RECOVER-REFORM-REUSE, FOR A SUSTAINABLE FUTURE

BIANNUAL NEWSLETTER OF THE START PROJECT

ISSUE #8 – MAY 2026 | DOI: 10.5281/ZENODO.20382148

EDITORIAL

Dear members of the START community,

As the START project reaches its conclusion on 31st May 2026, this final edition of our Newsletter offers an opportunity not only to reflect on what has been achieved, but also to look ahead to how these results contribute to a sustainable and resilient thermoelectric technology ecosystem in Europe.

Over the past four years, we have demonstrated a coherent and innovative value chain, transforming European mine wastes into high-performance, tellurium-free thermoelectric materials based on tetrahedrites and into functional devices. This progress reflects both the strategic relevance of START and the strength of its interdisciplinary approach, enabling the consortium to address the full innovation chain, from raw materials to devices, while promoting secondary resources, reducing dependence on critical materials in line with the EU Critical Raw Materials framework, and contributing to European priorities in sustainability, industrial competitiveness, and strategic autonomy, ultimately strengthening EU leadership in materials and energy technologies for the green transition.

START has also actively engaged with a wider community through dissemination, training, and outreach activities. Creative tools such as the Starty comics and the serious game have helped make our work accessible and support capacity building across diverse audiences.

Importantly, START does not end here. The Sustainable Thermoelectric Alliance (STA), the START European Thermoelectric Systems (SETS) service company, and the START Technology Marketplace provide a strong foundation for continued collaboration, innovation, and market uptake, further reinforcing the European thermoelectric ecosystem.

As Coordinator, I sincerely thank all members of the START consortium for their dedication and collaborative spirit. This success reflects a truly collective effort. I also extend my gratitude to the European Commission, to other European projects and external collaborators for the valuable exchanges and synergies developed, and to all who supported and engaged with START throughout this journey.

The end of START is not a conclusion, but a transition. I am confident that the results and networks developed will continue to contribute to a more sustainable, resilient, and autonomous European thermoelectric ecosystem.

Warm regards,

Filipe Neves

Co-funded by the European Union

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This publication reflects the views only of the author, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

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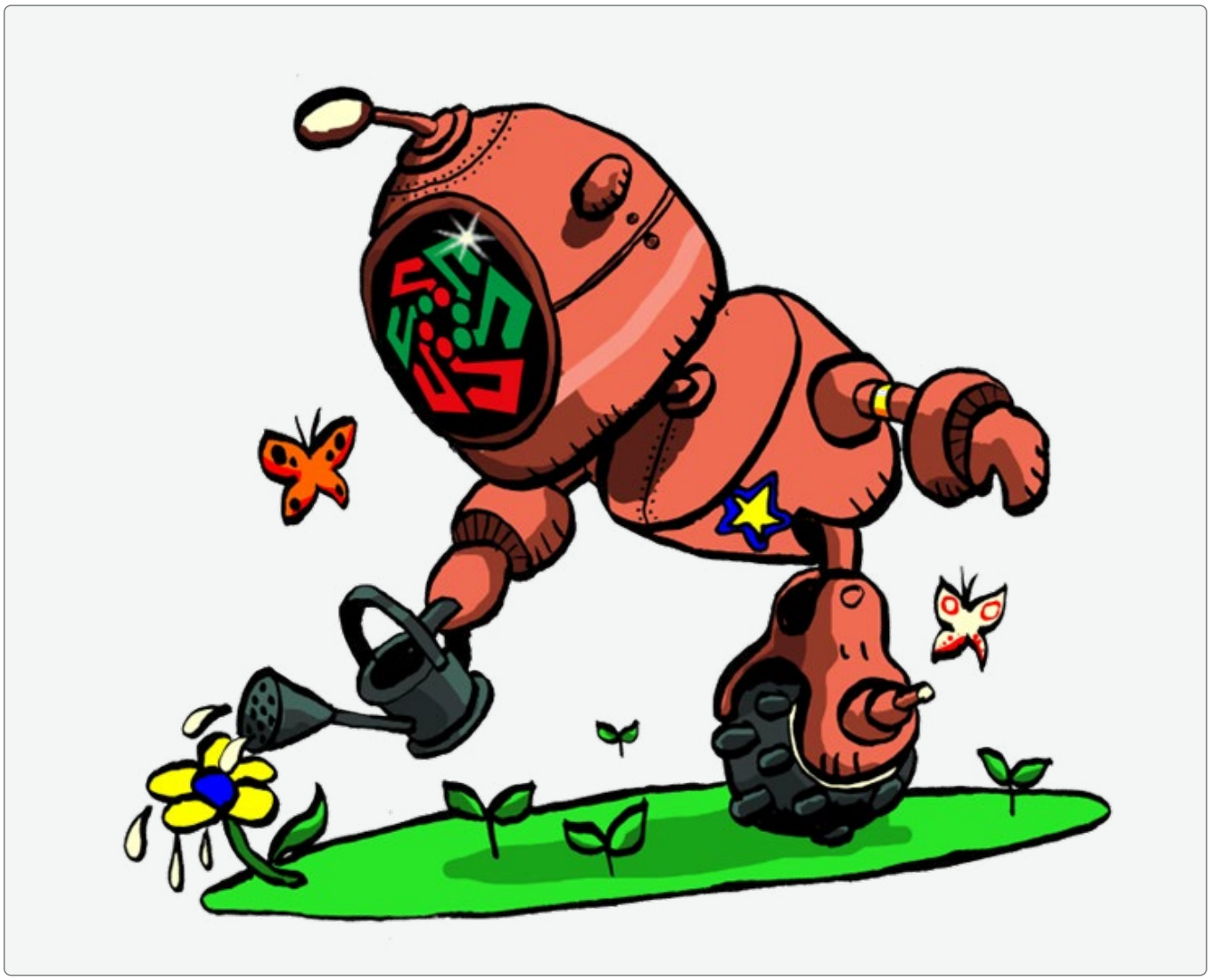
STARTY – 8: BIG SCIENCE TO GREAT AUDIENCES

"Science and comics share similarities - both require an idea that is unique and creative. Of course, other fields such as the literature and painting also necessitate uniqueness and creativity. But just science and comics can be objectively evaluated by the public. Science and comics in the same nature constitute a harmonious combination.

Comics have an enormous capacity to relate science stories and convey scientists' message to the audience. This was exemplified in some studies to build a science curriculum that incorporated comic strips and provided people with opportunities to read, discuss, and respond to the contents of these comics. The comic strips stimulate people's interest in science issues and promote science literacy. It is known that people exposed to science comics can give scientific explanations for the comics based on their own experiences. Spurred by curiosity from science comics, people are motivated to look for more information in magazines, newspapers, the Internet, and other sources. Posters that involve science-themed comics enhanced the public's understanding of science across multiple generations.

Hence, these are excellent reasons to have produced STARTY's comic to explain Science to the great audience, in a simple way."

João Mascarenhas | Author of Starty
Unidade de Materiais para a Energia – UME, Laboratório Nacional de Energia e Geologia, I.P.



START RESULTS – A SUMMARY

The work within START, like for any other Horizon Europe project, was organised in Work Packages (WPs). Although the interaction among work packages was intense, with information flowing among WPs to activate tasks on related topics, each WP had its own objectives and achieved results that can, with good approximation, be attributed to the work of the partners involved in each WP.

