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Phy2Climate

NEWSLETTER
PHY2CLIMATE
PROJECT

Clean biofuel production and phytoremediation solutions from contaminated lands worldwide

We are pleased to share the sixth issue of Phy2Climate newsletter, keeping you up to date with all the latest news and developments from the project. Phy2Climate is a project funded by Horizon 2020 EU's Research and Innovation programme. The overall objective of the Phy2Climate project is to build the bridge between the phytoremediation of contaminated sites with the production of clean drop-in biofuels and bio-coke.

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Pilot site visit and open day in Serbia

Serbian partners, in collaboration with the project consortium, organised the Serbian pilot site visit for partners, collaborators and local media and the first Phy2Climate project Open Day in June 2024.
The Serbian pilot site is located closed to the Begej Canal in Vojvodina region.
Pilot site preparation activities, including terrain delimitation, area division into control and experimental parcels, soil ploughing and levelling, installation of irrigation equipment, if applicable, were carried out by each pilot site leader. Mainly, the terrain delimitation, pilot site division, soil levelling was performed once in the first year of pilot site trials in 2022 and not repeated the following year. The soil preparation as well as the seeding were programmed and remained according to the local weather conditions and good agricultural practices in each pilot site, as well as the seeding seasons for each energy crop, considering that pilots are being made in both south and north hemispheres. The fertiliser programmes were carried out

according to the specific energy crop cycle and soil conditions, including frequency, nutrient dose, and application type (broadcasting, ferti-irrigation, foliar application).

The Serbian pilot site is located closed to the Begej Canal in Vojvodina region.
Credit: ETA Florence.

The Serbian pilot site is situated along Begej canal near Serbian-Romanian border where app. 5.900 m^3 of sediments from Begej canal is placed in a confined area. The pilot site has a total area of app. 3.800 m^2.
Dredging of fresh sediments from the canal was finalised by the end of 2021. The first growing season for Serbian pilot site was finished in June 2022, results regarding the biomass output, plant monitoring and energy crop characterization was included in the project deliverable D2.3. The soil characterization after the first growing season and all results from the second growing season are included in the deliverable D2.4.
Based on the results from the first growing season, rapeseed (Brassica napus) winter variety Zlatna owned by Institute of Field and Vegetable Crops, Serbia was selected for seeding in the second growing season.
Then approximately 120 kg of dried and baled harvest residues were transported to Novi Sad for further processing and pelletization in a pelletizing facility. Pelletization was completed in September 2023 and pellets were shipped to Fraunhofer in October 2023.
After the finalisation of the second growing season in 2023, the third growing season started in April 2024. Sorghum was selected for the third season, based on pot tests assessing metal bioavailability.
The Phy2Climate Open Day was organized by IFVCNS, one of the project partners, as study tour of the field site at Rimski Sancevi, Novi Sad, Vojvodina, Republic of Serbia, on Friday 7 June 2024, morning.
IFVCNS demo fields are located on the outskirts of Novi Sad, about 12 km from the city centre, where local stakeholders (policy makers, agriculture & environmental experts, students, entrepreneurs, and media) could access to the trials and have a direct contact with several involved project partners. There was also the chance to make interviews and video-recording of selected project activities, according to the reached results.
54 people in total attended this Open Day.

Project partners at The Serbian pilot site
Credit: Eta Florence.

Phy2Climate presented at the Open Day, project roll-up
Credit: ETA Florence.

Phy2Climate presented at the Open Day, several project materials from partners.
Credit: ETA Florence.

For further information, please see video interviews:

Intro to the Serbian pilot site **See the video**

Introduction to Phy2Climate project **See the video**

and check the scientifc article:

"Enhancing Phytoextraction Potential of Brassica napus for Contaminated Dredged Sediment Using Nitrogen Fertilizers and Organic Acids",
Plants, MDPI, March 2024. **Read more**

