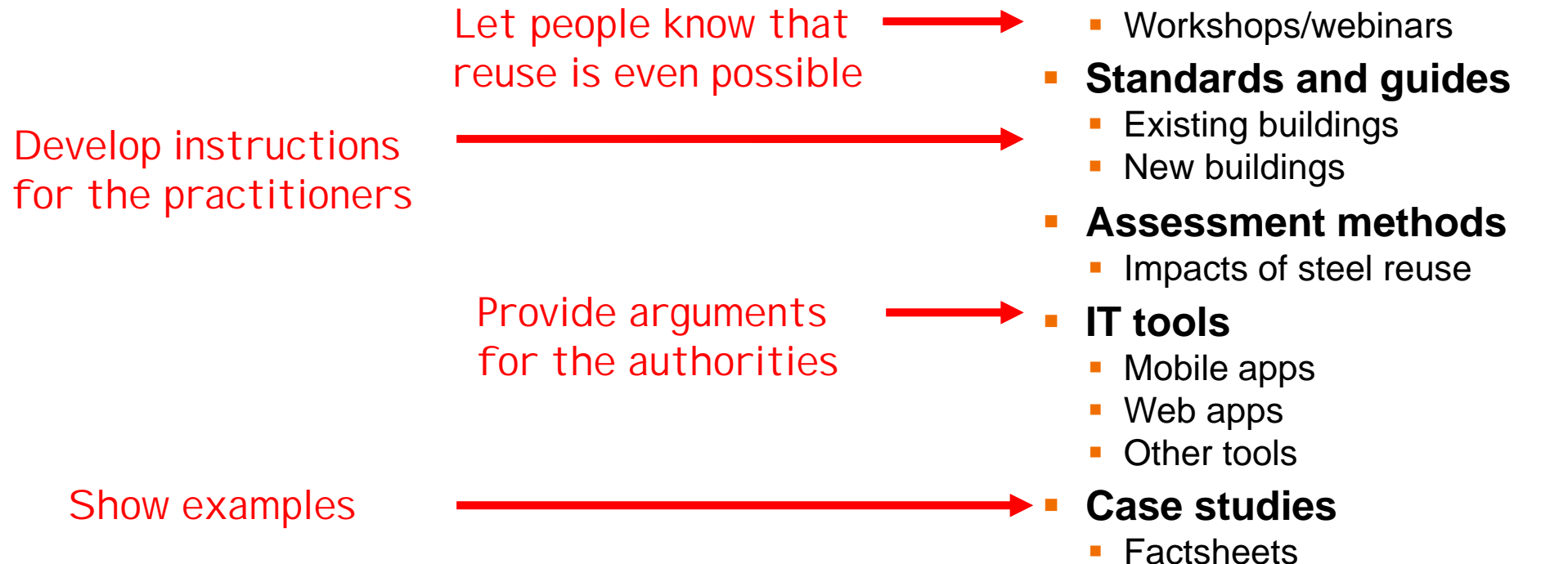
- pre-demolition audit protocol

ISO 16739

- building information modelling (IFC specification)



