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VTT

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

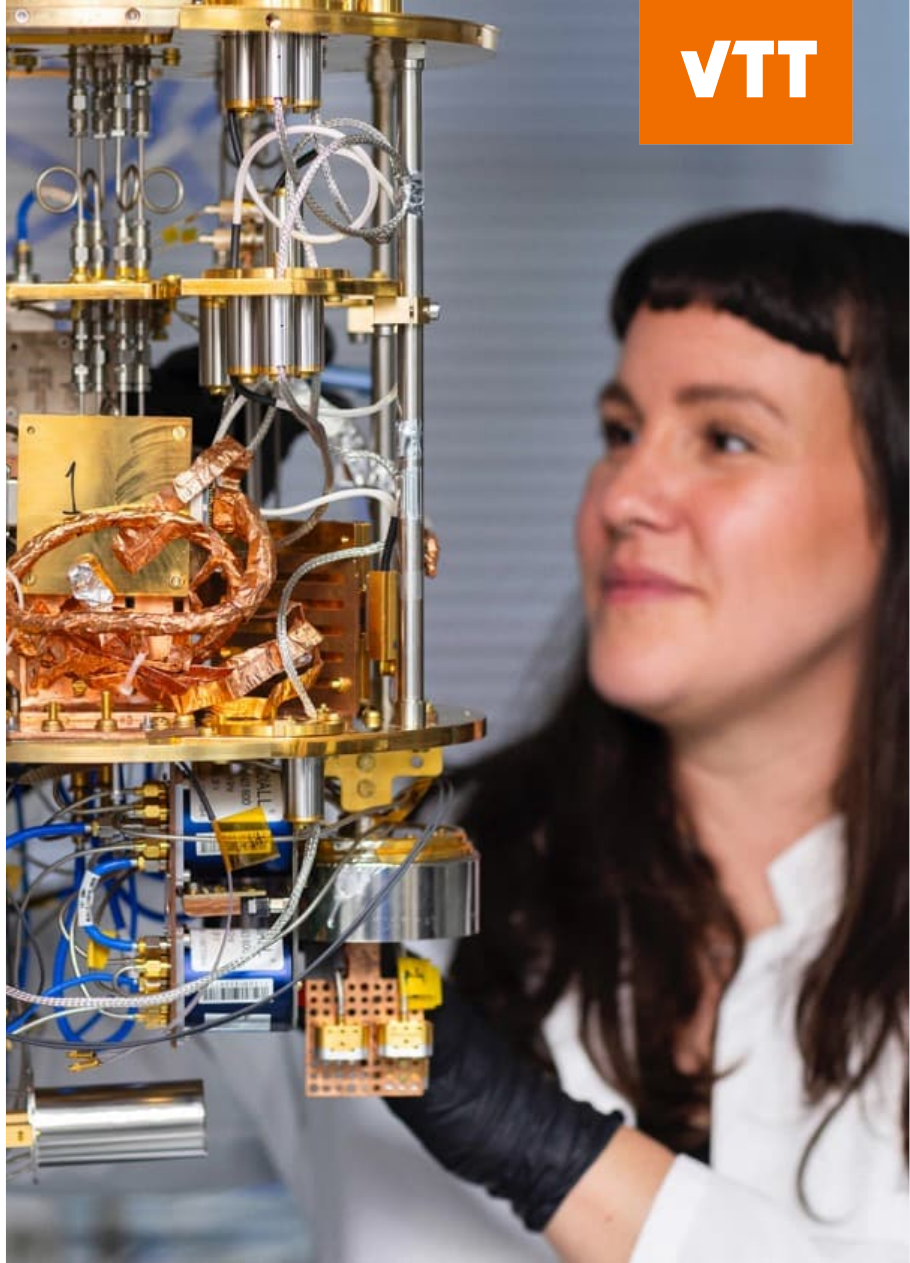
Petr Hradil
Norsk Ståldag, 6.11.2025

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 theworld’s biggest challenges and create sustainable growth, jobs and well-being.

2,390	1,100	296 M€
employees	customers	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.

