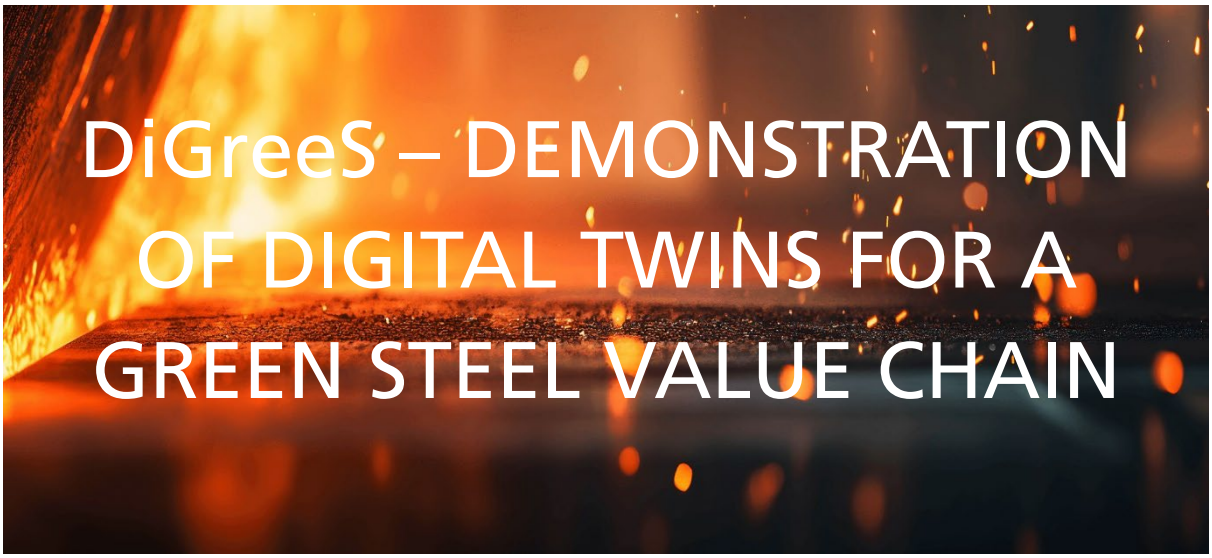


The EU project "DiGreeS" aims to make steel production "greener", digital, and more economical

Ambition and specific objectives

The transition to low-carbon and eco-friendly steel production in Europe requires a significant transformation of the steelmaking processes, particularly the introduction of new steelmaking routes. There is a clear need for enablers to plan and manage this revolution and ensure sustainable steel production. In this context, the steel production requires breakthrough technologies to reduce its environmental footprint as close to zero as possible. Additionally, a seamless digitalization of the production processes and skilled personnel are necessary to support and understand the transformation process. DiGreeS will tackle these challenges by implementing an integrated digitalization approach throughout the steel value chain, to enable an enhanced use of the industrial data collected along the process chain and ensuring the integration of human expertise for easier industrial implementation.

The aim of DiGreeS is to develop a user-friendly digital platform for networked production based on novel and soft sensors as well as related approaches and models, which will be demonstrated in three individual use cases targeting different segments of the steel value chain. Within DiGreeS comprehensive digital twins will be developed to support efficient feedstock verification and real-time control of crude steel (CS) production using electric arc furnaces (EAFs) and to increase the process yield while improving the quality of intermediate and final steel products. In this context, the potential of artificial intelligence (AI) and machine learning (ML) technologies will be fully exploited to support the optimal use of process data, and various scenarios specific to each use case (UC) will be modelled. Consequently, DiGreeS will apply digitalization solutions to improve the product quality of CS and final products, to enhance the raw material and energy efficiency of the steel production process, and thus to increase the circularity and reduce the CO_2 emissions of steel production.

These challenges will be tackled through the following specific objectives:

- Development of a data ecosystem for planning and process management that increases the data availability across the steel supply chain

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HADEA). Neither the European Union nor HADEA can be held responsible for them.

- Integration of novel sensor technologies combined with digital process models for real-time process monitoring and prediction of process conditions (e.g. slag parameters), as well as control and optimization of process parameters, including forecasting energy requirement and product quality
- Tracking of relevant process and material information across the entire process chain for synergetic process optimizations with improved database
- Feedstock characterization of the heavy melting scrap (HMS) through cutting-edge sensors, inline sensor and machine control-data feeding digital process models
- Establishment of decision support tools to support operators and process experts

Use cases along the steel value chain

The UC1 is focused on the HMS verification. Currently, the HMS characterization is based on visual inspection by experienced employees and random sample spectroscopic analysis with handheld X-Ray fluorescence. An improved and reliable scrap characterization is needed to allow operator-friendly sorting and better separation to reduce impurities in the targeted steel heat.