Workshop at EUBCE 2024

The European Biomass Conference & Exhibition (EUBCE, www.eubce.com) combines one of the world's leading R&D conferences with an international exhibition, and represents the leading platform for the collection, exchange and dissemination of scientific know-how in the field of biomass.
During the 32nd edition of the European Biomass Conference and Exhibition (EUBCE), organised by ETA in Marseille, France (24-27 June 2024), a workshop was organized on Tuesday 25th June for enabling the Phy2Climate project to engage with the international community of bioenergy engineers and researchers, as well as international industry stakeholders. The event was successful in terms of participation of internal and external audiences, and in terms of workshop outputs.
This session title was 'Conversion Technologies to Valorise Crops from Contaminated Land', and included its two sister projects, GOLD, and CERISiS, in which all three projects presented with the focus on the conversion and separation technologies.
These three Horizon 2020 projects; Phy2Climate, GOLD and CERESiS are aiming to bridge the gap between remediation of contaminated sites and the production of clean energy. All three projects use phytoremediation techniques, which uses plants to remove contaminants from soil, and in turn the cultivated energy crops will be used as biomass feedstock and converted to produce clean advanced biofuels.

The aim of the workshop was to enable these three H2020 sister projects to present together, each giving an overview of the individual project and the different conversion and separation technologies that each project is researching.

At the time of the workshop CERESiS was in the final part of the project so was able to present some of the most important results of the project.
GOLD and Phy2Climate completed two years of trial crops in the field, and therefore presented more of the first stages of the conversion process.

Phy2Climate project overview was presented by Christopher Kick (Fraunhofer UMSICHT, Germany) who presented also the project's pilot plant and the related TCR® technology. For this presentation an overview of the concept and the technology that is being used during the Phy2Climate project was presented as weel as a summary of the process stages.
After the three presentations a panel discussion was conducted by Marco Buffi, DG JRC, under the title 'The challenges of conversion technologies", with a representative from each project, as well as two external representatives.
During the panel discussion, the panellists discussed about the strategy to transfer results from H2020 projects into demonstration, scaling up and deployment of the technologies, and to support viable technologies in the market in the longer term.
In particular, the Q&A session of the workshop highlighted several key points regarding the use of contaminated biomass for biofuels production and the associated challenges and opportunities. For example, the thermochemical conversion processes tested in the Horizon 2020 projects GOLD, Phy2Climate, and CERESiS have been successful in processing contaminated biomass, producing biofuels, and concentrating pollutants, particularly metals, in the process's co-products. According to the panellists opinion, scaling up the technologies to an industrial level is deemed feasible but requires further research and development.

Phy2Climate, GOLD and CERESiS project workshop at EUBCE 2024.
Credit: EUBCE 2024.

There is a call for economic support to fund demonstration-scale projects to bridge the gap between successful small-scale experiments and full-scale industrial applications. Concerning the policy support for biofuels production, the value chains proposed by these projects, including the recovery of contaminated soils, should be recognized by EU policy frameworks. Aligning with the EU Soil Strategy and other relevant policies, biofuels production that incorporates phytoremediation offers additional environmental benefits. There is also a need for national-level support mechanisms to promote value chains that couple biofuels production with environmental restoration, helping countries to meet their national targets for renewable energy and soil recovery. In addition, these projects encourage collaboration and knowledge exchange with other research initiatives and industry stakeholders to further advance the field of phytoremediation for biofuels production. Finally, results from the Horizon 2020 projects should contribute to a more sustainable and circular economy by showcasing how contaminated biomass can be a resource for biofuels production while simultaneously remediating polluted soils.
Overall, the Q&A session underscored the successes and potential of using contaminated biomass for biofuels production, while also emphasizing the need for further research, economic support, and policy alignment to realize these technologies' full benefits at a larger scale.

Presentations at EUBCE 2024

As a selected EU project, Phy2Climate project joined the European Biomass Conference and Exhibition (EUBCE) in June 2024. Besides the project workshop (see details above), Phy2Climate's results and activities were illustrated in several sessions of the conference. Project partners presented their activities in oral and poster presentations in Marseille, France as follows:

