The Centre for Cleantech and Biomass Resource Efficiency (CCBRE)

Local roots. | Global vision. | Smart science.

Understanding and minimizing the environmental impacts of human activity

The Centre for Cleantech and Biomass Resource Efficiency (CCBRE) develops and applies advanced cleantech solutions for efficient biomass utilization and sustainable waste management, with a strong focus on delivering practical impact in the Plovdiv region and across Bulgaria. We address today's ecological challenges by translating scientific insight into scalable technologies that protect environmental quality, improve resource efficiency, and accelerate the transition to a circular economy.

Our work is interdisciplinary, combining environmental chemistry with process and systems-thinking, and integrating digital technologies and AI to strengthen analytics, process optimisation, and environmental impact assessment.

We develop and test solutions that convert biomass and organic waste into high-quality recycling products and renewable energy sources, while also tackling key pollution challenges – such as heavy metals and microplastics and advancing nutrient recycling, especially phosphorus recovery.

Our strengths include deep expertise, close collaboration with industry and public institutions, and strong international connections. We support partners through joint project development, access to advanced infrastructure, and guidance to move innovations from research into market-ready solutions and we feed these real-world lessons directly into education, training, and knowledge transfer.

02 Areas of Applied Research

Resource scarcity, environmental pollution, biodiversity loss, and climate change are increasing the pressure on societies and industries alike. **CCBRE** develops and tests practical solutions to protect and improve environmental quality and to close material loops – especially through circular-economy innovation, biomass valorisation, and applied environmental technologies.

Life Cycle Assessment (LCA) & CO_2 Emissions Calculation

We quantify the environmental performance of technologies, products, and processes using Life Cycle Assessment and related footprinting methods. This includes calculating greenhouse gas emissions (CO_2e) across the value chain (scope-based and life cycle perspectives), identifying emission hotspots, comparing alternatives, and supporting decision making for cleaner production, circular economy solutions, and investment priorities.

Water & Wastewater Technologies
(Advanced/Quaternary Treatment)

As requirements for drinking-water and wastewater treatment become more demanding, we develop and pilot advanced treatment concepts to remove micropollutants that conventional systems cannot reliably capture (e.g., pharmaceuticals, hormones, pesticides, solvents, dyes, and PFAS). We translate proven approaches – such as adsorption, oxidation, and membrane-based separation – into robust, affordable solutions for real – world operation.

Circular Bioeconomy, Waste Management & Biomass Valorisation

We develop technologies and implementation concepts that convert biomass and organic waste streams into high-quality recycling products and renewable energy carriers. Our work targets higher resource efficiency, lower emissions, and scalable solutions deployable with industry, municipalities, and utilities.

Cleaner Production & Industrial Symbiosis

We support the reduction and prevention of environmental impacts through optimization of industrial processes and the systematic use of synergies in industrial networks. This includes improving energy and material efficiency, reducing emissions, and enabling industrial symbiosis – where one company's by-products, waste heat, or residual streams become another company's resource.

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Environmental Contaminants & Monitoring (Microplastics, Heavy Metals, etc.)

We investigate contamination pathways and mitigation measures for pollutants such as microplastics and heavy metals, combining analytics with applied intervention concepts to improve environmental safety across water, soil, and recycled products.

Nutrient Recycling & Phosphorus Recovery (Recycling Fertilizers)

A core focus is nutrient recovery – especially phosphorus – through the development and implementation of phosphorus – rich organic recycling fertilizers. This addresses critical resource dependencies and supports circular, resilient agriculture.

Sustainable Resource Management

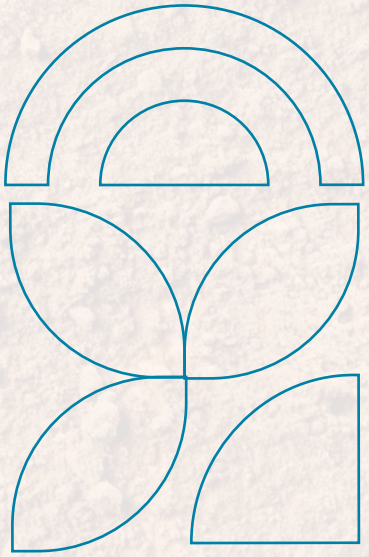
CCBRE develops solutions and decision-support approaches for the careful, future-proof use of resources such as water, energy carriers, and raw materials, and promotes circular-economy strategies that are technically feasible and implementable at regional level.

Trace Elements Analytics

Many organic pollutants occur in the environment at extremely low concentrations. Their detection in water matrices and along the food chain requires high-sensitivity analytical methods. We use trace analytics to identify hotspots, quantify risks, validate treatment performance, and support compliance and quality assurance.

Ecotoxicology & Effect-Based Assessment

We assess the impacts of hazardous substances and environmental samples on plants and animals using a range of test systems (e.g., mutagenicity tests, in-vitro cell cultures) and model organisms (e.g., Daphnia, zebrafish, bees). Effect-based methods help evaluate treatment efficiency and environmental safety even when the exact chemical mixture is unknown – especially relevant for complex effluents and recycled products.



