I4-GREEN

Pilots Action Plan & Portfolio of Investment Leads

D6.2

30/Jun/2024

Authors

Ramón Cabrera Ceñal, Adriana Gutiérrez, Antía Fernández Bautista

Entity

ICAMCYL

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 EISMEA. Neither the European Union nor the granting authority can be held responsible for them.

General information				
Work Package	WP6			
Deliverable	D6.2 – Pilots Action Plan & Portfolio of Investment Leads			
Due Data	30 April 2024			
Submission Date	30 June 2024			
Deliverable Lead	ICAMCYL			
Dissemination Level	X	Public (PU)		Confidential (CO)
Document Nature	X	Report (R)		Other (O)
Description of the related task and the deliverable. Extract from DoA	This deliverable is related to the following tasks: T6.1 EU Mirroring Strategy toward and EU-wide Demonstrator (M20-M30) T6.2 Building a Cross regional Portfolio of Investment Leads (M6-24) The deliverable consists of two parts: on one hand, a Pilots Action Plan, which includes a set of potential sites for replication of the I4-GREEN pilots and a combination of measures to promote their deployment; on the other hand, a Portfolio of Investment Leads, which consists of an analysis of S3 Platforms that can lead investments for these replication sites and a description of the main funding opportunities for this purpose.			
Authors	Ramón Cabrera Ceñal, Adriana Gutiérrez, Antía Fernández Bautista			
Reviewers	Ramón Cabrera Ceñal, Adriana Gutiérrez, Antía Fernández Bautista			
Status		Draft	X	Final

Revision History				
Version	Date	Author	Organisation	Status
V1	02/05/2024	RCC, AG, AFB	ICAMCYL	Draft
V2	21/05/2024	AFB, AG, RCC	ICAMCYL	Draft
V3	30/05/2024	AFC, AG, RCC	ACPMR, ICAMCYL	Draft
V4	28/06/2024	RCC, AG, AFB	ICAMCYL	Final

TABLE OF CONTENTS

List of Tables		
Table 1	Potential E-LIX replication sites	2.3.1.
Table 2	Potential IHO replication sites	2.3.2.
Table 3	Mining Industry and Global Value Chains: regions and organisations	3.3.1.
Table 4	Advanced Materials for Batteries: regions and organisations	3.3.2.
Table 5	Efficient and sustainable manufacturing: regions and organisations	3.3.3.
Table 6	SMEs to Industry 4.0: regions and organisations	3.3.4.
Table 7	Regions covered by the main TSSP (to promote investment projects) and secondary TSSPs (to provide expert partners)	3.2.
Table 8	Summary of pilot replication sites by region and pilot	3.3.1.
Table 9	Participants in the Investing Forum in Raw Materials	3.3.3.

List of Figures		
Figure 1	Aljustrel facilities	2.2.1.
Figure 2	Neves Corvo facilities	2.2.1
Figure 2	Sotiel treatment plant	2.2.1.
Figure 4	Aguablanca treatment plant	2.2.1.

Acronyms	
E-LIX	Atalaya / Lain Tech pilot project
IHO	Iron Holm Oak pilot project
IDSWI	Iron District of Southwest Iberia
IPB	Iberian Pyrite Belt
PGMs	Platinum Metals Group
REE	Rare Earth Elements
TSSP	Thematic Smart Specialisation Partnership
VHMS	Volcanic-Hosted Massive Sulphides

1. Executive summary

The I4-GREEN project is based on the development of two valuable green pilot projects:

- Iron Holm Oak project (IHO): an industrial mining project that aims to recover critical raw materials such as REE from iron ores
- Atalaya/Lain Tech project (E-LIX): an innovative technology to extract strategic raw materials (Zn, Cu, Co and PGMs) from low-grade ores

Both pilot projects are located in two outstanding mining districts: the Iron District of the SW Iberian Peninsula and the Iberian Pyrite Belt, respectively. These districts are spread over three of the four I4-GREEN regions: Alentejo, Andalusia and Extremadura.

This deliverable addresses the question of the replicability of these pilots. A study of potential sites (mines and mining projects) for replication has therefore been carried out, considering the geological similarities with the pilot locations and the importance of these sites in terms of their theoretical/estimated mining resources. This study has focused on the two aforementioned mining districts, providing 7 potential sites from Alentejo, 9 from Andalusia and 6 from Extremadura, as well as 2 other sites from the fourth I4-GREEN region –Castile and Leon-, although in a different geological context. The complete list therefore consists of 24 sites, of which 11 are potentially suitable for IHO replication and 13 for E-LIX. Future in-depth studies can certainly provide more potential sites to this list.

To promote cross-regional replication of the I4-GREEN pilot projects, a Pilots Action Plan has been designed. The actions proposed in this Plan aim to raise awareness among companies in the mining sector and administrations about the opportunity to implement such pilots.

On the other hand, a study of the S3 Partnerships (TSSPs) has been carried out, assessing overlaps between the project and the TSSPs, to find out for which of them the I4-GREEN project could represent an investment opportunity. In this study, the TSSP Mining Industry stands out as the most appropriate for promoting investment projects according to the I4-GREEN project model, while the rest of TSSPs can act as partner providers for specific issues.

A Portfolio of Investment Leads has been designed for this selected group of TSSPs as a tool to exploit synergies with the I4-GREEN project, promoting new projects and attracting investments for their respective regions. The Portfolio consists of two groups of investment opportunities: on the one hand, the list of potential sites for pilot replication and, on the other hand, the I4-GREEN as a project model for other mineral resources. The list of potential sites for pilot replication constitutes a concrete investment opportunity for the I4-GREEN regions (Alentejo, Andalusia, Extremadura and Castile and Leon); a detailed assessment of the mining potential of the remaining regions, especially those covered by the TSSP Mining Industry, could expand this list with new sites for replication. On the other hand, projects like I4-GREEN but focused on other mineral resources can be planned, depending on the mining potential of the regions involved.

Finally, a brief study on funding opportunities for the replication of the I4-GREEN pilots has been conducted, highlighting three EU funding sources as the most suitable: I3, INTERREG and Horizon Europe.

2. Pilots Action Plan

The Pilots Action Plan, as it is explained in Task T6.1, is closely related with the mirroring strategy (see deliverable D6.1) carried out among the four I4-GREEN regions: Andalusia, Extremadura and Castile & León in Spain, and Alentejo in Portugal.

A first step towards the achievement of the Action Plan is the identification of pilot sites similar to the cases deployed in I4-GREEN. Since the ultimate goal of the Plan is the replication of IHO / E-LIX sustainable circular models, these pilot sites should have geologic and metallogenic characteristics, so that the I4-GREEN pilots can be more easily replicated.

Once the potential pilots have been identified, a set of actions can be designed to promote in them the replication of the I4-GREEN pilot technologies, enabling an improved and more sustainable harnessing of the raw materials of the aforementioned regions. This plan will then be integrated later in the Portfolio of Investment Leads to enable the implementation of future investment projects.

2.1. The I4-GREEN pilots

The following description of the I4-GREEN pilot projects is intended to serve as a reference, on the one hand, for the type of deposits to be considered as replication sites and, on the other hand, for the pilot approach that can be replicated.

Sources of the following descriptions are the Pilots description and the Guide for Applicants of the I4-GREEN Open Call, both in the project's website (I4-GREEN, 2023), and the Atalaya Mining website (Atalaya Mining, 2024).

2.1.1. Iron Holm Oak (IHO)

The IHO pilot is focused on the sustainable recovery of endogenous resources, including EU strategic raw materials such as rare earth elements (REE), from tailings of the iron ore processing. This pilot is being developed by the I4-GREEN partners Gevora and Leonore.

The iron ore it is found in a set of mineral deposits along the called "Iron District of the SW Iberian Peninsula", that spreads by Andalusia, Extremadura and Alentejo regions. The deposit of the pilot site is Skarn type and is developed in the contact zone of Cambrian carbonate and intrusive rocks. The main iron ore is magnetite, with minor levels of hematite and accessory sulphides (pyrite, pyrrhotine and chalcopyrite). Feasibility studies carried out in some of these deposits have unveil interesting contents of monazite, one of the main REE bearing minerals.

In detail, the IHO pilot is located in a mining concession with 58 Mt of mineral resources, containing 38% Fe (magnetite as main mineral) and 0.3% REE (monazite).

The main topic addressed by the pilot is:

- Processing technology: to recover REE minerals from iron waste

In addition, other topics are tackled, such as:

- Water recycling: avoiding the need for waste ponds
- Green energy: prioritizing renewable energy sources
- Sustainable operation: selecting techniques with reduced impact on the environment
- Automation & digitization: for intelligent design of process plants
- Sustainable mobility: designing efficient exploitation, storage and disposal areas
- Circular recovery: designing a circular use of mining resources and tailings

The final goal of the pilot is to make a circular use of the exploited mining resources to recover strategic raw materials (REE), low grade irons and some other marketable resources (granodiorites).

2.1.2. E-LIX

The Atalaya/Lain Tech project (E-LIX) is based on a novel hydrometallurgical process for leaching Cu and Zn sulphides (chalcopyrite and sphalerite). The pilot project is run by the I4-GREEN partners Lain Technologies (Lain Tech) and Atalaya Mining.

These sulphides represent the main ore of the Cu-Zn deposits of the "Iberian Pyrite Belt", one of the most important mining zones of Europe. Deposits in this belt are of volcanic-hosted massive sulphide type (VHMS) and are the main source of copper and zinc in Spain and Portugal.

The pilot site is located at a 15 Mt/y processing plant near the Cerro Colorado open pit mine. Both the mine and the plant are operated by Atalaya Mining and are part of the Riotinto Project (Andalusia, Spain), which also includes the nearby San Dionisio and San Antonio deposits, both under development. Close to the Riotinto project (28 km) there is another Atalaya's asset, the Masa Valverde Project, also in development stage. All these deposits, totalling a resource of approximately 335.3 Mt of ore containing 1.99 MtCu, 2.66 MtZn and 0.98 MtPb, are already within the scope of the E-LIX pilot.

The E-LIX System, developed by Lain Tech with the financial support of Atalaya, is based on a new electrochemical process that extracts relevant metals from sulphide concentrates by means of singular catalyst under specific physicochemical conditions. Thus, the system puts copper and other metals into solution for subsequent recovery by precipitation or solvent extraction-electrowinning.

This system has been tested for six years in a semi-industrial pilot plant and will be implemented in an industrial-scale plant (E-LIX Phase I Plant), currently under construction. Once this plant is operational, it is expected to unlock relevant polymetallic resources in Atalaya's Riotinto District, including strategic EU raw materials (Cu, Co and PGMs) and Zinc, by increasing recoveries from low-grade ores.

2.2. Identification of pilot sites for replication

I4-GREEN's pilot technologies can have a significant impact at virtually all stages of the mining life cycle. For example, the proven feasibility of recovering metals or by products from complex ores can add value to an advanced exploration project, allowing it to attract investment and bring it ahead to the feasibility study. In other cases, I4-GREEN's pilot technologies can provide a more sustainable approach for operating mines. Similarly, technologies that enable the recovery of metals from waste can provide a prolonged period of industrial activity in declining mining areas. To this end, the identification of potential pilot sites will take a broad approach, including cases at different stages of development.

