POSIDON

POLLUTED SITE DECONTAMINATION PCP

BOOSTING INTERNATIONAL LEADERSHIP IN SOIL DECONTAMINATION MARKETS

POSIDON has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N.776838

PARTNERSHIP CONTACTS

Area Science Park
COORDINATOR, TECHNICAL PARTNER
Manuela Masutti
manuela.masutti@areasciencepark.it
Martina Terconi
martina.terconi@areasciencepark.it
www.areasciencepark.it

Port Network Authority of the Eastern Adriatic Sea
LEAD PROCURER, FRONT RUNNER
Eric Marcone
emarcone@porto.trieste.it
Erika Boscarol
eboscarol@porto.trieste.it
www.porto.trieste.it

Ayuntamiento de Bilbao
PROCURER, FRONT RUNNER
Mikel Gonzalez Vara
mgvara@bilbao.eus
Jorge Guaza San Miguel
jguaza@bilbao.eus
www.bilbao.eus

Centro de Estudios Ambientales Ayuntamiento de Vitoria-Gasteiz
PROCURER, OBSERVER
Juan Vilela Lozano
jvilela@vitoria-gasteiz.org
www.vitoria-gasteiz.org

SPAQuE
PROCURER, OBSERVER
Marta Popova
m.popova@spaque.be
www.spaque.be

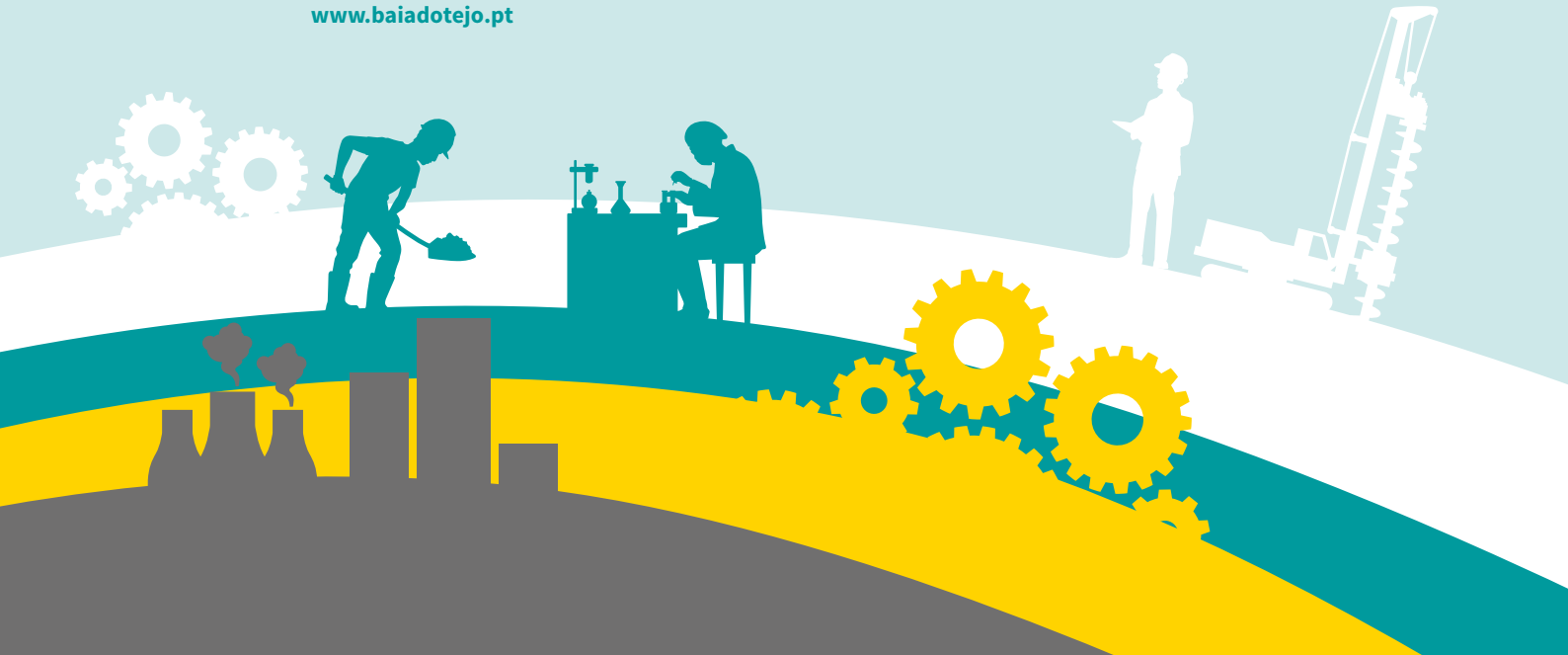
Baìa do Tejo
PROCURER, OBSERVER
Sérgio Paulo Barradas Saraiva
geral@baiadotejo.pt
www.baiadotejo.pt