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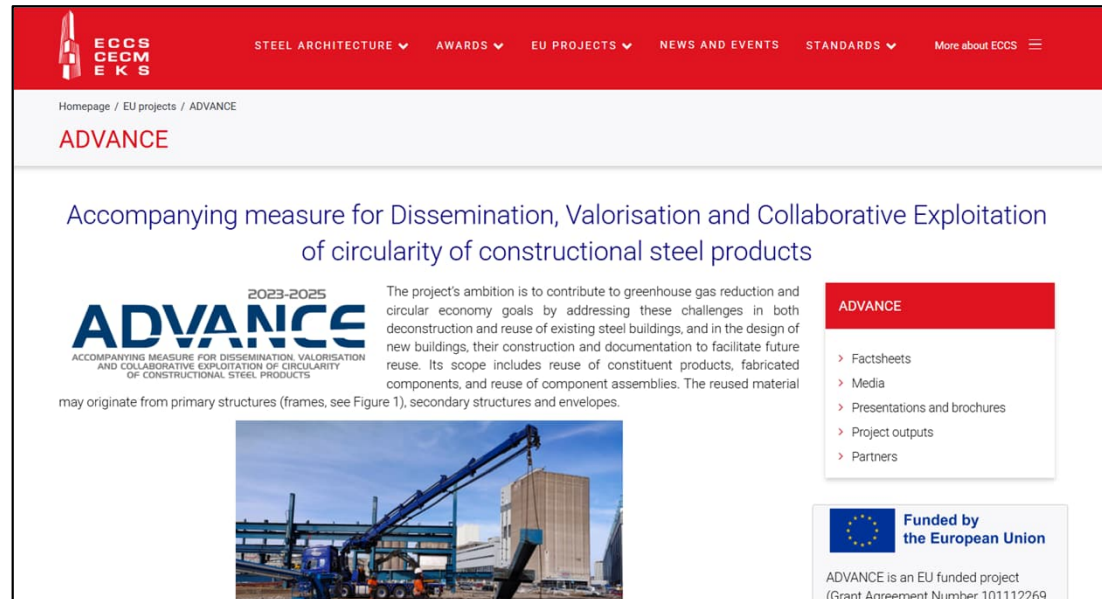
Funded by
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- **Dissemination materials**
 - Website
 - Brochures (20 languages)
 - 10 workshops/webinars
- **Updated guides** (7 languages)
 - Existing buildings
 - New buildings
- **Assessment methods**
 - Updated LCA for steel reuse
- **IT tools**
 - Updated mobile LCA app
 - Web app
 - Minigame
- **Updated case studies**
 - 5 additional factsheets

PROGRESS & ADVANCE outcomes

<https://www.steelconstruct.com/eu-projects/advance/>



The screenshot shows the website for the ADVANCE project, part of the ECCS CECM EKS initiative. The header is red with white text for navigation: STEEL ARCHITECTURE, AWARDS, EU PROJECTS, NEWS AND EVENTS, STANDARDS, and More about ECCS. Below the header, the breadcrumb trail reads 'Homepage / EU projects / ADVANCE'. The main title 'ADVANCE' is in red, followed by the subtitle 'Accompanying measure for Dissemination, Valorisation and Collaborative Exploitation of circularity of constructional steel products'. The project period '2023-2025' is noted. A large blue 'ADVANCE' logo is displayed, with the full project name underneath. A paragraph describes the project's goal to reduce greenhouse gas emissions and promote circularity in the steel construction sector. A photograph shows a blue crane lifting a large steel beam at a construction site. On the right, a red 'ADVANCE' button is above a list of links: Factsheets, Media, Presentations and brochures, Project outputs, and Partners. At the bottom right, the European Union flag logo is next to the text 'Funded by the European Union', with a note that ADVANCE is an EU funded project (Grant Agreement Number 101112269).

ECCS
CECM
EKS

STEEL ARCHITECTURE ▼ AWARDS ▼ EU PROJECTS ▼ NEWS AND EVENTS STANDARDS ▼ More about ECCS ≡

Homepage / EU projects / ADVANCE


ADVANCE

Accompanying measure for Dissemination, Valorisation and Collaborative Exploitation
of circularity of constructional steel products

2023-2025


ADVANCE
ACCOMPANYING MEASURE FOR DISSEMINATION, VALORISATION
AND COLLABORATIVE EXPLOITATION OF CIRCULARITY
OF CONSTRUCTIONAL STEEL PRODUCTS

The project's ambition is to contribute to greenhouse gas reduction and circular economy goals by addressing these challenges in both deconstruction and reuse of existing steel buildings, and in the design of new buildings, their construction and documentation to facilitate future reuse. Its scope includes reuse of constituent products, fabricated components, and reuse of component assemblies. The reused material may originate from primary structures (frames, see Figure 1), secondary structures and envelopes.