On the other hand, in order to take advantage of all the technologies deployed in the I4-GREEN pilots, it is important to identify and highlight those mines or projects more similar to the EHI and E-LIX pilots. The more they resemble, the easier they are to replicate. In this sense, priority sites will be those with the same deposit model and ore: Skarn and volcanic-hosted massive sulphides (VHMS) for EHI and E-LIX replication, respectively. According to this premise, the clearest possibilities for replication are located along the Iberian Pyrite Belt and the Iron District of the SW Iberian Peninsula, encompassing Andalusia, Extremadura and Alentejo.

In any case, it is worthy to take as well into account some other projects or mines that, in spite of being out of these districts and correspond to another type of deposit, present geological similarities with the I4-GREEN pilots. This is the case of some mining projects located in Castile and Leon, far from the aforementioned districts but maybe suitable for the I4-GREEN pilot replication. In these cases, as in the others, this replication could bring added value and push them towards the exploitation phase.

In the following paragraphs, a set of potential sites for pilot replication are presented for each region, engaging a variety of raw materials. Needless to say that this overview of sites is a first approximation and that an in-depth study of the mining potential of the regions concerned can certainly provide more potential sites.

2.2.1. Sites for E-LIX replication

The VHMS deposits are concentrated in the Iberian Pyrite Belt (IPB), one of the most important districts for this type of deposit in the world. The IPB constitutes a strip of around 240 km long and 35 wide that runs through the provinces of Sevilla and Huelva in Andalusia, Badajoz in Extremadura and Beja and Setúbal in Alentejo. In the Iberian Massif context, the IPB is located in the calledSouth Portuguese Zone.

The IPB's main metallogenetic feature is a Volcano-Sedimentary Complex (CVS), with an age Late Devonian-Early Carboniferous, which contains massive sulphide deposits (VHMS type). In these deposits, sulphides can appear both in lenses of massive sulphides and in stockworks of sulphide veins hosted by metamorphic rocks. The mineralogy comprises: pyrite (dominant), with variable proportions of sphalerite (Zn), chalcopyrite (Cu) and galena (Pb), between others.

The most outstanding deposits of the IPB (with more than 100 Mt) are: Riotinto, Masa Valverde, Tharsis, La Zarza, Aznalcóllar-Los Frailes and Sotiel-Migollas in Spain, and Aljustrel and Neves Corvo in Portugal. Additionally, other world-class deposits, with more than 30 Mt, are: Concepción, La Romanera, Las Cruces and Aguas Teñidas E in Spain, and S. Domingos and Lousal in Portugal.

Additionally, some sites in Extremadura and Castile and Leon have also been taken into account, despite being outside the IPB, as its mineralogical characteristics could be suitable for E-LIX processes.

Sources: (Tornos, López Pamo, & Sánchez España, 2000) (Inverno, y otros, 2015)

Table 1. Potential E-LIX replication sites

REGION	E-LIX REPLICATION SITES	STATE	COMPANY
Alentejo	Lagoa Salgada	Project	Ascendant Resources Inc.
Alentejo	Aljustrel	Mine	ALMINA-Minas do Alentejo S.A.
Alentejo	Neves Corvo	Mine	SOMINCOR
Andalusia	Romanera-Infanta	Project	Emerita
Andalusia	Lomero	Project	Denarius Metals
Andalusia	Tharsis	Project	Tharsis Mining
Andalusia	La Zarza	Mine	Tharsis Mining
Andalusia	Sotiel	Mine	Sandfire MATSA
Andalusia	Aguas Teñidas-La Magdalena	Mine	Sandfire MATSA
Andalusia	Aznalcóllar-Los Frailes	Project	Minera Los Frailes
Andalusia	Las Cruces	Mine	Cobre Las Cruces
Extremadura	Aguablanca	Project	Denarius Metals/Río Narcea Resources
Castilla and Leon	Otero de Herreros	Project	Hispania Resources

LAGOA SALGADA

The Lagoa Salgada Project, owned by Ascendant Resources Inc., is located in the western end of the Iberian Pyrite Belt, in Alentejo. The deposit was discovered in 1992 and since then has been intensively explored. With the feasibility study, the company concluded that with an underground mine operation it's possible to mine a rate of of 1,2 MT per annum (with an initial mine life of 14+ years).

The project consists of two deposits: Venda Nova North and South. The mineralization occurs as primary massive sulphides, surrounded by copper-rich stringer/fissure/stockwork, Weathering of primary sulphides has resulted in gossan deposits and transition massive sulphides.

According to the company's mineral reserve estimation (NI 43-101, 2023), the project contains:

- Reserves: 14.6 Mt @ 0.37% Cu, 1.5% Pb, 1.8% Zn, 0.07% Sn, 37 ppmAg and 0.38 ppmAu

These reserves (proven and probable) comprise the mentioned types of mineralization: gossan, massive and transition sulphides, stringer and stockwork.

The envisaged processes include sulphide flotation to recover Zn, Pb and Sn concentrates (also containing Cu, Ag and Au), and a final leaching stage to recover additional Ag and Au from tailings.

Source: Ascendant Resources Inc. website (Ascendant Resources, 2024); NI 43-101 Technical Report and DFS for the Lagoa Salgada Project (Ascendant Resources Inc., 2023);Technical Report on the Resource Estimate Update for the Lagoa Salgada Project (MICON International Ltd., 2019)

ALJUSTREL

Aljustrel is a zinc-lead-(copper) mine, located in the municipality of Aljustrel (Alentejo, Portugal), which is operated by the Company ALMINA-Minas do Alentejo, S.A. The mine has been extensively exploited from the mid-19th century (ALMINA, 2024).

Located in the Iberian Pyrite Belt, the deposit consists of six orebodies: Estação, Feitais, Algares, Moinho, S. João and Gavião, some of which are now exploited by underground mining. The treatment plant mainly produces Zn (99,000 tZn/year) and Pb (20,000 tPb/year) (Mining.com, 2023). The company employs more than 1,200 people (400 as direct employees) in both extraction and processing.

ALMINA is highly committed to environmental conservation. Thus, the company is promoting measures to minimise impacts, such as waste management or mine and processing water treatment. Thus, the company has made a new investment of EUR 11 million for dust control process.

On the other hand, the company has established a photovoltaic solar park for self-consumption with a capacity of 19.6 MW. According to the Company, this is the largest self-consumption plant in the EU (Molina, 2023).

Figure 1. Aljustrel facilities

Source: ALMINA (ALMINA, 2024)

NEVES CORVO

Neves Corvo is a copper-zinc-(lead) mine that is located in the municipality of Castro Verde (Alentejo, Portugal). The mine is operated by the Sociedade Mineira de Neves-Corvo, S.A. (SOMINCOR), a subsidiary of Lundin Mining, a Canadian base metal mining company operating in America and Europe.

Located in the western part of the Iberian Pyrite Belt, the Neves-Corvo deposit comprises seven main polymetallic massive sulphide lenses. Strong metal zoning distinguishes copper and zinc-(lead) rich zones, together with massive barren pyrite.

Mineral resources estimate at the end of 2023, both measured and indicated, was:

- Copper zones: 54,31 Mt with 1,209 ktCu; 462 ktZn and 185 ktPb
- Zinc & Lead zones: 63,60 Mt with 207 ktCu; 4,337 ktZna and 895 ktPb

Prospecting campaigns are underway at other blind massive sulphide deposits in the surrounding area.

Ore extraction is carried out by highly mechanised underground mining. The processing facilities consist of two plants:

- Copper plant, with a capacity of 2.8 Mt/year
- Zinc plant, with a capacity of 2.5 Mt/year

The production outlook for 2024 is: 30-35,000 tCu and 120-130,000 tZn, with additional Pb concentrates. Cu and Zn concentrates are shipped at Setubal to a variety of smelter costumers, mainly from Europe. Portugal stands out as the first Zn producer in Europe, thanks to Neves-Corvo operation.

Figure 2. Neves Corvo facilities.

Source: (Lundin Mining, 2024).

ROMANERA-INFANTA

Emerita, a Canadian mining exploration company, is the owner of the Iberian Belt West project (IBW). This project, located in the municipalities of Paymogo and Puebla de Guzmán (Huelva province, Andalusia), comprises three VHMS polymetallic deposits: Romanera, El Cura and Infanta, some of whichwere first exploited in Roman times and intermittently since then.

Romanera deposit consists of 2 lenses of massive or semi-massive Cu-Zn-Pb sulphides. Infanta, on its part, contains several mineralized horizons. According to the last mineral resource estimate (2023), both Romanera and Infanta contains:

- Indicated: 14.07 Mt @ 3.29% Zn, 1.66% Pb, 0.46% Cu, 75.2 gAg/t and 1.39 gAu/t, which represent a metal content of 463 ktZn, 233 ktPb, 65 ktCu, 34,030 kozAg and 629 kozAu.

Another 4.71 Mt of inferred resource has also been estimated.

Source: Emerita website (Emerita, 2024)

LOMERO

The Lomero Cu-Zn-Pb-Au-Ag project is located in the municipality of El Cerro de Andévalo (Huelva province, Andalusia). The project has been owned by Denarius Metals since 2021 and is being developed by its Spanish subsidiary Alto Minerals S.L.U. First, there were two open pits, Lomero and Poyatos, and an underground mine in operation from 1905 to 1990. The current project envisages both open pit and underground mining.

The project consists of two adjacent deposits, Lomero and Palomarejo, and contains three types of ores: massive sulfide, semimassive sulphide and stockwork. The high Au grade, one of the highest in the IPB, stands out. According to the last mineral resource estimate (SRK NI 43-101, November 2023), the Lomero project has the following resources:

- Indicated resource: 7.73 Mt @ 0.66% Cu, 1.03% Zn, 0.46% Pb, 2.27 gAu/t and 25 gAg/t, representing a metall content of 51,259 tCu; 79,893 tZn; 35,521 tPb; 565 kozAu and 6,095 kozAg
- Inferred resource of 3.45 Mt @ 0.29% Cu, 1.18% Zn, 0.53% Pb, 1.86 gAu/t and 22 gAg/t, representing a metall content of 9,884 tCu; 40,662 tZn; 18,422 tPb; 206 kozAu and 2,478 kozAg.

Source: Denarius Metals website (Denarius Metals, 2024)

THARSIS AND LA ZARZA

Tharsis Mining is the owner of the Tharsis, La Zarza and San Telmo mining rights, all in the province of Huelva (Andalusia). The company has advanced plans to reopen inactive mines at the Tharsis and La Zarza projects.

Tharsis Project is located in the municipality of Alosno and consists of seven deposits: Filón Norte, Centro, Sur, Sierra Bullones, Corta Esperanza, Lagunazo, Cantareras y Almagrera. These deposits were first exploited by the Tartessians (12th-5th centuries BC). Modern exploitation began in the mid-19th century and continued, with some gaps, until 2001. The Tharsis project contains important resources of Cu-Zn-Pb, but may also be an interesting source of silver, gold and cobalt.

La Zarza, located in the homonym municipality, was also exploited by Tartessians and Romans, and in modern times by underground mining (chambers and pillars) from 1853 to 1991, with a total production of 40 Mt. The deposit consists of a orebody 850 m long and 175 m wide of gold-rich sulphides. A JORC-compliant mineral resources estimate has calculated 9.8 Mt of indicated resources and 1.3 Mt of inferred resources.