Sara Bedin
TECHNICAL PARTNER
Sara Bedin
sara.bedin@pcpacademy.eu
www.linkedin.com/in/sara-bedin-722b0126

Fundacion Tecnalia Research & Innovation
TECHNICAL PARTNER
Ekain Cagigal
ekain.cagigal@tecnalia.com
www.tecnalia.com

Moragues and Scade Abogados
TECHNICAL PARTNER
Begoña Benito
bbg@grupomas.net
www.mas-abogados.com

Sociedad Publica Gestion Ambiental IHOBE
TECHNICAL PARTNER
Miriam Gonzalez
miriam.gonzalez@ihobe.eus
www.ihobe.eus



POSIDON
POLLUTED SITE DECONTAMINATION PCP

INTRODUCTION

The EU project POSIDON PCP has addressed the lack of innovation driven public demand in the brownfield decontamination sector in Europe, by promoting the first joint EU pre-commercial public procurement (PCP) to identify breakthrough solutions.

POSIDON PCP gathered 5 European procurers, two front-runners: Port Network Authority of the Eastern Adriatic Sea Port Of Trieste (IT) and Bilbao City Council (ES) and three observers: SpaQue (BE), CEA – Vitoria Gasteiz City Council (ES), Baja do Tejo (PT) all facing the same common soil decontamination need.