UC2 focuses on optimizing the production of crude steel by EAF. Currently, the process control of the scrap-based EAF is highly empirical, relying mainly on the individual skills of the operators and on fixed operating patterns, but not on real-time measured process data, making the current process inefficient in terms of material and energy. An innovative solution is needed to monitor and control sustainability of the running process conditions, to set up countermeasures to stay within the optimal process window.

UC3 is focused on the quality assurance of semi-finished products particularly steel sheets, and the optimization of the process parameters. The current process control is based on long-term system behavior, lacks regular updates and doesn't consider changes in the production system or inline sensor data, and the final quality of the product is determined after its levelling, blanking and annealing. Around 4% of the steel sheets need to be reworked (levelling and annealing), that leads to up to 20% of additional plant utilization because a rework of plate material is significantly more time consuming than the processing of the coil material. A new approach is needed to optimize the levelling process using data from previous process steps, as well as predicting final product quality before annealing, to reduce the rework by half (down to 2%).

Work progress – Mid 2025

WP1 Requirement analysis of the use cases deals with analyzing the current state of the use case environments, both with regards to physical and digital aspects. Data sources, interfaces, security and data sets pertaining to the use cases were reviewed and gaps and needs for implementing digital twins and process models were identified. Data structures were defined, soft sensors and new hardware specified to fill the gaps were identified. Moreover, missing information and IT/OT infrastructures are being identified.

WP2 Optimization and integration of additional sensor and data sources focuses on the mechanical and digital adaptation of the pre-defined sensors, and data sources so that they meet the requirements and can be adapted and integrated in existing process lines and infrastructure in the respective use case.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HADEA). Neither the European Union nor HADEA can be held responsible for them.

🔍 Use case highlights

Significant progress has been made in mechanical design, lab testing, and sensor calibration:

- **UC1:** Development of LIBS and camera systems to characterize heavy melting scrap; engineering concepts and sensor testing well advanced.
- **UC2:** Studies on the placement of Rogowski coils, off-gas sensors and acoustic emission (AE) sensors to monitor EAF operations and preliminary measurements to optimize the sensors for the EAF operational environment.
- **UC3:** Implementation of micromagnetic (3MA) sensors to measure tensile stress in steel sheets inline; initial lab tests using 3MA-X8 technology were completed successfully distinguishing between different stress conditions in steel plates.

WP3 Offline and online data architecture and data security implements suitable industrial data communication interfaces, structure data sets, and network local data archives for offline and online data sharing among industrial use-case parties and modelling experts.

🛠 Current progress across all UCs

To ensure the complete dataflow within and between the use cases and a better use of industrial data, appropriate interfaces from and to the IT system attached to the various steel manufacturing processes that play a crucial role in all forms of data communication were defined. This includes a data lake instance, a dashboard and a computational environment. A centralized offline data architecture and data storage systems, which serve as a solid basis for modelling and incorporate the necessary feature-generation functionalities has been designed. Moreover, a methodology for the cybersecurity design has been adopted adhering to the principle of "secure by design".

Regarding the security architecture design and utilization, cybersecurity risks are managed from the initial steps of the project. With the holistic security architecture, the introduced CSIRT and federated SOC operator the continuous monitoring of security posture will take place. Additionally, security incident management framework will be established and periodically tested for the purpose of further enhancing trust between participants (WP3).

WP4 Design of digital twins develops, adapts, and extends use case-specific process models using physical/analytical as well as data-based/ML approaches with inputs from process data and novel sensor information. The models will then be transferred into digital twins for integration into the architecture set up in WP3.

🔍 Use case highlights

- **UC1:** Initial trials with test images of a VIS camera to segment scrap pieces and investigation of methods to speed up segmentation.
- **UC2:** Definition of process input data needed for adaptation and validation of the existing BFI model for the EAF; assessment and evaluation of the first historical process data (electrical energy supply) at the Ascoval EAF.
- **UC3:** Definition of available data and internal efforts to bring all the relevant data into one data-warehouse; sharing of first data-batch and training materials helpful for the ML-model development; clarification about documentation and programming languages.

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HADEA). Neither the European Union nor HADEA can be held responsible for them.