This is the list of our work packages. Not considering the first, dedicated to the overall management of the project, and the sixth, dedicated to dissemination and communication, there were five "technical" workpackages, that we highlighted here in bold:

1. **Coordination and management**
2. **Selection of mine waste sites; physical minerals separation and concentration**
3. **Materials modelling and processing**
4. **Materials characterization**
5. **Device production, validation and demonstration**
6. **Dissemination and communication**
7. **Innovation and exploitation strategy**

The graph below explains the interconnection among the work packages:

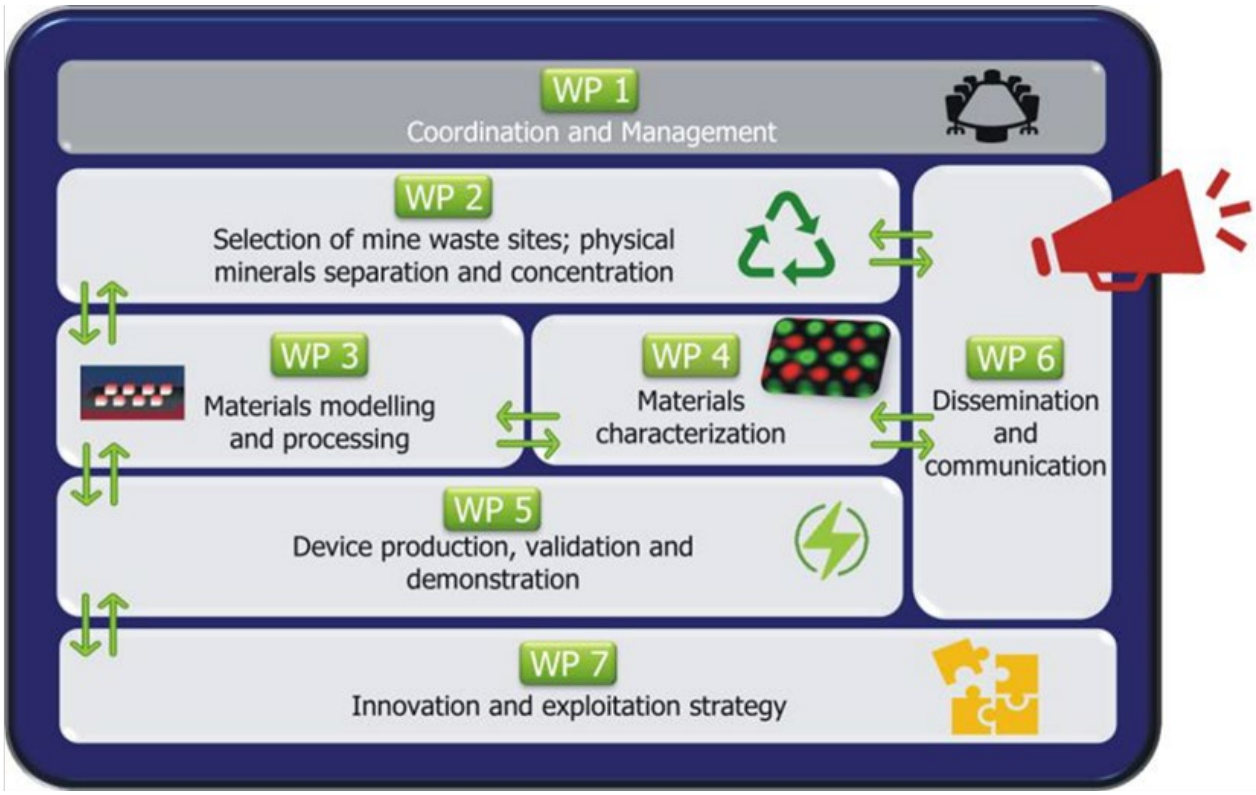


Figure 1 | START WPs.

For this final issue of the newsletter, we have summarised for you the achievements of the project, following the natural choice of subdividing them by WPs: as explained, the work in each work package was anyway influenced by the work in the upstream and downstream work packages, that stimulated improvements by iteration.

ACHIEVEMENTS OF WORK PACKAGE 2

"SELECTION OF MINE WASTE SITES; PHYSICAL MINERALS SEPARATION AND CONCENTRATION"

Work Package 2 of the START project played a pivotal role in bridging geological resource potential with downstream materials development, by delivering mineralogically suitable sulphide concentrates derived from mine waste for thermoelectric applications. WP2 successfully addressed the full chain from site identification and harmonised sampling to mineral processing and delivery of concentrates to subsequent technical work packages.

A major achievement of WP2 was the systematic identification and validation of suitable mine waste sites across Europe, as documented in its first deliverable (Deliverable 2.1). Geological Surveys from Austria, Germany, Portugal, Slovakia and Spain applied common criteria to select historic and active mining sites hosting tetrahedrite–tennantite mineralisation, considering mineralogical suitability, grain size, waste volumes, accessibility and logistical constraints. This coordinated effort resulted in a geographically and geologically diverse portfolio of donor sites, including volcanogenic massive sulphide, vein type and stratiform deposits. Critically, WP2 also established a harmonised sampling and characterisation protocol, ensuring methodological consistency despite the heterogeneity inherent to mine waste materials.

Building on this foundation, WP2 carried out extensive field sampling campaigns and laboratory characterisation. Across the participating countries, several hundreds of kilograms of mine waste and ore material were collected from waste rock dumps, tailings and underground sources. These materials were characterised mineralogically and granulometrically, revealing strong variability in mineral associations, liberation characteristics and grain size distributions. WP2 partners adapted separation workflows, accordingly, employing combinations of crushing, sieving, gravity separation, electromagnetic separation and, where required, flotation. This flexible and site tailored approach proved essential to maximise tetrahedrite recovery from complex sulphide assemblages.

Despite the technical challenges associated with fine grain sizes, complex parageneses and variable degrees of oxidation, WP2 succeeded in producing tetrahedrite rich concentrates of sufficient purity and grain size for downstream testing. In several cases, including Slovakia and Portugal, separation procedures yielded concentrates with demonstrably enhanced tetrahedrite content, validated through X ray diffraction and complementary analytical techniques. Importantly, suitable mineral concentrates were made available to WP3 (for materials modelling, processing and thermoelectric performance evaluation) even while some separation processes were still ongoing, ensuring that WP2 did not represent a critical bottleneck for the project.

Overall, WP2 delivered a robust and scientifically sound framework for sourcing, processing and supplying mineral derived sulphide materials from mine waste. Beyond its immediate contribution to the project, WP2 generated transferable knowledge on sampling strategies, mineral separation challenges and processing solutions that are directly applicable to future initiatives targeting critical raw materials recovery from extractive waste.

Figure 2 | Collection of tetrahedrite minerals from mine wastes, characterisation and selection of the most suitable minerals.

ACHIEVEMENTS FROM WORK PACKAGE 3

"MECHANOCHEMICAL PROCESSING AND OPTIMISATION OF THERMOELECTRIC MATERIALS"

WP3 of the START project played a central role in transforming mineral-derived sulphide concentrates into functional thermoelectric materials, effectively bridging upstream resource preparation with device-oriented material development. Building on the outputs of WP2, WP3 established a fully integrated processing chain — from composition design and powder synthesis to consolidation and shaping — tailored to the specific requirements of thermoelectric applications.

A major achievement of WP3 was the development and validation of a scalable mechanochemical synthesis route capable of directly upgrading mineral-derived feedstocks into high-performance p-type tetrahedrites without the need for conventional smelting. Starting from modelling-guided composition ranges, extensive experimental campaigns at laboratory scale enabled the optimisation of dopant combinations and mineral/synthetic ratios, identifying robust formulations such as $Cu_{11}(Fe_{0-5}Zn_{0-5})Sb_4S_{13}$. This approach demonstrated that natural compositional variability can be effectively managed and even exploited through controlled mechanochemical processing, enabling phase-pure materials with enhanced thermoelectric properties.