KEY DRIVERS

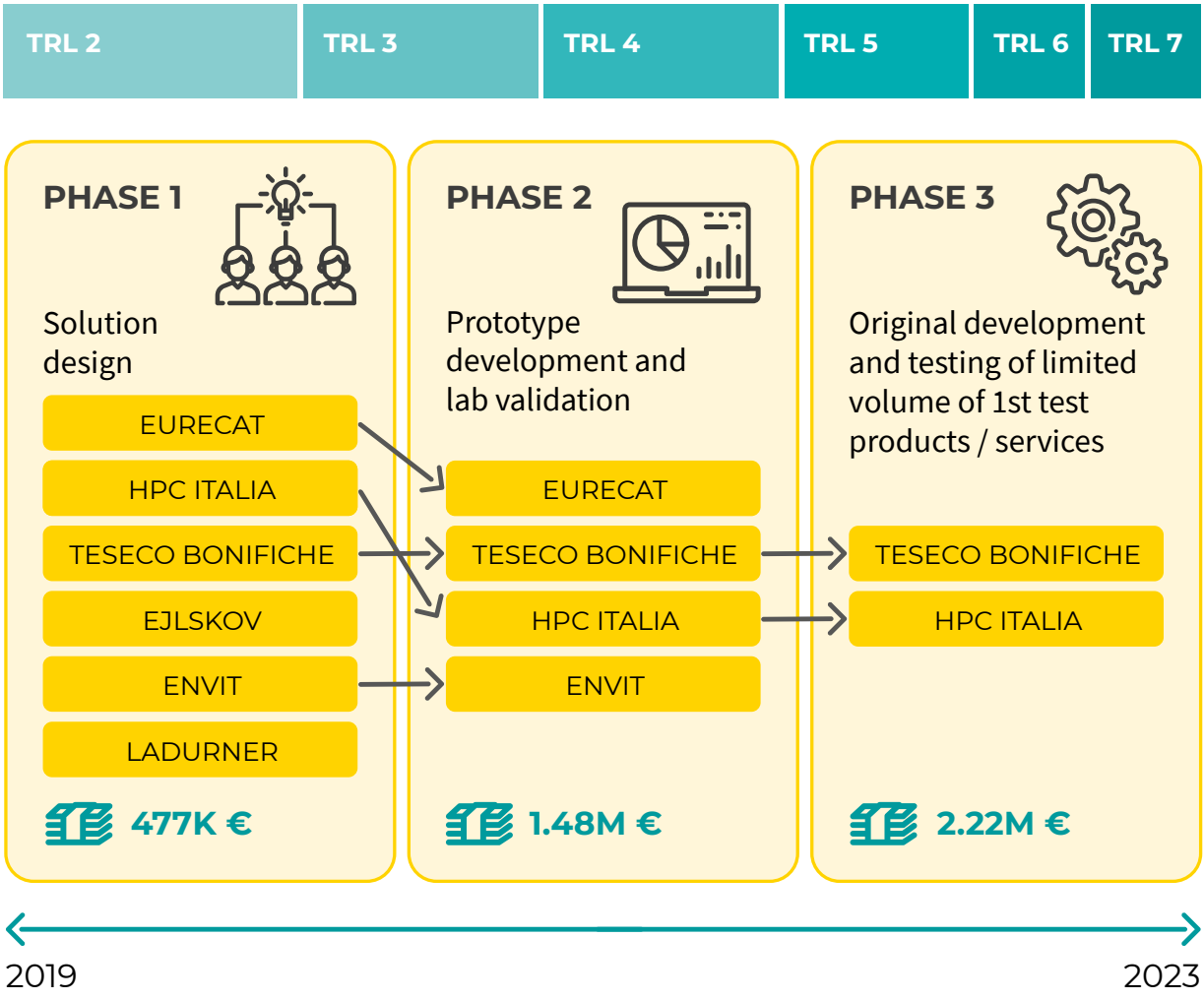
- Moving from traditional "push" and "market-driven" to "pull" and "demand-driven" innovation strategies and investments
- Addressing fragmentation of public demand through the aggregation at transnational level, optimizing the cost and value of the R&D
- Unlocking the internal market by offering concrete cross-border market and growth opportunities to companies
- Leaving IPR ownership rights to the participating companies in return for a financial compensation

POSIDON
POLLUTED SITE DECONTAMINATION PCP

POSIDON PRE-COMMERCIAL PROCUREMENT

The PCP procured applied research and technological development to identify innovative, in situ, cost-effective soil remediation technologies, capable of decontaminating heterogeneous anthropic soils in brownfields, composed of a mixture of various industrial wastes and soils consisting of clay and sand highly polluted by petroleum hydrocarbons (TPHs), PAHs and heavy metals (specifically Arsenic and Lead).

POSIDON PCP involved 13 different suppliers (organized in Consortia of enterprises and research centers) competing in parallel through different phases of development: 6 awardees were engaged in the solution design, 4 in the prototype development, and 2 in the original development of 2 prototypes field-tested in 2 diverse sites in Trieste (italy) and in Bilbao (Spain).



KEY FINDINGS

- Multiple sourcing and the separation between the development and large-scale deployment, is beneficial to develop a more competitive market, enhancing the incentive to strive to improve performance
- Gradually growing contract sizes facilitate the access of small innovative firms to the (procurement) market
- Virtuous process of co-evolution of demand and supply shortens the time-to-market for the suppliers that can better anticipate demand for new solutions
- Leaving IPR ownership with companies encourages them to pursue wider commercialization, which in turn offers extra contractual incentives to undertake additional R&D effort

POSIDON
POLLUTED SITE DECONTAMINATION PCP

SOIL-OMIC®

process with BIOflushing® technology

SOIL-OMIC Biological and Chemical-Physical formulations and processes

BIO FLUSHING BIOLOGICAL REMEDIATION TECHNOLOGY

teseco bonifiche

TESECO BONIFICHE srl

www.tesecobonifiche.it

Alessandro Gentini
+39 050 984317
agentini@tesecobonifiche.it

MAIN FUNCTIONALITIES / FEATURES / PERFORMANCES

Soil-Omic® is a process based on the application of advanced sequencing tools, metagenome analysis of environmental matrices and chemometric analysis, for the definition of site-specific protocols and formulations for the degradation of organic contaminants and the removal of inorganic contaminants.