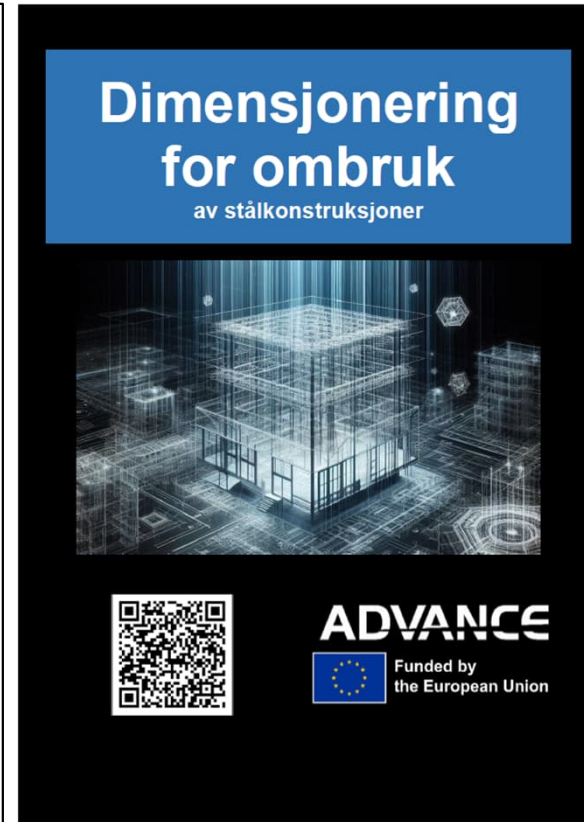
ADVANCE

- > Factsheets
- > Media
- > Presentations and brochures
- > Project outputs
- > Partners

 **Funded by
the European Union**

ADVANCE is an EU funded project
(Grant Agreement Number 101112269)

Brochures



Recommendations for Reuse



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The *ADVANCE* project's ambition is to contribute to greenhouse gas reduction and circular economy goals by addressing these challenges in both deconstruction and reuse of existing steel buildings, and in the design of new buildings, their construction and documentation to facilitate future reuse. Its scope includes reuse of constituent products, fabricated components, and reuse of component assemblies. The reused material may originate from primary structures, secondary structures and envelopes.

The reduction of greenhouse gas emissions of steel industry became essential in the recent years with the major focus on the construction sector, the single largest source of its environmental footprint. The construction sector comprises the opportunity to establish steel-based technologies in a leading position for the decarbonisation of other relevant industries dependent on steel solutions.



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EUROPEAN RECOMMENDATIONS FOR REUSE OF RECLAIMED STEEL PRODUCTS

— Volume 1: Reusing existing steel products and buildings —

Technical Committee 14
Sustainability & Eco-Efficiency of Steel Construction,
in the frame of Advance Project
2025



TC14 is the Technical Committee within ECES for Sustainability and Eco-Efficiency of Steel Construction. The committee aims to promote developments in industry, research and teaching communities that strengthen knowledge and capabilities in relation to sustainable steel construction.

The broad area of the issues includes, for example, the following aspects: Management of overall building performance during the whole lifecycle; Techniques for the improved environmental performance; Techniques for a high quality and comfort of the indoor environment; Energy efficiency; Minimization of resources and use of raw materials.

EUROPEAN RECOMMENDATIONS FOR REUSE OF RECLAIMED STEEL PRODUCTS — VOLUME 1

2025



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the European Union

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EUROPEAN RECOMMENDATIONS FOR REUSE OF RECLAIMED STEEL PRODUCTS

— Volume 2: Building design recommendations to facilitate future deconstruction and reuse —

Technical Committee 14
Sustainability & Eco-Efficiency of Steel Construction,
in the frame of Advance Project
2025