- 1BO.1.3, "Real-World Phytoremediation Data on Amaranth and Experience from A Two-Year Field Trial in The Phy2Climate Project", Zygimantas Kidikas, SME Biovala, Research, Lithuania;
- 3BO.6.1, "Pilot Biorefinery for Bio-Based Products and Biofuels from Phytoremediation Energy Crops", Christopher Kick, Fraunhofer UMSICHT, Germany;
- 1BO.7.4, "Phytoremediation of multi-contaminated dredged sediment with Brassica napus – from pot to field trial", Tijana Zeremski, Institute of Field and Vegetable Crops, Republic of Serbia;
- 5AV.4.11, "Conversion of Contaminated Biomass In An Innovative Biorefinery Into High-Quality Energy Carriers", Christopher Kick, Fraunhofer UMSICHT, Germany;
- 3CV.8.3, "Thermo-Catalytic Reforming of Jerusalem Artichoke Biomass from Phytoremediation Trials to Produce High Quality Biofuels", Alfreda Kasiuliene, Biovala, Lithuania;
- 1CV.2.16, "Phytoremediation of Soil Contaminated with Mining Waste in La Planta, Argentina", Snezana Maletic, University of Novi Sad, Faculty of Sciences, Republic of Serbia.

Related papers of the above presentations are included in the full open access conference proceedings database, free of charge for the final users.

The Scientific Programme of the EUBCE includes several other presentations and sessions dedicated to biomass feedstocks, conversion processes and technologies for advanced biofuels and bio-based materials production.

Moreover, Phy2Climate project hosted a stand in the EU projects area.

Presentation of Christopher Kick, Fraunhofer UMSICHT, at EUBCE 2024.
Credit: EUBCE 2024.

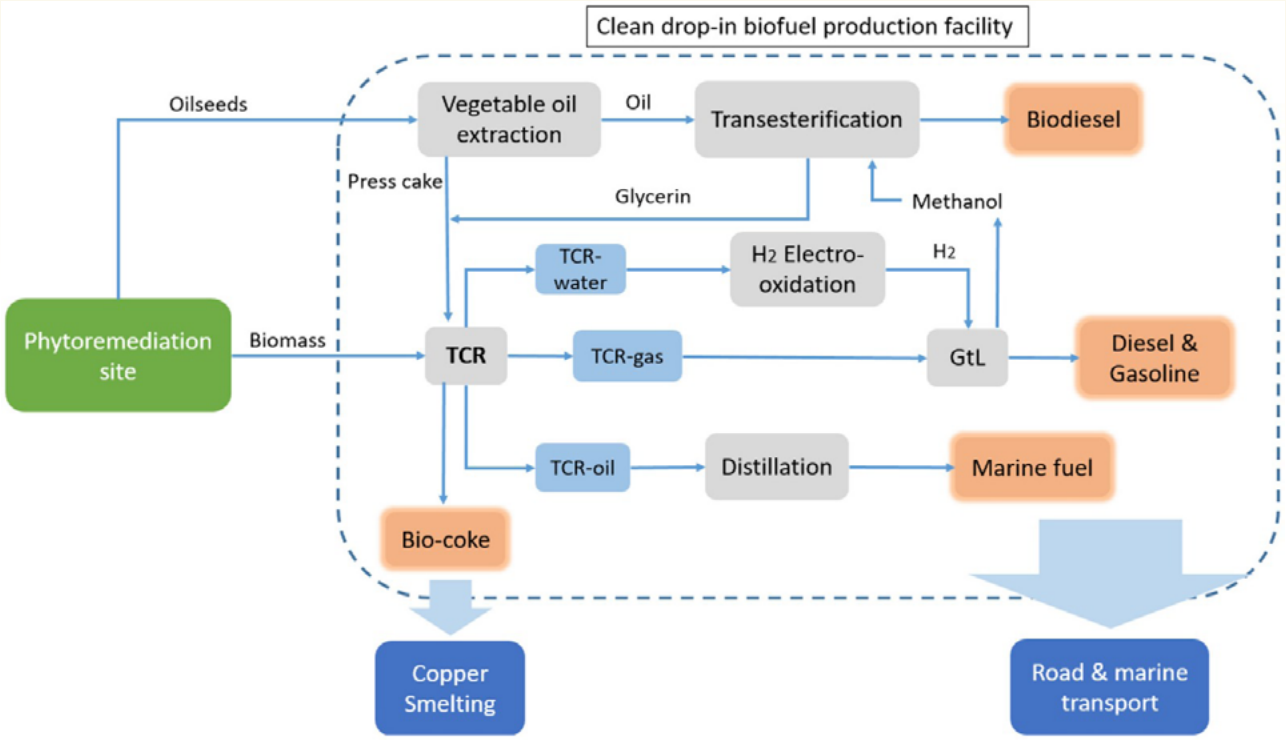
Phy2Climate partners at EUBCE 2024, project visibility point.
Credit: EUBCE 2024.

