# Establisment of the SUSTAINABILITY COMPETENCE CENTER based on Circular Economy principles at the University of Pannonia

Pannon Egyetem
University of Pannonia

# IMPRESSUM



**Project details**

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# GREETING



The work of the Commission's experts on sustainability based on a circular economy Competence Centre for Sustainable Economy based on Circular Economy at the University of Pannonia

Nowadays, the issue of global sustainability has become one of the highest priority topics. Accordingly, today, instead of just being a catchy slogan, circular economy has become a basic principle that alone can ensure the survival of modern society, but has only been applied to a limited extent. The University of Pannonia, once a leading national stronghold of environmental protection, but nowadays – more of sustainability and the circular economy, undertakes on the ground of science by putting this basic principle into practice in many areas of the national economy. Given that a paradigm shift on such a scale cannot be imagined without trained professionals and the sensitization of society, the University of Pannonia also undertakes the educational aspect.

**Dr. András Gelencsér**
Rector of the University of Pannonia

An outstandingly successful exmple of industry-university collaborations is the Competence Center tender, which in its methodology and its system of expectations fully meets the strategic goals set by the company. The University of Pannonia is our priority partner in circular economy and sustainability projects, and we are guided by similar objectives: to create the academic and research medium that builds the competences of the future. For the MOL Group, the exploration of new technologies is essential, and we undoubtedly rely on the results of the project. Moreover, for their operation, we count on engineers and professionals trained at the University of Pannonia.

**Dr. József Goldfárth**
Head of Oilfield Chemicals and Technologies, MOL

# GENERAL PRESENTATION OF THE TENDER PROJECT



The University of Pannonia and its consortium partners have undertaken to carry out research activities and technological developments supporting the transition to a circular economy in five key areas. During the project, we paid special attention to common thinking, the development of new knowledge and competences and close cooperation in order to realize significant developments with high added value. The planned Competence Expectation of centers that such industrial-service cooperation strive to create is an organizational form that is suitable and competitive for the development of products and services, the creation of innovative scientific and technological business models for community organization.

The University of Pannonia promotes sustainability and circular economy and treats them as a priority scientific field both in its educational and R&D activities. Building on this, in 2020, the Circular Economy Sustainability Competence Center was established, with the task of creating a new knowledge base at the University that is perceptible both at the business and community levels, facilitating meaningful change in sustainability and the circular economy.
The transition from linear to circular economy required new business models, new consumer behavior, new green and economical innovations and technologies, as well as new solutions for converting waste into raw materials. All of these tasks cannot be implemented alone or within the framework of a single project, long-term collaborations and broad-spectrum development work are necessary. Sustainability and the circular economy can only be interpreted as a complex system, which is why we compile our professional programs in such a way that the contents can be connected to each other to form a basic circle.



# OUR RESEARCH TOPIC AREAS

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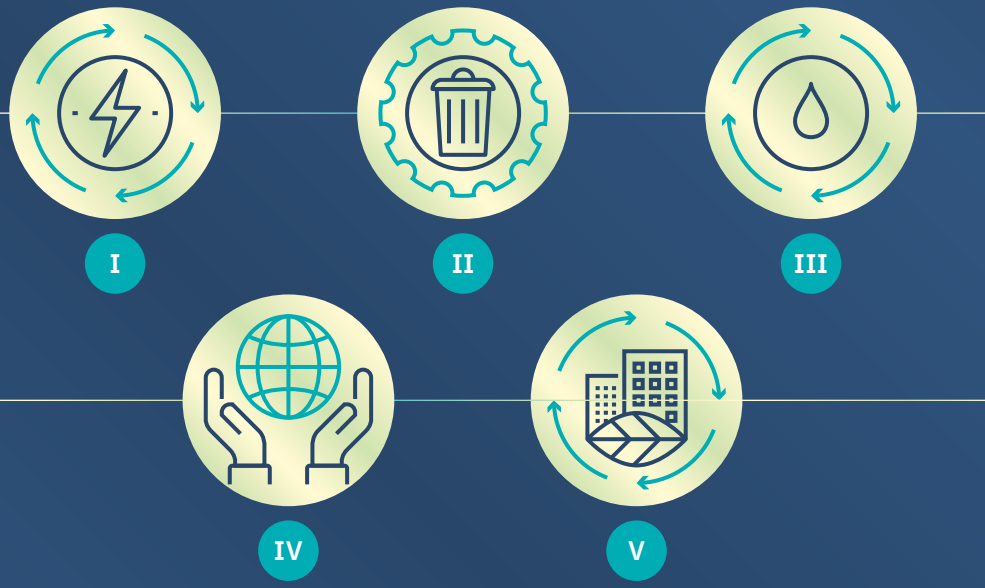
**I. Renewable energy**
- Synthesis gas based on waste production
- Conversion of synthesis gas into a more valuable product
- Innovative surfactant production experiments