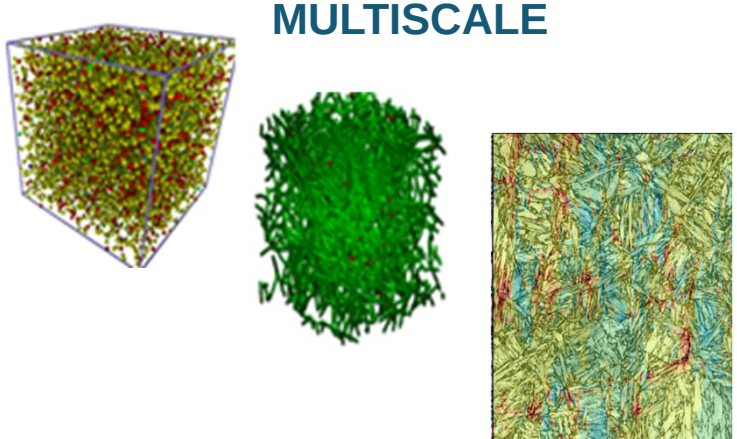
Spinnova
SOLAR FOODS
IBER INFINITED
PAPTIC
SemiQon
STEADY ENERGY
eniferBio
CooliBlade
The Warming Surfaces Company
Volare
ONEGO
Carbonaide

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.

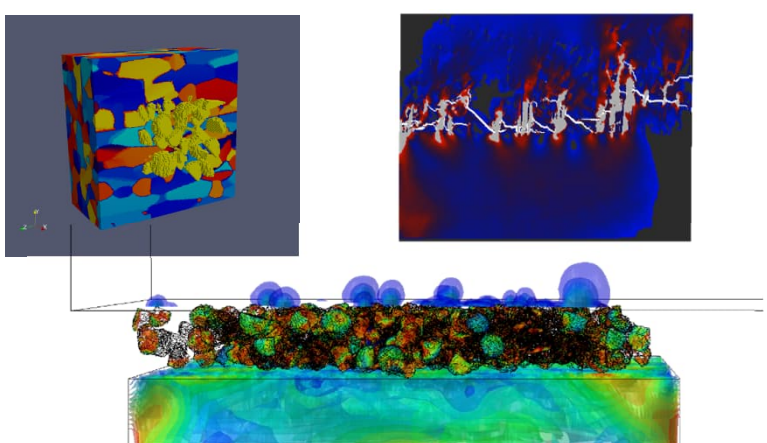
MULTISCALE



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

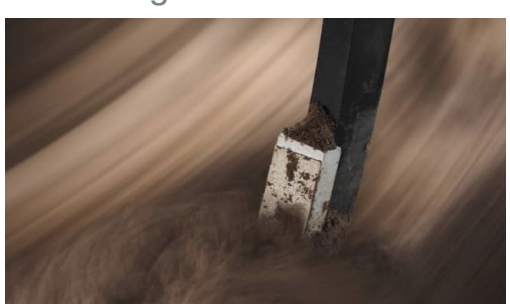
- Optimization of protective composite coatings

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

Use case type: New steel grade design

ArcelorMittal

- 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

U.S. DEPARTMENT OF ENERGY

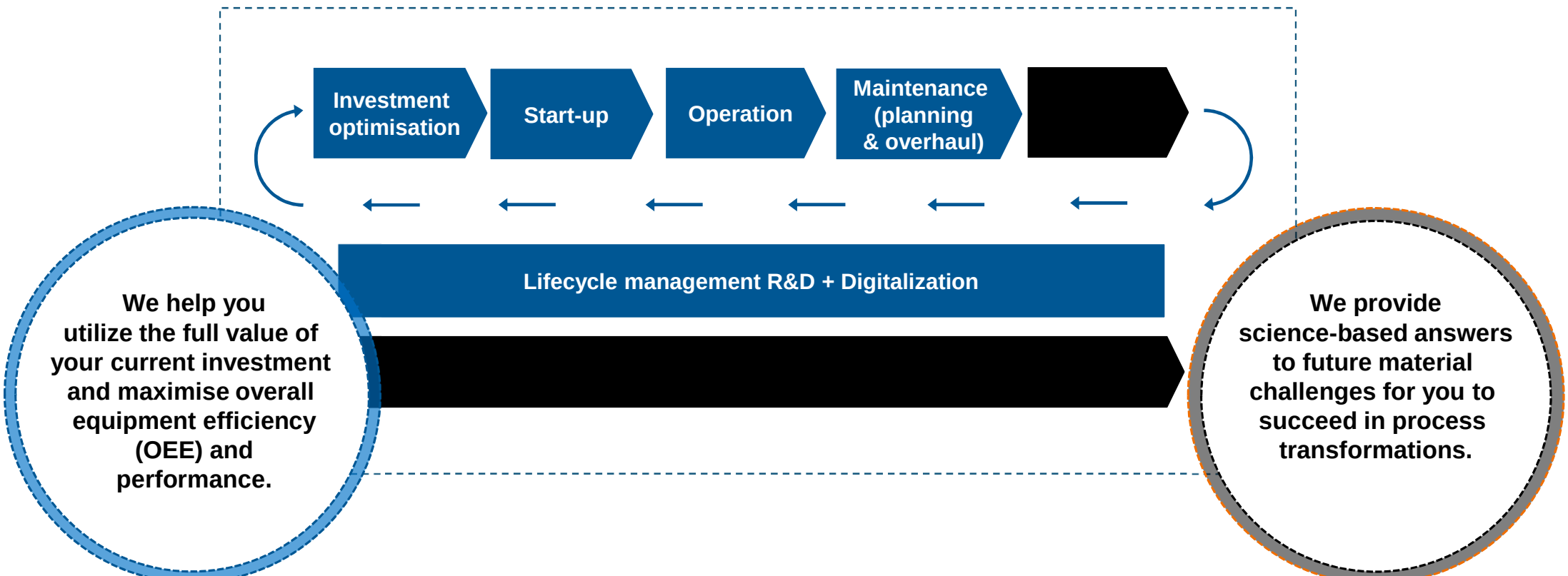
- Novel materials for the first wall of fusion reactors