Building on laboratory optimization, WP3 successfully scaled the process to pre-pilot and pilot levels. High-energy ball milling was implemented at increasing batch sizes — from tens of grams to kilogram-scale production — while maintaining compositional control, phase stability, and reproducibility. Dedicated process configurations, including contamination-free milling environments and controlled powder handling under inert atmosphere, ensured the reliability of the synthesis route across scales. Importantly, the work established practical rules linking mineral composition (notably Fe content) to process parameters, enabling systematic incorporation of mineral concentrates up to high loadings while preserving material performance.

In parallel, WP3 advanced the consolidation of these powders into dense bulk materials using fast and energy-efficient sintering technologies. The optimisation of parameters such as temperature, pressure and current profiles enabled the production of high-density tetrahedrite components with preserved nanostructure and record thermoelectric performance. At the same time, the work extended to the identification and optimisation of compatible n-type materials, ensuring chemical and processing compatibility for future module integration.

Crucially, WP3 did not focus solely on material composition and intrinsic performance, but also addressed manufacturability and downstream integration. The co-development of synthesis, sieving, and consolidation processes ensured that powders and bulk materials met the requirements for shaping, machining and assembly into thermoelectric generators. This included control of particle size distributions, adaptation of pellet geometries, and scaling of production throughput, enabling efficient interfacing with subsequent work packages.

Overall, WP3 delivered a robust, scalable and industrially relevant framework for converting mine-derived sulphides into high-value thermoelectric materials and components. Beyond its direct contribution to START, the work provides transferable knowledge on mechanochemical processing, compositional optimisation and process integration, supporting future applications of mineral-based materials in sustainable energy technologies.

Figure 3 | Mechanochemical synthesis of tetrahedrite concentrates to produce powdered compositions suitable for consolidation of preforming TE material samples.

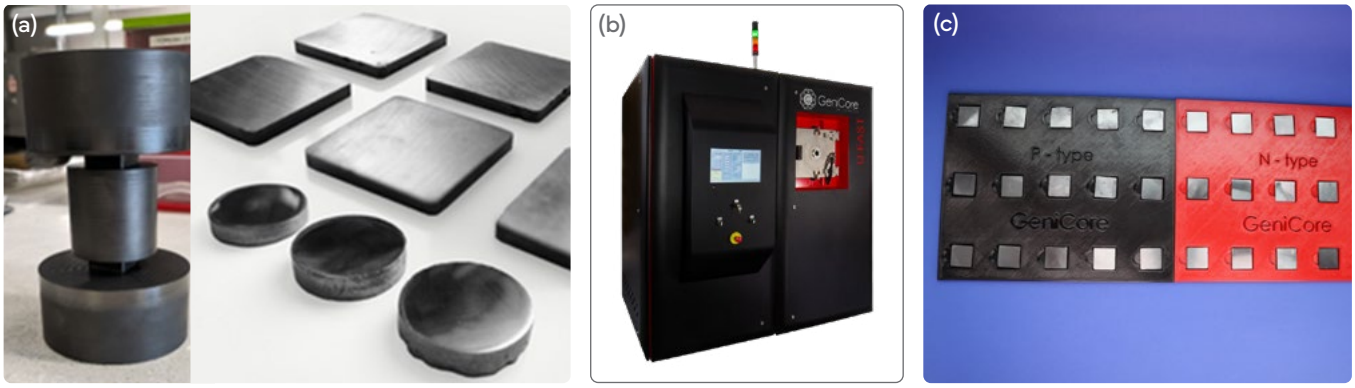


Figure 4 | (a) Tool for consolidation of TE samples, and shapes obtained for subsequent testing and/or production of devices; (b) U-FAST equipment for SPS consolidation; (c) p-type and n-type elements after consolidation

ACHIEVEMENTS FROM WORK PACKAGE 4

"MATERIALS CHARACTERIZATION"

The START project has delivered significant progress in the understanding and development of tetrahedrite-based thermoelectric materials. Our comprehensive analysis of literature data revealed notable inconsistencies in reported properties for synthetic tetrahedrite, highlighting the strong influence of processing conditions on material performance. The study also showed that dopant effects are complex : Fe doping significantly increases resistivity, while a beneficial synergy with Zn was identified.

Within the project, START has produced synthetic and mineral based tetrahedrite materials with some of the highest reported zT values, demonstrating their strong potential for thermoelectric applications. In parallel, the thermal stabilization task force identified Ni and Zn as promising stabilizers, with material stability comparable to Bi_2Te_3.

The work also showed that porosity, likely caused by gas formation during spark plasma sintering, is not expected to be beneficial for thermoelectric performance. Densification approaches such as hot isostatic pressing are therefore expected to further improve material properties. Overall, the tetrahedrite materials developed in START combine outstanding thermoelectric performance with promising stability, supporting their potential for future sustainable energy applications.

Figure 5 | Testing TE samples.

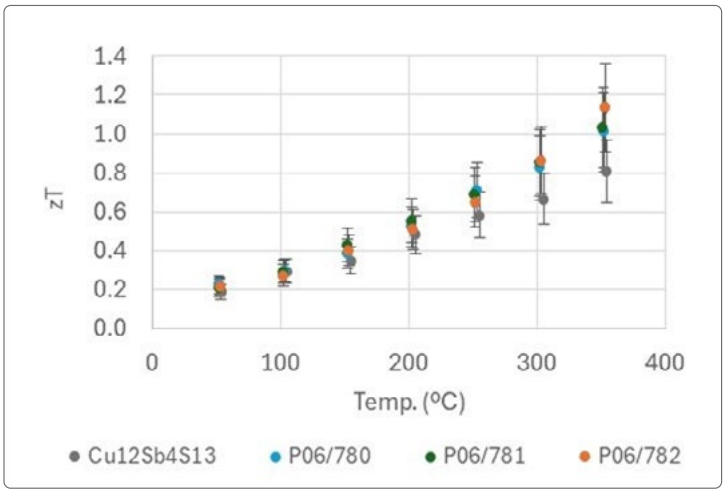


Figure 6 | Figures of merit zT of different TH-based compositions.

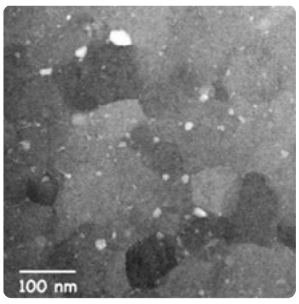


Figure 7 | Microstructural characterisation using high resolution electron microscopy (emission and transmission) was a key tool to close the loop in material development.

ACHIEVEMENTS FROM WORK PACKAGE 5

"DEVICE PRODUCTION, VALIDATION AND DEMONSTRATION"

Fabrication of devices

The fabrication and validation of the WP5 module progressed through several key phases, beginning with the procurement of spark plasma sintered MgSb and tetrahedrite (synthetic and mixed mineral) discs from Genicore. MgSb and synthetic TH were grinded to required heights at an external supplier. To compare the surface finishes produced by various preparation techniques, five MgSb samples were processed using diamond wire cutting, coarse grinding, fine grinding, polishing, and external commercial grinding. Surface roughness for each method was quantified via white light interferometry.

