

# InteGRated systems for Effective ENvironmEntal Remediation



greener

## NEWSLETTER

### Issue 5, Sept. 2022

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# 1. OUR GREENER SITES



The different contaminated sites are being selected by consortium (EU) partners to be used during innovation activities. As can be seen on the map below, polluted soil will be collected from Spain, Ireland, Belgium and Shandong (China). Contaminated water will be collected from Spain, the Netherlands and Germany. Overall, Spain will host 3 contaminated sites, Belgium 3, followed by Germany with 2, the Netherlands with 1, Ireland having 1 and China with 1 contaminated sites.



A close-up photograph of a small green seedling with two leaves growing out of a mound of dark brown soil. The background is a soft, out-of-focus green.

## 2. HOW FAR HAVE WE PROGRESSED?



### WP3: Characterisation of selected contaminated sites and identification of best available bioremediation techniques (UBU)

Under WP3 consortia from the Gudao and Noblejas sites were isolated by enrichment, using diesel as the sole carbon and energy source. The microbial composition of both consortia is reported, based in the sequencing of 16S DNA amplicons.

A provisional version for Deliverable D3.7 was submitted in February 2022, detailing the enrichment, isolation, metabolic- and functional-modelling of selected consortia. The metabolic and functional potentials of hydrocarbon-degrading and azo-dye decolourising consortia were assessed (UAM, USUR). The active metabolic pathways of a hydrocarbon-degrading community during the remediation of hydrocarbons were predicted at the species level, including cross-feeding interactions within the community (USUR). The role of each species within a bioelectrochemical system (developed as part of WP4) for the remediation of azo-dye wastewater, was predicted.

TAUW has finished the compilation of the specific Key Performance Indicators (KPIs) considered for 12 different GREENER technologies. Deliverable D3.8, already submitted, includes full information of the site including type of contaminant, concentration range, a description of two pilot scale experiments, as well as previous work information and challenges for the next activities.

### WP4: Remediation Technologies Development for Surface Water and Groundwater Technologies (LEITAT)

The activities aimed at developing and validating, at lab scale, several water remediation technologies both individually and integrated. During this period, the main objectives of this WP were:

- To complete the optimization of phycoremediation technology to remove dyes at lab scale
- To complete the optimization of phytoremediation technology at lab scale.
- To complete the optimization of the bio-electrochemical systems (BES) for TPHs, pesticides, antibiotics, dyes, metals removal as well as combination of the pollutants.
- To complete the optimization of the potential combination of BES in hybrid technologies with phytoremediation solutions for the removal of pesticides, TPHs, metals and antibiotics.



## 2. HOW FAR HAVE WE PROGRESSED?



- To define the conditions for the preparation of guidelines aimed at scaling-up the technologies developed throughout WP4.
- To identify and complete KPIs for each technology, in order to identify the performance changes when moving from laboratory to pilot scale.

WP4 activities have concluded and the planned deliverables have been delivered on time. These compile the main advances achieved for the different developed technologies as well as summarizing the guidelines for an eventual scale-up. It is worth mentioning that two technologies will undergo a scaling-up process. On the one hand, hydrocarbons removal by anodic oxidation has proven its feasibility to remove industrial polluted groundwater and will be tested in an industrial facility in the frame of WP6. On the other hand, two metal removal technologies will be further scaled up as a hybrid technology. This will include a first step consisting on an abiotic removal linked to reductive processes in a BES reactor (developed by LEITAT). The effluent will be then feed to a phytoremediation process (developed by UBU).

In more detail, at University of Surrey, a laboratory-scale device based on microbial bioelectrochemistry was developed, which can help to clean a specific type of industrial wastewater (dye processing effluent), otherwise toxic and difficult to clean. The device is able to convert highlytoxic Cr(VI) found in the wastewater to its less hazardous elemental forms, while simultaneously removing toxic dyes from the wastewaters (up to >90%removal). Moreover, a second device, based on similar technology, was developed for the removal of metals from wastewater contaminated with a range of heavy metals. Removal efficiencies up to 99% were observed.