The collaboration with other H2020 projects on the same topics progressed very well. For maximising the project impacts, in addition to the workshop at EUBCE 2024, Snezana Maletic, University of Novi Sad, Faculty of Sciences, presented "Insights to multi-annual phytoremediation pilot field trials covering heavy metal and organic soil pollution" (Phy2Climate project) activities and Christopher Kick, Fraunhofer UMSICHT, presented " Conversion routes in Phy2Climate: Valorisation of contaminated biomass applying a cascadic biorefinery process based on TCR technology" at the International workshop organised by GOLD project entitled "Bridging the gap between phytoremediation solutions on growing energy crops on contaminated lands and clean biofuel production", Athens, Greece and online, in March 2024.

Article on phytoremediation biomass for sustainable biofuel

Different Phy2Climate partners are the authors of the article "Feasibility of using phytoremediation biomass for sustainable biofuel production via thermochemical conversion", published online by Wiley in the "Special Issue: Selected papers from the 31st European Biomass Conference and Exhibition" of Biofpr, Biofuels, Bioproducts and Biorefining, in July 2024. This article was presented by Christopher Kick of Fraunhofer UMSICHT at the 31st EUBCE in Bologna, Italy, June 2023.
It is divided in five main chapters, as follows:
1 Introduction;
2 Materials and methods;
3 Results;
4 Discussion;
5 Conclusions.

This study explores a novel approach that combines soil recovery with biofuel production, presenting a strategy that addresses the increasing demand for biofuels while sidestepping the food–fuel debate. It also introduces an innovative method for recovering heavy metals from soils through their translocation into the solid product of the conversion process. Phytoremediation trials were conducted under real field conditions, and the thermochemical conversion of the harvested biomass was carried out at lab scale. Field trials, considered and described in this article, took place in 2021–2023 in Lithuania and Serbia. In Serbia, the contamination primarily



Developed biorefinery concept within the EU project 'Phy2Climate'.
Credit: Biofpr.

involved heavy metals, whereas the Lithuanian site was predominantly contaminated with hydrocarbons from petroleum products. The harvested biomass underwent pretreatment and was then used as feedstock for conversion into high-energy carriers. The conversion products were evaluated for their potential to substitute fossil fuels. Finally, the value chain, encompassing key stakeholders and factors impacting the profitability of this approach, was established, and initial estimates were made regarding the size of individual cost components.
Although phytoremediation is considered a low-cost and environmentally friendly technology, there is a lack of industrially implemented projects. Generally, one of the biggest challenges is the utilization of harvested biomass, which is considered waste in the case of, for example, heavy metal contamination and is therefore burned or deposited in a landfill. Using such biomass as a second-generation feedstock for biofuel production has significant potential to circumvent the food-versus-fuel dilemma, rejuvenate land, widely restore ecological health and productivity, enhancing biodiversity and ecosystem services and allowing for biomass utilization in biofuel production without inducing iLUC.
One approach to utilizing this biomass involves processing it in biorefineries. Outputs from these biorefineries range from energy-dense solid, liquid, and gaseous intermediates to standard biofuels like diesel or gasoline, depending on the complexity of the specific biorefinery. As part of the EU project Phy2Climate, a novel biorefinery concept is being developed to convert

contaminated biomass from phytoremediation sites into biocoke, which will replace petrol coke in the copper smelting industry, and biofuels, intended to substitute fossil-based marine fuels. In the initial stage, the biorefinery processes the biomass into storable intermediates that have a higher energy density than the original feedstock. This is achieved using the thermocatalytic reforming process (TCR), enabling the production of high-quality biocoke, bio-oil, and a hydrogen-rich syngas. The conversion process is succeeded by upgrading these intermediates into the biofuels mentioned above. This biorefinery concept not only substitutes fossil fuels but also allows for the recovery of metals accumulated in the biomass harvested from phytoremediation sites and the production of hydrogen through an innovative purification of the resultant aqueous phase from the biomass conversion. The biorefinery concept is illustrated in the following figure.