03 Competences & Infrastructure (CCBRE)

CCBRE provides modern laboratory and analytical capabilities as well as validation environments to develop, test, and assess cleantech solutions from concept to real-world application – focused on biomass resource efficiency, circular economy, and environmental technologies.

Laboratory & Analytical Infrastructure

- **ICP-OES:** metals and trace elements in liquids and extracts
- **CHNS elemental analysis:** determination of C/H/N/S in organic materials, soils, and biomass
- **FTIR polymer analysis:** identification of polymers (e.g., PE, PP, PET, PVC, PA, ABS), additives, ageing/oxidation, quality control
- **Microscopy & spectroscopy:** material characterization, contaminant detection, defect/impurity assessment
- **Sample preparation:** incl. microwave digestion for elemental and material analytics

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Testing, Validation & Implementation

Greenhouse experiments and controlled field trials to validate processes, products, and recycled fertilizers under realistic conditions

Applied process development and optimisation across value chains (e.g., biomass and residual stream valorisation, nutrient recycling)

Data, AI & Environmental Assessment

Data analytics, modelling & AI:
statistical evaluation, predictive models, "digital experiments," and data-driven process optimisation

Life Cycle Assessment (LCA):
life-cycle-based environmental performance evaluation to support robust decisions and credible communication

03 Services & Knowledge Transfer

Contract analytics performed by qualified laboratory staff

R&D collaboration with industry, municipalities, and research partners – from pilot concepts to market-oriented solutions

Training & continuing education (e.g., data science/AI, project management, grant proposal writing, academic writing & publishing, presentation skills)

04 Services & Knowledge Transfer

The Agricultural University – Plovdiv (AUP) is a leading applied research and education institution for agriculture in Southern Bulgaria. With four faculties – Agronomy; Horticulture & Viticulture; Plant Protection & Agroecology; and Economics – the university combines plant production, plant health, environmental management and agri-business expertise to address real challenges in farming and the agri-food sector.

AUP offers strong capacity for practice-oriented R&D, supported by extensive training and experimental infrastructure. Its experimental fields in the Plovdiv area and the experimental and training base in Yagodovo enable field trials under realistic operational conditions, including both conventional and organic management. This allows new crop management strategies, technologies and prototypes to be tested, validated and optimized in close-to-market environments.

Research and development activities cover key themes such as sustainable crop production, integrated plant protection, soil fertility and nutrient management, biodiversity and agroecology, climate adaptation measures, and the efficient use of water and other resources. The university also supports innovation in horticulture and viticulture, including cultivar evaluation, production systems, quality parameters and post-harvest considerations. Through its economics expertise, AUP adds competence in value-chain analysis, competitiveness, and the assessment of adoption barriers and opportunities.

AUP is well positioned as a partner for industry and public stakeholders seeking evidence-based solutions and measurable impact. It provides experimental design, data generation, laboratory and field analyses, technology evaluation and scientific reporting, as well as training and demonstration formats that facilitate knowledge transfer into practice. With its regional roots and comprehensive agricultural profile, the Agricultural University – Plovdiv serves as a reliable platform for turning research into implementable solutions for modern, resilient agriculture.

05 Team and Competences

Prof. Dr. Petar Mandaliev

Leads CCBRE's applied research programme at the interface of environmental chemistry, circular economy and biomass resource efficiency, with an emphasis on translating laboratory evidence and field data into implementable solutions and decision-support.

Prof. Dr. Violina Rizova

Scientific leadership in agricultural/environmental chemistry, supporting the development and validation of nutrient-recycling solutions (e.g., recycling fertilizers) through analytical verification and performance testing under greenhouse and field conditions.

Dr. Hadi Mahdipour

Heads Data Science & AI and develops reproducible analytics pipelines (statistical evaluation, predictive modelling and "digital experimentation") to improve process understanding, monitoring and optimisation in cleantech and biomass-related applications.

Dr. Rosen Kosturkov

Responsible for CCBRE's continuing-education activities and external training formats, translating methods and project experience into structured courses (e.g., proposal writing, applied data science, and methodological upskilling) for researchers and external stakeholders.

Dr. Horst Matzke

Implementation-oriented expertise in environmental process engineering and technology transfer, supporting the design of pilot-relevant concepts and the operationalisation of advanced environmental solutions from proof-of-concept to field deployment.

Dr. Reza Shojaee

Software and systems-engineering competence for scalable data infrastructures and AI-enabled applications (cloud/edge, distributed systems, automation), enabling robust integration of laboratory, monitoring and modelling workflows.

Mag. Mariia Shilova

Master's Degree in Ecology and Nature Management (Lomonosov Moscow State University) and supports projects with environmental assessment, structured experimental work and scientifically traceable sustainability concepts.

Mag. Eduardo Molina

Master's Degree in Environmental, Industrial and Food Biotechnology and contributes method competence in environmental process technologies, including treatment concepts for organic contaminants and valorisation routes for agro-industrial residues.

Contact

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