Source: Tharsis Mining website (Tharsis Mining, 2024).

SOTIEL AND AGUAS TEÑIDAS-LA MAGDALENA

Sandfire MATSA is the owner of three operating mines, -Sotiel, Aguas Teñidas and La Magdalena-, as well as other targets at various stages of development.

Sotiel has had several periods of activity since Roman times. The current Cu-Zn-Pb-Ag-Au underground mine, located in the municipality of Calañas (Huelva province, Andalusia) is in operation since 2015. The adjacent treatment plant processes the mineral from the three mines and has a capacity of 4.5 Mt per year (both polymetallic and "cobrizo" minerals). The process includes grinding and flotation.

Aguas Teñidas is an underground deposit that was discovered in the 1980's. The current mine, located in the municipality of Almonaster la Real (Huelva province, Andalusia), came into operation in 1997 and, after a period of inactivity, was reopened in 2009. Seven kilometres far from Aguas Teñidas mine is the La Magdalena mine, discovered in 2013; both mines are connected by an inland road.

Source: Sandfire MATSA website (Sandfire MATSA, 2024).

Figure 3. Sotiel treatment plant (Sandfire MATSA, 2024)

AZNALCÓLLAR-LOS FRAILES

The company Minera Los Frailes is the owner of the outstanding Los Frailes project. First, there were two major open-pit mines, Aznalcóllar and Los Frailes, located in the municipality of Aznalcóllar (Sevilla province, Andalusia) and approximately 1 km apart, which were active from 1975 to 2001.

The new Los Frailes mine will have an underground development. The treatment plant will have a capacity of 2.7 Mt per year with a closed water circuit.

According to the company, reserves and probable resources are around 80 Mt with a mineralization of Cu-Pb-Zn-Au-Ag.

Sources: Minera Los Frailes website (Minera Los Frailes, 2024) and Mining Technology website (Mining Technology, 2000).

LAS CRUCES

Las Cruces mine is located in the municipalities of Gerena, Guillena and Salteras (Sevilla province, Andalusia), in the eastern end of the Iberian Pyrite Belt. It is operated by the company Cobre Las Cruces (CLC), a subsidiary of the Canadian First Quantum Minerals. The current open pit mine is nearing its end but will be followed by an underground operation that will extend the mine's life for another 10-15 years. The deposit stands out by its elevated grade, 5-6% Cu, clearly higher than the common grade of the IPB deposits.

Adjacent to the mine, CLC has one of the most advanced and sustainable hydrometallurgical treatment plants of the world, in which produces Cu cathodes of the highest purity (99.999%, Grade A in London Metal Exchange). In parallel to the development of the new underground mine, CLC is working in a new polymetallurgic refinery to produce Cu, Zn. Pb and Ag.

Source: Cobre Las Cruces website (Cobre Las Cruces, 2024)

AGUABLANCA

Aguablanca is a Ni-Cu-Co-PGMs-Au inactive mine located in the municipality of Monesterio (Badajoz province, Extremadura). This deposit is not in the Iberian Pyrite Belt; however, taking into account its Cu-Co-PGMs paragenesis, it is worth to consider this case as potential site for E-LIX replication.

Geologically, the Aguablanca deposit is located in the Ossa-Morena zona of the Iberian Massif. The mineralization is hosted by brecciated mafic-ultramafic igneous rocks. The mineralized matrix comprises semi massive and disseminated sulphides and chalcopyrite veins.

The Aguablanca deposit was discovered in 1994 and was first mined open pit from 2005 to 2015 and then underground. The mine was closed in 2016 due the low Ni and Cu prices. The Aguablanca project includes a plant with a capacity to process 5,000 t per day. Aguablanca is currently 50% owned by Denarius Minerals and Rio Narcea Recursos S.L.

A historical metal resource estimate presents these measured and indicated resource:

- M&I: 6.4 Mt @ 0.63% Ni, 0.56% Cu, 150gCo/t, 0.28 gPt/t, 0.24 gPd/t and 0.15 gAu/t.

Figure 4. Aguablanca treatment plant

Sources: Denarius Metals website (Denarius Metals, 2024) and (Pina García, 2006)

OTERO DE HERREROS

Otero is a polymetallic project located in the municipality of Otero de Herreros (Segovia province, Castile and Leon). The project is owned by the mineral exploration company Hispania Resources. The property had a mining history in Roman times and these ancient workings now constitute the Cerro de los Almadenes archaeological site (El Adelantado de Segovia, 2023).

The project has been explored by several companies in the last 50 years. As a result of these investigations, a Cu-Zn-Ag-Sn-W polymetallic Skarn deposit was defined, consisting of 6 mineralized levels with more than 2,000 m long and to 610 m depth (Hispania Resources, 2023). It is remarkable than two (Cu and W) of these elements are included in the last EU list of critical raw materials.

The most important levels contain around 5.5 Mt with the following grades:

- M level: 2.5 Mt @ 0.70 %Cu; 26 gAg/t; 1.46% Zn; 0.23% SnO_2 and 0.04% WO_3
- I level: 1 Mt @ 0.22 %Cu; 12 gAg/t; 0.47% Zn; 0.18% SnO_2 and 0.21% WO_3

Metallurgical tests showed recoveries of 88% Cu, 89.7% Zn and 68.1% Ag. The scheelite (W) could be recovered by flotation from the sulphide tailings (Hispania Resources, 2023).

The future mine is expected to produce some 1,363 t per day, with an 18-year life expectancy (El Adelantado de Segovia, 2023).

2.2.2. Sites for IHO pilot replication

The IHO pilot project focuses on the recovery of valuable metals from a Fe-Skarn deposit. This type of mineralization is concentrated in the Iron District of the SW Iberian Peninsula (IDSWI), which extends over 120 km through the regions of Alentejo, Extremadura and Andalusia. The Iron ore deposits along this district were of significant economic importance, although all mines are now inactive, and constitute a clear opportunity for cross-regional replication.

In the Iberian Massif context, the IDSWI deposits are usually located in carbonate or volcanic Cambrian materials of the Ossa-Morena Zone, close to igneous rocks or important tectonic accidents. There are several interrelated types of Fe deposit (with variable contents on Cu sulphides) in this district that can be organized in two groups:

- Volcano-sedimentary stratiform deposits (e.g. Bilbaína, La Bóveda, Las Herrerías, Aurora-Las Galerías), where the ore is constituted by magnetite with occasionally important contents of hematite and barite.
- Replacement deposits. In this group there are magnetite mineralizations in skarn, related with the Burguillo, Aguablanca or Teuler plutons; magnetite deposits in the contact with albitic plutons (e.g. La Berrona, El Soldado); and deposits related with shear zones (e.g. Monchi, Colmenar-Sta. Barbara, Cala).

Some of these Fe deposits present many of the geologic and metallogenetic characteristics of the Iron oxide-Copper Gold (IOGC) type, one of the most outstanding type of mineral deposit. This is the case of magnetite associated to albite-actinolite alteration, present in some of these deposits.

All these types are frequently imbricated in the IDSWI deposits and, in fact, there is some discussion about the genetic model of some of these deposits. In any case, all of them are equally interesting and will be considered as possible sites for the IHO pilot replication.

Furthermore, despite being outside the IDSWI and having a different typology, other important Fe deposits from Alentejo and Castile and Leon have also been considered. Testing IHO technologies in different areas can expand the opportunities for the pilot's replication potential.

Sources: Sistema de Informação de Ocorrências e Recursos Minerais Portugueses – SIORMINP (LNEG, 2024); Cartografía de recursos minerales de Andalucía (Boixereu & Gumiel, 2011); Mapa metalogenético de la provincial de Badajoz (IGME, 2006); Carriedo y Tornos (Carriedo, 2006)

TABLE 2. Potential IHO replication sites

REGION	IHO REPLICATION SITES	STATE	COMPANY
Alentejo	Cercal	Closed	
Alentejo	Alvito	Closed	
Alentejo	Azenhas-Orada	Closed	
Alentejo	Monges-Nogueirinha	Closed	
Extremadura	La Bilbaína	Closed	
Extremadura	Alconchel	Project	Atalaya Mining
Extremadura	S. Guillermo, Colmenar, Sta. Justa	Project	
Extremadura	Monchi, Aurora y Consuelo	Closed	
Extremadura	La Berrona	Closed	
Andalusia	Cala and Teuler	Closed	
Castile and Leon	Ponferrada-Astorga	Closed	

CERCAL

Cercal is a locality in the municipality of Santiago do Cacem (Setúbal district, Alentejo), but it is also a region of the South Portuguese Zone of the Iberian Massif. Located on the Alentejo coast, this region contains several Fe-Mn mines that were exploited mainly in the 20th century. Some of them present today visible waste deposits.

The Fe-Mn vein deposits of Serra da Mina, of hydrothermal origin, are hosted by the Volcano-Sedimentary Complex (VSC) of the Iberian Pyrite Belt. The mineralization, closely associated with silica, consists of pirolusite, hematite, goethite and limonite. Alongside the vein type deposits, there are stratiform mineralizations (associated to jaspers and volcanogenic sediments) and schist impregnations.

The vein system, up to 5 km long of development and 10 m as maximum wide, is of great economic interest and has been extensively explored. One of the most important is the Rosalgar mine, close to Cercal do Alentejo. This deposit, with more than 3 Mt of Fe-Mn ore, consists of a main vein, 3.1 km long, with several branches. The paragenesis includes Fe and Mn oxides and carbonates, usually associated to quartz, as well as some Zn, Cu and Pb sulphides. Another outstanding deposits of this region are Toca do Mocho (Cercal do Alentejo) and Herdade dos Pendões (Odemira), with similar characteristics.

According to the metallogenetic model, the Fe-Mn mineralization was first precipitated as carbonates from hydrothermal solutions, and subsequently transformed into Fe-Mn oxides by alteration of the previous carbonates.

Source: Margarida Lemos Barbosa, end of degree project (Lemos Barbosa, 2021)

ALVITO

The Alvito group of mines is located in the municipality of Alvito (Beja district, Alentejo). The mine workings consist of three N-S aligned open pits: Pinheiros, Fonte Seca and Zambujal, which were active in the 19th century. In 2017-18, the site was explored as a possible IOGC deposit.

The deposit, Fe-skarn type, was formed in the mechanical contact of a gabbro-diorite suite (Beja Igneous Complex) with Cambrian marbles by the action of magmatic and hydrothermal fluids. The massive magnetite ore, hosted by the exoskarn facies, was generated in the retrograde stages of metassomatism. The mined mineralization consists of several lenticular stratiform masses of magnetite with some associated sulphides (pyrite, pyrrhotite, sphalerite and galena).

The Alvito deposit presents anomalous contents on Co, Ni and Zn, that could be of interest for exploration and also for an IHO-type study.

Sources: Cardoso Maia, M., Tese de Doutoramento (Cardoso Maia, 2022); mindat.org (mindat.org, 2024)

AZENHAS-ORADA

The Azenhas-Orada area consists of two iron ore mines separated by the Guadiana River. The Azenhas mine, 3.5 km far from Alvito mine, is located in the municipality of Vidigueira (Beja district, Alentejo). This mine consists of two main open pits (Azenhas I and II) that were exploited in the 20th century. On the other hand, the Orada mine is located in the municipality of Serpa (Beja district, Alentejo) and was exploited from the end of the 19th century until the middle of the 20th century.