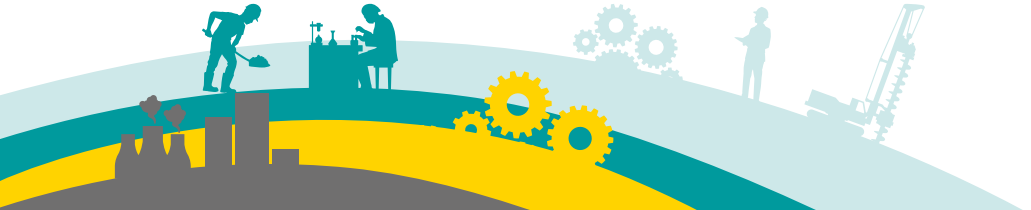
The solution operates with BIOflushing®, an in situ biological remediation technology that uses original plants and specialized hydraulic systems for biostimulation, bioaugmentation and chemical flushing of saturated and unsaturated soil.

ON-GOING / FUTURE TECHNOLOGICAL DEVELOPMENTS

Application of the Soil-Omic® process and BIOflushing® technology for the decontamination of soils and groundwater contaminated by chlorinated hydrocarbons (Trichlorethylene and perchlorethylene) and organochlorine pesticides (lindane). Application of SOIL-OMIC for the implementation of permeable reactive barriers for the treatment of TCE contamination plumes.

MAIN RADICAL INNOVATIVE ASPECTS

BIOflushing represents an in situ technology that operates on both saturated and unsaturated soil and which aims at the effective degradation of organic contaminants, through enhanced biological mechanisms, and at the desorption/transformation of inorganic contaminants, using site-specific formulations. This flexibility has required the development of original technologies and tools, which are unprecedented in the environmental remediation sector, and which therefore represent a radical innovation, both in terms of the process and the plant.
1) the application of molecular biology techniques for the planning of interventions and the development of chemical-physical-biological protocols based on the analysis of metagenomic and chemiometric big data;
2) the creation of *in situ* treatment devices capable of effectively saturating the soil and establishing a circulation of chemical and biological solutions designed for organic and inorganic decontamination;
3) the creation of machines specifically designed for the biostimulation of the soil microbiota, such as the mechanical nanobubble emulsifier.



FIELD-TESTING
PHASE 3 FINALISTS

PHASE 3 RESULTS

The results obtained in Phase 3 confirmed the effectiveness of the process and dedicated plant for the degradation of petroleum and polycyclic aromatic hydrocarbons, as well as for the removal of heavy metals from saturated and unsaturated soil.

In particular, in Bilbao, in approximately 5 months of operation of the plant, a significant reduction was recorded in the average inorganic contamination of the unsaturated soil (Arsenic -97%, Cadmium -82%, Chromium -31%, Nickel -56%, Lead -95%, Copper -96%, Zinc -94%) as well as organic contamination (Hydrocarbons (TPH) -85%, Dibenzo(a.h)anthracene -97%, Benzo(a)pyrene -97%, Indeno(1.2. 3-cd)pyrene -97%, Pyrene -97%, Benzo(a)anthracene -99%, Chrysene -97%, Benzo(b)fluoranthene -99%, Benzo(k)fluoranthene -96%, Sum PAH (EPA 16) -97%).

The water treatment system integrated into the plant also provided for the decontamination of the aquifer from the same contaminants.

SCIENTIFIC EVIDENCE

The reduction of the contamination factors of the unsaturated soil and the groundwater is demonstrated by the chemical analyzes conducted on the unsaturated soil and the groundwater during 3 characterization campaigns. Microbiological analyzes highlighted the role of specific microbiomes in the various phases of the on-site process and witnessed the enrichment of microbe biodiversity at the end of the treatment. Toxicity analyzes on the soil and on the eluate highlighted the effects of the treatment, both in the biological flushing and chemical flushing phases.

Sequential extractions were performed to assess changes in metal fractionation and mobility during the treatment.

The establishment of biological mechanisms and the production of volatile contaminants were monitored through soil gas analysis.