**II. Waste management**
- Assessment of domestic waste assets
- Development of sorting technologies
- Training development
- Mechanical and chemical recycling experiments
- Examination of polyurethane recycling

**III. Water technologies**
- Treatment of used oil wastewater from industrial downstream technology
- EOR upstream water treatment
- Well water and drinking water microplastic exemption

**IV. Sustainable tourism**
- Tourism all year round
- Sustainable festivals and events
- Attitude formation

**V. Sustainable urban development**
- Community city application development
- Creation of a sustainable city concept
- Launch of circular economy courses
- Attitude formation
- Waste collection optimization



# DEVELOPMENT OF THERMAL WASTE TREATMENT PROCESSES

Based ont he data of Hungarian Central Statistical Office, in 2019 the amount of municipal waste per person in our country was 387 kg, while at the EU level, the citizens of the state produced 34.4 kg of plastic waste per person, of which only 14.1 kg was recycled. Instead of the traditional incineration of waste, it is necessary to put more emphasis on the development of thermal waste treatment processes, such as pyrolysis and gasification, which can produce energy or fuel.

Therefore, within the main direction, we primarily examined the gasification of various wastes. During the research work, we established correlations between waste gasification parameters and product characteristics. Using computer simulation, the production of alternative motor fuels, hydrocarbon fractions and petrochemical material flows originating from the gasification process was investigated. A calculation methodology was developed that is suitable for the life cycle analysis of co-processing processes based on gasification, as well as for estimating the renewable share of products.

The improvement of the research infrastructure significantly contributes to the creation of new competencies and the development of existing ones: GPC, HPLC coupled chromatography system, automatic VRK equipment, rotary viscometer with accessories and thermostat, Automated Demulsibility Tester equipment, spectrometer system.

We used the results for the design of our own developed reactor systems (gasification, thermal-catalytic, tension generation, cracking, water vapor pyrolysis reactor systems). The reactor systems will be located in a new experimental hall, which will be both the intellectual and infrastructural base of the thermal waste management processes development.

Our goal is for MOL and the University of Pannonia to jointly build a competence that is unique in Hungary, which is suitable for the development of waste-based hydrocarbon production technologies in accordance with industrial needs.

The main participants in the work were: University of Pannonia and MOL.



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# WASTE MANAGEMENT



Today's most challenging environmental, economic and social problems include waste management, which is also a central element of sustainability and the circular economy. 2.5 billion tons of waste are generated in the EU every year, of which 10% is municipal waste. The EU has set the goal to raise the rate of municipal waste recycling and preparation for reuse to 65% by 2035, while reducing the rate of municipal waste disposal by landfilling below 10%. For this, it is essential that we have adequate knowledge of the amount and composition of waste assets, the development and capacity of the treatment infrastructure. In the framework of the project, we carried out a quantitative and qualitative analysis of the domestic waste streams, based on which we undertook the development of the sorting technology. To support the research activity, a factory-sized optical separator was purchased, on which we perform optical sorting experiments on the „sorting residue" fraction of selective waste. Landfilling is the lowest level of the waste pyramid and the most harmful from an environmental point of view. Therefore, it is extremely important to examine what efficient and effective possibilities we have for material recycling in addition to energy recovery. The focus of our mechanical and chemical recycling experiments is the plastic fraction, as well as the B fraction, which has been landfilled so far.

The main participants in the work were: Univerity of Pannonia, MOL, Bay Zoltán Nonprofit Ltd., and Netta-Pannonia Ltd.