### WP5: Remediation Technologies Development for Soil/sediment

#### Technologies (BATH)

WP5 was finalised during this period. The relevant activities aimed included the optimisation and

## 2. HOW FAR HAVE WE PROGRESSED?



validation at lab scale for several technologies, both individually and on an integrated system, for soil bioremediation. Main achievements during this period are described below:

- To complete the optimization of biostimulation/ bioaugmentation technologies for soil remediation at microcosms and mesocosms level.
- To complete the optimization of ecopile technology for soil remediation.
- To develop models that support the design and scale-up of the several soil microbial fuel cells developed at BATH (UNICA).
- To elucidate the metabolic degradation pathways of atrazine by soil microbial fuel cells with advanced MS-HPLC techniques (BATH).
- To complete the optimization of the hybrid BES technologies for soil remediation.

### WP6: Technology scale-up and field testing (ACCIONA)

The main objective of WP6 is to validate at pilot and real scale environments the soil and water remediation technologies developed in previous WPs.

The progress that has been made during these months are related with the definition and conclusions of the parameters for scaling-up the optimum technologies developed in previous WPs. The work has focused on the implementation and start of testing of the optimal technologies selected on a pilot scale. Monitoring and analysis of the first results obtained. Firstly activities focused on the development of pilot scale experiments of soil treatment in selected locations. Technologies under study are:

- Bioaugmentation and biostimulation technology for hydrocarbon removal in presence of metals and metalloids including Bioelectrochemical Systems (Hybrid system) (ACCIONA, UBU, UAM, LEITAT).
- Carriers technology as bioaugmentation strategy (JSI, UBU)
- Phytoremediation and biostimulation/bioaugmentation (Ecopile) and Bioelectrochemical Systems for hydrocarbon degradation (Hybrid system) (ITC, MIB, UAM, LEITAT)
- Microbial Fuel Cells for hydrocarbon degradation (BATH)

Final definition of the key parameters necessary to evaluate the effectiveness of the technologies developed in the previous WPs was succeeded aiming to advance the work of developing the methodology for the Decision-making tool. To this end, and with the support of all the partners involved, a general description of the general and specific key performance indicators (KPI) considered for 12 different GREENER technologies has been prepared. The determination of the KPIs will serve as a guide to evaluate the performance of the technologies under study, and thus develop the criteria for their selection and application in the sites to be remediated. The work carried out for the different decision-making tools under study will be used as reference models to be followed for the definition

## 2. HOW FAR HAVE WE PROGRESSED?



of the requirements and criteria to be taken into account for the development of the methodology to be applied for the tool. Moreover, the evaluation of the results obtained at laboratory scale together with the possibilities to perform the demonstration has been concluded. Once the final inputs of the results at laboratory and pilot scale are obtained, the suitability of soil sites, where the relevant technologies will be applied, will be evaluated in more detail.

As a summary the technology to be tested at field scale are the following:

- ▶ Bioaugmentation and Biostimulation for TPH degradation in soil with metal.
- ▶ Ecopile + BES for TPH degradation- Version V2.0.



*Figure 1: Location in ACCIONA's Facilities of the three containers for treatments under study. Visualization of soils under study and sampling.*

# 2. HOW FAR HAVE WE PROGRESSED?



## WP7: Impact Evaluations (MANO)

Related to the Techno-Economic Assessment, the literature review has been continued during this period. Discussions with the different partners were made and they were asked to estimate roughly the costs of the implementation of their technology at pilot scale. The first deliverable will be submitted in the beginning of September.

The environmental impact of the technologies was subject to a literature review to facilitate data modeling.

Regarding energy and exergy analysis, the literature review was continued during this period. Discussions with the different partners were conducted and it was decided to reattribute this task to LEITAT because they have more expertise on this subject. LCA and LCC results and Social-LCA results (EU & Chinese case studies) have been finalized.

The WP7 team has evolved during this period due to the reattribution of the tasks in the new amendment. A virtual meeting of all actors involved in this WP was organized to increase the interactivity between them. A workshop is being prepared to link the field-scale technology developers to the WP7 needs.