All monitoring data on the operation of the plant and the effectiveness of the technology were correlated.

PATENTING STATUS: Pending

"PROCESS FOR THE DECONTAMINATION OF SOIL AND GROUNDWATER OF AN AREA TO BE DECONTAMINATED FROM ORGANIC AND INORGANIC POLLUTANTS AND A PLANT THAT IMPLEMENTS THIS PROCESS"
Application number: 102022000017199.
Filing date: November 08, 2022

Achieved TRL: 8

Current status of the innovation:
In commercialization stage

Time to market: End of 2023

INTERESTED IN BUSINESS ACCELERATION SERVICES

- Gaining exposure on big trade fairs
- Finding customers
- Expanding to other EU/international markets
- Setting up a strategic partnership or alliance with marketing / sales / distribution entities

POSIDON has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N.776838

POSIDON
POLLUTED SITE DECONTAMINATION PCP

ERASE

ElectRode-Aided Soil rEmediation

MAIN FUNCTIONALITIES / FEATURES / PERFORMANCES

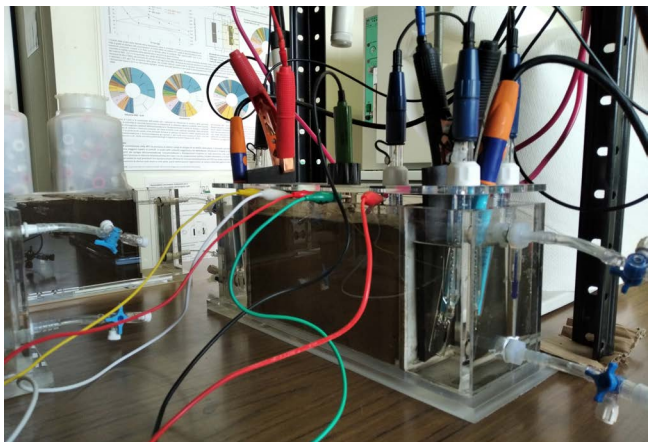
ERASE is an electrode-based remediation approach to integrate physical, chemical, and biological mechanisms for the clean-up of contaminated sites.

The solution is a total in situ approach thought to address complex polluted environments, different soil textures and various organic and inorganic pollutants at the same time. According to the design and operative conditions, it is possible to trigger different phenomena and removal mechanisms and to establish the optimal conditions for the treatment of the contaminants of concern at the polluted site dealing with.

The modularity of the technology allows operation on contaminated sources of different extensions and depths. As with any totally in situ approach, no significant excavation/disposal of soil is required. Furthermore, the estimated limited requirements of materials and equipment, in comparison to other established technologies, make this solution an innovative, sustainable, and cost-effective approach.

ON-GOING / FUTURE TECHNOLOGICAL DEVELOPMENTS

Improving flexibility in the power supply system and related controls, broadening the applicable range of voltages/currents, according to site-specific characteristics and needs. Testing the installation of electrodes inside semi-permeable chambers filled with proper electrolytes for increasing the recovery of metals.



HPC ITALIA SRL

HPC ITALIA
www.hpc.ag/it
Daniele Vezzoli
+39 02 4548899
daniele.vezzoli@hpc.ag

POLITECNICO DI MILANO - DICA
www.dica.polimi.it
Sabrina Saponaro
+39 02 23996432
sabrina.saponaro@polimi.it

MAIN RADICAL INNOVATIVE ASPECTS

The innovative aspect of ERASE is in the integration of three remediation types of mechanism (physical, chemical, and biological) to provide an improved, modular, and flexible system for the remediation of a porous medium (saturated or unsaturated) contaminated by different pollutants, either organics or inorganics or a mixture of them.

PATENTING STATUS: Pending

"ERASE - ELECTRODE-BASED REMEDIATION. SYSTEM AND PROCEDURE FOR IN SITU REMEDIATION WITH ELECTRODES FOR THE REMOVAL OF INORGANIC AND/OR ORGANIC POLLUTANTS IN A POROUS MEDIUM"
Application n. 102023000007398.
Filing date: April 17, 2023.