The results demonstrated that the polished samples achieved a superior surface finish, while the diamond wire-cut samples exhibited the highest roughness. To further investigate the impact of these surface profiles on adhesion, shear tests will be performed on coatings applied to these pellets to determine how roughness influences overall coating strength.

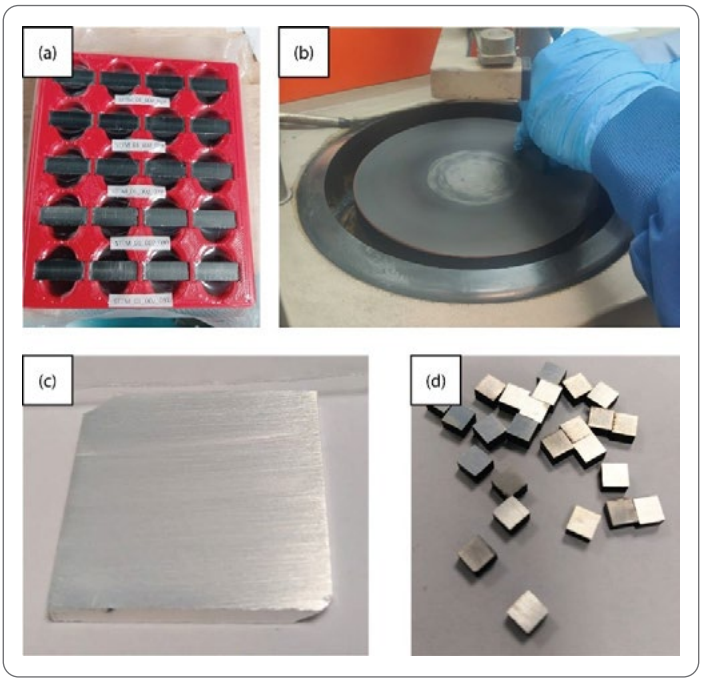
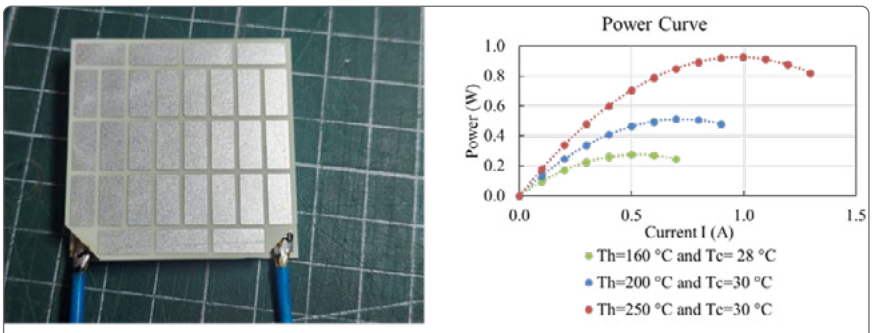


Figure 8 | (a) Sintered TH discs from GeniCore; (b) Polishing discs with SiC paper;
(c) Sputter coated discs with diffusion barrier layers on both sides; (d) Diced pellets to be used in the modules.

Subsequently, a sputtering process was employed to deposit a diffusion barrier layer on both the top and bottom surfaces of the discs. Once the diffusion barrier layers were sputtered, the coated discs underwent precision dicing to reach the final required pellet dimensions for module assembly. Pellets with matching heights and low resistances are chosen. A new substrate with a higher thickness with two-sided metallization will be used as the substrate for this iteration of the module to reduce warping.

To build the TEG module, both the Top and Bottom Diffusion Barrier Coated (DBC) substrates were screen-printed with bonding agent, and the pellets were placed precisely in their corresponding positions on the bottom DBC substrate. Finally, to complete the assembly, the top DBC substrate is placed on top of the pellets. The entire assembly is then subjected to a thermal cycle to bond the module. The produced module is then evaluated for defects using visual inspection, internal resistance estimation, non-destructive testing, and thermography.

Finally, two demonstrators were produced: the START µCHP (Combined Heat and Power)-TEG System (Figure 9) for mid-temperature applications, and the START Flex-TEG-Solar System (Figure 10) for low-temperature applications.



Thot (°C)	Tcold (°C)	Voc (V)	Rint (Ω)	Power (W)
160	28	1.06	1.06	0.27
200	30	1.40	1.04	0.47
250	30	1.90	1.03	0.88

Figure 9 | START µCHP (Combined Heat and Power)-TEG System for mid-temperature applications: a rigid device developed by Thermagy.

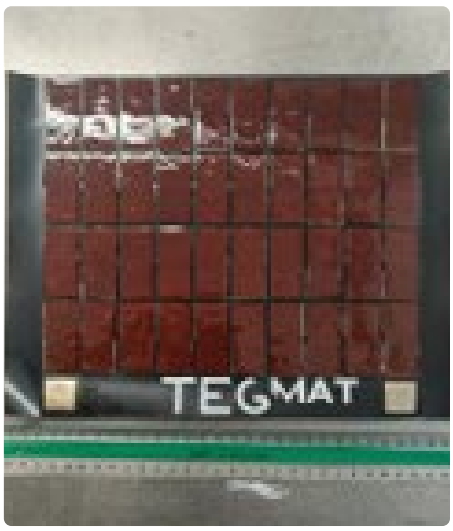


Figure 10 | START Flex-TEG-Solar System for low-temperature applications: a flexible, large surface device array developed by TEGnology.

Sustainability of START materials and modules

WP5 also focused on life-cycle environmental impact and cost assessment models and evaluated the performance of the TEGs with tetrahedrite legs. It was concluded that the TH-based TEG devices can be environmentally and economically sustainable when compared with current alternatives available on the market, such as BiTe and PbTe. This is visible in Figure 11.

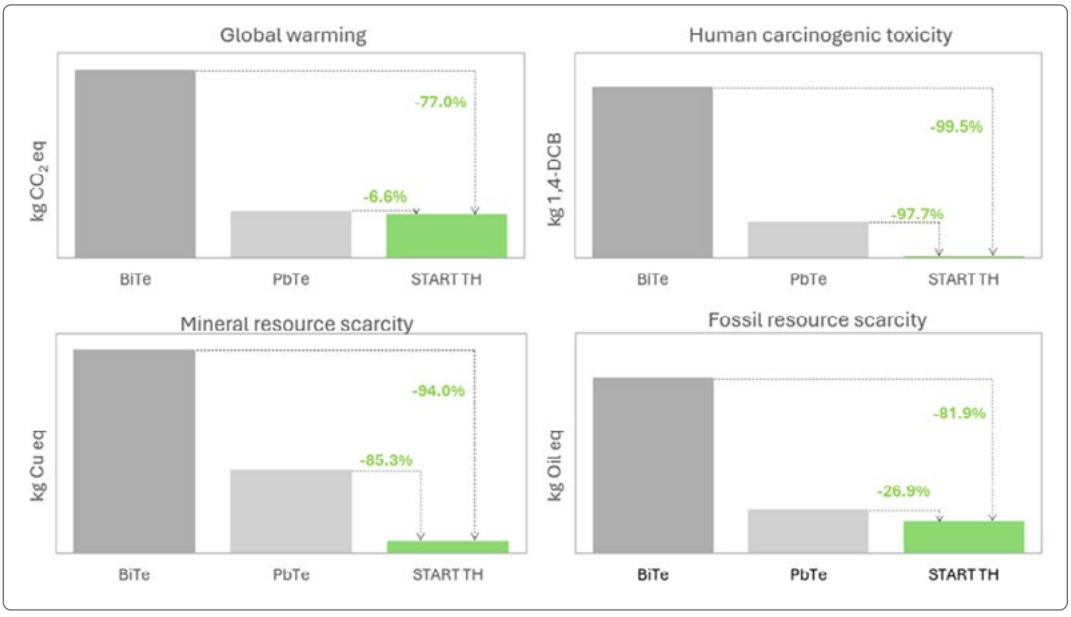


Figure 11 | The TE devices based on tetrahedrites represent a very sustainable alternative to present devices based on tellurium-containing materials, especially thanks to the use of secondary raw materials from mine waste. The picture depicts the reduced impact on global warming, human carcinogenic toxicity, mineral resource scarcity and fossil resource scarcity.