The Azenhas deposit consists of two lenticular bodies which were exploited by open pit mining; waste deposits are still available for study in this area. The Orada deposit has three main ore bodies, 60-250 m long and 5-30 m wide, developed over 6 km.

The Fe-ores are mainly hosted by basic metavolcanic rocks and Cambrian carbonate rocks. This lithological units are imbricated by a Variscan thrusting. All the whole is intruded by the Pedrogão granite. There are two types of magnetite: a first generation of massive magnetite hosted in volcanic rocks (amphibolites), and a second generation hosted in skarn rock.

Sources: Cardoso Maia, M., Tese de Doutoramento (Cardoso Maia, 2022); mindat.org (mindat.org, 2024)

MONGES-NOGUEIRINHA

The Monges-Nogueirinha mining area consists of a set of mines, aligned NW-SO, located near the town of Santiago do Escoural, in the municipality of Montemor-o-Novo (Évora district, Alentejo), and represent the most important mining works of the Montemor-o-Novo Iron Complex (Ossa-Morena Zone). These mines, mostly open pit, were first exploited in the 18th and early 19th centuries and later between 1850 and 1940, although there is evidence of mining from Roman and Muslim times. Total ore production has been estimated at around 206,000 t, representing the 60% of the iron ore production in the Complex.

The deposit consists of 8 main massive ore bodies of magnetite-pyrite, with secondary chalcopyrite and hematite, hosted by a Cambrian volcano-sedimentary sequence constituted by marbles, calc-silicate rocks and acid metavolcanic rocks. The mineralization comprises massive magnetite hosted by marbles, disseminated granular magnetite in amphibolite, magnetite-sulphides (pyrite, pyrrhotite and chalcopyrite) in calc-silicate rocks and hematite. Recent studies have suggested a continuum SEDEX-VHMS genetic model, although the structure of the mineralization is overprinted by several tectonic-metamorphic episodes of the Variscan Orogeny, especially a large shear zone.

Sources: Cardoso Maia, M., Tese de Doutoramento (Cardoso Maia, 2022); mindat.org (mindat.org, 2024)

BILBAINA

The Bilbaina mine is located in the municipality of Jerez de los Caballeros (Badajoz province, Extremadura.). The mine was exploited in the period 1910-1968.

This is a case of non-skarn related deposit, as it is classified as stratabound in Neoproterozoic volcanic rocks. However, taking into account both mineralization and resources, it is considered a site of interest for potential replication of the EHI pilot.

The deposit consists of a subvertical tabular mass 1,200 m long and 2-12 m wide. The Fe ore is magnetite and hematite, with pyrite and Fe oxides-rich levels. Different studies have pointed out grades of 52.5% Fe, 0.11% Cu and up to 2.91 gAu/t. Since 1949, the last company in charge of the operation has extracted a total of 1 Mt of ore with 54% Fe or 2.82 Mt with 48-50% Fe. The most recent exploration (in the 1970's) has estimated a resource of 6.85 Mt.

Source: Mapa metalogenético de la provincial de Badajoz (IGME, 2006)

ALCONCHEL

Alconchel Cu-Au deposit is part of the Ossa-Morena Cu-Au Project, a set of mining targets owned by Atalaya Mining. The Alconchel mine is located in the municipality of Las Herrerías de Alconchel (Badajoz province, Extremadura).

The deposit is stratabound type and consists of 4 levels of magnetite, hematite and barite, 2-15 m wide and 2 km long, hosted by a Cambrian volcano-sedimentary succession. In the 70's, the Spanish Geological Survey estimated a possible resource of:

- 12 Mt @ 44% Fe and 0.28% Cu

Later, a compliant NI 43-101 mineral resource estimate yielded this measured and indicated resources:

- M&I: 7.8 Mt @ with 0.66% Cu and 0.17 gAu/t. Inferred resources sum 15 Mt.

Source: Atalaya Mining webpage (Atalaya Mining, 2024) and (IGME, 2006)

S. GUILLERMO, COLMENAR Y STA. JUSTA

These three mines are located in the municipality of Jerez de los Caballeros (Badajoz province, Extremadura) and represent the most important deposit of the Iron District of the SW Iberian Peninsula (IDSWI) after Cala. Currently, this area is hosting the IHO pilot. The period of activity spans from the beginning of the 20th century to 1978. The exploitation was carried out by open pit, and also by underground mining in Colmenar. This mine, with the connected Sta. Barbara mine, produced 700.000 t ore with 57% Fe.

The mineralization is concentrated in a band with 5-6 km length and 3-40 m width. The skarn, in some places milonitised, contains a mineralization of magnetite with accessory monazite (among others) and occasional Cu-Fe sulphides. The grade in Colmenar was in average:

- 44.3% Fe, 0.03% Mn, 24.04% SiO_2, 3.55% Al_2O_3, 3.03% Na_2O, 0.5% S and 0.05% P

Drilling campaigns in the 1960' and 1970's yielded resource estimates of:

- Reserves: 3.66 Mt @ 45.4% Fe in Colmenar, and 7 Mt @ 35.25% Fe in Sta. Justa
- Probable: 6.86 Mt in Colmenar and 4.23 Mt in Sta. Justa

Source: Mapa Metalogenético de Extremadura (IGME, 2007)

MONCHI, AURORA Y CONSUELO

This mining group is located in the municipality of Burguillos del Cerro (Badajoz, Extremadura). There was an initial period of intermittent mining until 1883 and then continuous operation from 1953 to 1978. The deposit was exploited by underground workings (eleven plants of galleries reaching 350 m depth) connecting the three mines. In the 20th century mining period, the production rate was 45,000-60,000 t of high-grade concentrate (66-67% Fe), which was obtained by magnetic separation.

Mineralization is concentrated in 5 lenticular masses, 500 m long and 5-8 m wide, located along the distal skarn associated to the Burguillos pluton. The ore, basically magnetite, contains 50-63% Fe. The paragenesis includes some REE and Co minerals of interest for a potential replication of the IHO pilot.

In the same area, and associated to the same Burguillos pluton, there are some other Fe mines in the proximal skarn: San José, La Judía, Li-Hung-Chang and Imperio. These mines were exploited in the 1950's and 1960's and have been later explored by the Spanish Geological Survey (IGME).

There are no available mineral resources estimate. It seems that the exploitation ceased due to resource depletion. However, taking into account the verified presence of REE minerals, it is worth to have this group of mines in the list of potential sites to replicate the EHI pilot.

Source: Mapa Metalogenético de Extremadura (IGME, 2007)

LA BERRONA

La Berrona mine is located in the municipality of Jerez de los Caballeros (Badajoz province, Extremadura). This deposit has been barely exploited.

The mineralization, skarn-related, has a cylindrical shape, with an extension of 250x800m. The metallic paragenesis is mainly constituted by magnetite and hematite, with minor contents of pyrite, chalcopyrite and pyrrothite. A drilling campaign performed by the Spanish Geological Survey (IGME) in the 70's has resulted the following resources estimate:

- 26.2 Mt @ 26.8% Fe, 0.325% P, 4.4% SiO_2 and 2.97% Na_2O+K_2O

There is a metallurgical problem to extract the iron from the ore, because the high contents in phosphorus and alkalis. To remove these elements, it is needed a magnetic concentration and a very fine grinding.

Source: Mapa metalogenético de la provincial de Badajoz (IGME, 2006)

CALA AND TEULER

Cala mine is located in the municipality of Cala (Huelva province, Andalusia). The mine has had several periods of activity since Roman times, the most intense ones in the 20th century, with a definitive closure in 2010. The mining operation includes both open pit and underground mining; the size of the open pit "corta Mercedes" stands out, with 1,100 m in length and 200 m in width.

The Cala deposit is stratiform, consisting of two lenses (Filón N and Filón S) associated to a calcic skarn zone, which contain magnetite (with secondary hematite and limonite), pyrite, chalcopyrite and pyrrothite, with an average grade of 26.36% Fe and 0.24% Cu. The type of deposit seems to be complex, with an initial phase of IOGC linked to a shear zone with a later superimposed phase of skarn.

A resource estimate points out at 50 Mt @ 40% Fe and 0.4% Cu for the Cala deposit.

Teuler mine is located 5 km East of Cala mine. This exploitation consists of two open pits, currently inactives. The deposit consists of two magnetite masses in a similar geological situation to the Cala, related to the same intrusive, although here related to a magnesic skarn.

Sources: Cartografía de recursos minerales de Andalucía (Boixereu & Gumiel, 2011); Teresa Sánchez-García et al (Sánchez García, Bellido Mulas, & Mediato Arribas, 2017)

PONFERRADA-ASTORGA

The Ponferrada-Astorga Iron District stretches between these towns in the province of Leon for 40 km, although there are other smaller deposits in the NW extension of the metallotect. It is made up of three "cotos" (a Spanish mining term representing a grouping of mining concessions): Coto Wagner, Coto Vivaldi and Coto San Bernardo, which represent the most important iron ore mines in the region. They were in operation, both underground and open pit, from the 1950's to the 1980's, with a total production of 10,7 MtFe.

In contrast to the IHO pilot deposit, the Ponferrada-Astorga District is a sedimentary type of deposit, with oolitic iron layers hosted in an Ordovician succession. On average, the width deposit is about 5-8.7 m, but locally it can reach 20 m. The ore comprises several Fe minerals: magnetite (as in the IHO pilot deposit), siderite and chlorites; as accessories, there are different Fe, Cu and As sulphides, as well as Ti minerals, graphite and apatite. This latter limits the quality of the ore, as the phosphorus content is a handicap in the metallurgical process. There are not published studies on possible contents of REE in these deposits, but the presence of monazite is known in some levels of the same Ordovician succession.

The grade of the deposit is 52-53% Fe, with 0.36% Mn and 0.11% P_2O_5, among others. Although these cotos were intensively exploited, there is still a total resource of 269.5 MtFe (13 Mt Coto Wagner, 226.5 Mt Coto Vivaldi and 30 Mt Coto San Bernardo).

Source: La Minería en Castilla y León (SIEMCALSA, 2007)

2.3. Action Plan

A set of actions have been planned in order to promote the IHO and E-LIX pilot replication in the selected sites described in the previous chapter (as well as other companies that can be interested in such pilots). These actions are in line with those planned in the I4-GREEN WP7 (Communication and dissemination) and have to take advance of the project products, such as the outreach strategy, website, conferences, policy brief, meetings, newsletters, etc.

Also, the Pilot Actions Plan shall be consistent with the communication policy of the companies engaged in the E-LIX and IHO technologies. In this sense, the Plan represent a set of actions that can be implemented in more or less extent, depending on the scope these companies intend to give it.

The Pilots Action Plan contains the following items:

CORE MESSAGE

Ensuring a secure and sustainable supply of raw materials for European industry is a top priority for the EU, as highlighted by the forthcoming Critical Raw Materials Act (CRMA). The CRMA's main objective is to enhance domestic production of both primary and secondary critical raw materials (CRMs), targeting at least 10% of consumption from domestic extraction and at least 25% from recycling and reuse.