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

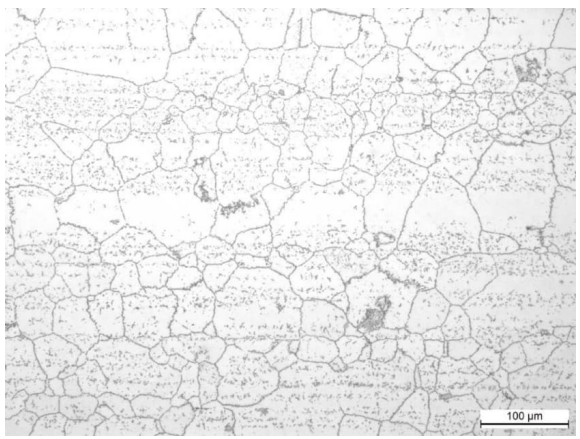
VTT ProperTune® has been developed together with our industrial partners and applied to their materials and products.

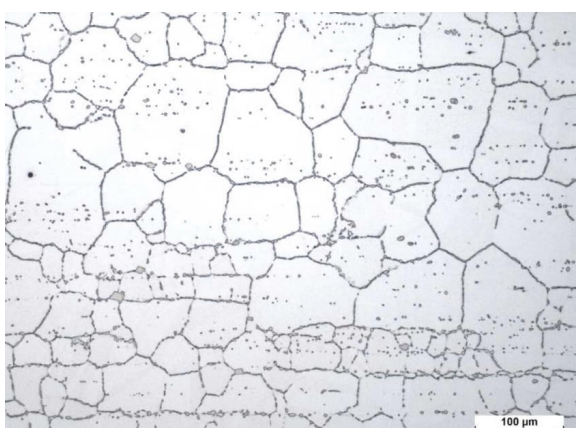
… to material service life management …

VTT ProperScan
Understanding tomorrow's materials



VTT ProperScan
Rejuvenation treatment of gas turbine inner casing material



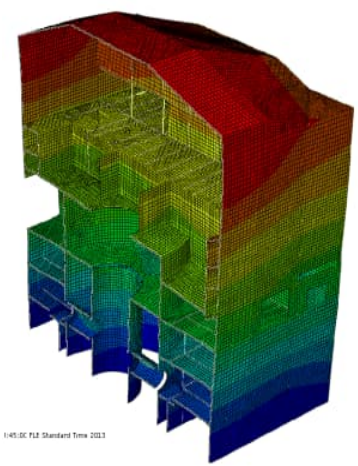


Challenge: Gas turbine service life is approaching the manufacturer recommended limit with no rejuvenation option. The power plant is facing an expensive replacement investment.