The initial trials converting biomass grown on soils contaminated with heavy metals or hydrocarbons show encouraging results. All tested biomasses were converted into energy-rich solid, liquid, and gaseous intermediates successfully. Preliminary analyses suggest that the biocoke produced could realistically be substituted for petroleum coke, although further detailed analysis is needed to reinforce these findings. The bio-oils derived exhibited high heating values of around 34 MJ kg–1, just slightly lower than the high heating value of fossil crude oils. The kinematic viscosity and sulphur content of the bio-oils were also significantly lower than the thresholds for the main marine fuel classes. Based on these technical parameters, the bio-oils meet the ISO 8217 standards for marine fuels at this stage of research. However, this study focused solely on technical aspects and did not address legal issues related to the classification of biomass as waste material cultivated on contaminated land.
The economic efficiency of this process is influenced by numerous parameters. It is crucial to align the technical aspects with the varying legal and economic frameworks of different countries. Given the increasing pressure on finite and non-renewable soil resources due to factors such as climate change, pollution, and degradation from intensive farming, alongside low agricultural land prices, greater consideration should be given to the societal value of healthy, functional soil in terms of sustainability.
In summary, our initial findings support the idea that combining phytoremediation with biofuel production offers a sophisticated and economically viable method of generating biofuels while reducing soil contamination and potentially recovering heavy metals through downstream processes. In continuation of the Phy2Climate project, further possible business models for different geographical conditions and soil contaminations will be elaborated and, finally, implemented in industrial-scale biorefineries.

For further information and specific references, please see this article: **Read this**

Innovative Workshop on “Transforming Contaminated Land into Green Energy”

Phy2Climate is excited to invite stakeholders, researchers, and industry professionals to our upcoming business-model workshop, **“Transforming Contaminated Land into Green Energy”.** This interactive event will take place online on Thursday, September 26th from 8.30 to 12.30, CET, and aims to explore innovative approaches for rehabilitating contaminated land through phytoremediation, turning these sites into valuable assets for renewable energy production.

The workshop will provide participants with insights into sustainable business models for transforming contaminated soil to a renewed source of healthy biomass. Reseachers will present the latest models and scenarios elaborated throughout the Phy2Climate project. Whether you're involved in energy, environmental management, or land rehabilitation, this workshop offers a unique opportunity to connect with like-minded professionals and contribute to the green energy transition.

Agenda
8:30 AM–Session Kickoff
9:00 AM -12.30 PM –Interactive Workshop

- Warm Welcome and Introduction
- Unveiling Four Business Models and Key Insights
- How to pursue Social Acceptance of Phy2Climate Approach
- Engaging Breakout Rooms Discussions (Tailored to Your Professional Profile)
- Presentation of Findings and Final Conclusions

Participants will gain insights into the potentials, results and conclusions from these cutting-edge research activities. We will break into sector-specific groups to discuss and reflect on the following topics:

- Existing and Needed Policies and Legal Frameworks
- Unlocking the Potential of Phytoremediation in Soil Recovery
- Engaging and Empowering Landowners and Farmers
- Managing Social Acceptance of innovative technologies
- The Phy2Climate Approach: Transforming biofuel production

This workshop is designed for:

- Policy makers and legal experts who can shape future regulations
- Soil remediation specialists driving practical solutions
- Agricultural processors and landowners key to on the ground phytoremediation
- Refineries ready to promote and utilize biofuel produced.

Don't miss out on this chance to be part of a forward-thinking initiative! For more details and to register, visit:

Read more

Phy2Climate

info@phy2climate.eu

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The project consortium has put together 16 partners from 9 countries with long-term expertise in soil remediation, phytoremediation, biofuel technologies and energy processes, environmental and social sustainability, legislative analysis, communication and dissemination as well as business development for innovative technologies.

Phy2Climate is a H2020 project with title "A global approach for recovery of arable land through improved phytoremediation coupled with advanced liquid biofuel production and climate friendly copper smelting process

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