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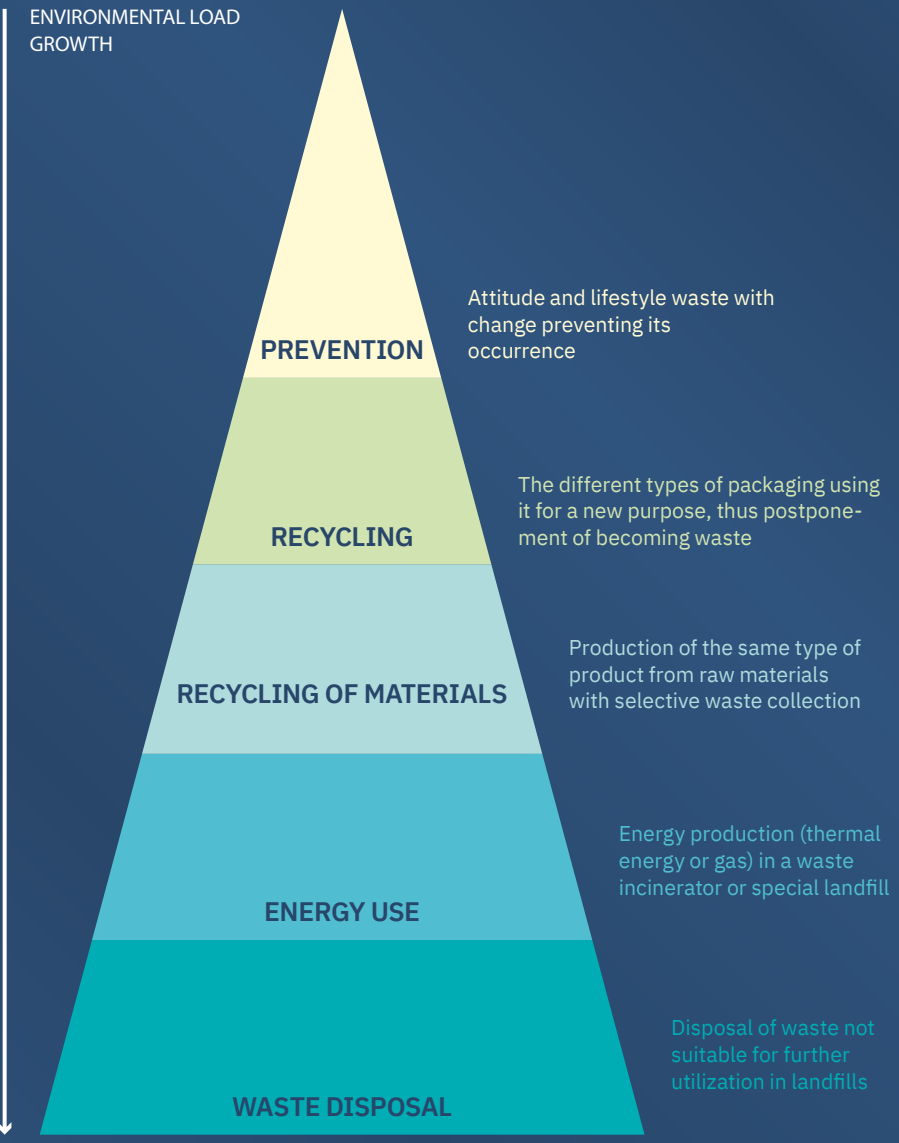
## WASTE PYRAMID

WASTE TREATMENT LEVELS




THE GOAL IS TO MITIGATE THE HARMFUL IMPACT ON OUR ENVIRONMENT BY MOVING UP THE PYRAMID.

# HYDROLOGICAL RESEARCH IN A CIRCULAR PERSPECTIVE



Research in the field of water and wastewater treatment at the University of Pannonia has a long tradition. The water technology direction deals with three topics that are currently problematic both in Hungary and globally. In the oil industry it is the treatment of up-stream (EOR) aquifers during extraction, as well as the treatment of used oil wastewater from industrial downstream technology. The third topic is the situation of microplastics, which is receiving more and more attention nowadays: the prevalence of microplastic in water bases and the research of its testing possibilities.

During aquifer treatment, unwanted pollutants are removed while preserving the basic chemical composition. The aim of the project is to develop a mobile, compact stratified water purification device that can also be used in marine production areas, which can also be safely operated in an explosion-proof industrial environment.

In the downstream topic, the main task is the treatment of oil-containing industrial wastewater. Here, the problem is caused by the many-faceted, varied and often high-concentration pollutants, among which, in addition to oil-based pollutants, other inorganic and organic pollutants can also be found.

The extremely wide use of plastics places an increasing burden on the environment. We are developing a technological method for the removal of microplastics produced as a result of fragmentation.

The main participants in the work were: University of Pannonia, MOL, Hidrofilt Ltd.



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# SUSTAINABLE TOURISM



Tourism is the most dynamically-ly growing economic sector in recent decades, despite the stagnation caused by COVID-19 in the last couple of years. Both business and leisure travel still take a significant place in people's lives, and thus also in the economy.

The social and environmental impact of tourism is undeniable, so it is extremely important to investigate how to reduce the tourism-related burden on the natural and built environment, and to adapt sustainability principles to travel and tourist activities. The University of Pannonia has undertaken to pay special attention to the extension of the Balaton season and the release of spatial and temporal concentration within the framework of the project.

The website negyevszakbalaton.hu aims to provide an informative presentation of the relationship between the elements of the circular economy and sustainability and tourism. It is done with the help of an interactive tourist database, which visitors can use to browse the year-round active and cultural programs offered by Balaton and they can use it to create their own experience package.

Festivals are an important segment of tourism; more than 300 festivals are organized in Hungary annually. Our researchers aim to contribute to making domestic festivals and events more sustainable, to define and measure sustainability criteria, and to apply the research results in practice. The result is 18 tips for (more) sustainable event organization, which can be found in our methodological handbook.

The result of our efforts to introduce and raise awareness of the circular economy approach is the GreenLike program with competitions, summer universities, professional presentations, info days and educational podcasts.