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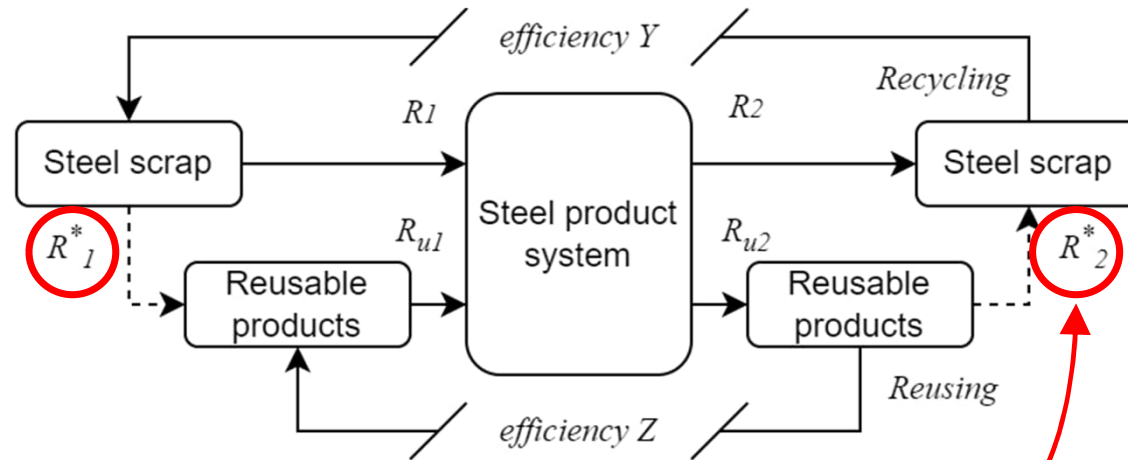
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EUROPEAN RECOMMENDATIONS FOR REUSE OF RECLAIMED STEEL PRODUCTS — VOLUME 2

2025



Updated LCA methodology



benefit (+)
load (-)

additional
parameters

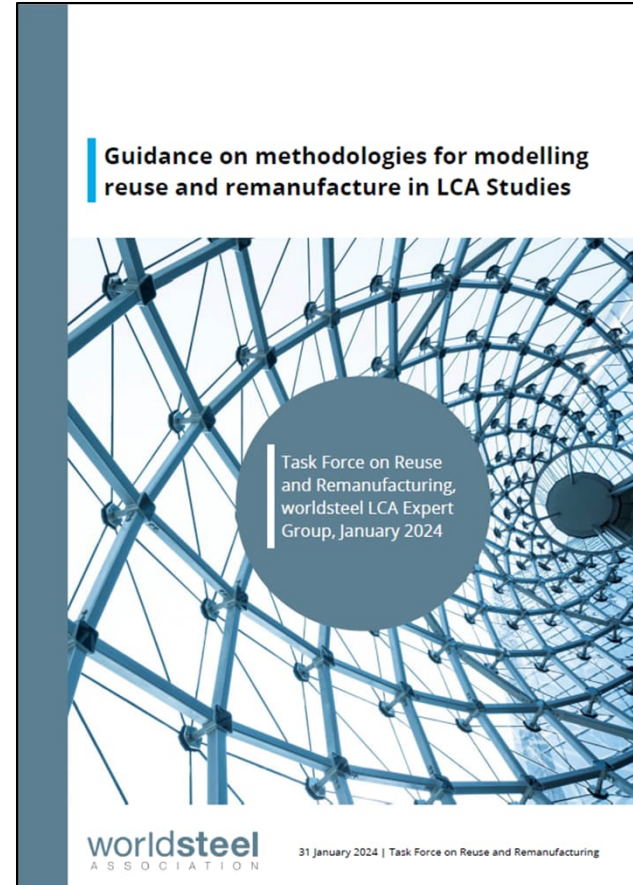
$$\text{net benefit of recycling} = (R_2 - R_1 + (R_{u2} - R_{u1})(R_2^* - R_1^*)) X_{sc}$$

$$\text{net benefit of reuse} = (R_{u2} - R_{u1})(X_{inc\ recycling} - X_{refurb})Z$$

