Deliverable 6.6

Exploitation plan - final version

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Abbreviations and acronyms

CA	Consortium Agreement
CBR	Case-Based-Reasoning
DSS	Decision Support System
EC	European Commission
EAF	Electric Arc Furnace
GA	Grant Agreement
IPR	Intellectual property rights
KER	Key Exploitable Result
KPI	Key Performace Indicator
RFCS	Research Fund for Carbon and Steel
RTO	Research and Technology Organization
SIM4	Sim4future società a responsabilità limitata semplificata
SSSA	Scuola Superiore di studi universitari e di perfezionamento Sant'Anna
UNICL	Institut Catholique de Lille
UNIRIO	University of La Rioja

1. Introduction

This final version of the Exploitation Plan builds upon the first version delivered at M12 and incorporates the results achieved during the complete project lifetime:

- Multi-sensor platform installed and operated in industrial environment (Deliverable D5.2 Assessment of the final system performances according to the predefined KPIs);
- Cloud infrastructure deployed (Deliverable D5.2 Report on the results of the field tests of the first release of the system and Deliverable D5.3 Guidelines for transferability and deployment of the system in the EU steel sector);
- AI-based event recognition functions validated (Deliverable D3.2 Procedures for events detection and implementation/suggestion of corrective actions);
- Digital training environment developed and tested (Deliverable D4.3 Training Interactive Simulation Solution and D4.4 Training Sessions specification a guidebook);
- Transferability assessment completed (Deliverable D5.3 Guidelines for transferability and deployment of the system in the EU steel sector).

During the implementation phase, the consortium successfully designed, installed and demonstrated the iSteel-Expert system in an industrial environment, integrating heterogeneous sensing technologies, cloud-based data management, AI-supported decision support functionalities and immersive training solutions.

The exploitation strategy has therefore evolved from a preliminary assessment of market opportunities into a concrete deployment roadmap addressing:

- industrial exploitation of the iSteel-Expert platform;
- commercialization opportunities for individual technological modules;
- transferability to additional EAF plants;
- exploitation of training and knowledge-preservation solutions;
- protection and valorization of intellectual property generated during the project.

The final exploitation plan also includes lessons learned during industrial validation and identifies the actions required to maximize uptake after project completion.

2. Areas of impact

Realized Benefits during Demonstration

The industrial demonstration confirmed the feasibility of:

- Continuous monitoring of EAF operations through multi-sensor integration.
- Centralized collection and processing of heterogeneous data sources.
- AI-assisted identification of process events and operational anomalies.
- Enhanced workforce support through knowledge capture and expert-guided decision support.
- Development of advanced training environments supporting knowledge preservation and transfer.

Although long-term industrial deployment is still required to quantify full-scale impacts across the European steel industry, the project demonstrated the technical readiness of the proposed approach and validated its potential contribution to:

- productivity improvement;
- energy optimization;
- reduction of unsafe operator exposure;
- reduction of knowledge loss due to workforce ageing and turnover;
- more effective operator training and upskilling.

3. Market Evolution (2024→2026)

3.1 Market Evolution Since the First Exploitation Plan

Since the preparation of D6.1, the steel sector has continued its acceleration towards digital transformation, AI-assisted process management, workforce digitalization, remote services and expert support, digital twins and immersive training solutions.

The increasing shortage of experienced personnel, together with the ongoing transition toward low-carbon steelmaking routes, reinforces the need for systems able to:

- preserve organizational know-how;
- support less experienced operators;
- facilitate rapid transfer of operational expertise;
- improve operational consistency across sites.

These trends strengthen the market positioning of iSteel-Expert and confirm the relevance of its exploitation strategy.

3.2 Competitive Positioning of iSteel-Expert

The final project results confirm that iSteel-Expert differs from existing market solutions because it integrates: multi-sensor monitoring, AI-assisted event recognition, knowledge preservation mechanisms, human-centred decision support, immersive operator training.

While most commercial solutions remain focused on furnace optimization, slag management and predictive maintenance.

3.3 Commercial Readiness Assessment

The unique value proposition of iSteel-Expert lies in combining process intelligence with workforce knowledge management and training.

Table 1. Commercial Readiness Analysis.

Strengths	Remaining Challenges	Recommended Mitigation Measures
Industrial demonstration successfully completed	Site-specific customization	Modular deployment architecture
Demonstrated integration capability	Data integration with customer systems	Standardized implementation methodology
Strong alignment with workforce digitalization trends	Cybersecurity and data governance requirements	Flexible licensing model
Compatible with existing EAF operations	Change management and operator acceptance	User training programs

4. Targeted stakeholders

4.1 Stakeholder Landscape

The successful exploitation of iSteel-Expert results requires the involvement of a broad ecosystem of stakeholders spanning technology providers, steel producers, workforce representatives, research organizations and industrial networks.

The project outcomes address not only technological challenges related to process monitoring and decision support, but also organizational challenges associated with workforce development, knowledge preservation and digital transformation across the European steel sector.

The identified stakeholder groups are described below.

- **Steel Producers**

  Steel producers represent the primary target group for the exploitation of the project results. The integrated iSteel-Expert platform, advanced sensing solutions and AI-driven decision support functionalities are expected to help steel companies enhance their operational awareness, workforce support, and process monitoring capabilities.