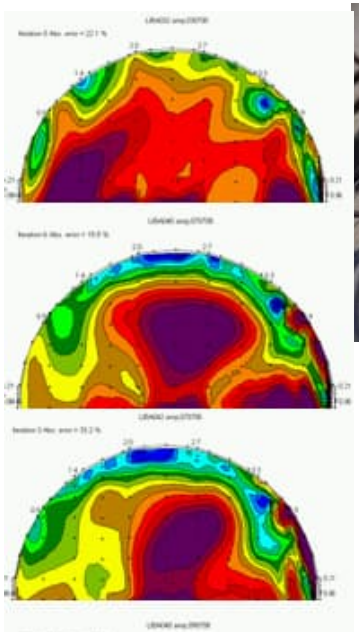
Solution:

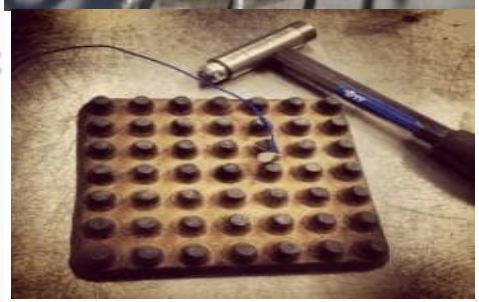
- VTT carried out metallographic analysis and mechanical testing of heat-treated material samples
- The results confirm that heat treatment of casing will offer sufficient rejuvenation potential of the material properties to facilitate the targeted service life extension
- Helen proceeded with the heat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

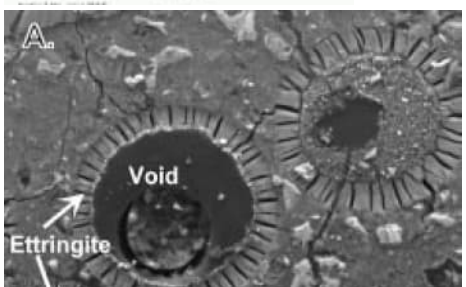
Structural Materials



- **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





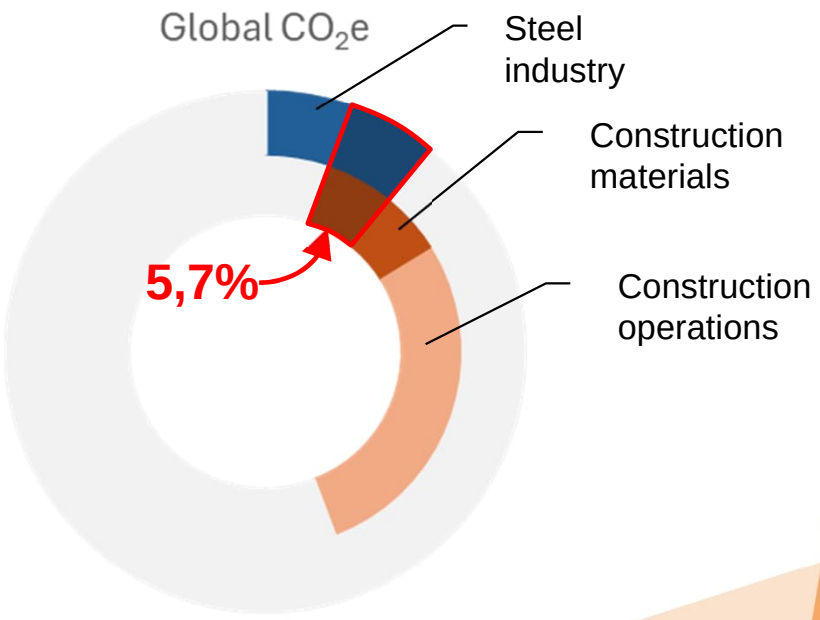


… to solutions beyond the service life boundaries

Constructional steel …

… causes significant CO_2e impact globally

- Construction industry is responsible for ~39% of global CO_2 (11% materials, 28% operations)
- Steel industry is responsible for ~8% of global GHG emissions ~11% of global CO_2
- Constructional steel share is ~52% of total steel production