The focus on recycling and reuse will emphasize utilizing mining waste from both active and abandoned mines across Europe, which presents significant potential for sourcing CRMs and secondary raw materials (SRMs). The I4-GREEN project is pivotal in this effort, as it develops innovative methods for extracting valuable metals from such ores. This initiative aims to effectively tap into mining potential and boost domestic production of critical raw materials, bringing economic and employment benefits through the use of advanced, sustainable, and environmentally friendly technologies tested in the project.

Aligned with circular economy principles, the I4-GREEN project seeks to optimize resource efficiency, promote sustainable industrial practices, and reduce dependence on external raw material sources.

TARGET GROUPS

These actions have several target groups:

- Mining companies in charge of mines and projects suitable for pilot replication. Examples of these companies include those have been mentioned in the previous description of replication sites (SOMINCOR, Emerita, Denarius Metals, Tharsis Mining, MATSA, CLC, etc.).
- Funding bodies or funding facilitators that could provide funds for the replication of the pilot projects. This is closely related to the second part of this report, the Portfolio of Investment Leads, since the opportunity for a body to invest in a project coincides with opportunity for a company to finance the same project.
- Policy makers and research institutions that can promote further studies to understand the potential application of pilot technologies in the mining landscape of the I4-GREEN regions. This point could refer to policy makers like Regional/National Administrations and Research institutions like the Spanish Geological Survey (IGME)

ACTIONS

- ONLINE PRESENCE

The Plan can make use of the I4-GREEN project website, but also the website of the companies involved in the implementation of the IHO and E-LIX pilots. It is important to highlight the replication possibilities that these pilots have in the I4-GREEN regions, providing valuable information but always taking into account the dissemination policies of the companies.

- MEETINGS

Meetings are a traditional and effective way of communicating, even more so when the target is a selected group of companies and institutions. A general meeting to showcase implemented technologies and pilot test results is a recommended way to establish first contacts that can lead to future collaborations. These are being implemented taking advantage of the project meetings every 6 months.

On a broader level, it would be useful to present the I4-GREEN technologies at some other events, such as the Raw Materials Week (Brussels, Belgium) or the Mines and Minerals Hall (Seville, Spain), to give the project a European projection.

Specific meetings could be organised with regional/national administrations to convey the message discussed in the following section. The Pan-EU workshop to be held in Seville in June 2024 under Junta de Andalusia premises reflects one of the specific activities on this behalf.

In addition, specific meetings could be organised with funding bodies or platforms, such as TSSPs, could be organised to secure financing for the replication of the pilots.

- POLICY BRIEF

In essence, is the same message that is offered on websites and in meetings, but here with a different purpose. National and regional administrations are responsible for funding and promoting general exploration programmes for mining potential. This potential usually refers to the main elements present in the ore, but not to other possible valuable by-products. This is the case, for example, of the iron ores, normally considered as a source of Fe and sometimes Cu or Au; now, the IHO pilot opens the opportunity to take advantage of possible REE contents in these Fe ores, and for this it would be quite interesting to know which deposits contain REE in their ores.

The I4-GREEN pilot projects represent an opportunity to expand the mining potential with some valuable raw materials that have so far not been overlooked. It is important to communicate this fact to the competent authorities so that they include in the general exploration campaigns an assessment on the content of those metals (REE, Co and others) that can now be extracted by means of the I4-GREEN technologies. This is especially important for deposits without mining plans or mining companies that can characterise the ore, such as most of the iron ore mines described in the previous chapter.

The EU Critical Raw Materials Act is promoting national exploration programmes to know the real mining potential in such substances. To this end, it is very important to communicate the I4-GREEN results to the authorities in charge of these programmes.

3. Portfolio of Investment Leads

As it is said in the I4-GREEN's Grant Agreement (WP6, T6.2), part of the value proposition of this project is on the synergies that could be established between the I4-GREEN's ecosystem and the Thematic Smart Specialisation Partnerships (TSSP) of the EC's S3P-Industrial Modernisation (DG REGIO/JRC). To this end, one objective of WP6 is to synchronize the activities of I4-GREEN with these TSSPs in order to develop joint SME investment projects.

To achieve this objective, a summary of objectives and organisations of the relevant TSSPs is presented in the next paragraphs. Subsequently, taking into account the overlaps between these TSSPs and the I4-GREEN scope, as well as the locations identified in the previous chapter for pilot replication, a Portfolio of Investment Leads will be developed.

3.1. Thematic Smart Specialisation Partnerships (TSSPs)

Originally, the Smart Specialisation Platforms (S3Ps) were promoted by the European Commission with the aim to develop and implement their regional R & I strategies for Smart Specialisation (RIS3)" (European Commission, 2022). In the period 20152022, the EC has launched four S3 thematic platforms:

- Agrifood
- Energy
- Industrial Modernisation
- Sustainable Blue Economy

These platforms constitute the structure for the creation of a cross-regional network of strategic Thematic Smart Specialisation Partnerships (TSSPs) and enable these partnerships to work together in common smart specialisation areas (European Commission, 2022). Working at the regional scale, Thematic Smart Specialisation Partnerships (TSSPs) encompass regions with a common interest in exploring and developing new value chains related with shared priority areas based in their respective smart specialisation strategies (European Commission, 2024).

Recently, the EC has set up the Smart Specialisation Community of Practice (S3 CoP) as a central node that enables the guidance, network, development and implementation of the S3 (European Commission, 2024). Thus, the four S3 thematic platforms, as well as the related TSSPs, are now integrated in the S3 CoP.

The S3 thematic platform for Industrial Modernisation encompasses a total of 25 TSSPs. Some of these partnerships are closely related with the aims of the project; actually, the I4-Green proposal has been backed by two of them:

- Mining Industry and Global Value Chains (ICAMCYL, ISMC, ACPMR partners are part of this S3P partnership)
- Advanced Materials for Batteries for Electro-Mobility and Stationary Energy Storage (ICAMCYL, ISMC partners are part of this S3P partnership)

Furthermore, there are some other TSSPs that can provide access to "provider" communities, such as:

- Efficient and Sustainable Manufacturing
- SMEs to Industry 4.0

A brief list of the main facts (mission, objectives, shared smart specialisation areas, regions, organisations and related projects) about these TSSPs is presented in the next paragraphs (source: EC S3 Community of Practice webpage (European Commission, 2024)).

It is important to note that, at the time of writing, some of these TSSPs are in the process of redefining their mission, objectives and thematic working areas.

3.1.1. Mining Industry and global value chains

The main aspects of the TSSP are presented below. In green, the overlaps of objectives, regions and organisations with the I4_GREEN project's scope are highlighted and will be explained in 3.2 - Assessment of overlaps between TSSPs and I4-GREEN.

OBJECTIVES

- Promote collaboration among regions throughout the European Regional Innovation Hubs of Responsible Mining Business Solutions
- Strengthen innovation capacity
- Identify opportunities for cross-regional demonstration
- Extend the knowledge of implied organisations to promote new business and regional growth
- Develop a strategy to attract and promote investments in RDI and industrial pilots

SHARED SMART SPECIALISATION AREAS

- Sustainable mining development
- Social acceptance
- Skills development
- Engagement of SMEs in value chains
- Actions for circularity
- Digitalisation

COUNTRIES, REGIONS AND ORGANIZATIONS

Table 3. Mining Industry and Global Value Chains: regions (leaders underlined) and organisations.

MINING INDUSTRY AND GLOBAL VALUE CHAINS		
Countries	**Regions**	**Organisations**
Finland	Kainuu	Reg. Council of Kainuu
	Lapland	Reg. Council of Lapland, GTK, Univ. Lapland, East & North Finland EU Office
	North Karelia	Business Joensuu, GTK, East & North Finland EU Office
France	Nouvelle Aquitaine	AVENIA Cluster
Greece	Sterea Ellada	Region of Sterea Ellada, Univ. Athens (NTUA)
Portugal	**Alentejo**	**CDDR Alentejo, Cluster Portugal Mineral Resources**
	Centro Portugal	**CDDR Centro, Univ. Coimbra, NOVA School of Science and Technology, Cluster Portugal Mineral Resources**
Spain	**Andalusia**	**Reg. Government of Andalucía, Iberia Mining Cluster**
	Asturias	**Univ. Oviedo**
	Castile and León	**Iberia Mining Cluster, ICAMCyL**
Sweden	Bergslagen	Sweden Mining Innovation Bergslagen
	Västerbotten	Swedish Mining Innovation, North Sweden EU Office
	Norbotten	Region Norrbotten, North Sweden EU Office, Univ. Lulea

Source: S3P Mining Industry and Global Value Chains (European Commission, 2024)

3.1.2. Advanced Materials for Batteries

The main aspects of the TSSP Advanced Materials for Batteries are presented below. In green, overlaps with the scope of the I4_GREEN project are highlighted.

MISSION

- Develop RDI projects on topics related with advanced materials for batteries, including characterisation, durability and resistance under extreme conditions

OBJECTIVES

- Consider advanced materials as a Key Enabling Technology
- Secure the access to raw materials for battery manufacturing
- Link research in advanced materials for batteries with industry application
- Contribute to innovation to reduce costs related with advanced materials

SHARED SMART SPECIALISATION AREAS

- Applications for mobility and stationery uses
- Materials for energy storage
- Improved Li-ion batteries for stationary uses
- Na-ion batteries (post Li-ion)
- Full battery pack (testing of industrial cells and materials for recycling)

COUNTRIES, REGIONS AND ORGANIZATIONS

Table 4. Advanced Materials for Batteries: regions (leaders underlined) and organisations

ADVANCED MATERIALS FOR BATTERIES		
Countries	**Regions**	**Organisations**
Austria		
Belgium	Brussels-Capital region	
	Flanders	
Finland	Central Ostrobothnia	Finncobalt
	Kainuu	
	Lapland	
	North Karelia	
	Northern Ostrobothnia	
	Northern Savonia	
France	Auvergne Rhône-Alpes	Enwire, Tenerrdis
	Nouvelle Aquitaine	
Germany	Baden-Württemberg	
	Bavaria	
	Hessen	
Italy	Emilia Romagna	
	Lombardy	
	Piedmont	
Netherlands	Metropol Reg. Eindhoven	
Norway	Viken	NANOPOW
	Western Norway	
Slovakia		
Slovenia	Slovenia East	Nat. Institute of Chemistry
Spain	Andalusia	Andalusian Energy Agency, ICAMCYL, CEGASA
	Aragón	
	Castile and León	
	Basque Country	
	Catalonia	
	Galicia	
	Navarra	
	Valencia	

Source: Advanced Materials for Batteries (European Commission, 2024)

3.1.3. Efficient and Sustainable Manufacturing

The main aspects of the TSSP are presented below. In green, overlaps with the scope of the I4_GREEN project are highlighted.

MISSION

- Increase process efficiency (increasing quality and reducing costs)
- Promote manufacturing sustainability (reducing emissions and wastes, as well as energy and materials consumption)
- Promote manufacturing sustainability (human inclusion)

OBJECTIVES

- De-/remanufacturing for Circular Economy: technologies at TRL 7-8 oriented to sustainability
- Polymer based functional products: advanced and sustainable materials & processes
- Digital transformation: industry technologies (5.0) to manufacturing environments
- Energy-flexible and resource-efficient factory operation: optimise consumption of energy and materials in manufacturing to achieve emission neutral factories.