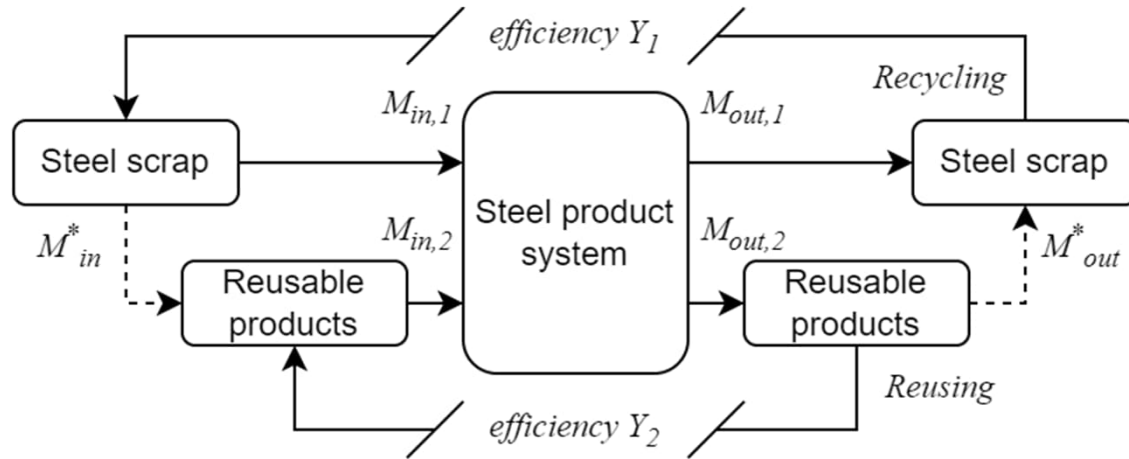
$$X_{inc\ recycling} = X_m - (R_2^* - R_1^*) X_{sc}$$

$$X_{sc} = (X_{pr} - X_{re})Y$$

pr primary production
re recycling
m manufacturing



Updated LCA methodology



$$e_{moduleD1.1} = (M_{out,1} - M_{in,1} + (M_{out,2} - M_{in,2}) \frac{M_{out}^* - M_{in}^*}{M}) \cdot (E_{MR,1} - E_{VM,1}) Y_1$$

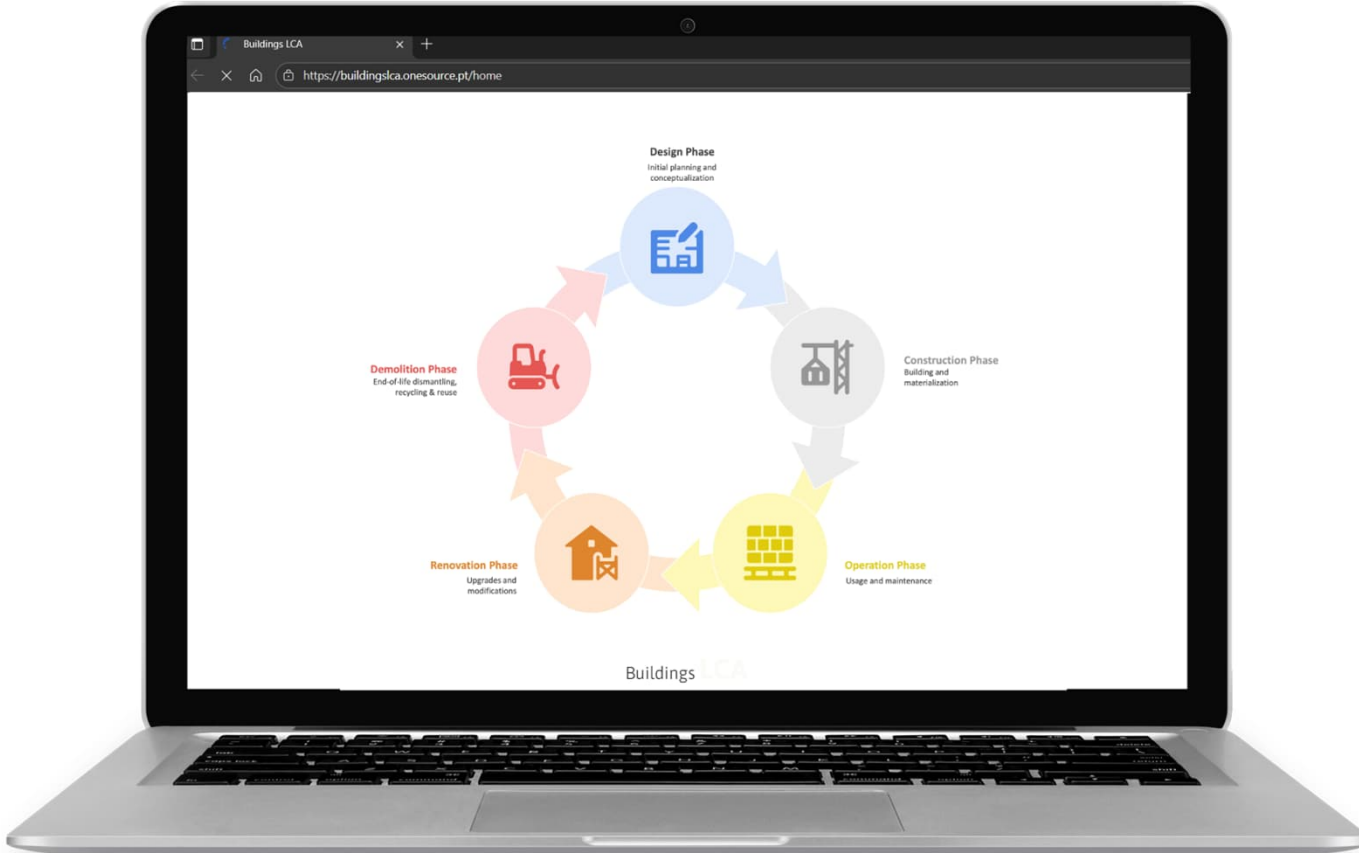
$$e_{moduleD1.2} = (M_{out,2} - M_{in,2}) \cdot (E_{MR,2} - E_{VM,2} - \frac{M_{out}^* - M_{in}^*}{M} (E_{VM,1} - E_{MR,1}) \frac{Y_1}{Y_2}) Y_2$$