## WP8: Promotion and Exploitation of Results (AXIA)

WP8 aims at the extensive dissemination, communication, and exploitation results of GREENER. AXIA is continuously disseminating messages related to the GREENER concept and advancements. Moreover, AXIA is progressing the training activities with 3 more GREENER talks, the informative videos/presentations where partners highlight their advancements of work and how this contributes to the project's impacts, towards greener solutions for remediation of contaminated sites. Moreover, partners have organized workshops on different occasions, such as the 11th of February 2022 (UBU), as well as on dedicated topics (the IPR training on May 2022, led by SIE and co-organised by AXIA). Partners have attended several workshops and conferences which are mapped in a centralized file. Dissemination events and press releases/ newsletters are promoting the project's concept. 14 new publications in renowned scientific journals and conference proceedings were published, underlining the importance of the GREENER's advancements. All open access publications can be found in the GREENER website's dedicated section, Zenodo, ResearchGate and Open AIRE.

New Videos from ITC and UBU were also announced during this period. Moreover, a patent dissemination strategy is built, which will be communicated to partners and will be updated during the project's implementation.

Regarding exploitation, a global market analysis report has been updated and carried out as part of

## 2. HOW FAR HAVE WE PROGRESSED?



the market scale up activities within the GREENER Exploitation strategy. More concretely, key market drivers and barriers 2022 for the bioremediation global industry have been scanned considering latest technological trends (e.g., enzyme redesigning techniques, new molecular techniques for microbial optimization...), plus a review on proposed actions coming from the public and private sector for an efficient future scale up across many applications. As a conclusion, a first SWOT analysis outlining the main market constraints and strengths of GREENER results has been designed.

Furthermore, the scale up phase at demonstration site has commenced from M36, where key exploitable results of the project will be tested for commercial impact. On this matter, exploitation activities are to be focused in the coming months on efficiently monitoring the impact and performance of the 13 KERs officially identified by the project consortium, which include, for instance, an improved biopile, highly innovative fuel cell designs (PFCs) or improved technologies for water treatment and microalgae cultivation. Concerning the IP plans for the consortia, partners have been internally discussing about IP protection for specific KERs (one patent considered at the moment) as well as diverse license agreements for future exploitation after termination of scale up phase. Mainly to support communication activities inside and outside the project, SIE, which is appointed as exploitation manager, has also co-organized an IP related workshop open to industry stakeholders about the importance of IP foreground protection and lessons learned from the GREENER experience. More external exploitation related actions are expected in the coming months, such as the presentation of the stakeholder platform as well as its current functionalities, which are currently under discussion and mainly lie on the impact of a decision making tool to test efficiency of future bioremediation technologies.



# 3. GREENER TALKS



## GREENER TALK WITH MATERIA NOVA



Materia Nova is participating in the third GREENER talk, in the framework of the H2020 GREENER project, focusing on exploring the bacterial ability to produce metallic particles as an efficient remediation strategy. Dr Stephanie Roosa, Project Manager at Materia Nova, has offered an interesting talk explaining the involvement of Materia Nova in the project and the possibilities the GREENER project implementation is offering.



Take a look at the video : [www.youtube.com/watch?v=VuVvHZPnyKE](https://www.youtube.com/watch?v=VuVvHZPnyKE)

## GREENER TALK WITH TAUW



AXIA Innovation organised the fourth talk in the framework of the H2020 GREENER project. Dr Alfredo Perez de Mora, Project Manager on Soil and Groundwater Remediation from TAUW, shed light on the involvement of TAUW in the project and the progress achieved so far.

Take a look at the video : [www.youtube.com/watch?v=Sy8WKCVjUX4](https://www.youtube.com/watch?v=Sy8WKCVjUX4)

# 3. GREENER TALKS



## GREENER TALK WITH LEITAT



AXIA Innovation organised the fifth talk in the framework of the H2020 GREENER project. Dr Eduard Borrás, Principal Researcher in LEITAT, thoroughly discussed on the involvement of LEITAT in the project, their progress and achievements so far, in particular related to the "Development of bio-electrochemical systems (BES) and hybrid technologies for contaminated water".



**Take a look at the video : [www.youtube.com/watch?v=uzlUuaUhZY0](https://www.youtube.com/watch?v=uzlUuaUhZY0)**



# 4. IP WORKSHOP



Sustainable Innovations (SIE) organised an interesting workshop on IP aspects under biotechnology-related projects, with GREENER Project H2020 being one of them.