  Potential beneficiaries include:

  - EAF steel producers;
  - Consteel® EAF operators;
  - future DRI-EAF facilities;
  - steel companies pursuing Industry 4.0 initiatives;
  - plants facing workforce renewal challenges.

  Expected benefits include:

  - improved process visibility;
  - enhanced operational decision-making;
  - improved training and onboarding;
  - preservation of process know-how;
  - support for continuous improvement initiatives.

- **Industrial Workforce and Plant Personnel**

  Plant operators, supervisors, maintenance personnel and process engineers represent a strategic stakeholder group for long-term exploitation. The gradual retirement of experienced personnel and the growing complexity of industrial operations create a strong need for solutions supporting knowledge capture and transfer. The immersive training environment and knowledge-preservation functionalities developed within iSteel-Expert are expected to contribute to:

  - accelerated onboarding of new personnel;

- transfer of operational expertise;
- workforce upskilling;
- reduction of knowledge loss due to personnel turnover;
- improved operational consistency.

- **Technology Providers and Plant Builders**

  Technology suppliers, automation providers and engineering companies constitute an additional stakeholder category. The project outcomes provide opportunities for integration of:

  - advanced sensing technologies;
  - AI-assisted decision-support systems;
  - knowledge-management solutions;
  - digital training environments.

  For TENOVA, this stakeholder group represents a key exploitation channel through the integration of project results into future technology packages, digital services and modernization projects.

- **Research, Education and Training Organizations**

  Universities, research centres and training providers may exploit the project results through: scientific publications, advanced education programmes, industrial training activities and future collaborative research projects.

  The methodologies developed for AI-assisted operation support and simulation-based training provide opportunities for further scientific and educational developments beyond the steel sector.

- **Industrial Associations, Innovation Networks and Policy Stakeholders**

  Organizations such as ESTEP, the RFCS community and other industrial innovation platforms can support the dissemination and replication of project outcomes throughout the European steel ecosystem. These stakeholders can contribute to technology transfer, exchange of best practices, promotion of digitalization initiatives and workforce development strategies.

Table 2. Stakeholder–KER[1]–Exploitation–Deployment Matrix.

Stakeholder Group	Main Interest	Relevant KERs	Exploitation Route	Expected Benefit	Deployment Phase
Steel producers	Operational excellence	KER1, KER2, KER3	Commercial deployment	Improved productivity and process visibility	Phase 2–3
EAF operators and workforce	Knowledge transfer and support	KER1, KER4	Daily operation and training	Faster onboarding and skill development	Phase 2–4
Technology providers and plant builders	Product integration	KER1, KER2, KER3	Engineering projects and services	Expanded digital offerings	Phase 1–3
TENOVA customers	Digital transformation	KER1, KER2, KER3	Commercial products and support services	Enhanced plant digitalization	Phase 2–3
Universities and RTOs	Research and education	KER3, KER4	Publications, research projects and training	Scientific advancement	Phase 1–4
Training organizations	Workforce development	KER4	Training programmes	Improved industrial competencies	Phase 2–4
ESTEP and industrial networks	Replication and dissemination	All KERs	Technology transfer and networking	Wider sector adoption	Phase 1–4
DRI-EAF operators and green steel projects	Future deployment and innovation	KER1–KER4	Replication and technology uptake	Support to future low-carbon steelmaking routes	Phase 4

[1] KER – Key Exploitable Result, see section 5 Identification of Key Exploitable Results

4.2 Stakeholder Involvement Across the Exploitation Roadmap

The successful deployment of iSteel-Expert results depends on the progressive involvement of different stakeholder groups throughout the post-project exploitation phases (see paragraph 10). While the initial activities will focus on consolidation of project outcomes and preparation of commercial offerings, later phases will progressively involve industrial adopters, technology providers, workforce representatives and the broader steel innovation ecosystem.

The stakeholder engagement strategy therefore evolves together with the exploitation roadmap, ensuring that the most relevant stakeholders are involved at the appropriate stage of deployment and market uptake.

Table 3. Stakeholder Engagement Across the Exploitation Roadmap.

Exploitation Phase	Primary Stakeholders	Main Objective	Relevant KERs
Phase 1 (2026–2027) Consolidation	Consortium partners	Consolidation of project results, deployment guidelines, commercial preparation and IPR management	KER1, KER2, KER3, KER4
Phase 2 (2027–2028) First of kind	Early adopter steel producers, TENOVA customers, EAF operators	First commercial deployments and validation outside the demonstration environment	KER1, KER2, KER3
Phase 3 (2028–2030) Industrial Scale-Up	European EAF operators, technology providers, industrial networks	Expansion of market penetration and establishment of recurring digital services	KER1, KER2, KER3, KER4
Phase 4 (Beyond 2030) Long-Term Expansion	DRI-EAF operators, green steel projects, training organizations, policy and innovation networks	Replication across future low-carbon steelmaking routes and workforce development programmes	All KERs

5. Identification of Key Exploitable Results

The iSteel-Expert project generated four Key Exploitable Results (KERs) representing the core technological and methodological assets developed and validated during the project.