ACHIEVEMENTS FROM WORK PACKAGE 7

"INNOVATION AND EXPLOITATION STRATEGY"

Innovation Agenda and Roadmaps

An Innovation Agenda was co-created by project partners as a strategic plan outlining the continuous innovation required for START to develop its unique tetrahedrite-based thermoelectrics value chain. The Innovation Agenda serves as a guiding framework to drive creativity, research, development, and the implementation of new ideas, technologies, or processes. This work was done thanks to interactions with project partners and external experts.

The START Innovation Agenda defines four priority areas and six innovation pillars to guide the START value chain going forward. With a comprehensive and common understanding of Innovation, the partners' individual and joint capacities brought towards a START based ecosystem, the definition and use of short-to-long term innovations across the value chain and communication, dissemination, exploitation and coordination for the involvement of stakeholders. The innovation pillars are well aligned with the START value chain and consider:

- **Value chain and process optimization**
- **New product development and application-driven innovation**
- **Sustainable Materials and circular innovation**
- **Digitalisation and data-driven innovation**
- **Business models, market uptake, and commercial sustainability**
- **Collaboration, knowledge sharing, and capacity building**

Complementing the Innovation Agenda, several roadmaps were also developed. In total, 6 roadmaps were created to guide the several stages of the START value chain towards commercialisation. These roadmaps showcase the potential evolution of START efforts between 2026 and 2030 and include the definition of actions, signposts/milestones, key performance indicators and wildcards. These visual outputs could act as the blueprints for further development of the START project efforts.

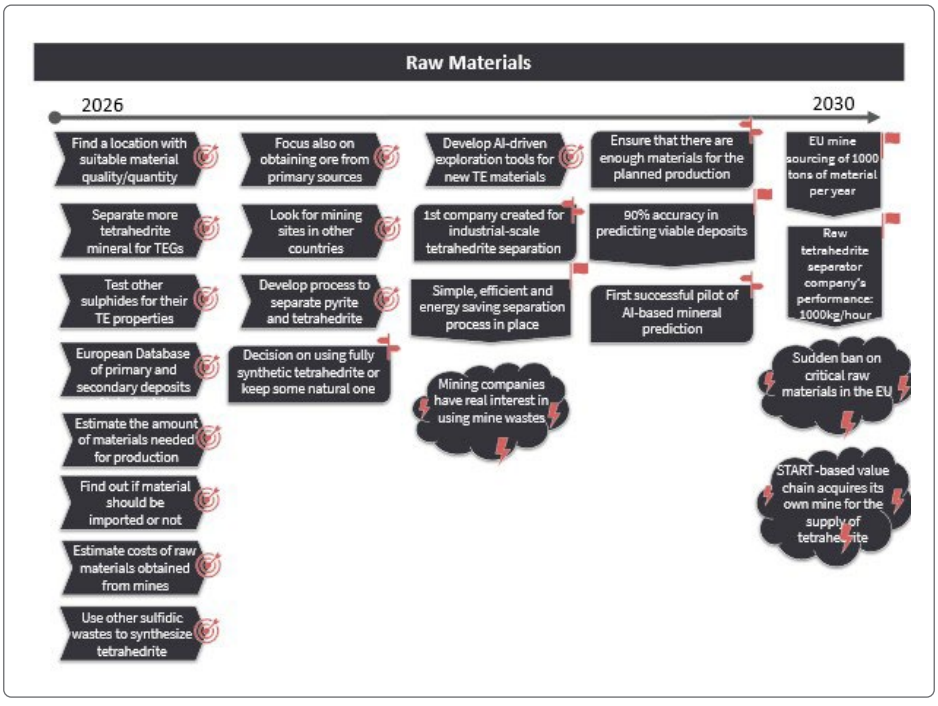


Figure 12 | Raw materials-related roadmap for the development of the START value chain.

Sustainability and Deployment

As part of ensuring the long-term impact of the START project, the consortium worked closely to define and establish a sustainable post-project ecosystem[1] built around three key components: the Sustainable Thermoelectric Alliance (STA), the START European Thermoelectric Systems (SETS) service company, and the START Technology Marketplace (START TM). The process involved a series of strategic discussions, workshops, and consultations with project partners and external stakeholders, aimed at identifying the most effective structure to sustain collaboration, support innovation, and accelerate market uptake of thermoelectric technologies beyond the project lifetime.

The Sustainable Thermoelectric Alliance (STA) was created to provide a long-term, open platform for collaboration across research, industry, and policy actors. It builds on the START network and enables continued knowledge exchange, joint activities, and ecosystem development.

In parallel, the START European Thermoelectric Systems Ltd. (SETS) was established as a service-oriented entity to support the Alliance and its members by facilitating commercialisation, business development, and access to market opportunities, helping to bridge the gap between research results and industrial application.

Finally, the START Technology Marketplace (START TM) was developed as a digital hub to make project results, tools, and resources accessible, while enabling interaction between stakeholders and supporting the transition from innovation to market uptake. Together, these three components form a coherent and scalable framework to ensure the continuity of START outcomes and to strengthen the European sustainable thermoelectric ecosystem in the long term.

START Alliance and Service Company

Following extensive discussions throughout the project lifecycle, the consortium agreed to establish the START Alliance[2] to ensure the long-term continuity of the START network beyond the EC-funded period. The Alliance is designed to sustain and expand the project's impact by fostering a robust and self-supporting thermoelectric ecosystem in Europe.

The START Alliance will function as a central knowledge hub, supporting the creation, growth, and market uptake of sustainable thermoelectric technologies supported by the START Service Company (SSC) SETS[3] acting in alignment with the START Strategic Plan and the Innovation and Commercialization Roadmap, The SSC will serve as a long-term catalyst for commercialization, providing tailored support to consortium members and will also deliver value-added commercial services across the thermoelectric value chain, in line with its business plan and identified market opportunities.

Key actions of the START Strategic Plan include the creation and maintenance of the START Technology Marketplace digital platform [4], promotion of START services across the thermoelectrics value chain, support for systemic transformation toward a sustainable thermoelectric ecosystem, identification of new European research opportunities, and expansion of the START Alliance by demonstrating its added value to relevant stakeholders.

Figure 13 | The logos of the Alliance, the Service Company and the Technology Marketplace.

(1) https://start-sets.eu/
(2) https://start-sets.eu/about-sta/
(3) https://start-sets.eu/about-sets/
(4) https://start-sets.eu/start-tm/

Have fun and learn with the START game!

The "Energy from Waste Heat" serious game is an online game[5] designed for 1 to 4 players, combining learning and fun. Through playful gameplay, it introduces key ideas about how thermoelectric devices are made, used, and managed at the end of their life. The game highlights innovative devices produced using tetrahedrites recovered from mine waste, offering a sustainable alternative to traditional tellurium-based thermoelements — the main goal of the START project.