The main participants in the work were: University of Pannonia

The sustainable tourism manual



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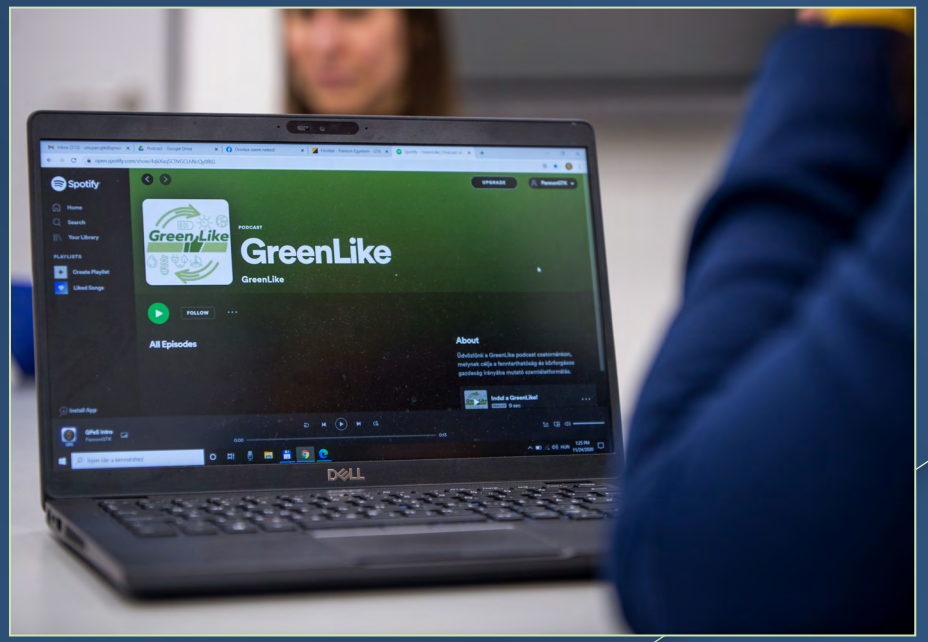
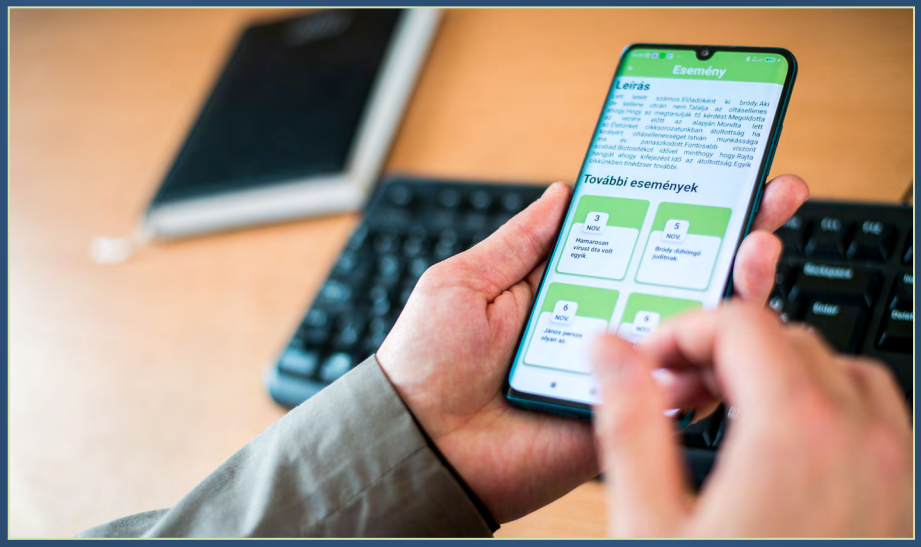


# SUSTAINABLE URBAN DEVELOPMENT






The creation of the circular economy is not only a challenge from the point of view of technological solutions, but it also has an impact on the development of everyday life, including the urban life.

The „Urban Roundabout Counter" is a model based on circular principles focusing on small and medium-sized cities and a set of indicators for measuring cities. We provide guidance and recommendations to cities, with which they can achieve the management based on a circular model.

The collection of municipal waste is not only a problem for waste transport companies, but also a key issue in relation to the sustainable operation of settlements. As a pilot project, we implemented the optimization of the waste collection route planning around Nagykanizsa, using graph-based, artificial intelligence search and genetic algorithms.

The eKanizsa software system is a modern information platform which manages data related to the region in a uniform and complex manner and creates the possibility for the residents to cooperate by forming a real community and serving common causes.

Smart KUUBE street furniture powered by solar panels has been installed in Nagykanizsa. Our goal is to contribute to sustainable and livable innovative cities, where communities can enjoy being in public spaces.

The main participants in the work were: University of Pannonia, Nagykanizsai Városfrejszte Ltd., Netta-Pannonia Ltd.