WP9 Project, data and innovation management in the first reporting period

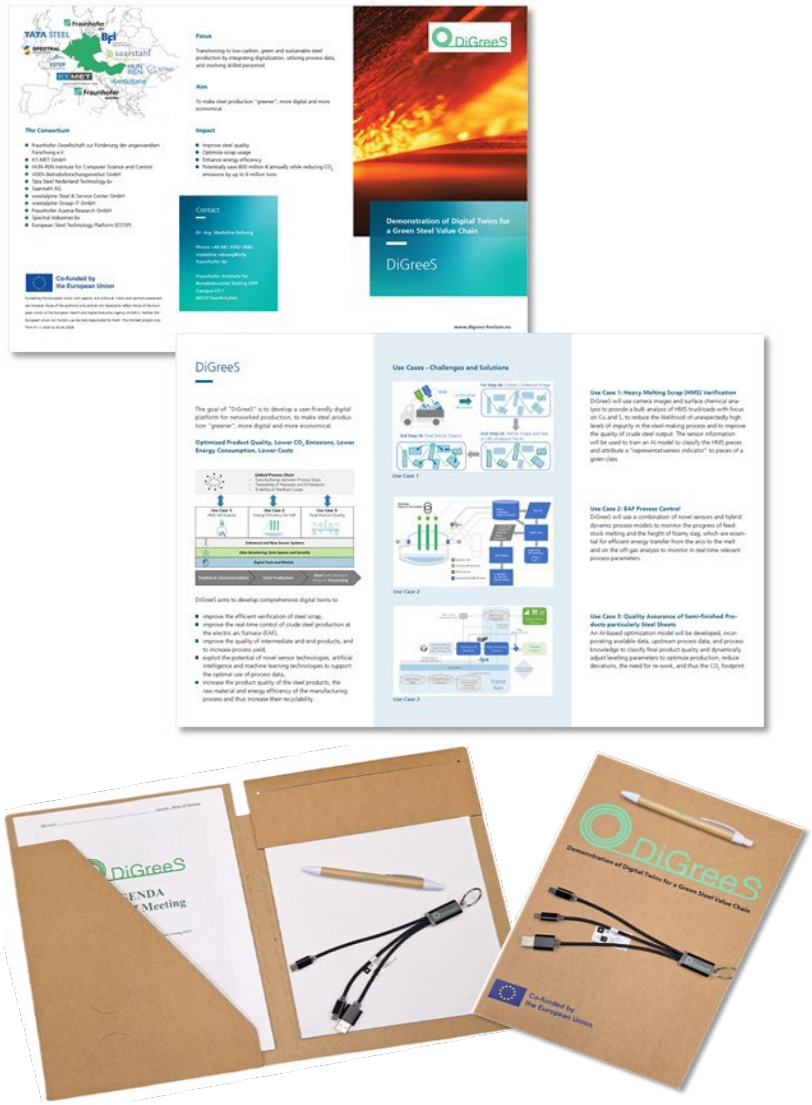
WP9 provided a clear organizational framework, guidance, and all necessary support mechanisms to enable a smooth project workflow and to ensure that objectives and milestones are met on time. As a prerequisite for all technical WPs, WP9 ensures that all contractual commitments are met on time. It also coordinates communication, dissemination, will provide optimal visibility and wide outreach to relevant stakeholders, particularly co-programmed partnerships, and will ensure the uptake, use, and exploitation of results throughout the three reporting periods.

🛠 Current progress regarding communication and dissemination

Webpage: Stay updated on DiGreeS

Presentation of the project at PURESCRAP at the INCITE Workshop! | PURESCRAP and ESTEP Spring Dissemination event 2025

Communication material: Promotion material, flyer, poster



Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HADEA). Neither the European Union nor HADEA can be held responsible for them.

Impact

Various scenarios are being modelled for three different use cases. The innovative digitalization solutions used are intended to increase the product quality of steel products, improve the raw material and energy efficiency of the manufacturing process, and thus enhance their recyclability. At the same time, the digital platform aims to reduce the steel industry's CO_2 emissions by up to 6 million tons per year and save annual costs of up to €800 million.

DiGreeS consortium:

- Fraunhofer-Gesellschaft: Fraunhofer Institute for Nondestructive Testing IZFP (DE)
- K1-MET GmbH (AT)
- HUN-REN Institute for Computer Science and Control (HUN-REN SZTAKI)
- VDEH-Betriebsforschungsinstitut GmbH (DE)
- Fraunhofer Austria Research GmbH (AT)
- Spectral Industries BV (NL)
- Tata Steel Nederland Technology BV (NL)
- Saarstahl AG (DE)
- Voestalpine steel & service center GmbH (AT)
- Voestalpine group-IT GmbH (AT)
- ESTEP Plateforme technologique européenne de l'acier (B)

DiGreeS key data:

- Leading coordination by Fraunhofer Institute for Nondestructive Testing IZFP (Dr.-Ing. Madalina Rabung)
- Funded by: European Union (HORIZON-CL4-2024-TWIN-TRANSITION-01-44)
- Duration: 11/2024 to 04/2028
- Total EU funding amount: around € 5 million
- Project webpage: DiGreeS
- Demonstration of Digital twins for a Green Steel value chain | DiGreeS | Project | Fact sheet | HORIZON | CORDIS | European Commission

Co-funded by the European Union

Funded by the European Union. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Health and Digital Executive Agency (HADEA). Neither the European Union nor HADEA can be held responsible for them.