

5. Research and development activities

During the year, the following R&D projects are highlighted, some of which started in previous years.

Steel for Construction Italy business unit

Feralpi Siderurgica S.p.A.

The Coralys project, co-financed by the European HORIZON 2020 programme, has completed the phase of defining processes for reclaiming slag and residues by producing ferro-alloys and charging materials. Subsequently, tests were conducted in an external pilot plant, aimed at the recovery of metal fractions through oxide reduction. The activities included the selection of the most suitable by-product mixes, the development of compaction methods and the preparation of the size, also thanks to the collaboration with an external company for briquetting, useful for future applications. The results of the activities led to the preparation of a technical-economic feasibility analysis for the industrial continuation of the project proposal, both through a dedicated external plant and in EAF, supplemented by environmental, scenario and dissemination

studies in cooperation with partners. The Coralys project, which ended in March 2025, demonstrated both the industrial symbiosis between industry, research and institutions and an enabling factor for the activation of circular economy pathways and the optimisation of recovered materials.

The "Steel Zero Waste" project, co-funded by the MISE and launched in 2021, aims to improve the environmental sustainability of the steel-making process through innovative technologies aimed at reducing waste and solid, liquid and gaseous emissions. In 2025, testing and evaluation activities were completed on the heating of billets via electrical induction with hot charge and welding, as well as the development of a system for the dewatering of production sludge, useful for reducing its volumes and promoting its reuse. In a parallel fashion, tests were completed for the recovery of white and black slag as building materials and trials on the use of plastic materials as a substitute for traditional polymers and fossil carbon in EAF. Analyses were also carried out on the performance of the scrap shredding machine, with the aim of optimising melting and increasing the recovery of oxides, by integrating an acoustic monitoring system for melting in EAF. The project ended in April 2025.

The ModHeaTec project (Modular HEATing Technology through renewable resources for steel production), launched as part of the European R&S Horizon – Twin Transition call, continued in 2025 at Feralpi Siderurgica in collaboration with other production sites and research bodies. The initiative aims to develop and test alternative heating systems to gas, based on electrical sources, with the aim of significantly reducing CO₂ emissions in steel production. During the year, Feralpi Siderurgica completed the evaluations and basic design for the construction of a small-scale experimental plant for billet heating by means of next-generation electrical conduction. The solution, whose implementation and experimental testing phase will be completed in 2026, aims to improve the technology of electric conduction heating and improve process control as well as the reliability of the technology. At the same time, ESF Elbe-Stahlwerke Feralpi GmbH, in agreement with the project consortium, also started experimenting with electric induction heating technology and began collaborating with Feralpi Siderurgica, contributing with tests and experiments on its billet

samples and assessing the potential application of the technology in its plant configuration.

Modiplant Project, (MODular hybrid technology in the Steel PLANT production), continued in 2025 and conducted by Feralpi Siderurgica with the participation of ESF Elbe-Stahlwerke Feralpi GmbH, within the European programme RFCS-2022-CSP-Big Tickets for Steel. The initiative aims to develop an innovative system for billet heating by electricity, as an alternative to induction, to be implemented in an industrial-scale demonstration. During the year, analyses and operational simulations were carried out, and a cycle simulator was developed to define the most efficient configuration in terms of consumption and costs, in relation to the different productivity levels of the line. During the year, the operating and setting tests of the system's working cycles were started. The objective of this phase is to evaluate the functionality and acquire know-how regarding the new heating method, with a view to maximising its use within Feralpi's rolling cycle.

Project Sunshine, launched in 2024, aims to improve the quality of billets, with a focus on shape and rhomboid defects, through the introduction of innovative technologies and advanced monitoring approaches. The activities include the adoption of new casting practices with dedicated ingot moulds, the implementation of advanced sensors for continuous control such as the measurement of billet shape, the development of advanced solidification models and the application of artificial intelligence criteria to identify the causes of defects. The ultimate objective is to optimise the geometric quality of the billets, with positive effects not only in the casting phase but also in the subsequent rolling process. In 2025, the measurement instrumentation was acquired, the new monitoring system was tested, and new casting configurations were implemented. In addition, thanks to collaborations with research partners, data analysis was initiated to enable the identification of correlations between shape defects and continuous casting management.

KEY



Industrial commitment



Environmental commitment



The **E-Ecodownstream project** ("Development of heating technologies for the Efficient renewable Energy CONsumption of CO₂-neutral DOWNSTREAM-processes"), launched in 2025 and co-financed under the Horizon Europe Twin Transition Call, aims to promote the use of alternative energy resources to methane and consequently reduce CO₂ and greenhouse gas emissions. The project also aims to reduce consumption through the study of energy recovery methods associated with rolling mills or other dispersed plant sources. To this end, a mapping of the dispersed energies was carried out to assess possible reuses. A heating burner was also configured to be converted to the use of H₂, to be tested in a pilot plant owned by the research partners.