Source: World Steel Association, World Green Building Council

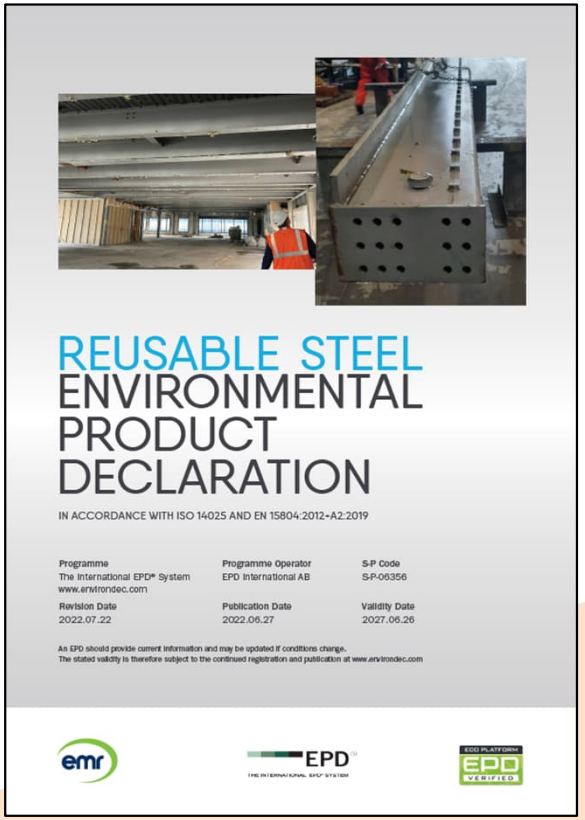
Constructional steel …

… offers significant CO_2 saving when reused

product stage
333 $kgCO_2e/t$

86% reduction

product stage
47 $kgCO_2e/t$



2017-2020

PROGRESS

PROVISIONS FOR GREATER REUSE OF STEEL STRUCTURES

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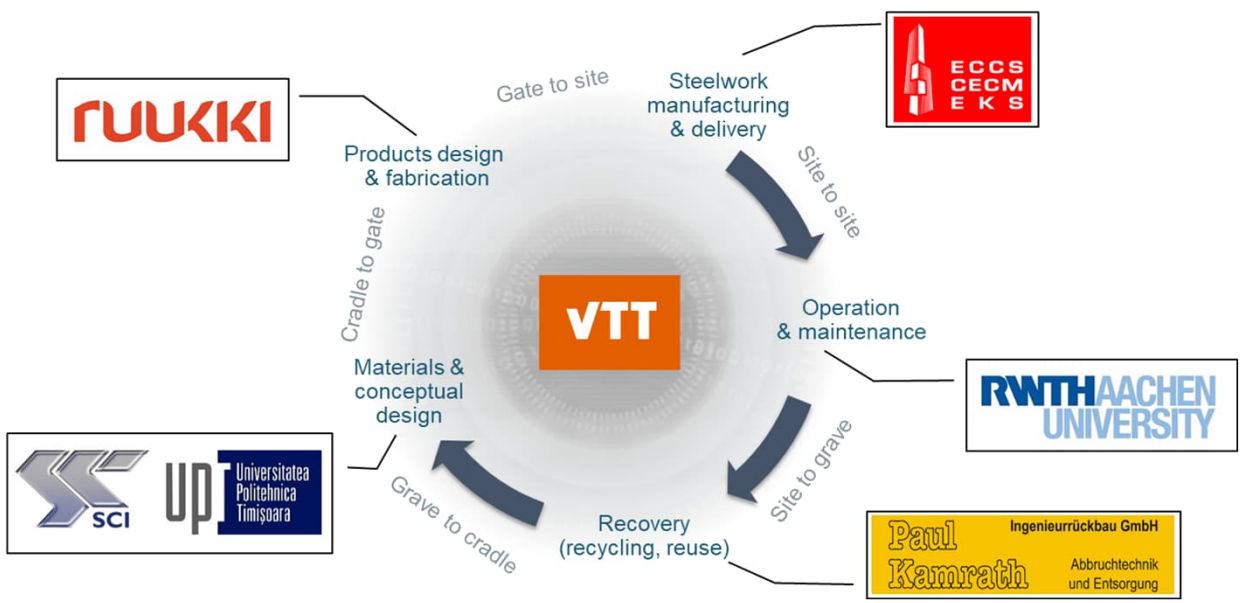


- **Protocols**
  - Pre-deconstruction audit protocol
  - Material testing protocol
  - Deconstruction protocol
- **Guides**
  - Existing buildings
  - New buildings
- **Assessment methods**
  - LCA & LCCA for reused steel
  - Reusability index
- **Case studies**
  - 11 factsheets
- **Other results**
  - 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