benefit (-)
load (+)



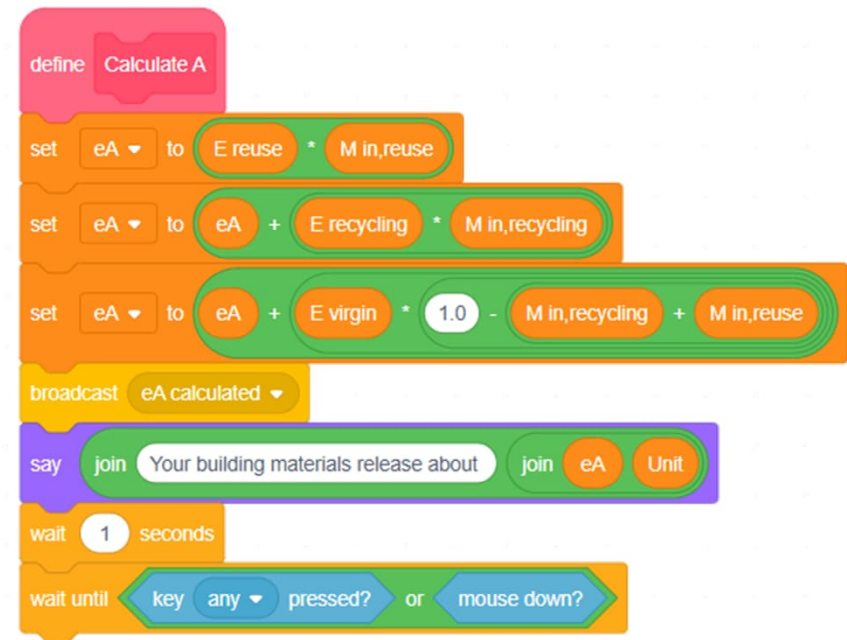
Mobile app and web tool

<https://buildingslca.onesource.pt/>



Online minigame

<https://scratch.mit.edu/projects/1161220510/>




Case studies

ADVANCE 2023-2025

ACCOMPANYING MEASURE FOR DISSEMINATION, VALORISATION AND COLLABORATIVE EXPLOITATION OF CIRCULARITY OF CONSTRUCTIONAL STEEL PRODUCTS