The Key Exploitable Results (KER) have already been identified together with their preliminary exploitation paths in the first stages of the project, and no variations have been observed in the second reporting period.

The four KERs are briefly described below:

KER1 – iSteel-Expert Integrated Digital Expert Platform

The iSteel-Expert platform is a cloud-based digital expert system integrating heterogeneous plant data, advanced sensing technologies, artificial intelligence and operational knowledge into a unified environment. The platform supports situation awareness, expert-assisted decision-making, knowledge preservation and workforce support for Electric Arc Furnace operations.

KER2 – Advanced Sensor Suite

The Advanced Sensor Suite consists of a multi-sensor monitoring architecture combining optical, thermal, acoustic and vibration measurements to provide comprehensive visibility of plant conditions and process behaviour. The modular design enables both stand-alone deployment and integration into broader digitalization and automation solutions.

KER3 – AI Event Detection and Decision Support Framework

This framework includes the artificial intelligence algorithms and data-processing methodologies developed for automated event recognition, anomaly detection and recommendation generation. The solution enhances operators' ability to interpret complex process conditions and supports more informed and consistent operational decision-making.

KER4 – Immersive Training Environment

The immersive training environment provides simulation-based training and knowledge-transfer capabilities designed to support workforce development, onboarding of new personnel and preservation of critical operational expertise. The solution combines digital learning approaches with realistic industrial scenarios to facilitate continuous upskilling of plant personnel.

Together, these results form an integrated ecosystem supporting process monitoring, operational decision-making, workforce development and knowledge preservation in steelmaking operations.

Table 4 summarizes the KERs.

Table 4. Overview of the Key Exploitable Results and the identified exploitation paths.

KER	Owner	Exploitation Leader	Description	Potential exploitation:	Target Market:
KER1 – iSteel-Expert Integrated Digital Expert Platform	TENOVA	TENOVA	Cloud-based expert system integrating sensor data, AI algorithms and operational knowledge. Supports situation awareness and decision support in EAF operations.	Integration into Tenova digital portfolio.	EAF steel producers. Greenfield DRI-EAF projects. Existing Tenova customers.
KER2 – Advanced Sensor Suite	TENOVA	TENOVA	Integrated monitoring architecture including: • optical monitoring; • thermal monitoring; • vibration analysis; • acoustic monitoring.	Stand-alone deployment. Integration into Tenova automation packages.	
KER3 - AI Event Detection and Decision Support Framework	TENOVA + SSSA	TENOVA	AI models for event recognition and recommendation generation.	Future digital services. Remote support solutions.	
KER4 – Immersive Training Environment	UNICL, UNIRIO, SIM4	SIM4	Simulation-based operator training framework.	Steel industry training services. Extension to other industrial sectors.	

6. Individual exploitation plans

The four KERs identified within the project present different exploitation pathways, stakeholders and market opportunities. The following tables summarize the exploitation strategies defined by the consortium partners for each KER, considering expected developments, target groups, barriers and planned exploitation routes.

The following subsections summarize through Tables the individual exploitation plans defined by the consortium partners for each of the four Key Exploitable Results identified within the project.

While KER1 and KER 2 represent the most mature outcomes of the research activity, dedicated exploitation plans have also been defined for KER3 and KER4, reflecting their strategic relevance for the future deployment, commercialization, and long-term sustainability of the iSteel-Expert results.

6.1 Exploitation plan for KER1 – iSteelExpert Integrated Digital Expert Platform

Table 5: Exploitation plan for KER 1

Question	TENOVA	SIDER	SSSA	UNICL UNIRIO SIM4
Expected result and/ or development	Commercial deployment of a validated cloud-based digital expert platform supporting situation awareness, workforce support and knowledge preservation in EAF operations.	Continued industrial utilization of the demonstrated platform and assessment of replication opportunities within the Pittini Group.	Exploitation of validated AI methodologies for event detection, decision support and industrial research activities.	Exploitation and further development of the validated immersive training environment for industrial education and workforce development.
Value proposition	Integration of a demonstrated digital expert solution into TENOVA's digital portfolio, enabling advanced operational support and knowledge-preservation services.	Improved operator awareness, structured knowledge transfer and long-term preservation of operational know-how.	Industrial validation of advanced AI methodologies and opportunity for further scientific and industrial exploitation.	Availability of an industrially validated training environment supporting education, workforce upskilling and future research activities.
Potential target group(s)	Steel producers	Own personnel and operators	Steel industry technical and scientific community	Industry operators and scientific community
Stakeholders and decision makers	- EU steel producers - Technical experts, researchers and scientific community networks, associations, and EC	Workers; clients; general public communities	Steel industry, plant builders, researchers, scientists	Industry and scientific community