**Take a look:**

**[www.youtube.com/watch?v=I3afqrap5ss](https://www.youtube.com/watch?v=I3afqrap5ss)**

Followingly, we published a press release summarising the content of the workshop, the outcomes and the exploitation activities of the GREENER project!

**For more press releases and newsletters check below:**

**PRESS RELEASES  
& NEWSLETTERS**



## IP TRAINING WORKSHOP

**Protection of results in the  
Biotechnology industry – an IP approach**

**The workshop will be held online**

**FREE REGISTRATION**

**17<sup>th</sup> May 2022  
15<sup>00</sup> - 16<sup>30</sup> CET**



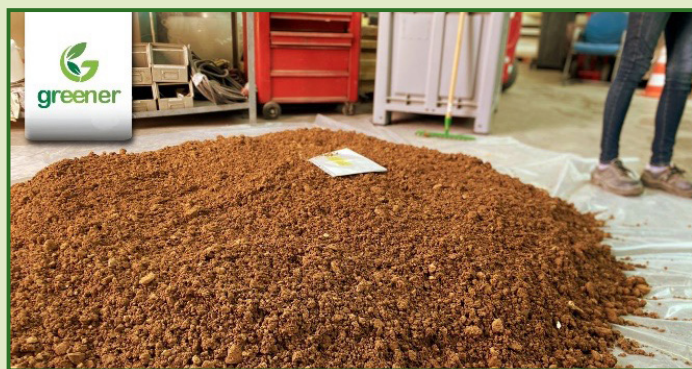
This project has received funding from the European Union's Horizon 2020 Research and Innovation programme under the Grant Agreement No.826312



# 5. GREENER MEETINGS/ VISITS



On 24<sup>th</sup> of May Universidad de Burgos and Universidad Autónoma de Madrid visited ACCIONA premises aiming to the scaling-up of the bioaugmentation / biostimulation technology, as a preliminary assay for the future implementation of the biopile. Also, Bioelectrochemical Systems (BES) technology from Leitat Technological Center was installed to improve the bioremediation of hydrocarbons in soils.



Our consortium has gathered on 27<sup>th</sup> of April for the GREENER Project H2020 36M review meeting! The meeting was held online, and the partners presented in detail their outcomes, actions, deviation of work and their next steps.

**Visit our website to find out more about our consortium and their activities:**  
[https://lnkd.in/dyQxU\\_2](https://lnkd.in/dyQxU_2)

A promotional banner for the '36M Review Meeting' held on April 27, 2022. The banner features the 'greener' logo at the top left. The central text reads '36M Review Meeting' in large green letters, with '27th April 2022' below it in a smaller green font. On the right side, there is a laptop displaying a video conference with multiple participants. The bottom of the banner is a collage of logos for the consortium's partners, including Universidad de Burgos, ICCRAM, Axia Innovation, Sustainable Innovations, University of Bath, acciona, Jožef Stefan Institute, LEITAT, UAM (Universidad Autónoma de Madrid), MicroGen Biotech, Institute of Technology Carlow, Tauw, and others. The background of the banner is white with large, faint green leaf graphics.

# 5. GREENER MEETINGS/ VISITS



After 2 years time the GREENER project partners LEITAT and University of Burgos had their physical meeting in LEITAT's premises in Barcelona. The aim of this meeting was to discuss the scaling up of the phytoremediation and BES technologies, with a focus on the water remediation of site for the elimination of metals.



**Check out the GREENER sites here:**

**[https://www.greener-h2020.eu/en/static/greener\\_contaminated\\_sites](https://www.greener-h2020.eu/en/static/greener_contaminated_sites)**



Our GREENER Project coordination team Universidad de Burgos met with our partners from Universidad Autónoma de Madrid and ACCIONA company in Madrid. During the meeting, the techniques for

scaling up the laboratory results of the GREENER project were determined.