SHARED SMART SPECIALISATION AREAS

- Sustainable development
- Advanced manufacturing
- Digitalisation
- Energy efficiency
- Industry and innovation
- Responsible production

COUNTRIES, REGIONS AND ORGANIZATIONS

Table 5. Efficient and sustainable manufacturing: regions (leaders underlined) and organisations

EFFICIENT AND SUSTAINABLE MANUFACTURING		
Countries	**Regions**	**Organisations**
Austria		Isovolta, Saubermacher
Belgium	Flanders	Veltha
	Wallonia	
Finland	East and North Finland	TUT
	Tampere	
France	**Auvergne Rhône-Alpes**	Continental, Polymeris, SWARM, Univ. Lyon
	Pays de la Loire	
Germany	Lower Saxony	Arculus, Fraunhofer IWU, Hohner
	Saxony	
	Saxony-Anhalt	
Italy	Bolzano-South Tirol	Afil, ART-ER, COMET, Eginsoft, Gualini Lamiere, Politecnico di Milano, STIIMA CNR, Univ. Brescia
	Emilia Romagna	
	Lombardy	
	Friuli-Venezia Giulia	
Netherlands	East Netherlands	Brianport Development
	South Netherlands	
Poland	Malopolska	
Portugal	Norte	INEGI, **INESC, Produtech**
Slovenia		
Spain	Basque Country	Accio, AIN, Eurecat, ICN2, IRIS, Rofin, Tecnalia
	Catalonia	
	Navarra	
United Kingdom	Scotland	
	Wales	

Source: Efficient and Sustainable Manufacturing (European Commission, 2024)

3.1.4. SMEs to Industry 4.0

The main aspects of the TSSP are presented below. In green, overlaps with the scope of the I4_GREEN project (objectives and organisations) are highlighted.

MISSION

- Increase industrial competitiveness by highlighting benefits of industry 4.0 solutions and technologies to SMEs.

OBJECTIVES

- Involve SMEs in the Industry 4.0 throughout digital services
- Increase productivity and promote new business models for SMEs throughout KETs and roadmaps
- Integrate systems (production, skills, knowledge and training) following the Industry 4.0 model
- Market-oriented approach
- Promote interactions with clusters and innovation cooperative processes

SHARED SMART SPECIALISATION AREAS

- Digital Techs
- Advanced manufacturing techs
- Nanotech
- Advanced materials

COUNTRIES, REGIONS AND ORGANIZATIONS

Table 6. SMEs to Industry 4.0: regions (leaders underlined) and organisations

SME INTEGRATION FOR INDUSTRY 4.0		
Countries	**Regions**	**Organisations**
Italy	Friuli-Venezia Giulia	Univ. Pisa, Fondazione Ugo Bordoni
	Tuscany	
Poland	Mazowieckie	Random
Slovenia		TECOS
Spain	Castile and León	
	Catalonia	
	Navarra	
	Valencia	

Source: SME Integration for Industry 4.0 (European Commission, 2024)

3.2. Assessment of overlaps between TSSPs and I4-GREEN

Comparing the objectives and organisations of the TSSPs with the activities and stakeholders of I4-GREEN, there seems to be overlap between the project and some of the following TSSPs:

(It is needed to recall again that some of these TSSP are now redefining their mission, objectives and thematic working areas. For that, the conclusions of this matching exercise may change)

MINING INDUSTRY AND GLOBAL VALUE CHAINS

All the objectives of this TSSP coincides with the aims of the I4-GREEN project:

- Promote collaboration among regions throughout the European Regional Innovation Hubs of Responsible Mining Business Solutions
- Strengthen innovation capacity
- Identify opportunities for cross-regional demonstration
- Extend the knowledge of implied organisations to promote new business and regional growth
- Develop a strategy to attract and promote investments in RDI and industrial pilots

Three of the four I4-GREEN regions (Alentejo, Andalusia and Castile and Leon) are represented in the TSSP. In addition, all the organisations representing these regions, as well as other parts of Spain and Portugal, in the TSSP are on the I4-GREEN stakeholders list (see deliverable D5.1), and some of them (underlined) are partners in this project:

Portugal:
- CDDR Alentejo
- CDDR Centro
- ACPMR Associação Cluster Portugal Mineral Resources
- Univ. Coimbra
- NOVA School of Science and Technology

Spain:
- Reg. Government of Andalucía
- Univ. Oviedo
- Iberian Sustainable Mining Cluster
- ICAMCyL

This TSSP, with a clear focus on the mining sector and composed of regions with an interest in mining, can very well promote investment projects such as I4-GREEN, especially through its Spanish and Portuguese partners, not only in their regions but also in the other TSSP regions of Finland, France, Greece and Sweden. Therefore, the list of pilot replication sites in the I4-GREEN regions can be included in the Portfolio of Investment Leads for the Mining Industry and Global Value Chain TSSP, which could be expanded by considering the implementation of I4-GREEN project type in potential locations in the other TSSP regions.

ADVANCED MATERIALS FOR BATTERIES

Two objectives of the TSSP overlaps the aims of I4-GREEN:

- Secure the access to raw materials for battery manufacturing
- Contribute to innovation to reduce costs related with advanced materials

Some of the materials recovered in the I4-GREEN IHO pilot projects, such as Co, PGMs and REE, are used in the manufacture of different types of batteries (Li-ion, nickel-metal hydride) and fuel cells, which fall within the scope of the TSSP.

The two leading regions –Andalusia and Castile and Leon- are part of the I4-GREEN project, as well as their respective organisations:

Andalusia: - Andalusian Energy Agency (as part of the Junta de Andalucía)
CYL: - ICAMCYL

In this case, the TSSP is not directly related to the mining scope of the I4-GREEN, but it is interested in access to certain raw materials that can be provided by the project. In this sense, it is interesting to synchronise the activities of both parties and look for synergies that provide TSSP with secure and

economic access to raw materials, and I4-GREEN with new potential technology partners from different regions of the EU.

EFFICIENT AND SUSTAINABLE MANUFACTURING

Some of the objectives of this TSSP could overlap with the I4-GREEN approach, especially with regard to sustainability and the use of renewable energies:

- De-/remanufacturing for Circular Economy: technologies at TRL 7-8 oriented to sustainability
- Energy-flexible and resource-efficient factory operation: optimise consumption of energy and materials in manufacturing to achieve emission neutral factories.

Although there is no overlap between the regions involved in the TSSP and the I4-GREEN project, there are two Portuguese organisations in the TSSP that are also included in the project's list of stakeholders:

Portugal: - INESC
- Produtech

As in the previous case, the TSSP is not directly related to the mining field of I4-GREEN, but it does share with the project an interest in sustainability and process efficiency. In this sense, it is interesting to synchronise the activities of both parties and look for synergies that provide TSSP with new fields for the development of its objectives, and I4-GREEN with new potential partners with expertise in sustainability and efficiency.

SMEs TO INDUSTRY 4.0

Several overlaps have been observed between the objectives of this TSSP and the scope of I4-GREEN:

- Increase productivity and promote new business models for SMEs throughout KETs and roadmaps
- Market-oriented approach
- Promote interactions with clusters and innovation cooperative processes

Furthermore, Castile and Leon is present both in the TSSP and the I4-GREEN project, although there are no organisations from this region in the TSSP.

As in the previous cases, TSSP is not directly related to the mining scope of I4-GREEN but shares an interest in the integration of SMEs in market-oriented projects related to cooperative innovation, as is the case of I4-GREEN or possible replicated projects. It is therefore appropriate to synchronise the activities of both parties and to look for synergies that provide TSSP with new fields for the development of its objectives, and I4-GREEN with new potential partners to facilitate the integration of suitable SMEs.

CONCLUSIONS

On the basis of this assessment, it is possible to classify TSSPs into two types:

- Main TSSPs, directly related to the I4-GREEN project activities. This is the case of the TSSP Mining Industry, which brings together organisations interested in promoting the mining industry in their respective regions. The I4-GREEN project model fits perfectly with the objectives of the TSSP and there is, therefore, a clear opportunity for the consortium to promote investment projects according to this model.
- Secondary TSSPs, related with some aspects of the I4-GREEN project. This is the case of the rest of TSSPs, with overlaps in aspects such as final applications (TSSP Batteries), sustainability and efficiency (TSSP Manufacturing), and SMEs engagement (TSSP SMEs). These TSSPs could provide I4-GREEN project (or replicated projects) with expert partners from a wide array of EU regions.

Table 7 shows EU regions where these TSSPs could promote investment projects according to the I4-GREEN project model or provide expert organisations for potential project partnerships.

Table 7. Regions covered by the main TSSP (to promote investment projects) and secondary TSSPs (to provide expert partners)

COUNTRY	REGIONS	MAIN TSSP	SECONDARY TSSPs		
		MINING	BATTERIES	MANUFAC.	SMEs
Austria			X	X	
Belgium	Brussels-Capital reg.		X		
	Flanders		X	X	
	Wallonia			X	
Finland	Central Ostrobothnia		X		
	Kainuu	X	X		
	East and North Finland			X	
	Lapland	**X**	X		
	North Karelia	**X**	X		
	North. Ostrobothnia		X		
	Northern Savonia		X		
	Tampere			X	
France	Auvergne Rhône-Alpes		X	**X**	
	Nouvelle Aquitaine	X	X		
	Pays de la Loire			X	
Germany	Baden-Württemberg		X		
	Bavaria		X		
	Hessen		X		
	Lower Saxony			X	
	Saxony			X	
	Saxony-Anhalt			X	
Greece	Sterea Ellada	X			
Italy	Bolzano-South Tirol			X	
	Emilia Romagna		X	X	
	Friuli-Venezia Giulia			X	X
	Lombardy		X	**X**	
	Piedmont		X		
	Tuscany				**X**
Netherlands	East Netherlands			X	
	Metropol. Eindhoven		X		
	South Netherlands			X	
Poland	Malopolska			X	
	Mazowieckie				X
Portugal	Alentejo	X			
	Centro Portugal	X			
	Norte			X	
Slovakia			X		
Slovenia	Slovenia East		X	X	
Spain	Andalusia	X	X		
	Aragón		X		
	Asturias	X			
	Basque Country		X	X	
	Castile and León	X	X		X
	Catalonia		X	**X**	**X**
	Galicia		X		
	Navarra		X	X	X
	Valencia		X		X
Sweden	Bergslagen	X			
	Norbotten	X			
	Västerbotten	X			

3.3. Portfolio of Investment Leads

The following Portfolio is a result to carry the I4-GREEN approach to the TSSPs (and other possible investors) selected through the assessment of overlaps between TSSPs and I4-GREEN.

As a result of the previous study, two types of TSSPs have been distinguished that may play a different role in the development of potential investment projects related to I4-GREEN.

On the other hand, Portfolio's opportunities are defined based on the I4-GREEN project model, applied to both similar deposits/ores and other possible mineral resources.

Finally, some actions to promote the exploitation of the Portfolio's opportunities will be proposed.

3.3.1. The role of the TSSPs

The four considered TSSPs, according to their objectives, can promote or support to a greater or lesser extent investment projects on the basis of such a model. Therefore, for these TSSPs, the I4-GREEN project model represents an opportunity to target investment projects to their respective regions, especially in those with a relevant mining potential, as those represented by the TSSP Mining Industry.

This TSSP represent 13 regions in 6 EU countries where it would be possible to consider, according to their mining potential, investment projects similar to that of I4-GREEN, demonstrating the capacity of this TSSP to mobilise investments across Europe.

