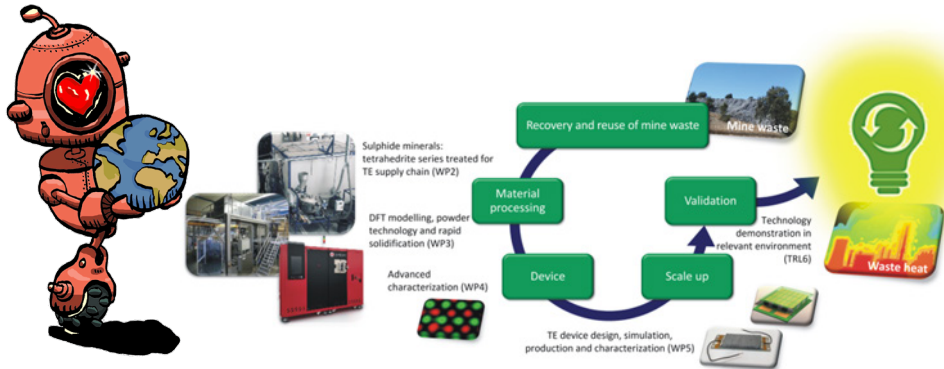


START: SUSTAINABLE ENERGY HARVESTING SYSTEMS BASED ON INNOVATIVE MINE WASTE RECYCLING

AN INNOVATION ACTION PROJECT CO-FUNDED BY THE EUROPEAN UNION VIA ITS HORIZON EUROPE PROGRAMME



MAIN OBJECTIVE

Create a sustainable supply chain for green energy harvesting products



TELLURIUM-FREE THERMOELECTRIC DEVICES

Using a unique technological solution, START is transforming waste secondary sulphide materials in sustainable high added-value components for tellurium-free thermoelectric devices.

START produces advanced p-type materials that incorporate discarded waste secondary sulphides, mainly tetrahedrite, a widely available copper-antimony sulfosalt mineral not containing tellurium, that is rather scarce and must be imported to Europe (mostly from China).



DURATION 48 months (June 2022 - May 2026)

COST 9.19M€

GRANT 7.67M€

COORDINATOR LNEG (PT)

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- The use of **mine wastes** as valuable secondary raw materials for the development of advanced energy conversion devices creates an increased economic incentive to eliminate environmentally hazardous tailings.
- A huge amount of the primary energy produced worldwide is **lost to the environment as waste heat**, which can be recovered using thermoelectric devices.
- Opportunity for an **efficient use of resources** and to decrease resource dependence and waste
- Diversification of the sources of renewable energy production systems using green energy harvesting through thermoelectrics.

In line with:

- European Green Deal
- EU Action Plan on Critical Raw Materials
- EU Action Plan on Circular Economy
- UN Sustainable Development Goals



Action Plan on Critical Raw Materials



ACTION 3

Launch research and innovation on waste processing, advanced materials and substitution of critical raw materials



ACTION 4

Map the potential supply of secondary critical raw materials in Europe and identify viable recovery projects



ACTION 5

Identify priority mining and processing projects for critical raw materials in the EU



ACTION 8

Develop research and innovation projects to reduce environmental impacts of raw materials extraction and processing



ACTION 9

Develop strategic international partnerships to secure a diversified supply of sustainable critical raw materials, starting with pilot partnerships with Canada, interested countries in Africa and the EU's neighborhood (partially)



SUSTAINABLE DEVELOPMENT GOALS

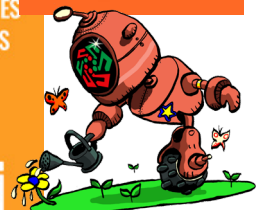
7 AFFORDABLE AND CLEAN ENERGY



9 INDUSTRY, INNOVATION AND INFRASTRUCTURE



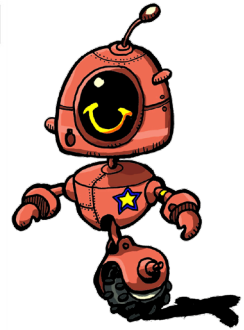
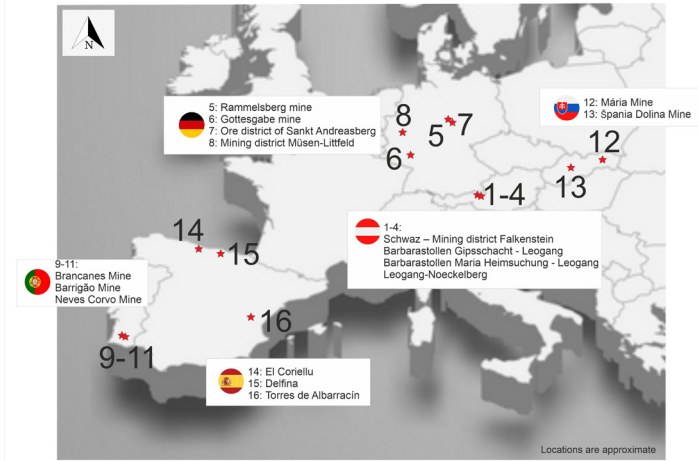
11 SUSTAINABLE CITIES AND COMMUNITIES



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ACHIEVEMENTS OF THE FIRST PART OF THE PROJECT

Sites containing mineralogically suitable sulphide minerals for producing the p-type semiconductor thermoelement were identified in various historical European mines, based on the volume of sulphides, the presence and content of tetrahedrite, and accessibility and logistical issues.



Several hundred kg discarded mining waste sulphides were collected where the necessary authorisations were granted.

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Tetrahedrite-rich concentrates from these minerals were successfully processed via High Energy Ball Milling (HEBM) in a pre-pilot scale (300 g batches) to produce kg scale batches of mineral-derived tetrahedrite p-type powder materials incorporating different amounts of synthetic material.

Spark Plasma Sintering successfully produced thermoelectric elements. A compatible n-type TE material was also identified.



Based on simulated performances, two applications have been selected: combined heat and power (CHP) and low-grade waste heat from heavy industry.

Work is underway to assemble the first TE device of the START project.

Life cycle assessment (LCA) and life cycle costing (LCC) studies are used for benchmarking.

Focus Groups and a Delphi Survey were organised to assess the market perspective and the social acceptance.

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