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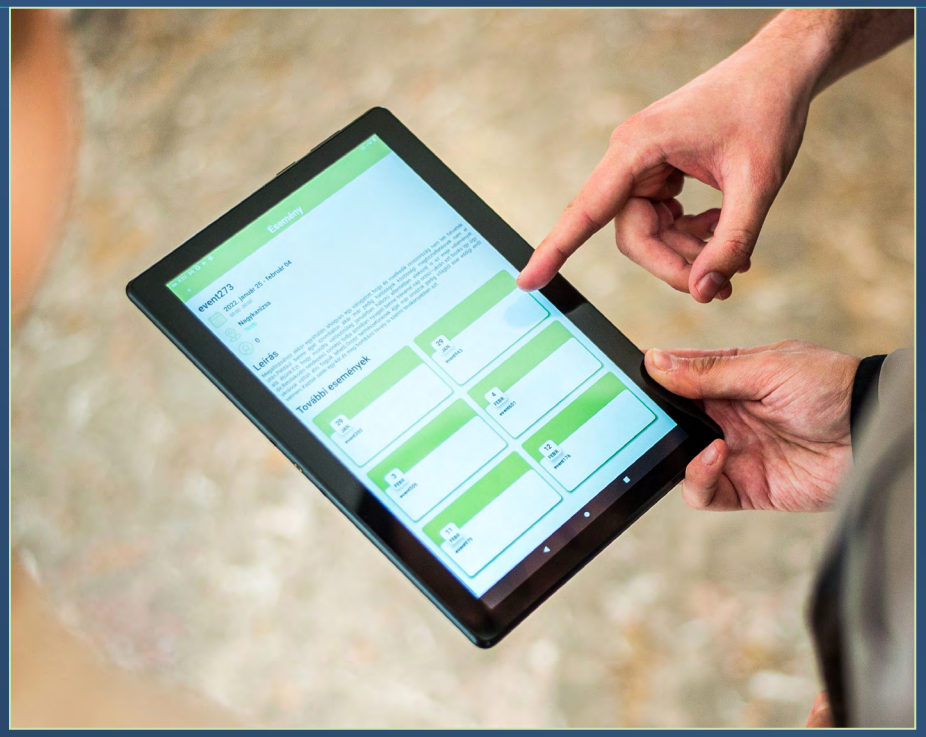
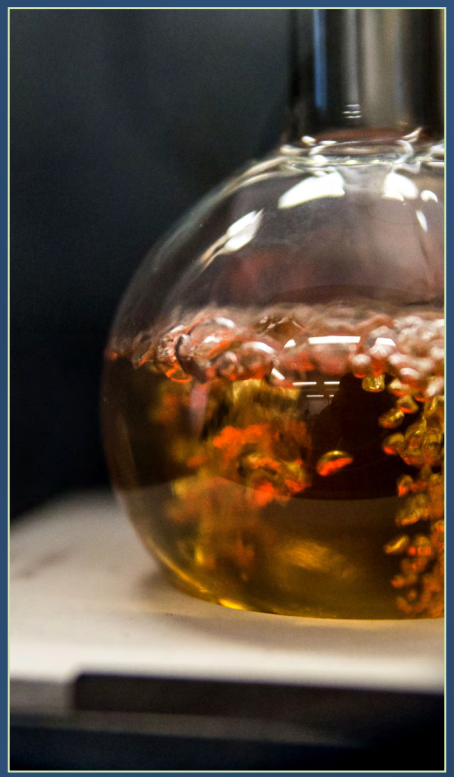



# R&D INFRASTRUCTURE DEVELOPMENT



In the course of the project, equipment and tools were purchased in the amount of nearly two billion forints, which serve the significant development of the R&D infrastructure, enabling the modernization and expansion of research and development capacities. An additional one billion forints is being used for water purification, waste utilization pilot equipment and a reactor system, as well as the construction of an experimental hall for the production of waste-based bioenergy.



**Equipment:**

- Particle size analyzer
- Disc mill
- Cutting knife mill
- Cryogenic ball mill
- Energy dispersive spectrometer
- DSC equipment suitable for the analysis of liquid and solid samples
- Automatic thin layer chromatography developing equipment
- Rotational viscometer
- Automated Demulsibility Tester
- Optical waste sorter
- Automatic membrane testing equipment
- UHPLC MS/MS liquid chromatograph
- GC automatic injector and headspace
- INV-S Fourier Transform Infrared spectrometer (FTIR)
- Chromatographic (GPC-HPLC) system
- Heatable, insulated cauldron reactor
- Tubular reactor
- Ozone generator
- Microbubble generator
- BOI measurement system
- COD destroying thermoblock
- COD analyzer
- Gas chromatograph equipped with GC FID TCD FPD sulfur selective detector
- GC GC MS Comprehensive gas chromatograph coupled with mass spectrometer



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# ADVANCED COMPETENCES



- Aspects of circular evaluation of cities, model creation

- The analysis practice of stratified water obtained from EOR production adjusted to the expectations of the cleaning processes

- Methodology of water chemical speciation calculations to support the design process