On the other hand, the role of the other assessed TSSPs could be as providers of specific partners related with their respective areas of expertise: advanced materials for batteries, sustainability and efficiency in processing, and SMEs engagement.

In both cases, there are some regions/organisations, also participating in I4-GREEN project, which can play a key role in leading actions within the scope of these TSSPs, particularly:

- TSSP Mining: Andalusia (Reg. Government of Andalusia, ISMC)
  Castile and Leon (ICAMCYL, ISMC)
  Alentejo (CDDR Alentejo, ACPMR)
- TSSP Batteries: Andalusia (Andalusian Energy Agency)
  Castile and Leon (ICAMCYL)
- TSSP SMEs: Castile and Leon

3.3.2. Investment opportunities

The portfolio consists of two groups of investment opportunities:

1) The list of potential I4-GREEN replication sites
2) I4-GREEN as a project model for other mineral resources

LIST OF POTENTIAL SITES FOR PILOT REPLICATION

The first group of investment opportunities is the list of potential sites for pilot replication. This list has been outlined in the section 2.2 as a first approximation (in-depth studies could expand this list with new sites) and comprises 24 potential sites for replicating the activities of the I4-GREEN pilots. A summary of sites per region and pilot is shown in the table 8.

This set of 24 sites from the four I4-GREEN regions constitutes the first part of the Portfolio, as each one represents a concrete opportunity to build an investment project based on the I4-GREEN project model.

Obviously, this list can be expanded if new sites are identified through in-depth studies. It is important to note that this list has been largely restricted to sites most similar to those studied in the pilot projects. However, it would be possible to add other mineral deposits with other typologies, located in other EU regions, which contain ores compatible with studies carried out in I4-GREEN (this would be the case of the selected sites from Castile and Leon).

Table 8. Summary of pilot replication sites by region and pilot

REGION	IHO REPLICATION SITES	E-LIX REPLICATION SITES	TOTAL
Alentejo	Cercal		7
Alentejo	Alvito		
Alentejo	Azenhas-Orada		
Alentejo	Monges-Nogueirinha		
Alentejo		Lagoa Salgada	
Alentejo		Aljustrel	
Alentejo		Neves Corvo	
Andalusia	Cala and Teuler		9
Andalusia		Romanera-Infanta	
Andalusia		Lomero	
Andalusia		Tharsis	
Andalusia		La Zarza	
Andalusia		Sotiel	
Andalusia		Aguas Teñidas-La Magdalena	
Andalusia		Aznalcóllar-Los Frailes	
Andalusia		Las Cruces	
Extremadura	La Bilbaína		6
Extremadura	Alconchel		
Extremadura	S. Guillermo, Colmenar, Sta. Justa		
Extremadura	Monchi, Aurora y Consuelo		
Extremadura	La Berrona		
Extremadura		Aguablanca	
Castile and Leon	Ponferrada-Astorga		2
Castile and Leon		Otero de Herreros	
TOTAL	11	13	24

I4-GREEN AS A PROJECT MODEL FOR OTHER MINERAL RESOURCES

The I4-GREEN project could serve as a model for projects addressing other mineral deposits outside the Iberian mining districts, probably with different typologies but similar ores. For these deposits, it is likely that adjustments to the I4-GREEN technologies will be necessary to adequately adapt to the characteristics of these typologies, but the model includes several aspects of great interest that could be directly applied:

- An approach to recover critical raw materials and other valuable minerals from low grade or complex ores, contributing to the objectives of the EU Critical Raw Materials Act
- The use of innovative technologies with high TRL, taking into account the necessary concepts of circularity, sustainability and respect for the environment
- The involvement of a wide inter-regional range of mining companies, SMEs, regional administrations, clusters, etc.

This broad approach could serve as a model for projects targeting similar ores in a wider range of typologies, allowing the I4-GREEN project to be replicated across Europe and thus expanding opportunities to promote investment projects.

3.3.3. Actions to promote the exploitation of the Portfolio' opportunities

Actions to promote exploitation of these opportunities include those already outlined in Pilots Action Plan. In addition, further actions can be targeted to encourage TSSP organisations and investors to promote investment projects based on the I4-GREEN model, such as:

- Previous studies on the availability of suitable ores for I4-GREEN pilots in the TSSP regions
- Workshops/presentations/meetings with I4-GREEN representatives, investors and TSSP leaders

One of these actions has already been launched: the Investing Forum in Raw Materials – Sustainable ecosystems of innovation and Strategic Alliances, which was held in Seville in June 2024. This workshop can serve as an example of proposed actions to promote the exploitation of the Portfolio's opportunities.

INVESTING FORUM IN RAW MATERIALS. SUSTAINABLE ECOSYSTEMS OF INNOVATION AND STRATEGIC ALLIANCES

This fruitful Forum was held in Seville the 17th of June 2024 and organised by the Iberian Sustainable Mining Cluster (ISMC). The general aim of this Forum was to connect EU raw materials stakeholders with investors, investing institutions and investment mechanisms.

The Forum included the following activities and speakers:

- PROJECT GALLERY: where companies could display posters showing their projects to investors.
- ADMINISTRATION: presentation of the mining outlook of Andalusia –the main mining region in Spain- by the General Director of Mines of the Andalusian Government.
- ASSOCIATIONS: presentation of the Executive Manager of the Association of research, extraction, mining-metallurgical transformers, auxiliary and services companies (AMINER).
- CLUSTERS: presentation of the Iberian Sustainable Mining Cluster (ISMC) General Manager about the regional innovation ecosystems and the role of the I4-GREEN pilots as lighthouses to attract investments.
- EC-DG GROW: presentation on strategic projects under the European Critical raw materials act.
- EISMEA: presentation on the Interregional Innovation Investment I3 Mechanism.
- FINANCIAL EXPERTS: presentation on financing opportunities focusing raw materials and circular economy projects.
- COMPANIES: presentation of 5 mining projects from Spain and France.
- NETWORKING LUNCH: organised to facilitate and exchange of ideas among participants.

The Forum was attended by 39 people, 27 of them physically and 12 online, representing 30 different entities: 2 mining associations, 2 mining clusters (Portugal and Spain), 2 EU administrative bodies, 1 regional administration, 1 foundation, 2 financial consulting and 20 mining and services companies.

Table 9. Participants in the Investing Forum in Raw Materials.

ENTITY	TYPE	ENTITY2	TYPE2
ACPMR	Cluster	Iberian Sustainable Mining Cluster - ISMC	Cluster
AGQ Mining & Bioenergy SL	Company	ICAMCYL	Foundation
Alto Minerals SL	Company	IDEXMA, Sostenibilidad y Medio Ambiente	Company
AMINER	Association	Kandelium Minerales,S.A.	Company
AZCATEC Tecnología e Ingeniería S.L.	Company	Lithium de France	Company
CUBICOFF Ingeniería Abierta	Company	Minas de Estaño de España S.L	Company
EC-Consulting Ltd.	Financial Consulting	MINEPRO	Company
Ecocastulum	Company	Pan Global Resources	Company
EOSA	Company	PRIMIGEA / ANEFA	Association
EU Comission-DG Grow	EU Administration	Qualifica2 S.L.	Company
EU Comission-EISMEA	EU Administration	SATORI Consulting	Financial Consulting
EUMICON	Company	Seequent	Company
GEOMATEC	Company	Tharsis Mining, S.L.	Company
Gobierno de Andalucía	Reg. Administration	VERVICTECH	Company
I.P. Control, S.L.	Company	Xcalibur	Company

3.4. Funding Opportunities

The opportunities of investment described in the previous chapter require a source of funding for their development. Thus, the TSSPs as well as other types of facilitators/investors can prepare investment projects according to the requirements of these financing channels.

As the TSSP activity is based on the cross-regional cooperation, the following financing sources have been restricted to the EU funding channels. Of these, three have been selected as the most suitable for this type of project.

- I3 Instrument, as the current funding source for the I4-GREEN project
- Interreg POCTEP, as a suitable source of funding for cooperation projects between Spain and Portugal
- Horizon Europe, with specific calls for projects focused on the processing and refining of critical raw materials.

3.4.1. I3 Instrument

The Interregional Innovation Investments (I3) Instrument is part of the European Regional Development Fund (ERDF) and is managed by the European Innovation Council and SMEs Executive Agency (EISMEA).

The basic aim of the Instrument I3 is to support interregional innovation projects (TRL 6-9) in their commercialisation and scale-up phases. These funds are intended for projects taking place in regions with shared smart specialisation priorities (S3) and falling within the following thematic areas:

- Green transition
- Digital transition
- Smart Manufacturing

In the Instrument I3 programme, the Agency applies two different call strands that coincide with the scope of the I4-GREEN project:

- Strand 1: Financial and advisory support for investments in interregional innovation projects
- Strand 2a: Financial and advisory support to the development of value chains in less developed regions

STRAND 1 — the target are mature partnerships, to help them accelerate market uptake and scale-up of innovative solutions in shared smart specialisation priority areas, as well as to develop a portfolio of investment projects.

STRAND 2a — the focus is on increasing the capacity of regional innovation ecosystems in less developed regions to participate in global value chains, as well as the capacity to participate in partnerships with other regions.

For both strands, project budget is EUR 2-10 million, with a duration of 18-36 month and a funding rate of 70% for all cost categories and beneficiaries (except 100% for financial support to third parties, or FSTP). The annual budget for both strands for the period 2021-24 was around EUR 75-80 million.

Additionally, a new I3 Instrument call was presented in November 2023:

- Strand 2b: Capacity building in less developed regions

STRAND 2b — the aim is to provide support in building and reinforcing innovative and resilient ecosystems and connect them externally. The budget for the 2023-24 work programme is EUR 26 million.

The last calls were launched in September 2023. The next calls for proposals for I3 Instrument in 2024, expected to be published in the 2nd quarter of 2024 (deadline in the last quarter) with a total estimated budget of EUR 67 million, are:

- Strand 1: Financial and advisory support for investments in interregional innovation projects
- Strand 2a: Financial and advisory support to the development of value chains in less developed regions

It is also important to be aware of the publication of the new work programme 2025-2026 to explore further opportunities to finance investment projects.

Sources: European Innovation Council and SMEs Executive Agency (EISMEA, 2023) (EISMEA, 2024)

3.4.2. Interreg

European Territorial Cooperation, also known as INTERREG, is a funding instrument that promotes regional development through cooperation between EU regions. One of the Interreg programmes is dedicated to cross-border cooperation between Spain and Portugal: the POCTEP programme. Taking into account the geographical position of the replication sites, this programme is the most suitable source of INTERREG funding for the replication of the I4-GREEN project.

The POCTEP programme (Interreg EU, 2024) is an Interreg Cooperation Programme for Spain-Portugal that promotes cross-border development and cooperation between both countries to address key challenges in the border area (1,234 km, one of the longest in the EU). In the period 2021-27, Interreg POCTEP represents the largest cross-border cooperation programme in the EU, with a budget of EUR 427 million, of which EUR 320 million are funded by the European Regional Development Fund, ERDF).