Platforms to cooperate	ESTEP			
Barriers	Integration with site-specific automation architectures, cybersecurity requirements and customer-specific customization needs	People awareness and acceptance	Developments are plant-specific	Mostly tailored for EAF operator role
Strategy to react on barrier(s)	Deployment guidelines developed within WP5, modular implementation architecture and standardized integration methodologies will reduce deployment risks and facilitate industrial adoption	Communication and dissemination activities will aim at reaching all relevant stakeholders, explaining the project benefits and paving the way for results acceptance	In cooperation with TENOVA formalized procedures are developed for rapid customization of the proposed solutions	Modular structure and generalization of logic and interfaces of the simulated environment. Foresee possibility to customize or adjust solution for other roles
Exploitation route	Commercial deployment through the TENOVA digital portfolio, engineering services, software licensing and long-term support agreements.	Industrial utilization, operational validation and support to future replication activities.	Commercial agreement with TENOVA to exploit the developed software. Scientific publications, collaborative research projects and industrial innovation initiatives.	Education, workforce training, industrial learning programs and knowledge-transfer activities.
Time to market	2027-2028			

6.2 Exploitation plan for KER2 – Advanced Sensor Suite

Table 6: Exploitation plan for KER 2

Question	TENOVA	SIDER
Expected result and/or development	Commercial deployment of a validated modular sensor suite supporting advanced monitoring and operational awareness in EAF plants.	Continued utilization of the demonstrated monitoring solutions and evaluation of their wider application within the Pittini Group production environment.
Value proposition	Integration of validated sensing technologies into TENOVA equipment packages, modernization projects and digital service offerings, enabling enhanced process visibility and operational support.	Improved visibility of plant conditions and enhanced support for operational monitoring, process understanding and workforce knowledge retention.
Potential target group(s)	Steel producers	Own personnel and operators
Stakeholders and decision makers	- EU steel producers - Technical experts, researchers and scientific community Networks, associations, and EC	Workers; clients; general public communities
Platforms to cooperate	ESTEP	
Barriers	Site-specific installation constraints, integration with existing automation architectures and customer-specific monitoring requirements.	Operational acceptance, maintenance requirements and adaptation to specific production environments.
Strategy to react on barrier(s)	Deployment guidelines developed during the project, modular sensor architecture and standardized integration procedures will facilitate industrial implementation and reduce deployment risks.	Progressive adoption supported by operator involvement, validation under real production conditions and continuous assessment of operational benefits.

Exploitation route	Commercial deployment through equipment modernization projects, engineering services and integration within TENOVA's digital solutions portfolio.	Continued industrial utilization, operational validation and contribution to future replication activities and industrial demonstrations.
Time to market	2027-2028	

6.3 Exploitation plan for KER3 – AI Event Detection and Decision Support Framework

KER3 addresses the use of advanced Artificial Intelligence tools to interpret the information conveyed by process data, videos and other signals gathered by the monitoring solution (see KER2) for an early identification of relevant events and anomalies, to support the elaboration of appropriate and timely countermeasures that prevent major issues and faults on the plant.

Table 7. Exploitation plan for KER3 – AI Event Detection and Decision Support Framework.

Question	TENOVA	SSSA
Expected result and/or development	Commercial deployment of validated AI models supporting event recognition, operational awareness and decision-support functionalities integrated within TENOVA's digital solutions portfolio.	Further scientific and industrial exploitation of AI methodologies, event-detection algorithms and decision-support approaches validated during the project.
Value proposition	Enhanced operational support through AI-assisted interpretation of process conditions, enabling faster and more consistent decision-making.	Industrial validation of AI methodologies and generation of new opportunities for scientific research and industrial collaboration.
Potential target group(s)	Steel producers and EAF operators.	Research organizations, steel industry technical community and AI researchers.
Stakeholders and decision makers	Steel producers, plant managers, process engineers, automation specialists and digitalization managers.	Researchers, scientists, technology developers and industrial innovation networks.
Platforms to cooperate	ESTEP	
Barriers	Need for site-specific model adaptation, data availability and user trust in AI-supported decision-making.	Transferability of AI models across different industrial environments.
Strategy to react on barrier(s)	Deployment guidelines developed within WP5, modular implementation architecture and progressive industrial validation will facilitate customization and adoption.	Continuous refinement of algorithms, additional industrial validation cases and future collaborative research activities.
Exploitation route	Integration into TENOVA's Digital Expert Platform, future AI-based digital services, remote support solutions and software licensing agreements.	Scientific publications, collaborative research projects, industrial innovation initiatives and commercial agreements related to software exploitation.
Time to market	2027–2028	

6.4 Exploitation plan for KER4 – Immersive Training Environment

KER4 addresses workforce development, knowledge preservation and operator training through immersive and simulation-based learning environments. The exploitation strategy focuses on industrial training services, education activities and future cross-sector applications of the developed methodologies.

Table 8. Exploitation plan for KER4 – Immersive Training Environment.