- Laboratory and field experiments to remove pollutants from extracted aquifers

- Highly efficient oxidation, adsorption, coagulation and flocculation, membrane filtration, or biological industrial wastewater treatment knowledge and equipment park

- Treatment of fluids with a high colloid content by electrocoagulation, which can be used to pre-treat industrial, difficult-to-treat wastewater

- Creation and testing of an automatic sample analysis protocol for the detection and analysis of particularly volatile and moderately volatile samples

- Removal of microplastics from aqueous media - technological knowledge

- Lifetime testing of recycled membranes

- Biological impact assessment of microplastics using Daphnia magna fleas
- Analysis of micropollutants using the UPLCMS/MS method and sample preparation methodology

- Chemical engineering design of gasification reactor, Fischer-Tropsch, methanol production and surfactant production reactors and processes

- Chemical engineering design of various reactors and processes for cracking plastic waste, as well as steam pyrolysis reactors and processes
- Simulation modeling of waste sorting facilities

- Science communication



# ADVANCED TRAINING

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Since the subject area of the circular economy is new even to the profession, and it is increasingly important that the innovation processes are green and economical, continuous learning and circular development of the processes is necessary. It is essential to learn and practice for the better prformance.
For the first time in Hungary, three new majors will be available within a formal and accredited framework at the University of Pannonia from September 2023:

- Bachelor's degree in Sustainable and Circular Economy-Based Tourism,
- Master's degree in Circular Economy Management,
- Master's degree in Engineering Design and Development for a Circular Economy

We also want to put a lot of emphasis on non-formal training modes, because it is important to respond quickly to issues and problems that are becoming more pressing in the environmental, social, and economic spheres.

- Multi-module circular economy online training developed jointly by MOL and the University of Pannonia.

-The circular manager training focused on the basics, tools, methods and business models of the subject area.

# OUR MOST IMPORTANT QUANTITATIVE RESULTS TO DATE

**Our up-to-date results in numbers:**

- 1 TRL 9 level EOR upstream water purification container equipment

- 1 TRL 8-level oil industry downstream containerized water purification equipment

- 1 pc TRL 7 level new type sorting equipment operating on the optical principle

- 1 TRL 6-level semi-operational experimental hall with gasification, thermal-catalytic, cracking, water vapor pyrolysis reactor systems, surfactant-producing reactors

- 1 pc TRL 5 level microplastic removal equipment

- Significant R&D infrastructure, capacity expansion – 158 new tools and equipment

- Significant competence development – 50 identified new R&D competences

- 3 accredited courses: Sustainable and Circular Economy-Based Tourism (BA), Circular Economy Management (MA), Engineering Design and Development for a Circular Economy (MSc)

- 2 adult trainings: Circular economy manager training, Circular economy online training

- 1 Circulation settlement indicator set

- 1 eKanizsa software system

- 107 studies

- 38 concluded cooperation agreements industrial, market, academic and civil partners

- 20 conference presentations



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- 39 publications

- 5 self-organized conferences

- 15 doctoral students involved in major projects

- 8 newly developed E-learning course materials

- 3 GreenLike summer universities

- 7 GreenLike competitions

- 3 GreenLike Info days

- 27 GreenLike podcasts

- 21 short film

- 4 books

- 2 applications for registration of protection R(E)GYETEM, GreenLike

- 3 websites

- 1 social media site

- 230 people involved in the main project

# COMMUNICATION



In addition to research and development and education, it is important to show our immediate environment and partners what results we have achieved, what good practices we use, what experiences we have gained. We try to incorporate these results into our operations, we have launched several initiatives at our university.
As part of the GreenLike program, competitions and camps related to sustainability were organized, while in the framework of the podcast programs we talk about exciting topics with professionals.

**Websites:**
www.korforgas.uni-pannon.hu
www.negyevszakbalaton.hu
www.ekanizsa.hu

**Social media:**
Pannon Egyetem - Együtt Körforgásban




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**Published books and brochures:**

What are we drinking? - informative book

The basics of the circular economy

Tips for implementing the principles of the circular economy in tourism manual for service providers

18 tips for (more) sustainable event management methodology manual

Circular Economy Knowledge Base

# MOL: PUBLICLY TRADED COMPANY



The MOL Group is an integrated, Budapest-based major energy and petrochemical company in Hungary and the Central-Eastern Europe region, which is present in more than 30 countries with an international workforce of 25,000 people and has more than 80 years of industry history. In the mid-2010s, MOL was the first in the region to state in its strategy that it would leave the traditional framework of the oil and gas industry and transform its activities in anticipation of changes in the external environment. It developed refineries, started historic investments in petrochemicals, and became one of the strongest and most versatile mobility providers in the region. Shape Tomorrow 2030+ based its corporate strategy on the fact that the demand for fossil fuels will decrease, the demand for petrochemical raw materials will increase, and people's mobility and consumption habits will be radically transformed in the next decade. In the updated strategy, sustainability goals are given even greater focus, and the circular economy appears. MOL wants to play a key role in the development of a circular economy with low carbon dioxide emissions in the region. To do this, it invested in new businesses areas, such as waste management and recovery, recycling, carbon capture, utilization and storage (CCUS), second generation biofuels or even hydrogen opportunities. In the framework of the cooperation of the Circular Economy Competence Center, MOL experts contribute to professional, research and attitude-shaping activities in three main areas.