The **Thelma project** ("THERmochemical conversion of Municipal biowaste into a sustainable, biogenic coal Alternative"), launched in 2025 and co-funded under the RFCS (Research Fund for Coal and Steel) call, aims to promote the construction of an industrial plant for the production of Biocoal within the consortium. It aims to test this material on an industrial scale with the main consequence of minimising CO₂ emissions to the environment. During 2025, the activity with the research partners were set up.

Steel for Construction Germany business unit

ESF Elbe-Stahlwerke Feralpi GmbH



ModHeaTec Project - ESF Elbe-Stahlwerke Feralpi GmbH is continuing its support activities for Feralpi Siderurgica in defining the configuration of the pilot plant to be built and in assessing a potential test phase, taking into account the production processes and layout of ESF's plants. The tests will use samples of blums from ESF to evaluate both the impact on product quality and the technical, economic and scalability aspects of the proposed solutions. The project was started in 2023. In 2025, ESF participated in the machinery design phases in collaboration with Feralpi Siderurgica.



Modiplant project. ESF Elbe-Stahlwerke Feralpi GmbH has started analysis activities regarding the plant engineering solution for an innovative electric billet reheating system. Specifically, the company is supporting Feralpi Siderurgica S.p.A. in evaluating the industrial implementation of this technology and in monitoring the testing phase. The aim is to verify the feasibility of replicating the solution at the ESF plant, taking into account both the know-how acquired and the plant constraints, while simultaneously exploring various possible installation configurations within the rolling mill department. The project was started in 2023. In 2025, ESF participated in the plant developments for Feralpi Siderurgica, which also included monitoring the test phases to evaluate the potential application within the production layout defined for ESF.



FlexHybHeat Project. This project focuses on simulating billet heating using various energy sources (such as electricity, hydrogen, natural gas or ammonia) and assessing potential combinations to determine the most suitable technological mix and ensure maximum flexibility for a future heating concept. This assessment is ongoing during 2025. A second area of activity concerns the development of a new heating control system, which includes the calculation of CO₂ emissions and a real-time cost analysis, simultaneously considering the stability of the electricity grid and the quarterly fluctuations of the energy market.



InduGasHeat project. The InduGasHeat project, launched in July 2025, focuses on the implementation of innovative gas heating systems based on ultra-high temperature induction (UHT-TJ) and aims to test this technology by replacing fossil fuel burners both in preheating furnaces for forging and in ladle preheating stations, demonstrating the feasibility of a *plug-and-play* implementation. At the ESF Elbe-Stahlwerke Feralpi plant in Riesa, the project involves the complete replacement of a gas-fired ladle preheating station with an equivalent electric solution, demonstrating a total reduction in CO₂ emissions and an improvement in energy efficiency in the preheating phase.

Specialities Business Unit

Acciaierie di Calvisano S.p.A.



The MultisensEAF project ("*Multi-Sensor Systems for an optimised EAF Process Control*"), launched in 2023, aims to develop innovative strategies for optimising the EAF process through the integration of advanced sensors, process simulators and control systems based on artificial intelligence techniques. During 2025, the implementation of the online process simulator, developed with internal resources, was completed, and the testing of the main sensors continued: acoustic for electric arc coverage and monitoring of scrap melting; radar in the LF (Ladle Furnace) for the position and stability of the liquid bath; "OES" and "Fast Slag Analysis" systems for real-time analysis of slag; and water flow sensors in the cooling panels. At the same time, management rules based on the composition of the slag were refined, with the aim of optimising the coverage of the electric arc, reducing the erosion of the refractory and supporting decisions relating to additions during the tapping phase. Also in 2025, the development phases of predictive modelling in EAF were completed, together with the integration of the sensor systems under development. In particular, the estimated temperature of the steel in the EAF was made available to operators to support the management of the production cycle. In addition, adaptation to different steel grades is underway with the aim of optimising the model created for the different configurations of scrap charge mixes.



The Biorecast project, launched in 2023, aims to develop innovative solutions to replace the coal injected into EAFs with alternative materials such as biocoal and polymers. The aim is to contribute to the improvement of the slag foaming process and the coverage of the electric arc, with particular attention to the production of special steels and the reduction of the environmental impact. As part of the project, Acciaierie di Calvisano plays a central role in the study and validation of these substitute materials, through tests aimed at evaluating their effects and operational performance under real conditions. To support these activities, the plant has implemented an innovative EAF material storage and propulsion system, which made it possible to carry out an extensive experimental campaign during the year. In 2025, tests were completed that made it possible to collect useful data for the analysis of the reference conditions with the injection of polymers as an alternative to coal, with the aim of proceeding with the comparison with the tests to be carried out with Biocoal during the project. In a parallel fashion, all the elements for defining the necessary characteristics for Biocoal obtained from the recovery of other production processes were provided, and the first samples were received for validating the necessary characteristics for injecting the material into the EAF.