The program encompasses 36 NUT3 regions of both countries (21 in Portugal and 15 in Spain), which are organised in six Cooperation Areas:

- AC1 Galicia / Northern Portugal
- AC2 Northern Portugal / Castilla y León
- AC3 Castilla y León / Central Portugal
- AC4 Central Portugal / Extremadura / Alentejo
- AC5 Alentejo / Algarve / Andalucía
- AC6 Plurirregional

The POCTEP Programme 2021-2027 (Interreg EU, 2022) is organised around seven priorities, the first two of which coincide with the objectives of the I4-GREEN project model:

PRIORITY 1: Leverage the potential of cooperation to consolidate the innovation, scientific and technological ecosystem; promote the creation of knowledge and business networks; foster digitalization and improve business competitiveness, especially of SMEs and micro-SMEs.

PRIORITY 2: Promote cooperation to maximize the use of the territory's endogenous resources and the development of key initiatives and sectors, making progress in smart specialization.

Sources: Interreg POCTEP (Interreg EU, 2022) (Interreg EU, 2024)

3.4.3. Horizon Europe

Horizon Europe (HE) is the EU's framework programme for research and innovation (R&I) funding for the period 2021-2027, with a budget of EUR 95.5 billion.

HE consists of three pillars:

- Pillar I: Excellent Science
- Pillar II: Global Challenges and European Industrial Competitiveness
- Pillar III: Innovative Europe

This second pillar is organised into six clusters, which are:

- CL1: Health
- CL2: Culture, Creativity and Inclusive Society

- CL3: Civil Security for Society
- CL4: Digital, Industry & Space
- CL5: Climate, Energy and Mobility
- CL6: Food, Bioeconomy, Natural Resources, Agriculture and Environment

CL4 is the most suitable for I4-GREEN replication. The current Work Programme (2023-2025), with a total budget of EUR 15.349 billion, consists of six destinations:

- Destination 1: Climate neutral, Circular and Digitised Production
- Destination 2: Increased Autonomy in Key Strategic Value Chains for Resilient Industry
- Destination 3: World-leading Data and Computing Tecnologies
- Destination 4: Digital & Emerging Technologies for Competitiveness and Fit for the Green Deal
- Destination 5: Open Strategic Autonomy in Developing, Deploying and Using Global Space-based Infrastructures, Services, Applications and Data
- Destination 6: A human-centred and ethical development of digital and industrial technologies

The second destination has a Resilient Value Chains call with a specific Innovation Action that could well encompass I4-GREEN replication projects:

- Technologies for processing and refining of critical raw materials

As with the other sources of financing, it is important to be aware of the publication of the next work programme to explore further opportunities to finance investment projects.

Sources: European Commission (European Commission, 2024) (European Commission, 2023)

References

ALMINA. (2024). Obtenido de https://www.almina.pt/pt/a-empresa

Ascendant Resources. (2024). Obtenido de Ascendant Resources - Lagoa Salgada project - Lagoa Salgada fesibility: https://www.ascendantresources.com/English/Operations/Lagoa-Salgada-Project/default.aspx

Ascendant Resources Inc. (2023). *NI 43-101 Technical Report and DFS for the Lagoa Salgada Project.* Obtenido de NI 43-101 Technical Report and DFS for the Lagoa Salgada Project Setúbal District, Portugual, July 2023

Atalaya Mining. (2024). Obtenido de Proyecto Ossa Morena: https://atalayamining.com/operations/proyecto-ossa-morena/

Atalaya Mining. (2024). Obtenido de E-LIX Phase I Plant: https://atalayamining.com/operations/e-lix-phase/

Atalaya Mining. (2024). Obtenido de Atalaya Mining - Proyecto Ossa Morena: https://atalayamining.com/operations/proyecto-ossa-morena/

Avrupa Minerals. (2024). Obtenido de Avrupa Minerals - Portugal/Alvalade copper-zinc VMS project: https://avrupaminerals.com/project/alvalade/

Boixereu, E., & Gumiel, P. y. (2011). Descripción de las mineralizaciones de la Zona de Ossa-Morena. En *Cartografía de recursos minerales de Andalucía* (págs. 83-108). Madrid: García-Cortés, A., ed. ppal.- Madrid: InstitutoGeológico y Minero de España; Consejería de Economía, Innovación y Ciencia de la Junta de Andalucía.

Cardoso Maia, M. (2022). *Metallogenic evolution of gold and iron deposits from the Ossa-Morena Zone (SW Iberia) - Constraining ore deposition conditions and vectoring future mineral exploration.* Évora: Universidade de Évora.

Carriedo, J. y. (2006). Los yacimientos de óxidos de hierro y mineralizaciones de cbre-oro asociadas del SO peninsular: un modelo vertical de evolución. *Macla, 6*, 135-136.

Cobre Las Cruces. (2024). Obtenido de Cobre Las Cruces - Mina and Planta: https://www.cobrelascruces.com/

Denarius Metals. (2024). Obtenido de Denarius Metals - Alto Minerals - Lomero Project Overview: https://denariusmetals.com/project/spain/alto-minerals/lomero-project-overview/

Denarius Metals. (2024). Obtenido de Denarius Metals - Aguablanca project: https://denariusmetals.com/project/spain/alto-minerals/aguablanca-project-overview/

EISMEA. (November de 2023). Obtenido de European Innovation Council and SMEs Executive Agency - I3 Instrument. Informative session: https://eismea.ec.europa.eu

EISMEA. (30 de April de 2024). Obtenido de European Innovation Council and SMEs Executive Agency (EISMEA): https://eismea.ec.europa.eu/programmes/interregional-innovation-investments-i3-instrument_en

El Adelantado de Segovia. (2023). Obtenido de https://www.eladelantado.com/provincia-de-segovia/los-recursos-mineros-de-otero-de-herreros-atraen-la-atencion-de-empresas-punteras-del-sector/

Emerita. (2024). Obtenido de Emerita - Iberian Belt West: https://es.emeritaresources.com/proyectos/iberian-belt-west/

European Commission. (2022). Obtenido de Inforegio: EU Science Hub: https://joint-research-centre.ec.europa.eu/scientific-activities-z/smart-specialisation_en

European Commission. (2023). *Horizon Europe Work Programme 2023-2025 - 7. Digital, Industry & Space.*

European Commission. (2024). Obtenido de Inforegio: EU regional and urban development: https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice_en

European Commission. (2024). Obtenido de Inforegio: Thematic Smart Specialisation Platforms: https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/thematic_platforms_en

European Commission. (2024). Obtenido de Research and Innovation - Horizon Europe: https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-europe_en

European Commission. (2024). Obtenido de S3P Mining Industry and Global Value Chains: https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/partnership_industrial_mod_mining_en

European Commission. (2024). Obtenido de Advanced Materials for Batteries for Electromobility and Stationary Energy Storage: https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/partnership_industrial_mod_advanced_materials_en

European Commission. (2024). Obtenido de Efficient and Sustainable Manufacturing: https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/partnership_industrial_mod_efficient_sustainable_manufacturing_en

European Commission. (2024). Obtenido de SME Integration for Industry 4.0: https://ec.europa.eu/regional_policy/policy/communities-and-networks/s3-community-of-practice/partnership_sme_integration_for_industry_4_0_en

Hispania Resources. (2023). Obtenido de Hispania Resources. News: http://hispaniaresources.com/hispania-acquires-otero-property-in-castille-y-leon-spain/

I4-GREEN. (2023). *Open Call*. Obtenido de https://i3-i4green.eu/opencall/

IGME. (2006). *Mapa metalogenético de la provincia de Badajoz, excala 1:200.000.* IGME.

IGME. (2007). *Mapa metalogenético de Extremadura.* Juntade Extremadura.

Interreg EU. (2022). Obtenido de Programa de cooperación transfronteriza España-Portugal (POCTEP) 2021-2027: https://interreg.eu/programme/interreg-spain-portugal-poctep/

Interreg EU. (2024). Obtenido de Interreg POCTEP (Spain, Portugal): https://interreg.eu/programme/interreg-spain-portugal-poctep/

Inverno, C., Díez-MOntes, A., Rosa, C., García-Crespo, J., Matos, J., García-Lobón, J., . . . Sánchez-García. (2015). Introduction and Geological Setting of the Iberian Pyrite Belt. En *3D, 4D and Predictive Modelling of Major Mineral Belts in Europe* (págs. 191-208). Springer International Publishing Switzerland.

Lemos Barbosa, M. (2021). *Caraterizaçao mineralógica e geoquímica da mineralizaçao ferro-manganesífera da Serra da Mina (Cercal, Faixa Piritosa Ibérica).* Aveiro (Portugal): Universidade de Aveiro.

LNEG. (2024). Obtenido de Sistema de Informação de Ocorrências e Recursos Minerais Portugueses - SORMIINP: https://geoportal.lneg.pt/pt/bds/siorminp/#!/

Lundin Mining. (2024). Obtenido de Neves-Corvo: https://lundinmining.com/operations/neves-corvo/

MICON International Ltd. (2019). Obtenido de Technical Report on the Resource Estimate Update for the Lagoa Salgada Prooject, Setubal District, Portugal: https://s21.q4cdn.com/765868678/files/doc_downloads/2019/11/Lagoa-Salgada-TR_FINAL_Nov-5.pdf

mindat.org. (2024). Obtenido de mindat.org - Serra dos Monges nº 1 mine - Nogueirinha mine: https://www.mindat.org/loc-109196.html

mindat.org. (2024). Obtenido de mindat.org - Alvito mine: https://www.mindat.org/loc-46818.html

mindat.org. (2024). Obtenido de mindat.org - Azenhas mine - Orada mine: https://www.mindat.org/loc-64910.html

Minera Los Frailes. (2024). Obtenido de Minera Los Frailes - Producción: https://mineralosfrailes.es/produccion/produccion.html

Mining Technology. (2000). Obtenido de Mining Technology - Boliden Ltd Zinc, Copper, Lead and Silver Mine: https://portergeo.com.au/database/mineinfo.asp?mineid=mn314

Mining.com. (2023). Obtenido de https://www.mining.com/web/almina-minas-halts-zinc-and-lead-concentrate-operations-at-aljustrel/

Molina, P. S. (2023). *PV Magazine*. Obtenido de https://www.pv-magazine.es/2023/12/04/la-minera-portuguesa-almina-inicia-la-produccion-de-un-autoconsumo-fotovoltaico-de-196-mw/

Pina García, R. (2006). *El yacimiento de Ni-Cu-EGP de Aguablanca (Badajoz: caracterización y modelización genética.* Madrid: Pd. D. Thesis. Universidad Complutense de Madrid.

Sánchez García, T., Bellido Mulas, F., & Mediato Arribas, J. a.-M. (2017). *Geología de la zona de Santa Olalla de Cala, Zona d eOssa-Morena (Badajoz y Huelva, España).* IGME.

Sandfire MATSA. (2024). Obtenido de Sandfire MATSA - Nuestras operaciones: https://sandfirematsa.es/nuestras-operaciones/

SIEMCALSA. (2007). *La Minería en Castilla y León.* Junta dse Castilla y León.

Tharsis Mining. (2024). Obtenido de Tharsis Mining - Operaciones (Proyecto Tharsis - Proyecto La Zarza): https://tharsismining.com/proyecto-tharsis/

Tornos, F., López Pamo, E., & Sánchez España, F. (2000). The Iberian Pyrite Belt. En *Database on Global VMS Districts.* Ross Large and Derek Blundell - GEODE.