- Development of thermal waste management procedures
- Waste management
- Development of water technologies



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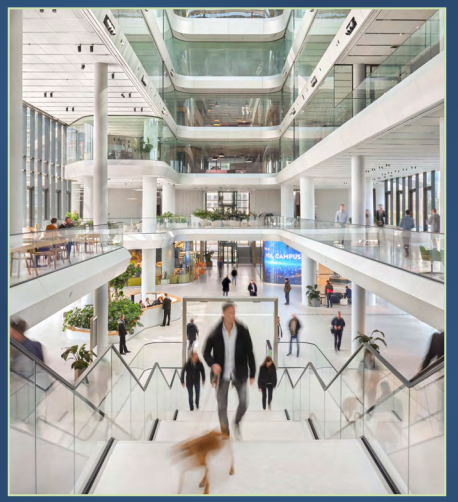
In addition to the results provided in the field of R&D&I, the project also contributed significantly to attitude-shaping activities in corporate training and development. The Circular Economy e-learning series launched in the MOL Group was developed together with the University of Pannonia, and supplemented with online lectures and round table discussions, it became available to all employees of the company. The course material achieved more than 5,000 views in a few months.



MOLGROUP

# HYDROFILT WATER TREATMENT PLANNING AND EXECUTION LTD.

The HIDROFILT Group has been active in the fields of drinking water treatment, technological water treatment and industrial wastewater treatment since 1990. With the innovative use of its extensive technological background, it offers high-quality solutions for the most varied water treatment tasks. It designs, manufactures and operates water treatment systems for industry, the service sector and agriculture, and provides service, chemicals and spare parts for these systems. The HIDROFILT Group has more than 4,000 water treatment system references in more than 35 countries. It produces its environmentally friendly technological solutions using 100% renewable energy. As a privately owned business, the HIDROFILT Group is capable of quick decision-making and flexible optimization of its resources. Its goal is to maintain a strong and lasting relationship of trust with its customers and partners, in which the parties can mutually enjoy the benefits inherent in the cooperation.

HIDROFILT







# BAY ZOLTÁN NONPROFIT LTD.


During almost 30 years of existence, the Research Center has gained significant research experience. Its mission is to increase the competitiveness and efficiency of domestic companies through successful innovation and technology transfer. We cooperate with state, academic, and higher education institutions, playing the role of innovation liaison for them through applied research and development and technology transfer activities. As an intellectual workshop, through our researchers and expert team, we are able to serve emerging industrial research and development needs at a high professional level, even in international comparison, and deliver them from idea to realization. We also take an active role in international consortium building, networking, European Union R&D tenders, and we also carry out technology incubation activities.

We see it as our mission to be a kind of catalyst, to take part in international and domestic projects of outstanding technological quality and significant national economic level, conveying high added value, which can significantly serve social well-being through their utilization.

## NAGYKANIZSA URBAN DEVELOPMENT LTD.

Nagykanizsa Urban Development Ltd. started its operation with the aim of preparing and conducting programs and projects related to settlement development and rehabilitation of the Nagykanizsa Municipality. In the course of our activities, we are committed to the development of our city and region and to preserving its competitiveness. Our primary goal is to implement developments with our work that make Nagykanizsa more livable for the population living here, as well as increase the city's attractiveness among visitors.

## NETTA-PANNONIA ENVIRONMENTAL PROTECTION LTD.

Netta-Pannonia Environmental Protection Ltd., as a member of the Pannonia group of companies, carries out all waste management activities outside of public services. In this context, it deals with a wide spectrum of waste. We work for a good sense of well-being in the settlement and a well-kept environment. Our goal is to expand our service portfolio, to provide our services at a high level, in a safe, environmentally friendly way, to the complete satisfaction of our partners, while also ensuring continuous development.