# 6. PUBLISHED WORK



Accepted			
journals		How to balance the voltage in serially stacked bioelectrochemical systems	LEITAT
		Dissolution-based uptake of CeO <sub>2</sub> nanoparticles by freshwater shrimp – a dual-radiolabeling study of the fate of anthropogenic cerium in water organisms	JSI
		When Beneficial Biofilm on Materials Is Needed: Electrostatic Attachment of Living Bacterial Cells Induces Biofilm Formation	JSI
		Isolation, Identification, and Selection of Bacteria With Proof-of-Concept for Bioaugmentation of Whitewater From Wood-Free Paper Mills	JSI
		Facile fabrication of Au@polyaniline core-shell nanocomposite as efficient anodic catalyst for microbial fuel cells	Jiangsu University
		A Periplasmic Photosensitized Biohybrid System for Solar Hydrogen Production	Jiangsu University
		N-acyl-homoserine lactones in extracellular polymeric substances from sludge for enhanced chloramphenicol-degrading anode biofilm formation in microbial fuel cells	NTU
		Enhanced chloramphenicol-degrading biofilm formation in microbial fuel cells through a novel synchronous acclimation strategy	NTU
		Evaluation of biostimulation, bioaugmentation, and organic amendments application on the bioremediation of recalcitrant hydrocarbons of soil	UBU
proceedings		Assessing the effect of electrode orientation on the performance of soil microbial fuel cells, EFC21	BATH
		Towards cost-effective soil microbial fuel cell designs, EFC21	BATH
		Minimalistic soil microbial fuel cells for bioremediation of recalcitrant pollutants, EFC21	BATH
		"Innovative circular applications in civil works infrastructures: ACCIONA success stories"	ACCIONA
		"Integrated systems for effective environmental remediation", EBC-VIII conference	UBU, LEITAT, TAUW
		"Bioelectrochemical remediation of heavy metals polluted groundwater from industrial areas", EBC-VIII	LEITAT
		"Antibiotics removal using electroactive anodic biofilms in a single chamber bioelectrochemical reactor", EBC-VIII	LEITAT
Upcoming publications			
		Influence of carbon-based cathodes on biofilm composition and electrochemical performance in soil microbial fuel cells	BATH, UNICA, LEITAT, SUR
		Electrochemical Behaviour of Soil Microbial Fuel Cells in Soils with different Physicochemical Properties	BATH, UNICA, LEITAT, SUR

# 7. DISSEMINATION EVENTS

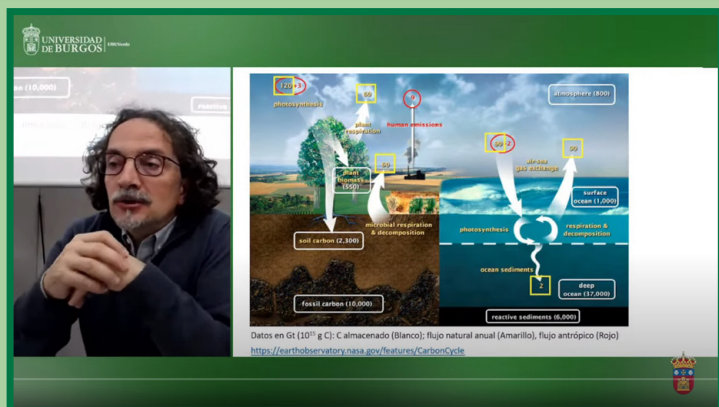


The GREENER Project H2020 coordinator Universidad de Burgos organised on 9.2.2022 a workshop called "Contaminants busted!". The workshop was given to children that became researchers and learned how to discover and remove pollution from soil, water and air!



On February 2022, UBU organised a school talk and workshop in Burgos (Spain). The idea behind this event was to familiarise young participants with science and investigate the willingness to become scientists when they grow up.

# 7. DISSEMINATION EVENTS



A new conference talk by ICCRAM Research Center at University of Burgos was released on "Adaptation of soils and agricultural practices to climate change". Professor Carlos Rad gave an interesting presentation in Spanish related to the GREENER Project activities:  
<https://lnkd.in/du5KQgKu>

ACCIONA participated in the CIRMAT ("Circular Materials") symposium. CIRMAT encompasses not only materials, but also new developments for a circular economy, and brings together the main institutions and companies in the Spanish sector.

ACCIONA presented "Ejemplos prácticos de aplicaciones de circularidad en construcción"; a presentation of the applications and projects, among which GREENER was highlighted, that promote the circularity in the maintenance of the soil resource. The CIRMAT symposium took place on 24<sup>th</sup> February 2022.