Question	UNICL	UNIRIO	SIM4	TENOVA	SIDER
Expected result and/or development	Further development and exploitation of immersive learning methodologies for industrial education and workforce development.	Integration of project outcomes into academic and professional training activities.	Commercial exploitation of simulation-based and immersive training solutions.	Integration of training functionalities into future digital service offerings.	Utilization of training tools for workforce onboarding and knowledge transfer.
Value proposition	Enhanced industrial education through realistic and interactive training environments.	Improved knowledge transfer between academia and industry.	Availability of validated immersive training solutions supporting industrial workforce development.	Complementary workforce-development services supporting customer digital transformation.	Faster onboarding and preservation of operational know-how.
Potential target group(s)	Students, industrial trainees and workforce development programmes.	Academic community and industrial personnel.	Industrial operators and training organizations.	Steel producers and TENOVA customers.	Plant operators and newly recruited personnel.
Stakeholders and decision makers	Universities, training centres and industrial partners.	Research and education communities.	Industrial companies, training providers and technology-transfer organizations.	Customers, HR departments and plant managers.	Workforce representatives, production managers and training coordinators.
Platforms to cooperate	ESTEP				
Barriers	Need for adaptation to different industrial roles and operational contexts.	Long-term maintenance and	Market acceptance and sector-specific	Integration with customer training programmes.	User engagement and organizational adoption.

		update of training content.	customization requirements.		
Strategy to react on barrier(s)	Modular structure of the training environment and customization of learning scenarios.	Continuous update of educational content and collaboration with industry.	Development of configurable training modules for different applications and sectors.	Integration with broader digitalization and workforce-support services.	Progressive deployment supported by demonstration of operational benefits.
Exploitation route	Training programmes, education activities and future research projects.	Higher education, postgraduate programmes and industrial courses.	Commercial immersive-training solutions and technology-transfer activities.	Digital services supporting training, onboarding and knowledge preservation.	Internal workforce development and continuous training initiatives.
Time to market	2027–2028				

7. IPR management and protection

7.1 Regulatory framework

The IPR strategy and protection plan of iSteel-Expert complies with the rules defined in the Grant Agreement (GA) and in the Consortium Agreement (CA). The GA establishes the rights and obligations between the European Commission and the partners of the iSteel-Expert consortium. GA No. 101112102, Article 16 (Intellectual property rights (IPR) – background and results – access rights and rights of use), defines the rules for handling intellectual property rights, their use and their dissemination. The iSteel-Expert CA further defines and specifies the relevant IP arrangements, in full compliance with the provisions of the GA.

The CA is the written agreement among the project partners (beneficiaries/parties) on the ownership of results, including joint ownership, transfer of results, dissemination of results (including unpublished results and background), use of names, logos and trademarks, and access rights. All partners therefore agreed on the rules governing IPR ownership, access rights to results and background for project execution, IPR protection and the handling of confidential information, as addressed in greater detail in the CA. During the project, all partners adhered to these agreements and all project activities were compatible with them.

The IPR-relevant key terms in the context of EU-funded projects are background, results and access rights. The definitions below, as specified in the GA and CA, are summarised for ease of reference:

Background means any data, know-how or information – whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights – that is (a) held by the beneficiaries before they acceded to the Agreement and (b) needed to implement the action or exploit the results. The background included in the CA is reported there in Appendix 1.

Results means any tangible or intangible effect of the action, such as data, know-how or information, whatever its form or nature, whether or not it can be protected, as well as any rights attached to it, including intellectual property rights.

Access rights means rights to use results or background.

7.2 Protection strategy: know-how and trade secrets

Throughout the project, the partners developed significant know-how on the topics addressed. This includes multi-sensor monitoring of the electric arc furnace (EAF) area, data acquisition and preprocessing for cloud transmission, and feature-extraction and signal-processing routines for optical, acoustic, and vibration data. It also encompasses Key Performance Indicators (KPI) computation, event-detection and decision-support logic, alongside immersive simulation solutions for operator training and knowledge preservation.

This expertise is the principal asset generated by the action and forms the foundation of the exploitation paths described in the previous sections.

Considering the nature of the results, which are primarily embedded in the software developed during the project (data preprocessing and feature-extraction modules, KPI and event-detection algorithms, decision-support logic, dashboards, and the training simulation environment) and the associated

operational and modeling know-how, the partners concluded that patent protection would offer limited practical advantage.

Software-embodied algorithms, configuration parameters, and proprietary know-how are difficult to protect effectively through patents. Once disclosed in a patent specification, they would be vulnerable to circumvention while remaining costly to enforce.

The partners therefore decided against filing patents, opting instead to protect the results as trade secrets and confidential know-how. Consequently, the source code, algorithms, parameter sets, engineering specifications, and datasets will remain undisclosed and governed by the confidentiality provisions of the Consortium Agreement (CA).

This choice is consistent with the exploitation strategy of the consortium: the industrial partners will exploit the results by integrating the protected software and know-how into their own products and services, while the research and academic partners will valorize the underlying scientific methodologies through publications and further research, taking care that dissemination activities do not disclose the confidential, exploitation-relevant details of the results.

Confidentiality is maintained through the obligations set out in the CA, controlled and credential-based access to the cloud platform, restricted access to source code and datasets, and non-disclosure arrangements with any third parties involved in future deployment. The decision not to patent does not prevent the partners from reconsidering, by common agreement and in accordance with the CA, the protection of specific future developments should their nature justify a different approach.