As players progress, they earn points by making smart choices linked to circular economy and sustainability principles, such as recycling mine waste, selecting responsible materials, designing better products, and choosing sustainable production, use, and end-of-life solutions.

The game blends luck and strategy, featuring random cards and questions that guide players through four main stages of the thermoelectric device value chain. With its colourful and attractive graphic design, the game also features Starty — the hero from the START project comics — as the game pawn. We recommend reading the comics before playing to get the most out of the experience.

The "Energy from Waste Heat" game is currently in an open testing phase, and everyone is invited to try it out! It's available in all languages of the project (DA, DE, EN, ES, FR, HU, IT, NL, NO, PL, PT, SK). If you would like to explore this fun and educational element of the START project, please get in touch with us:

✉ **cristina.rocha@lneg.pt**

✉ **david.camocho@lneg.pt**

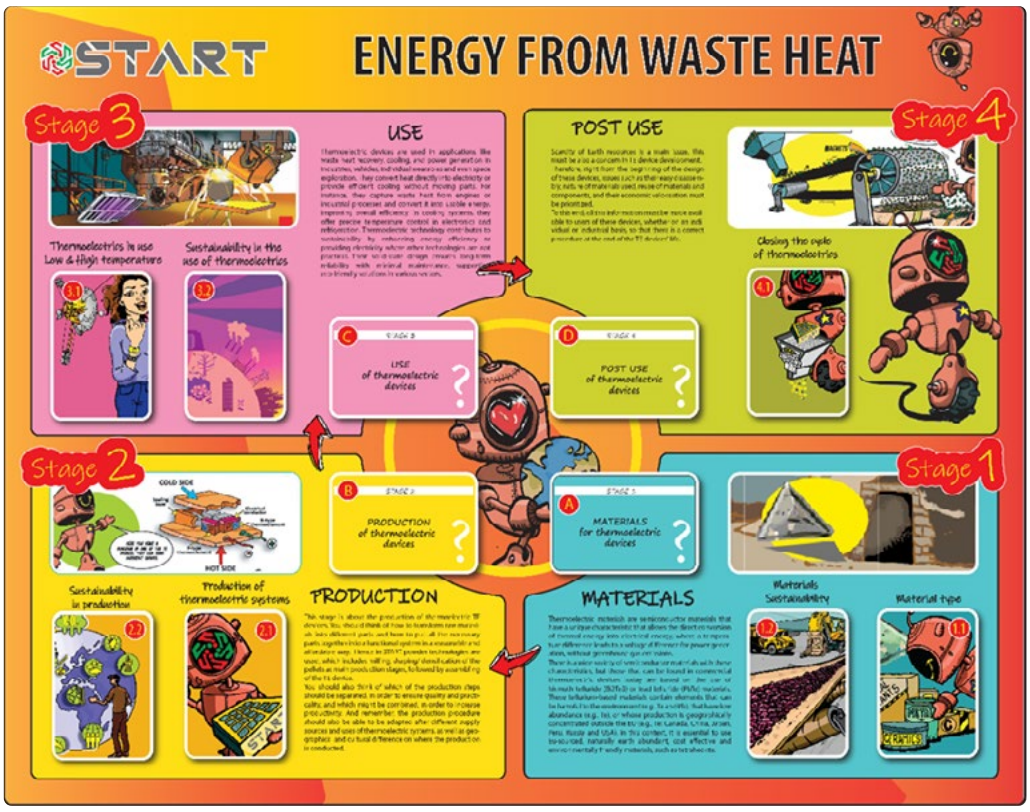


Figure 14 | The board of the START Serious Game "Energy from Waste Heat" in its physical English version.

(5) https://start-game.eu/

DISSEMINATION AND COMMUNICATION NEWS

SEMINAR AT CENIMAT|I3N, 30TH APRIL 2026, CAPARICA, PORTUGAL

As part of the START project's lasting commitment to innovative science communication, a seminar entitled "Communicating Science Creatively: Lessons from the START Project" was recently delivered at CENIMAT|i3N within the NANOMAT Talk series. This initiative brought together researchers and students to explore novel approaches to making scientific knowledge more accessible and engaging.

The session, co-delivered by F. Neves, J. Mascarenhas, and D. Camacho, highlighted the importance of creativity in science communication, showcasing tools such as comics and game-based approaches to reach broader audiences. A particularly engaged audience included students from the Master Programme in Advanced Materials Innovative Recycling (AMIR-EM), who actively contributed to discussions and expressed strong interest in the project's Higher Education (HE) objectives.

The event provided a valuable platform for dialogue, knowledge exchange, and the sharing of best practices in science communication strategies. The START team also acknowledges the support and invitation from the local hosts, which were instrumental in the success of this initiative.

This activity exemplifies the broader legacy of START: fostering impactful dissemination and inspiring innovative approaches to connecting science with society.

Figure 15 | Seminar at CENIMAT|I3N, 30th April 2026, Caparica, Portugal.

FINAL TRAINING WORKSHOP, LISBON, 26TH MARCH 2026

The START Training Workshop was held on 26th March 2026 in Lisbon, bringing together researchers, industry representatives, and thermoelectrics experts to explore sustainable materials and technologies developed within the project. In fact, to maximise participation and impact, the workshop was organised alongside meetings of the SUSTENET network, enabling the presence of external experts and fostering exchange beyond the START consortium. This alignment supported both attendance and the inclusion of guest lecturers.

The event, entitled "Thermoelectric Tetrahedrites from Secondary Raw Materials and Other Sustainable TE Materials", was designed to provide a comprehensive overview of thermoelectric technologies, combining START results with broader perspectives on sustainable materials, processing, and applications.

The workshop featured a full-day programme structured into four thematic blocks (see also Table 1), covering:

- **Overview of the START project and its expected legacy**
- **Fundamentals of thermoelectric materials**
- **Applications in energy production and cooling**
- **Sustainable sourcing from mine waste**
- **Materials processing and characterisation**
- **Development of thermoelectric devices**
- **Sustainability assessment within the START framework**

9:30	9:35	Welcome	Organisers - LNEG / START	0:05
9:35	10:05	The START Project and its Expected Legacy	Filipe Neves - LNEG / START Coordinator	0:30
10:05	10:50	Thermoelectric Materials: an overview	Antonio Gonçalves - University of Lisbon	0:45
10:50	11:20	Coffee break	-	0:30
11:20	12:05	Applications of Thermoelectrics for Energy Production and Cooling	Kornelius Nielsch - IFW Dresden	0:45
12:05	12:50	Sustainable Raw Materials Sources from Mine Waste	Luis Albardeiro – LNEG (START)	0:45
12:50	14:00	Lunch	-	1:10
14:00	14:45	TE Materials Processing	Alvise Bianchin - MBN Nanomateralia (START)	0:45
14:45	15:30	Characterisation of TE Materials	Patricia Carvalho – Sintef (START)	0:45
15:30	16:00	Coffee break	-	0:30
16:00	16:45	Thermoelectric Devices	Aniruddha Ray - RGS Development (START)	0:45
16:45	17:30	Sustainability in Thermoelectrics: the START Case	Eduardo Santos - 3Drivers (START)	0:45
17:30	17:30	End of Workshop	-	0:00

Table 1 | Programme of the START Training Workshop held in Lisbon on 26/03/2026.

Lectures were delivered by a combination of START partners and external experts, ensuring both depth and diversity of perspectives.