Achieved TRL: 7

Current status of the innovation: Under development

Time to market: Within 2026

INTERESTED IN BUSINESS ACCELERATION SERVICES

- Finding investors
- Finding customers
- Finding public funding for incremental developments

FIELD-TESTING
PHASE 3 FINALISTS

PHASE 3 RESULTS

At the operative conditions applied during Phase 3 of the project, some evidence of increased metal mobility resulted in the tests, with reduction in soil concentration for some metals.

Electrode-aided oxidation tests highlighted the action of the direct electric field in promoting the migration of oxidants, such as persulfate, in soil and, for Trieste site, also the effectiveness of AC-powering in heating the soil for persulfate thermal activation.

Monitoring data confirmed the action of persulfate at both sites, with a decline in polyaromatic hydrocarbons and petroleum hydrocarbons in Trieste and with relevant oxidation of organic matter (to whom pollutants are sorbed) in Bilbao.

SCIENTIFIC EVIDENCE

Sulfate content in the soil at the end of the tests demonstrated the action of the DC field in promoting the distribution of persulfate, especially considering the low volume that was injected to avoid leaching into groundwater.

Monitoring data showed the action of persulfate in reducing PAHs and petroleum hydrocarbons in soil and in oxidizing the organic matter to whom pollutants were sorbed, promoting their desorption from soil particles.

Higher PAH removal was related to the higher soil temperature induced by the AC-powering. With regards to metals, a certain reduction in the peak concentrations was observed, caused by their increased mobility.

POSIDON has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N.776838

POSIDON
POLLUTED SITE DECONTAMINATION PCP

RIBAS

Reactive Infiltration BAsin for in-situ Soil treatment

RIBAS
REACTIVE INFILTRATION BASIN FOR IN-SITU SOIL TREATMENT

MAIN FUNCTIONALITIES / FEATURES / PERFORMANCES

RIBAS has been conceived as an innovative soil remediation technology for in-situ application; it allows remediating a contaminated soil with metals and/or petroleum hydrocarbons, avoiding excavation. The solution can deal with a variety of sites since it can be adapted to the specific contaminants by changing the applied reagents. Its novelty is the combination of three different technological approaches, which are usually implemented stand alone in the field of soil/groundwater remediation or in mining activities. The whole life-cycle footprint of RIBAS is considerably lower compared to the landfilling option, achieving an 81% reduction of greenhouse emissions, estimated for a real scale implementation, and economic costs are also strongly decreased: 35% reduction of expense.

The treatment efficiency achieved remediation goals as low as <50 mg/kg for TPH. Removal of metal(oid)s, attained rates of 0.9, 3.2, 6.5, and 9.5 mg/kg/day, for As, Pb, Cu and Zn, respectively. These indicate a timeframe needed to reach the target thresholds limits of 21, 28, 4.5 and 2.5 months for As, Pb, Cu and Zn, respectively.

ON-GOING / FUTURE TECHNOLOGICAL DEVELOPMENTS

The aim pursued by the consortia Eurecat-Amphos 21 is to promote the RIBAS solution in order to reach potential private and public clients, which in principle are site owners, public administration and/or bidders. Moreover, the current need of the consortia is to execute one or more field tests for the validation of results obtained at prototype scale. For this field testing we need both contaminated site and financial resources.

eurecat
Centre Tecnològic de Catalunya

EURECAT
www.eurecat.org

Carmen Bosch
+34 938 777 373 ext. 7665
carme.bosch@eurecat.org

AMPHOS 21
SCIENTIFIC AND STRATEGIC ENVIRONMENTAL CONSULTING

AMPHOS 21
www.amphos21.com

Jordi Guimerà
jordi.guimera@amphos21.com

MAIN RADICAL INNOVATIVE ASPECTS

The technological assets of RIBAS are the following: 1) an infiltration basin, 2) a permeable reactive barrier, 3) soil confinement with sheet-pile walls, and 4) a hydraulic barrier with well-points for water extraction. Based on the market and State-of-Art evidence monitoring, it is the first time that our innovative technological approach is implemented for an in-situ soil remediation of various pollutants.

PATENTING STATUS: Under secret

It has been taken reasonable measures to protect the secrecy and a timestamp registry is pending. Work to file a patent is in progress.