7.3 Intellectual property developed by each partner

The following subsections outline, for each partner, the core elements of intellectual property, comprising know-how, software, and confidential results, developed during the project and protected as trade secrets:

TENOVA SPA (Coordinator)

- **Sensor and cloud acquisition architecture –** design and configuration know-how of the multi-sensor monitoring system (including the proprietary panel-based acoustic sensor) and of the Microsoft Azure data-acquisition, historicization and cybersecurity infrastructure for the EAF area.
- **Signal pre-processing and feature-extraction software –** image, acoustic and vibration processing modules and feature-extraction routines, together with the related sampling and spectral-analysis parameters.
- **Integrated digital expert platform –** The Project platform, comprising integrated KPI-calculation software, event-detection logic, and operator dashboards, serves as the primary vehicle to foster transferability and deployment know-how across the EU steel sector.

Scuola Superiore Sant'Anna (SSSA)

- **AI-based algorithms for anomaly detection –** The implementation of advanced artificial intelligence strategies enables the systematic and automated detection of process anomalies during Electric Arc Furnace (EAF) operations.

- **Specialized techniques for imbalanced classification** - Based on LightGBM algorithms, this approach successfully overcomes the challenges of imbalanced training datasets.
- **Proof-of-concept support for corrective action suggestions**: Based on genetic algorithms and integrated with ML predictions, this AI tool formulates the problem as a constrained optimization task. By balancing alarm avoidance with minimal deviation from current operating conditions, the proposed approach can provide operators with specific, actionable recommendations rather than mere alerts.

Siderpotenza S.p.A. (SIDER)

- **EAF operational know-how and data inventory –** the detailed inventory of meltshop procedures, signals and historicized data and the newly digitalised equipment-status data used to configure and validate the system.
- **Field validation and demonstration know-how –** results and lessons learned from the field-test campaigns and the assessment of the system against the predefined KPIs in a real industrial environment.

Sim4Future S.r.l.s. (SIM4)

- **TISEMEAFOT interactive training solution –** Expertise in developing the immersive, interactive training solution for EAF operator training and troubleshooting with focus on conceptual and process-centered training modules with multimedia content and quizzes.
- **Training scenarios and guidebook –** This implemented asset includes a comprehensive library of configurable training scenarios along with an associated guidebook. It successfully capitalizes on the project's training methodology to standardize knowledge preservation and operator onboarding.

Institut Catholique de Lille (UNICL)

- **Simulation and training platform –** This training platform for Electric Arc Furnace (EAF) operations features a simulation-assisted VR environment. Trainees can interact within a realistic control room, receiving process feedback directly linked to simulated furnace behavior. Furthermore, the simulation can ingest historical data exported from Excel files to replicate specific operational heats

Universidad de La Rioja (UNIRIO)

- **Knowledge structuring & AI-driven consulting** - Expertise in organizing knowledge bases, designing assessments, and developing cognitive support tools.
- **Adaptive learning & AI response systems** – Expertise in training content and building AI-powered response systems integrated with specific documentation.

8. Exploitation and Transferability Beyond the Demonstration Site

One of the key objectives of the iSteel-Expert project was not only to develop and validate an innovative digital expert system in an industrial environment, but also to assess its applicability beyond the demonstration site and facilitate its future deployment throughout the European steel industry.

The project adopted a modular architecture combining advanced sensing technologies, cloud-based data management, artificial intelligence algorithms and immersive training solutions. This approach was intentionally designed to maximize transferability and enable adaptation to different plant configurations, operational practices and digital maturity levels.

The industrial demonstration confirmed that the overall system architecture can be replicated in other Electric Arc Furnace facilities through an appropriate customization process primarily involving sensor configuration, integration with plant information systems and adaptation of AI models to site-specific operating conditions.

The modular structure of the platform allows individual components to be deployed independently or as part of the complete iSteel-Expert solution, depending on customer needs and implementation priorities.

8.1 Contribution of WP5 Transferability Assessment

A major contribution to the exploitation strategy was provided by the transferability activities performed within WP5. The WP5 assessment analysed the applicability of the developed solutions to different steelmaking environments and identified the technical, organizational and operational factors influencing successful deployment.

In particular, the assessment addressed:

- compatibility with batch EAF operations;
- compatibility with continuous charging EAF configurations;
- integration requirements with existing plant automation systems;
- scalability of cloud-based infrastructure;
- transferability of AI-based event recognition models;
- adaptation requirements for training and knowledge-preservation modules.

The outcomes of WP5 provide practical deployment guidelines and reduce implementation risks for future industrial adopters, supporting the commercial exploitation of the project results after project completion.

8.2 Potential Deployment Scenarios

Based on the project results and transferability assessment, the consortium identified several potential deployment scenarios.

- **Existing EAF Plants:** the most immediate exploitation opportunity concerns existing EAF facilities seeking to improve:
  - operational awareness;
  - workforce support;
  - knowledge preservation;
  - operator training;
  - process monitoring capabilities.

The modular nature of iSteel-Expert enables gradual implementation according to plant priorities and available digital infrastructure.

- **Consteel® EAF Installations**

  The project results are particularly relevant for facilities equipped with continuous charging technologies where additional process information can further enhance operational support and decision-making capabilities. TENOVA intends to evaluate integration opportunities with future Consteel® projects within its digital portfolio.