The workshop took place at the Hotel Ikonik Lisboa, selected for its accessibility and suitable facilities. The event was organised as a hybrid session, enabling both in-person and remote participation. Technical arrangements included professional audio-visual support, live streaming, and recording. The session was hosted online via a dedicated webinar platform, allowing controlled participation and interaction, Integrated registration and attendance tracking, and high-quality recording and backup. EPMA coordinated logistics, including participant registration, communication, certification, and management of the online platform.

The workshop attracted 79 registrations (32 in-person and 47 remote). A total of 45 participants attended, including 29 participants on-site and 16 participants joining remotely. This distribution reflects typical engagement patterns for hybrid, open-access events.

Participant feedback was highly positive. A post-event survey indicated that the workshop was consistently rated “Excellent” or “Good”, confirming strong satisfaction with both content and organisation.

All lectures were recorded, edited, and published as individual videos on YouTube, with a dedicated playlist providing access to over five hours of content. This ensures continued availability of the training materials and supports long-term knowledge transfer.

The START Training Workshop represents the culmination of the project’s training activities, delivering valuable insights into sustainable thermoelectric materials and reinforcing collaboration within the European research community. We hope that you had the chance of participating in some of our training events and could profit from them!

Figure 16 | Training workshop, Lisbon, 26th March 2026 : the lecture by L. Albardeiro.

Figure 17 | The lecture by A. Bianchin.

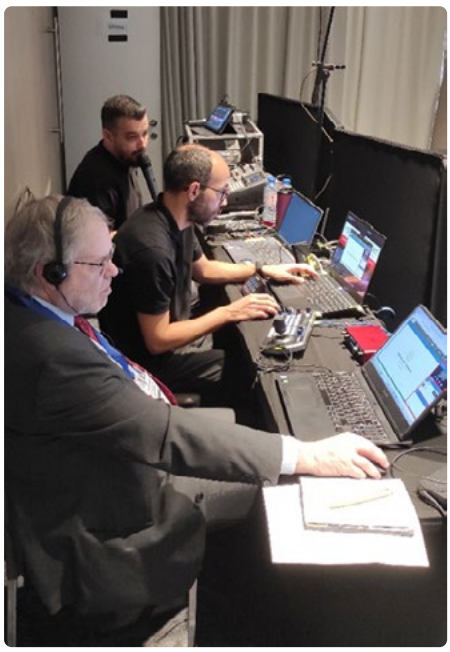


Figure 18 | The technical table where the session was managed, for recording and streaming.

Figure 19 | The lecture by K. Nielsch.

Figure 20 | The group of participants at the Training Workshop in Lisbon.

FINAL START EVENTS, BRUSSELS, 19TH - 20TH MAY 2026

To conclude its dissemination and communication activities, the consortium held its final sessions in Brussels alongside the EIT RawMaterials Summit 2026 (19th – 21st May 2026). A dedicated technical workshop took place on 19th May, followed by a session within the Summit on 20th May.

These events represented a key milestone for START, serving not only as closing dissemination activities but also as a springboard for its long-term legacy, ecosystem development, and sustainability beyond EU funding.

START Final Workshop Event Highlights the Full Value Chain of Thermoelectric Solutions

On 19 May 2026, the START project held its Final Event in Brussels (Hotel Thon Centre, Room Bergen), bringing together stakeholders from research, industry, policy, and innovation. Titled "The START Solution : Thermoelectric Tetrahedrites from Secondary Raw Materials for Sustainable Energy Production from Waste Heat", the event presented the full value chain developed during the project, from the recovery of secondary raw materials and mine waste to advanced thermoelectric materials, devices, and applications for waste heat recovery. It also introduced START's long-term legacy activities.

The event was a key moment for sharing the project's results in a clear and structured way. It highlighted the sustainability and circularity of tetrahedrite-based thermoelectrics, as well as their potential for industrial uptake. It also provided a platform for exchange between research, industry, and policy communities, supporting the development of the START Alliance and the START Service Company.

Throughout the day (see the agenda below), sessions covered the main steps along the value chain, including raw material sourcing from mine waste, processing of tetrahedrite ores, materials engineering and characterisation, thermoelectric devices, and real-world applications. Sustainability aspects, life-cycle assessment, and industrial perspectives were also discussed, alongside START's longer-term ecosystem and service-oriented activities.

All presentations were delivered by START partners, ensuring strong scientific content and alignment with the project's results, while respecting confidentiality and intellectual property considerations.

The event concluded with a round table focused on the future of thermoelectrics in Europe, exploring how to strengthen coordination across the field and how to build lasting cooperation beyond the project, including the idea of a Thermoelectrics Industrial Association. About 25 participants took part in the workshop in person in Brussels, and 8 others joined online.
The whole session has been streamed live and recorded. The videos will be available on our website and YouTube channel[6].

9:15	9:25	Welcome	Organisers - LNEG / START
9:25	9:55	The START Project: from EU Mines to Sustainable TE Devices	Filipe Neves - LNEG / START Coordinator
9:55	10:25	Sustainable Raw Materials Sources from Mine Waste	Daniel Oliveira - LNEG
10:25	10:55	Enrichment of tetrahedrite-containing minerals	Stanislav Šoltés - Štátny geologický ústav Dionýza Štúra
10:55	11:25	Coffee break	-
11:25	11:55	High Energy Ball Milling of Synthetic and Natural Tetrahedrites	Alvise Bianchin - MBN Nanomateralia
11:55	12:25	Consolidation of Tetrahedrite-based Compositions	Marcin Rosiński - GeniCore
12:25	13:25	Lunch	-
13:25	13:55	Characterisation of Tetrahedrite-based Compositions	Patricia Carvalho - SINTEF
13:55	14:25	Mid-Temperature TH-based Devices for Heat Harvesting	Aniruddha Ray – Thermagy
14:25	14:55	Low-Temperature TH-based Devices for Heat Harvesting	Hao Yin - TEGnology
14:55	15:25	Coffee break	-
15:25	15:55	Sustainability of TH-based TE Materials and Devices	Eduardo Santos - 3Drivers
15:55	16:25	START's Legacy: The Alliance and the Service Company	Emese Karácsonyi - La Palma Research Centre
16:25	17:25	Round Table: An Industrial Thermoelectric European Association?	Moderator: Luis Lopes - La Palma Research Centre Panel: D. Crane (DTP Thermoelectrics) M. Den Heijer (Thermagy) E. Karácsonyi (LPRC) D. Narducci (University Milano Bicocca, European Thermoelectric Society) G. Roy (Thermo Power Systems)
17:25	17:30	Recap and End of Event	Filipe Neves - LNEG / START Coordinator

Figure 21 | Agenda of the workshop "The START Solution : Thermoelectric Tetrahedrites from Secondary Raw Materials for Sustainable Energy Production from Waste Heat", Brussels, Thon Hotel, 19th May 2026.

(6) YouTube : https://www.youtube.com/playlist?list=PLVMVwVj38L8oZ4MhFrQjUYg6khYpZ3QLw

Figure 22 | F. Neves opening the START Workshop on 19th May 2026.

Figure 23 | H. Yin showing the demonstrator of the Flex-TEG STAT device.

Figure 24 | A. Ray illustrating the START µCHP (Combined Heat and Power)-TEG System.

Figure 25 | E. Karácsonyi explaining the legacy activities of START.

Figure 26 | The Round Table concerning the possible creation of an industrial association for thermoelectrics in Europe, with panellists in the room (left to right at the desk: M. den Heijer, G. Roy, E. Karácsonyi) and remotely connected (left, D. Narducci; right, D. Crane). Moderator. L. Lopes.

Figure 27 | The group of participants in the START workshop on 19th May.