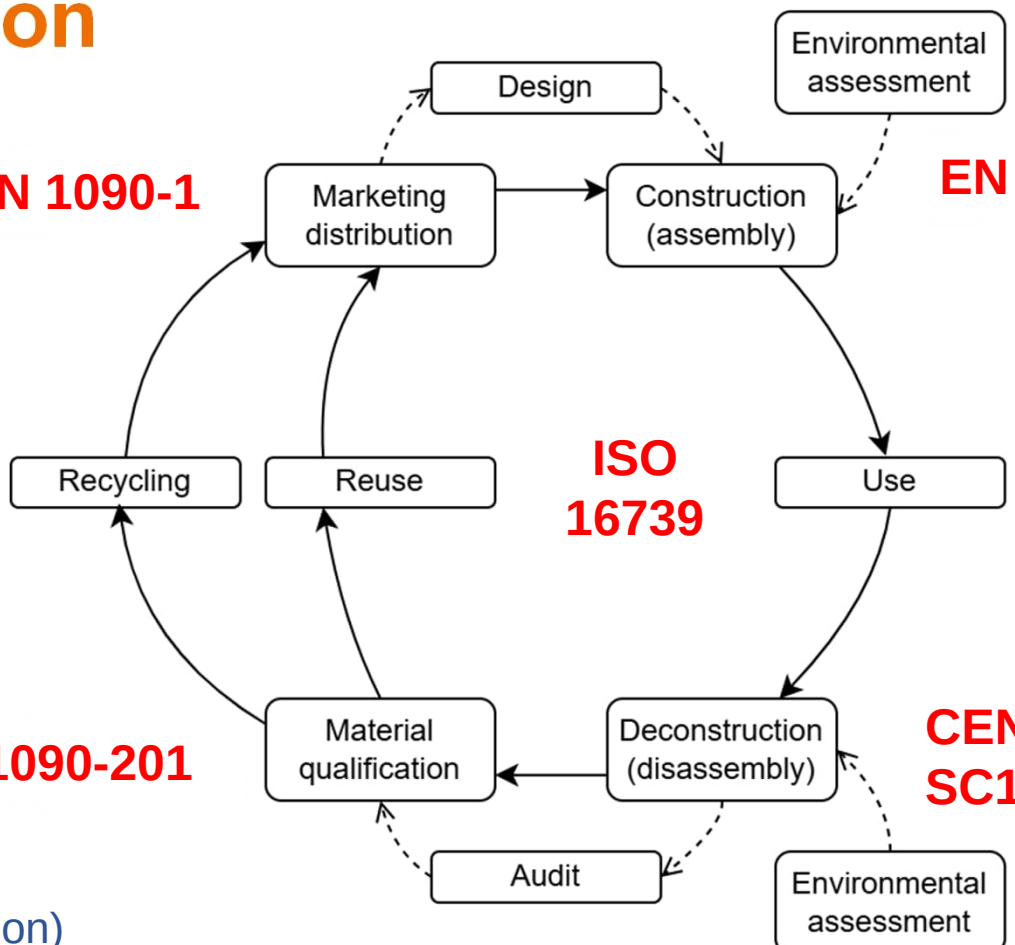
CEN/TC250/SC3/AHG
· design rules for reused steel

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)



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

Let people know that reuse is even possible →

Develop instructions for the practitioners →

Provide arguments for the authorities →

Show examples →

- **Dissemination materials**
  - Internet presentations
  - Brochures
  - Workshops/webinars
- **Standards and guides**
  - Existing buildings
  - New buildings
- **Assessment methods**
  - Impacts of steel reuse
- **IT tools**
  - Mobile apps
  - Web apps
  - Other tools
- **Case studies**
  - Factsheets

2023-2025

ADVANCE

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

Funded by the European Union

- **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

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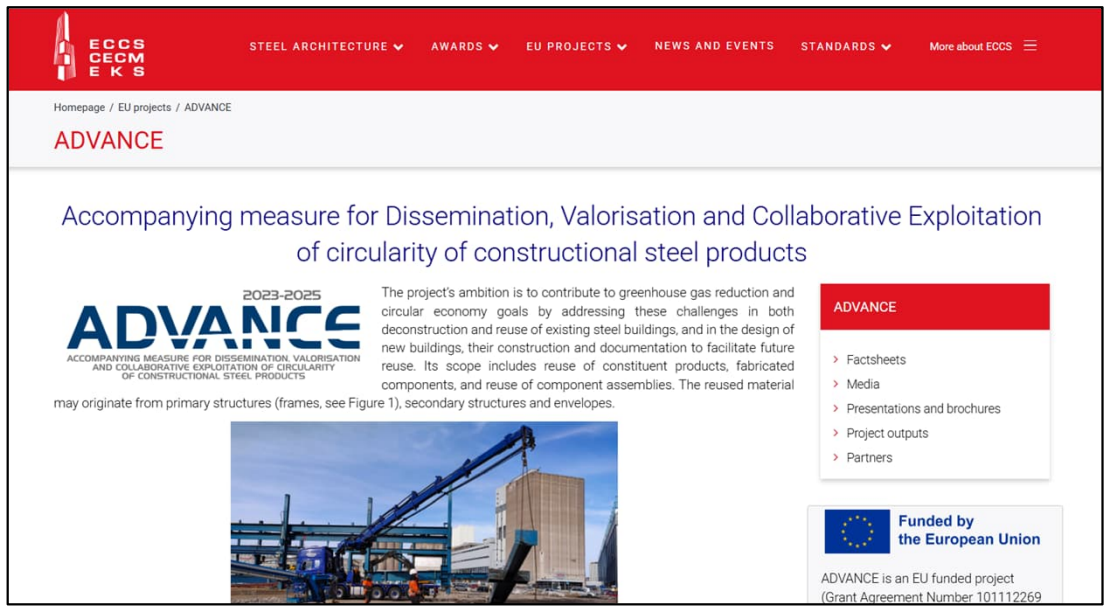
https://www.steelconstruct.com/eu-projects/advance/