Reuse of Steel Case Study no. 12

Design for circularity – Petite Maison, Luxembourg



Project summary

Client: University of Luxembourg (UL)
 Subsidized by: Esch2022 and F&ESch.arb
 Contractors: Annen, CDO, Gardula, Schre
 Mabilux, Prefalux, Reckinger
 Architects: Carole Schmit (UL), Dragos GH
 Structural engineers: Andrius Kozma (DESA
 Odenbreit (UL)
 Steel fabricator: ArcelorMittal
 Engineering: Betic Ingénieurs-Consults, BH
 DESA Ingénieurs-Consults, Gori Securite Sa
 Ingénieurs-paysagistes, Metricio, Paul Wur
 Architects, Schroeder & Associés
 Construction cost (including demolition): N

Description of the new building

The Petite Maison building¹, located in Esch-Belval, Luxembourg, was initiated as an architect January 2021 to promote the circularity of construction materials and contribute to the Euro Culture Esch2022. The project comprised design, construction, use and deconstruction phases specifically designed for disassembling/deconstruction and reuse, incorporating the latest in European project REDUCE² on demountability and reuse of composite structures.

The main part of the building structure consisted of:

- a steel frame, measuring 10.8 meters (m) x 8.1 m, following a structural grid of 1.35
- modular and prefabricated structural kits³ in standard sizes, including concrete slabs with bolted shear connections, adaptable steel connections,
- diagonal bracing system (roof and wall),
- a timber roof with steel profiled cladding sheets, supported by steel posts,
- timber wall panels, partitions, cladding, and
- prefabricated concrete foundations.

During the use phase, the building was open for guided public visits, workshops, lectures, a Restopops. A mobile exhibition on deconstruction, designed by Rotor in Brussels, as part of called FCBE was hosted in Petite Maison as well and was open to public visit from December 2023.


In August 2023, the deconstruction of the Petite Maison building commenced. QR codes were reusable building components, linking them to a virtual database to facilitate future reuse.

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ACCOMPANYING MEASURE FOR DISSEMINATION, VALORISATION AND COLLABORATIVE EXPLOITATION OF CIRCULARITY OF CONSTRUCTIONAL STEEL PRODUCTS

Reuse of Steel Case Study no. 13

Reuse of steel sheet piles



Project summary

Project: Remediation of "Schwarze Pumpe"
 Spremberg, Germany
 Project owner: LMBV GmbH
 Design: Arge, CDM Smith
 Contractors: Arge Lobbe / Bauer
 Steel product: Sheet pile PU 22 x 140 m – 2
 Steel manufacturer: ArcelorMittal
 Construction cost: N/A

Reuse of steel sheet piles

Sheet piles can be applied in many fields, such as water transport solutions like quay walls, hazard protection solutions such as dams, mobility infrastructure solutions like rail and road bridges, tunnels, underground car parks, and environmental protection solutions such as polluted soil remediation. The modularity of steel sheet piles facilitates their reuse; they can be extracted from the ground at the end of their service life. In temporary applications, steel sheet piles are often reused multiple times in the same project or for subsequent projects. Steel sheet piles are top choice in temporary scenarios for example, cofferdams in water, linear excavations, water retention, complicated utilities installation and repairs, and limitation of settlement in nearby structures and services.

Temporary applications, such as excavation pits, have shorter life cycles, often under 2 years commonly employ sheet piles for such purposes, with sections sometimes reused up to 10 sections are particularly suitable for reuse due to their compactness and high stiffness. After (50 cm) is typically removed if deformations or damages from the installation process are or too. In addition, it is becoming increasingly accepted by project owners to install used applications. After long service lives, the sheet piles can still be extracted from the soil, be as input for the newly produced steel. This establishes a perfect cycle for the infinite use of degradation of material properties.