- **Future DRI-EAF and Green Steel Installations**

  The continuing transition of the European steel sector toward low-carbon production routes creates additional exploitation opportunities. The capabilities developed within iSteel-Expert for knowledge management, AI-assisted operation support and workforce training are expected to remain highly relevant in future DRI-EAF facilities and other emerging low-carbon steelmaking configurations, where the availability of experienced operators and rapid knowledge transfer will become increasingly important.

8.3 Industrial Exploitation by Industrial Partners

The transferability assessment performed within the project confirmed that the developed architecture can be deployed beyond the demonstration environment and adapted to different steelmaking contexts. TENOVA therefore intends to exploit the project outcomes through the integration of the developed technologies into its digital product portfolio and service offering.

The most relevant exploitation opportunities concern:

- deployment of the integrated digital expert platform;
- integration of advanced sensing solutions into future projects;
- adoption of AI-based operational support functionalities;
- development of complementary digital services supporting operational excellence and workforce development.

The exploitation potential of iSteel-Expert extends beyond EAF operations to other steel production processes, such as reheating furnaces, rolling mills and heat treatment lines, and potentially to other industrial sectors addressed by TENOVA, including mining and mineral processing.

For steel producers, the demonstrated transferability provides confidence that the approach can be adapted to different operational environments while preserving the benefits achieved during the project.

The results therefore create a realistic pathway toward broader adoption across the European steel industry and support the long-term sustainability of the project outcomes.

As industrial end-user and demonstration partner, SIDER intends to exploit the project outcomes to support operational decision-making, workforce training and knowledge-preservation activities within its production environment.

The demonstrated approach may support:

- improved operator awareness;
- enhanced knowledge transfer between experienced and newly recruited personnel;
- more structured workforce training activities;
- continuous preservation of operational know-how.

Furthermore, the project outcomes may provide a basis for assessing future deployment opportunities within other facilities of the Pittini Group where similar operational requirements exist, contributing to the long-term sustainability and industrial uptake of the project results.

SIDER will continue acting as industrial reference site supporting future validation activities and demonstration of operational benefits to potential adopters.

8.4 Exploitation by Research and Academic Partners

The academic partners (SSSA, UNICL and UNIRIO) and SIM4 intend to exploit the project outcomes through complementary scientific, educational and innovation activities.

SSSA will capitalize on the AI methodologies, data analytics approaches and decision-support strategies developed during the project through: scientific publications, conference contributions, future RFCS and Horizon Europe projects, collaborative industrial research initiatives.

UNICL and UNIRIO will exploit the developed knowledge in: higher education activities, postgraduate programmes, industrial training initiatives and future research collaborations related to AI-enabled industrial systems and workforce development.

SIM4 will continue exploiting the immersive and simulation-based training methodologies developed within the project through customized learning environments, technology-transfer activities and future sector-specific training applications.

9. Post-Project Exploitation Roadmap (2026–2030)

9.1 Strategic Vision

The iSteel-Expert project has successfully demonstrated the feasibility of an integrated digital expert platform for Electric Arc Furnace operations, combining advanced sensing technologies, cloud-based data processing, artificial intelligence, and immersive training solutions.

The consortium considers the successful industrial demonstration achieved within iSteel-Expert as the starting point for a broader exploitation pathway. Through a combination of commercialization, knowledge transfer, training activities and continued innovation, the project results are expected to generate sustainable industrial, scientific and societal value well beyond the project duration.

Beyond its initial EAF focus, iSteel-Expert provides a foundation for future deployment across multiple steel production processes, creating opportunities for wider industrial adoption of digital knowledge-preservation, AI-assisted operational support and training solutions.

The post-project exploitation strategy aims to transform the demonstrated solution into a commercially deployable offering capable of supporting operational excellence, workforce development, and knowledge preservation throughout the European steel sector.

The post-project exploitation roadmap is structured around four progressive phases encompassing product consolidation, industrial deployment, market scale-up, and long-term expansion beyond the original project scope. The overall post-project exploitation roadmap is schematically depicted in Figure 1, while the different phases are described in deeper details in the following subsections.

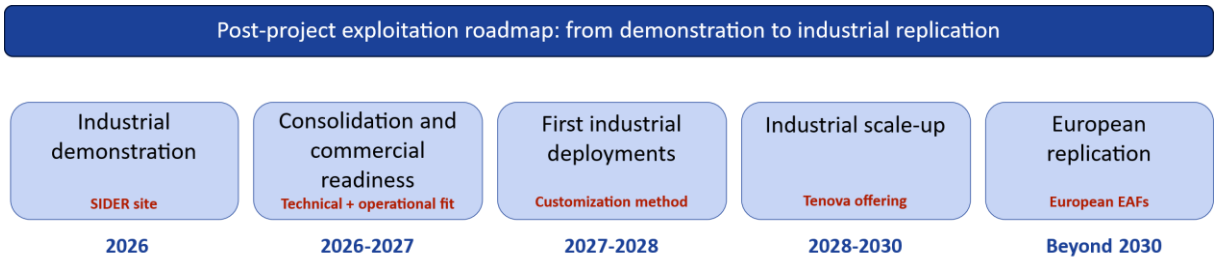

Figure 1. Schematic overview of the post exploitation roadmap.