Brochures

Funded by
the European Union

Recommendations for Reuse

Funded by
the European Union

Updated LCA methodology

Funded by
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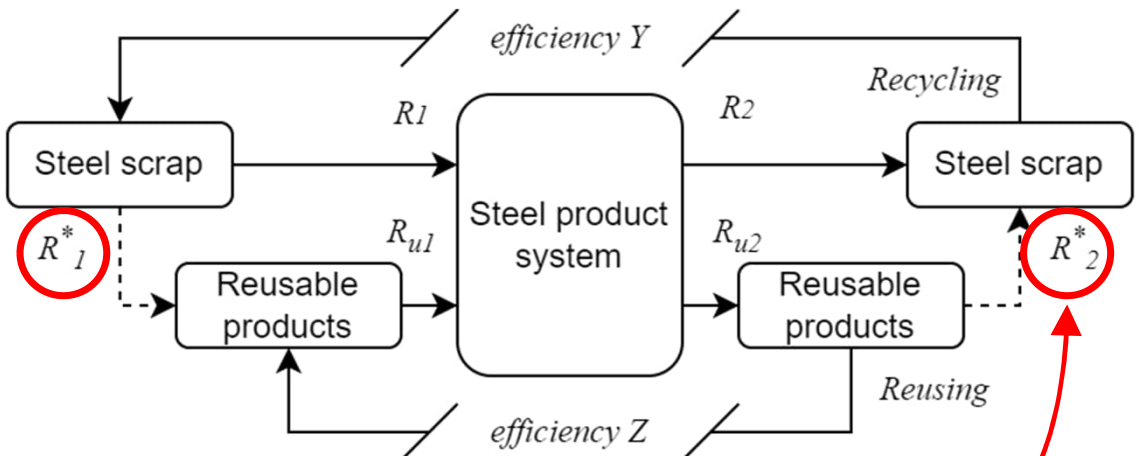


benefit (+)
load (-)

additional parameters

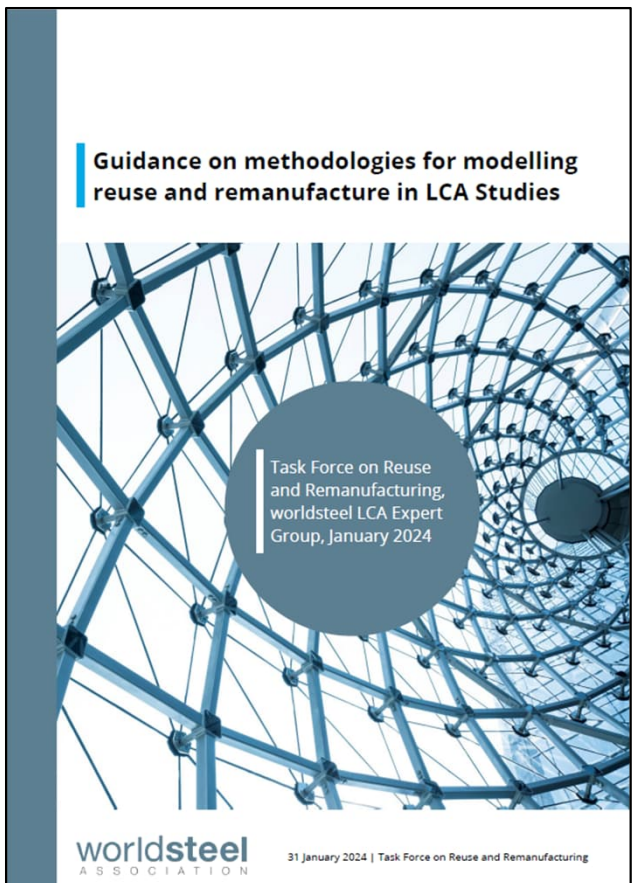
$$net\ benefit\ of\ recycling = \left(R_2 - R_1 + (R_{u2} - R_{u1})(R_2^* - R_1^*)\right) X_{sc}$$