Reuse of steel sheet piles in temporary applications

Decontamination of polluted soils


Soil decontamination projects involve enclosing contaminated areas with steel sheet pile typically includes surrounding the area with an impervious sheet pile wall, excavating con

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ACCOMPANYING MEASURE FOR DISSEMINATION, VALORISATION AND COLLABORATIVE EXPLOITATION OF CIRCULARITY OF CONSTRUCTIONAL STEEL PRODUCTS

Reuse of Steel Case Study no. 14

The deconstruction and reassembly of a hall with truss



Project summary

Client: SYTEVOM
 Contractor: VIRY – FA
 Architect: ER ARCH
 Structural engineers: ALBYA, IC
 Steel fabricator: VIRY – FA
 Original steelwork: 1970s

Description of the existing building

The original building was situated in Gonnevillers in the north of Paris. The building served as indoor riding ring. It has been designed as a frame structure with hot rolled IPE sections used for the columns and truss girders. The truss girder was composed of equal leg angle sections of different sizes: L50x5 used for the upper chord, L60x5 used for the lower chord, L40x4 used for the uprights and diagonals in the centre of the truss and again L50x5 used for the truss elements near the columns. The connection between truss elements and upper and lower chord may be seen as specific feature as these connections are welded.

In total nine frames form the hall.


During the initial inspection of the existing building several members were observed to have suffered from buckling. These trusses were not re-usable and therefore they had been separated from trusses planned to be reused. Nonetheless, these trusses were kept in order to be used for the reassessment of material properties of the structural steel elements.

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ACCOMPANYING MEASURE FOR DISSEMINATION, VALORISATION AND COLLABORATIVE EXPLOITATION OF CIRCULARITY OF CONSTRUCTIONAL STEEL PRODUCTS

Reuse of Steel Case Study no. 16

The deconstruction and reassembly of steel hall in a new



Project summary

Location: Helsinki, Finland
 Owner of hall: City of Helsinki
 New Owner: Veijoluut Kaakinen
 Contractor / client of demolitio
 Demolition contractor: Parkkipu
 Deconstruction time: Fall 2023
 Auction sale price of hall: 440 0

Description of the existing building

The project deals with dismantling Market Hall building in Hakaniemi district, Helsinki. The Hämeentie 1 Helsinki, Finland was located in the heart of Helsinki metropolitan area. It Group. The Market Hall was also known as "The Glass Hall". It opened as temporary market hall opened in January 2018 to enabled the continuation of activities from old historical building market hall building throughout its entire 5-year renovation period. The Glass Hall operated for 5 years before dismantling. Deconstruction began in fall 2023. The old Hakaniemi Market Hall is a well-known building, and this temporary market hall also became very popular among citizens.

Picture 1 Deconstruction of steel frame hall in Hakaniemi, Finland

Picture 2 In the middle is the temporary market hall, the old Market Hall


The Glass Hall is one-story hall and was built on a pile foundation. The size of the building is about 2 300 square meters (the main building was approximately 92 meters long and 23 meters wide). The load-bearing structure of this 2300 m² hall is a steel

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Reuse of Steel Case Study no. 15

Deconstruction and relocation of four standard kit modules in a new complex of buildings in Râmnicu Vâlcea, Romania




Project summary

Client: S.C. CCS IMOB CONSTRUCT S.R.L.
 Structural engineers: S.C. BON STEEL S.R.L.

Description of the existing building

A standard kit solution was developed in 2006 to build steel structures adaptable for different locations (climate/seismic conditions) and applications, in different locations in Romania. The structure of standard kit was designed as 6 bays of 6.0 m, with a single span of 15.0 m and a height at eaves of 7m, with the possibility to connect several such kits for longer lengths.

Buildings from four construction sites, implemented between 2008 and 2010 in Bala Mare (A), Râmnicu Vâlcea (B), Târgu Mureş (C), and Cluj-Napoca (D) were disassembled, relocated and integrated in a new complex in Sibiu, Romania in 2019. The secondary structure consists of cold-formed steel purlins and side rails. The 3D views of the relocated structures are presented in Figure 1.



Bala Mare Râmnicu Vâlcea Târgu Mureş Cluj-Napoca

Fig. 1. 3D view of the initial structure (structural model)



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2023-2025

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Thank you!

petr.hradil@vtt.fi
[#VTTStructuralMaterials](https://twitter.com/VTTStructuralMaterials)