

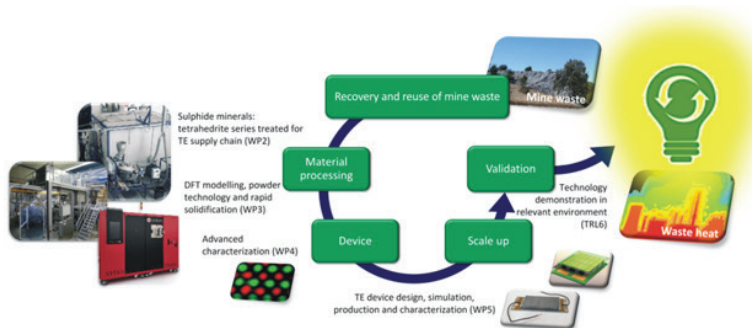


SUSTAINABLE ENERGY HARVESTING SYSTEMS BASED ON INNOVATIVE MINE WASTE RECYCLING

Co-funded by the European Union via its Horizon Europe programme

START is a Horizon Europe Innovation Action developing tellurium-free thermoelectric energy-harvesting systems from European mine tailings.

By transforming waste sulphide minerals into high-value materials, the project demonstrates a circular, secure and sustainable supply chain for green energy technologies.



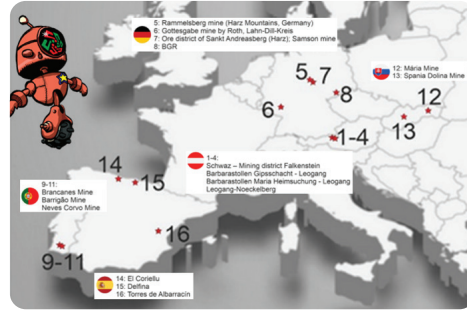
WHY IT MATTERS

- A large share of industrial energy is lost as waste heat
- Thermoelectrics can convert this heat directly into electricity
- Current technologies rely on imported materials (tellurium, not available from Europe)

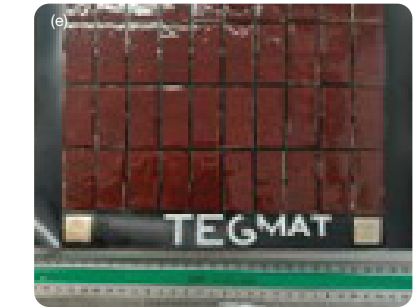
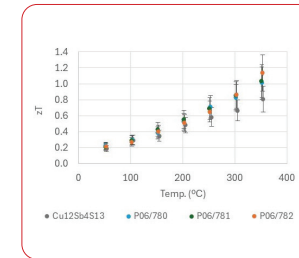
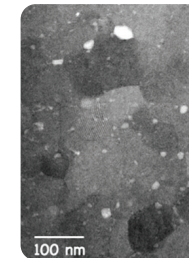
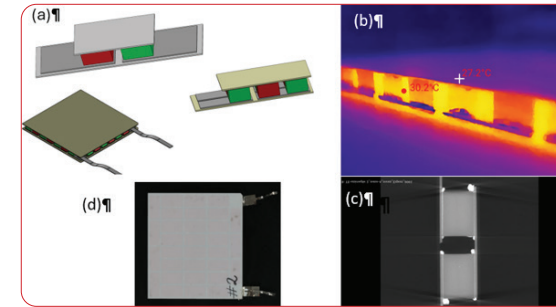
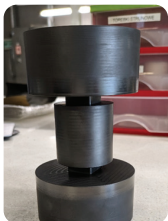
START turns mining waste into a solution.

WHAT START ACHIEVED

- Identified and processed **European mine waste** rich in tetrahedrite (TH)
- Converted heterogeneous waste** into high-performance thermoelectric materials

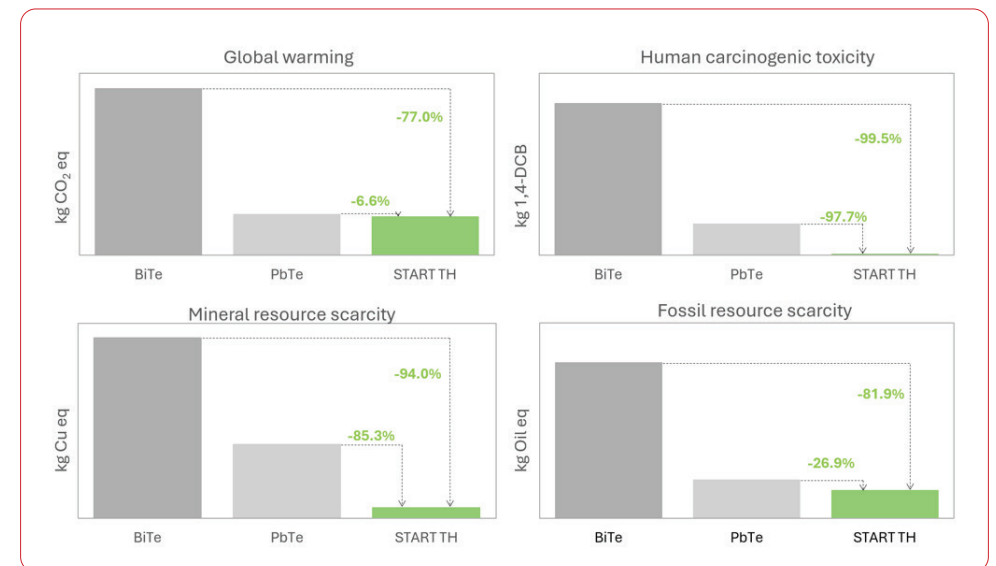


- Produced **tellurium-free p-type components** with excellent performance and stability
- Demonstrated **scalable fabrication** from material to modules (two different modules and applications)



- (a) Schematic illustration of the unicouple, tricouple, and the TEG module
- (b) Thermal image of the fabricated module
- (c) Non-destructive evaluation of unicouples
- (d) START μ CHP (Combined Heat and Power) - TEG System
- (e) START Flex-TEG-Solar System

- Validated environmental and economic sustainability** through LCA and cost analyses



FROM INNOVATION TO MARKET

START developed business cases:

- START μ CHP(Combined Heat and Power)-TEG System
- START Flex-TEG-Solar System

In addition, it created value-chain models, a dedicated Technology Marketplace, and supported the creation of new entities to drive exploitation and adoption of thermoelectric solutions:

- A Sustainable Thermoelectric Alliance (STA)
- The START European Thermoelectric Systems OÜ (SETS) service company

IMPACT

- Reduced dependence on critical raw materials
- Supports circular economy and mine-site remediation
- Enables clean energy harvesting from waste heat
- Strengthens European industrial resilience
- Aligned with European Green Deal, Circular Economy, Critical Raw Materials Act, UN SDGs



PROJECT FACTS

Duration:
June 2022 – May 2026
Budget: €9.19M
EU Grant: €7.67M
Coordinator: LNEG (Portugal)



<https://www.linkedin.com/company/start-he-project>



https://twitter.com/START_HEproject



<https://es.slideshare.net/StartProject>



<https://zenodo.org/communities/start-heproject>

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