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

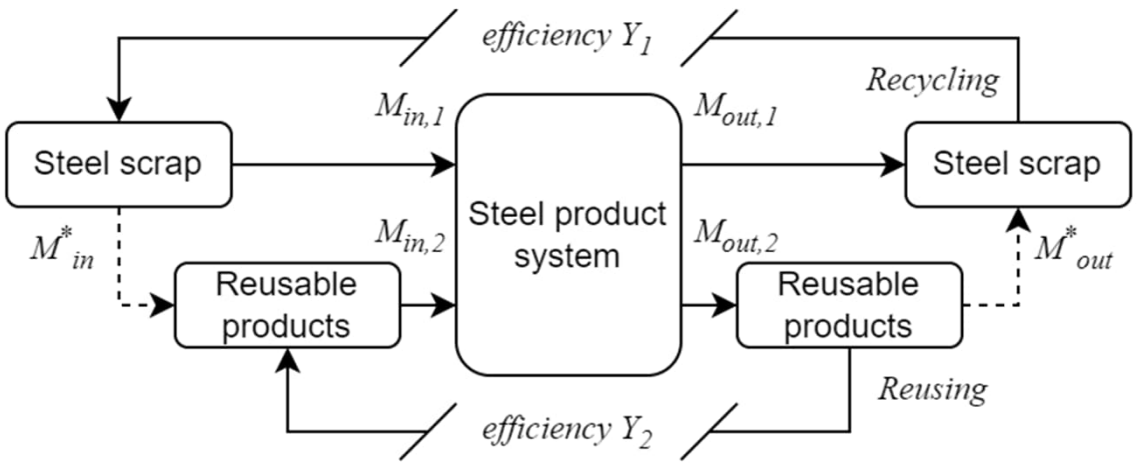
$$X_{inc\ recycling} = X_m - (R_2^* - R_1^*)\ X_{sc}$$

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

pr **primary production**
re **recycling**
m **manufacturing**



Updated LCA methodology



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

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

benefit (-)
load (+)

Mobile app and web tool

https://buildingslca.onesource.pt/

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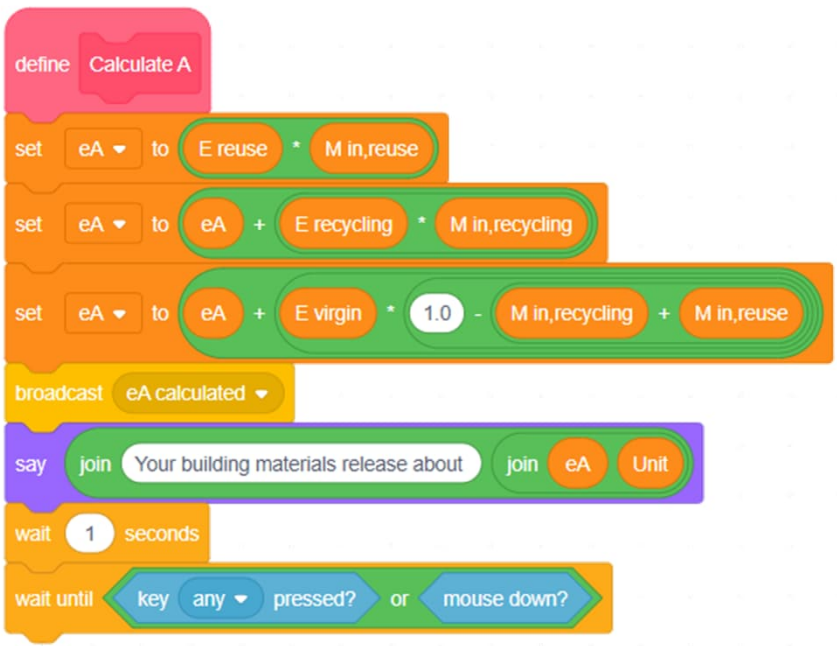
Online minigame

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



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Case studies

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2023-2025

ADVANCE

Accompanying Measure for Dissemination, Valorisation and Collaborative Exploitation of Circularity of Constructional Steel Products

Thank you!

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