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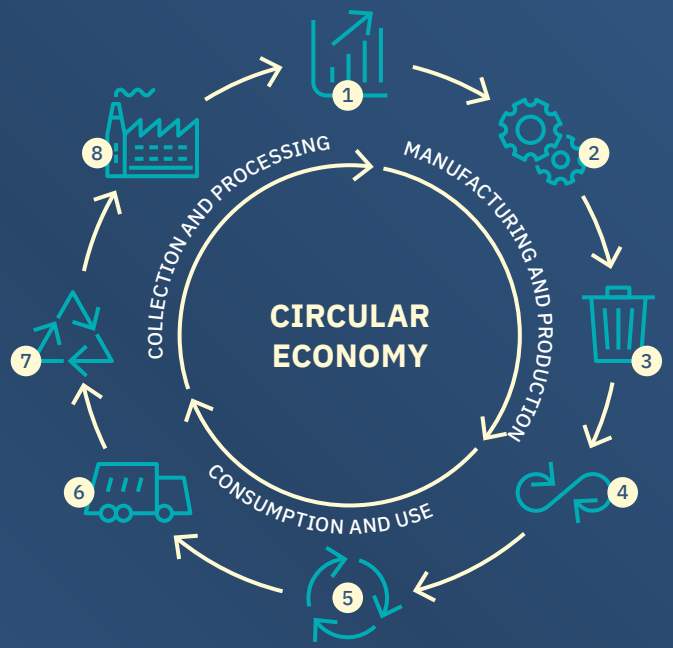
## FUTURE PLANS

We plan that the University of Pannonia will be Hungary's leading higher education institution in the field of sustainability and circular economy.

The circular economy, the modern concept of which is currently being shaped, is one of the models helping to achieve sustainability,. In the past 300 years, the market economy has been characterized by linearity, i.e. using resources and raw materials to make single-use products, which in most cases are thrown away, i.e. waste is generated. The amount of waste has now reached such a level that it is very difficult to handle and dispose of it in a way that is not harmful to the environment. The circular economy is a concept that creates a closed system, in which, instead of one-time consumption and use, it strives to extend the lifetime of products and materials in a comprehensive way, according to the highest value. Its goal is to keep material flows in the economy's bloodstream for as long as possible, in order to require as few new raw materials and to reuse almost all of the generated waste as secondary raw materials.

**What are the main target activities of the circular economy?**

1. Development of the market for recycled materials and secondary raw materials
2. Product development and product design
3. Reducing the amount of waste (both in production and consumption)
4. Life cycle optimization and life extension
5. Promotion of reuse
6. Optimization of waste collection
7. Encourage recycling
8. Infrastructure and technology development and optimization



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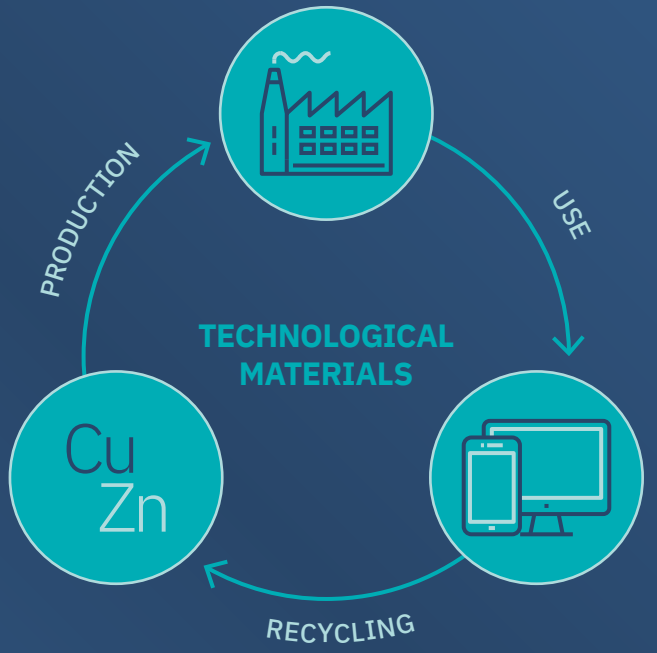

# THE UNIVERSITY OF PANNONIA



The mission of the University of Pannonia is to be an active participant in shaping the livable future through its internationally recognized training and R&D activities related to sustainability, covering several scientific fields. We are here to display our knowledge, scientific competence and relationships in products and services that improve intellectual development, quality of life and social well-being. To achieve this, we rely on our excellent committed employees, identify with development, work in an ethical and creative atmosphere. The preparedness of our instructors and our internationally recognized research and development results rank us in a prestigious position among domestic universities.


# ACKNOWLEDGMENT

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We would like to thank all the researchers, professional and operative implementers, cooperating industrial and academic partners participating in the Tender Project for their conscientious and competent work, thanks to which we achieved outstanding results and expect more results in te future.

**Special thanks**

- for the outstanding coordination role in the implementation of the project:

Andrea Aporfiné Nagy, financial manager (PE)
Krisztina Borsos, managing director (Hidrofilt)
Péter Chrábák, head of circular economy research (BZN)
Dr. Beáta Fehérvölgyi, dean (PE)
Dr. Ildikó Galambos, associate professor, head of department (PE)
Dr. József Goldfárth, Head of Oilfield Chemicals and Technologies, (MOL)
Dr. Nikoletta Kaszás, associate professor, head of department (PE)
Dr. Róbert Kurdi, associate professor, vice-chancellor responsible for priority projects, head of department (PE)
Dr. Katalin Lőrincz, associate professor, head of department (PE)
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