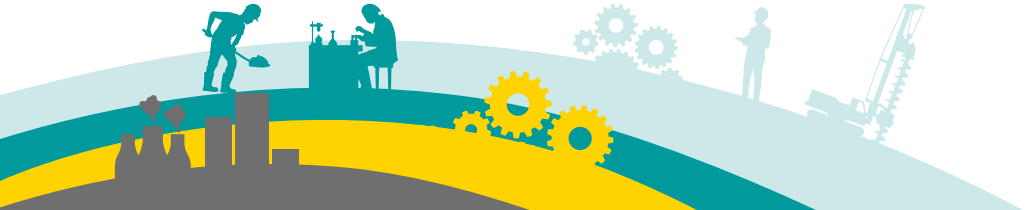
Achieved TRL: 5

Current status of the innovation: Under development

Time to market: Within 2027

INTERESTED IN BUSINESS ACCELERATION SERVICES

- Finding investors
- Finding public funding to incremental developments
- Setting up a strategic partnership or alliance with marketing / sales / distribution entities



PROTOTYPE DEVELOPMENT
OTHER PHASE 2 AWARDEES

ReMix

MAIN FUNCTIONALITIES / FEATURES / PERFORMANCES

ReMix technology enables the removal of toxic metalloids such as arsenic and antimony from contaminated soils, simultaneously with toxic metals such as lead, zinc, cadmium and copper. Another feature is the simultaneous removal of organic contaminants. The ReMix was developed based on a closed chemical platform (now called ReSoil) previously developed by Envit for the removal of toxic metals from soil by chelation with ethylenediaminetetraacetate (EDTA).

This involves recycling process solutions and EDTA in a pH gradient of 12.5 to 2 achieved by adding quicklime and sulfuric acid, thoroughly rinsing the washed soil in a filter press, and adsorbing the remaining EDTA chelates onto the Fe-oxide hydroxide shell that develops around zero-valent iron after it is added to the soil slurry. In ReMix, toxic metalloids are transferred from the soil to the washing solution after amorphous and crystalline Fe-oxide hydroxides in the soil are dissolved by oxalic acid and Na-dithionite, and organic contaminants are dissolved from the soil into the washing solution with anionic surfactants.

ON-GOING / FUTURE TECHNOLOGICAL DEVELOPMENTS

ReMix technology was tested on artificially contaminated (spiked) soil. Feasibility testing on historically contaminated soils is required. The use of anionic surfactants to remove organic contaminants resulted in excessive foaming, which requires further investigation.

ENVIT Ltd.

www.envit.si

Neža Finzgar
+386 41 344198
info@envit.si

MAIN RADICAL INNOVATIVE ASPECTS

A radical innovation is the simultaneous removal of toxic metals, metalloids and organic contaminants from process solutions (soil washing and rinsing solutions), preventing the accumulation of salts and maintaining the quality of process solutions in multiple batches, to enable closed-loop soil remediation without wastewater generation.

PATENTING STATUS: Patented

"REMOVAL OF ARSENIC, ANTIMONY AND TOXIC METALS FROM CONTAMINATED SUBSTRATE"
WO2022184903A1

Achieved TRL: 5

Current status of the innovation:
Under development

Time to market: Within 2025

INTERESTED IN BUSINESS ACCELERATION SERVICES

- Gaining exposure on big trade fairs
- Finding investors
- Finding customers
- Finding public funding to incremental developments
- Expanding to other EU/international markets
- Setting up a strategic partnership or alliance with marketing / sales / distribution entities
- Setting a licensing agreement

POSIDON has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N.776838

www.posidonproject.eu

AREA SCIENCE PARK

Autorità di Sistema Portuale
del Mare Adriatico Orientale
Porti di Trieste e Monfalcone

Bilbao

Centro
de Estudios Ambientales

CEA

Ingurugiro
Gaietarako Ikastegia

assainir · valoriser les sols
spaque

baía do tejo

tecnalia
MEMBER OF BASQUE RESEARCH
& TECHNOLOGY ALLIANCE

SARA BEDIN
smart PRO curement

MAS abogados

ihobe

info@posidonproject.eu