9.2 Phase 1: Consolidation and Commercial Readiness (2026–2027)

The first phase focuses on converting the project demonstrator into a market-ready solution while preserving the technological and scientific assets generated during the project. TENOVA will lead the industrial exploitation of the project results by:

- Consolidating the software architecture developed during the project into a standardized product configuration.
- Integrating iSteel-Expert functionalities within the company's digitalization portfolio.

- Finalizing deployment methodologies and technical guidelines derived from the WP5 transferability assessment.
- Defining commercial packages based on modular and full-system deployment approaches.
- Evaluating opportunities for integration with existing automation and remote-service platforms.

SIDER will continue utilizing selected project outcomes within its production environment and will:

- Monitor long-term operational performance of the implemented solutions.
- Assess extension opportunities to additional plant areas.
- Provide operational feedback supporting future commercialization activities.

Research Partners, SSSA, UNICL, UNIRIO and SIM4 will:

- Consolidate scientific knowledge generated during the project.
- Publish project findings in scientific journals and conferences.
- Identify opportunities for additional R&D projects building upon iSteel-Expert outcomes.

9.3 Phase 2: First Industrial Deployments (2027–2028)

The second phase aims to demonstrate transferability outside the original pilot environment and establish the first commercial references. The primary target market will include: existing EAF steel producers in particular Consteel® users, steel plants pursuing digital transformation programs and facilities seeking improved workforce training and knowledge-management solutions.

TENOVA intends to market the iSteel-Expert solution through a modular approach allowing customers to adopt:

- The complete Digital Expert Platform.
- Individual monitoring modules.
- Advanced AI decision-support functionalities.
- Training and knowledge-management tools.

Commercialization routes will include: software licensing, engineering and integration services, remote support services and long-term maintenance agreements.

SIDER will act as a reference user supporting validation of achieved benefits and replication assessments within similar operating environments.

Research organizations will exploit the results through advanced training courses and scientific dissemination. New research initiatives related to industrial AI and workforce development will be pursued.

9.4 Phase 3: Industrial Scale-Up (2028–2030)

Phase 3 focuses on expanding market penetration and transforming iSteel-Expert into a recognized digital solution for EAF operations. TENOVA will pursue deployment in:

- Existing EAF plants undergoing modernization.
- New EAF installations.
- Plants implementing advanced Industry 4.0 strategies.
- Facilities seeking remote operation support and workforce digitalization.

The deployment approach will progressively evolve from project-based customization towards standardized implementation methodologies.

Additional developments may include:

- Enhanced AI models based on accumulated operational data.
- Expanded decision-support functions.
- Improved predictive maintenance capabilities.
- Enhanced training functionalities.
- Increased interoperability with plant-level digital systems.

9.5 Phase 4: Long-Term Expansion Beyond 2030

The final phase aims to extend exploitation beyond the original EAF application domain and contribute to future low-carbon steelmaking routes. Potential target applications are:

- DRI-EAF installations.
- Low-carbon steelmaking plants.
- Green steel production routes.
- Other metallurgical processes requiring advanced operational support and workforce knowledge preservation.

Moreover, the consortium foresees opportunities for remote expert-support services, knowledge-preservation solutions and advanced simulation and immersive training systems.

Table 9 provides a summary and an overview of the four above-described phases of the post-project exploitation roadmap.

Table 9. Summary of the different phases of the post-exploitation roadmap.

Phase 1 (2026-2027)	Phase 2 (2027-2028)	Phase 3 (2028-2030)	Phase 4 Beyond 2030
iSteel-Expert commercial-ready version available.	First commercial deployments completed.	Multiple operational installations across different industrial contexts.	Preservation of industrial know-how.
Exploitation responsibilities fully allocated among partners.	First commercial deployments and business opportunities generated.	Established recurring digital-service business model.	Faster onboarding of new personnel.
IPR protection and ownership arrangements finalized.	Additional industrial validation cases available.	Demonstrated operational benefits under different production conditions.	Improved operational consistency.
Scientific and training assets consolidated for future use.	Demonstrated transferability of the solution.	Recognition of iSteel-Expert as a mature digital solution for EAF operation support.	Enhanced workforce attractiveness.
			Support for the digital transformation of the European steel sector.

10. Conclusions

The iSteel-Expert project successfully demonstrated the feasibility of a novel digital expert system combining multi-sensor monitoring, artificial intelligence, knowledge preservation and immersive training technologies for Electric Arc Furnace operations.

The project achieved industrial validation of the integrated platform and generated a portfolio of exploitable assets with clear commercial and scientific value.

The consortium identified four principal Key Exploitable Result:

- Integrated Digital Expert Platform;
- Advanced Sensor Suite;
- AI-based Decision Support Framework;
- Immersive Training Environment.

TENOVA intends to exploit the project results through integration into its digital product portfolio and service offering, while the research partners will leverage the developed methodologies, software components and knowledge for further scientific, educational and industrial activities.

The demonstrated transferability of the proposed architecture provides a realistic pathway towards broader deployment within the European steel industry, supporting digitalization, workforce development and operational excellence.

Beyond the direct exploitation of individual project results, iSteel-Expert has established a transferable framework supporting digitalization, workforce upskilling and knowledge preservation across current and future steelmaking routes, including EAF and DRI-EAF operations.