<https://eventos.uc3m.es/71809/detail/cirmat-nuevos-desarrollos-para-una-economia-circular.html>



GREENER Project H2020 was presented at the Master en ingeniería y Gestión Ambiental. From our coordination team, Dr Rocio Barros and Dr Blanca Velasco Arroyo (Universidad de Burgos, ICCRAM Communication), and our scientific coordinator Dr Eduard Borràs (Leitat Technological Center), presented the GREENER technologies on 6<sup>th</sup> April 2022!

The lectures given are summarised below:

- GREENER project. Integrated strategies for effective bioremediation
- GREENER project. Application of bio-electrochemical systems for the decontamination of soil and groundwater

# 7. DISSEMINATION EVENTS



## GREENER PROJECT H2020 ATTENDED THE CICS2022

Carlos Rad and Rocio Barros from Universidad de Burgos traveled to Portugal to attend the event and present 2 papers including GREENER results.

- Application of a microbial consortium immobilized onto a biochar for the remediation of a polluted soil with hydrocarbons
- In vitro toxicological evaluation of three contaminated soils presenting different levels of hydrocarbons and heavy metals

**VISIT CICS2022**



Our GREENER Project H2020 coordinator, University of Burgos, is promoting youth dissemination activities, by organising a workshop (June 2022), engaging around 45 children in the GREENER activities.

# 7. DISSEMINATION EVENTS



Find out more here:  
<https://lnkd.in/esFvPFwG>

ICCRAM - University of Burgos and Leitat Technological Center attended 8th European Bioremediation Conference (EBC-VIII) at Chania, Greece during June 12 - 17, 2022. Congratulation to our colleagues Rocio Barros, Blanca Velasco Arroyo, Aqib Hassan, Ali Khan, Eduard Borràs, and Marti Aliaguilla.

Visit the conference link here:  
<https://www.ebc-viii.tuc.gr/en/home>

## FEBRUARY 11<sup>TH</sup>: INTERNATIONAL DAY OF WOMEN AND GIRLS IN SCIENCE

GREENER Project H2020 is happy to celebrate this year on February 11<sup>th</sup> the International Day of Women and Girls in Science! Just 30% of the world's researchers are women! GREENER project is really honored to have women scientists working together consisting of Biochemical Engineers, Environmental Scientists, Biologists, Chemical Engineers, Biotechnologists, Environmental Biotechnologists, Economists, and Agronomists.



Our coordinator Dr Rocio Barros and colleague Sonia Martel presented the University of Burgos technologies, under the occasion of the International Day of Women and Girls in Science 2022.

Take a look at their activities in this video:

<https://lnkd.in/dFwY5e>  
(You may turn on English subtitles)

# 7. DISSEMINATION EVENTS



## AWARDS

Great news for our partner JSI - Institut "Jozef Stefan" that has been awarded with the bronze medal from ARCA 2021, for their work: "A method for making spatially defined aggregates by precisely positioning cells based on electrostatic interaction".

You can find out more here: <https://lnkd.in/d52sVQpH>



3 more awards for our partner SDAS - Ecology Institute of Shandong Academy of Sciences on "Construction and application of petroleum contaminated soil bioremediation engineering technology system". In particular, SDAS won:

- the first prize of Science and Technology Progress of Shandong Province,
- the first prize of Technology invention of Liaoning Province and
- the third prize of Patent Award of Shandong Province.

### Remediation Sites



## NEW VIDEO



Institute of Technology, Carlow and AXIA Innovation have developed a new video presenting briefly the ecopiles led by ITC. The group is leading the development and optimisation of a hybrid technology for soil bioremediation.

**SUBSCRIBE TO GREENER  
YOUTUBE CHANNEL!**

Check out our teaser video here:  
<https://lnkd.in/dnMHJ9BU>

# 8. UPCOMING EVENTS



PARTNER	WHAT?	WHEN
USUR, BATH, LEITAT	ISMET8 conference (invited speaker on "Simultaneous azo dye and chromium removal from dyeing process effluent using Microbial Electrolysis Cells")	September 2022
All partners	Clustering week in Ljubljana	7-11 November 2022
UAM, ITC	Training on "Introduction to bioinformatic tools for the analysis of Targeted Metagenomics"	8 February 2023 (online)





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The GREENER team  
Project Coordination team:  
University of Burgos – ICCRAM



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