FINAL EVENT: SIDE SESSION OF THE EIT RAWMATERIALS SUMMIT

«A THERMOELECTRICS ECOSYSTEM FROM SUSTAINABLE SECONDARY RAW MATERIALS»

The START project was a sponsor of the EIT RawMaterials Summit 2026 and, as such, was granted the opportunity to organise a dedicated one-hour session within the Summit programme. The EIT RawMaterials(7) Summit is a major European event, bringing together key stakeholders from industry, research, and policy to discuss raw materials innovation, sustainability, and resilience.

The session took place on 20th May 2026 (11:45–12:45), hosted in the "Press" Room of the Egg Conference Centre. To align with the Summit's themes and audience, it was titled **"A Thermoelectrics Ecosystem from Sustainable Secondary Raw Materials"**, with a focus on the raw materials dimension of START.

Participation in the START side session was subject to registration for the EIT RawMaterials Summit 2026, with details provided on the official Summit website.

The programme (see the agenda in Figure 21) featured a series of short presentations covering the project, the use of raw materials derived from European mine wastes (tetrahedrites, as you should know) as an alternative to imported tellurium-based materials, and the processes employed in the fabrication of thermoelectric devices. The session also introduced the project's legacy initiatives, namely the START Alliance and the START Service Company. It concluded with a 30-minute round table discussion on "Mine Wastes as a Pillar for Resilience", involving speakers from both within and beyond the START consortium.

(7) https://eitrawmaterials.eu/events/eit-rawmaterials-summit

The START Project: EU Mine Wastes for Sustainable TE Devices	Filipe Neves - LNEG / START Coordinator
Valorising European Mine Wastes	Daniel Oliveira - LNEG
Environmental Sustainability and Economic Feasibility of TE devices	Eduardo Santos - 3drivers
START's Legacy: The Alliance and the Service Company	Emese Karácsonyi - La Palma Research Centre
Round Table: Mine Wastes as a Pillar for Resilience	Moderator: Gracia Olivenza – ASGMI Panellists: I. Herraez Chamorro (Tecnicas Reunidas, PERMANET project) D. Oliveira (LNEG) D. Yilmaz (Institute for Energy Technology, REESOURCE Project) H. Yin (TEGnology)

Figure 28 | Agenda of the Side Session inside the EIT RawMaterials Summit 2026.

About 30 participants joined the workshop in the Press Room, that was a great opportunity to bring the themes of our project to the larger raw materials community, as it had already been the case with the two side events that we had organised and co-organised during the Raw Materials Weeks of 2024 and 2025.

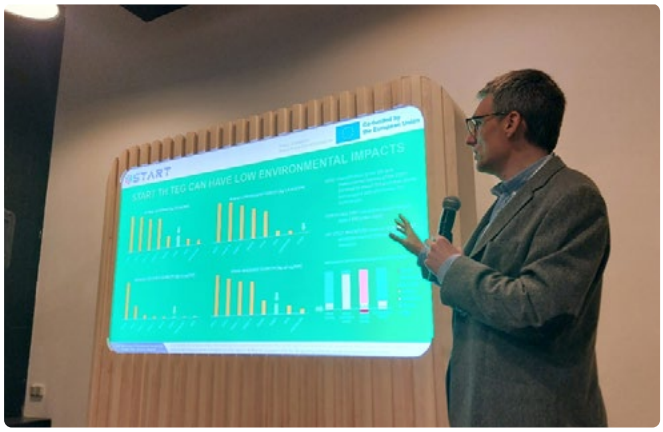


Figure 29 | The presentation by E. Santos on the sustainability of START materials.

Figure 30 | The panel discussion led by G. Olivenza (ASGMI).

Figure 31 | The Press Room during the panel discussion.

Figure 32 | Speakers of the Side Session. Left to right. G. Olivenza (ASGMI), E. Santos (3drivers), F. Neves (LNEG), E. Karàcsonyi (LPRC); H. Yin (TEGnology), I. Herraez Chamorro (Tecnicas Reunidas, PERMANET project), D. Oliveira (LNEG). Not in the picture: D. Yilmaz (Institute for Energy Technology, REESOURCE Project).

CONSORTIUM TOUR

EUROPEAN POWDER METALLURGY ASSOCIATION AISBL

EPMA - www.epma.com

We complete our tour of consortium members, and in this issue you can meet EPMA, the Dissemination and Communication leader in the project!

The European Powder Metallurgy Association (EPMA) is a non-profit organisation founded in Brussels in 1989, representing the European powder metallurgy (PM) sector. Its scope covers the full PM value chain, from metal powder production to the manufacture of final components through processes such as press & sinter, isostatic pressing, metal injection moulding, metal additive manufacturing, and FAST sintering.

EPMA's mission is to support and strengthen the European PM community by fostering collaboration between industry and research. As of 2026, the Association brings together around 250 members across the entire supply chain, including powder producers, feedstock suppliers, component manufacturers, end-users, equipment providers, service organisations, consultants, and research institutions. It supports its members through a range of initiatives, notably its Sectoral and Working Groups.

Key EPMA activities include organising the annual European PM Congress & Exhibition (EuroPM series), which becomes the global WorldPM event every six years (next edition scheduled for 2028); hosting technical seminars and workshops across Europe; collecting and analysing market data; providing training through initiatives such as the EPMA Summer School and the Young Engineers scheme; monitoring relevant EU regulations (e.g. REACH); participating in (and also coordinating) EU-funded R&D projects, like START; coordinating collaborative "Club Projects" among members; and promoting excellence through competitions and awards.

Within the START project, EPMA acted as Dissemination and Communication Manager, leveraging its extensive network to maximise project visibility and foster engagement across the PM community. In particular, it mobilised its Functional Materials group (EuroFM) to support outreach and collaboration. EPMA also ensured a strong presence at its flagship EuroPM events, hosting a project booth each year from 2022 to 2025, including the WorldPM Congress in Lyon (2022), followed by EuroPM editions in Lisbon (2023), Malmö (2024), and Glasgow (2025), and offering lecture slots in its yearly PM Summer School (Ciudad Real 2022, Dresden 2023, Alessandria 2024, Lund 2025). EPMA has been organising and coordinating most START events during the 4 years of the project.

Figure 33 | The annual EuroPM Congress & Exhibition brings together the powder metallurgy community from Europe and beyond, currently attracting around 800 participants. The event features over 200 technical presentations alongside a large industrial exhibition. The figure shows the plenary session at the 2024 edition.

In this last issue of the newsletter, EPMA wishes to thank all the partners (all the consortium, in fact!) who collaborated in the preparation of this document series.

Without their full support in delivering the contents, proofreading them several times, and crosschecking consistency, these newsletters would have been much less interesting and fruitful. The audience liked this content (we have thousands of downloads in total for the newsletter series!) and this made our work less heavy.

CONTACTS

This is the last edition of the newsletter, as the project is ending in May 2026; thus, from now on please refer to the website for any further information.

Here are all the links where you still can find our news, including all previous issues of the newsletter:

Website: https://www.start-heproject.com/
START European Thermoelectrics Systems: https://start-sets.eu/
Twitter: https://twitter.com/START_HEproject
LinkedIn: https://www.linkedin.com/company/86266991/
Twitch: https://www.twitch.tv/start_he_project
YouTube: https://www.youtube.com/channel/UCHVjEhpVz9uaEgzICj2InPA
SlideShare: https://es.slideshare.net/StartProject/
Zenodo: https://zenodo.org/communities/start-heproject/

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