

# Circular economy in Serbia

Innovative projects and bussiness models



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# Innovative solutions for the circular economy

## INTRODUCTION

To encourage and accelerate the development of solutions and business models that will reduce greenhouse gas (GHG) emissions via circular economy practice, the **United Nations Development Program (UNDP) in Serbia, together with the Ministry of Environmental Protection of the Republic of Serbia** and partners, launched two projects in 2022. These projects resulted in **16 award-winning innovative circular solutions and 12 awarded circular vouchers for cooperation between academia and businesses in less than a year.**

## EU FOR GREEN AGENDA IN SERBIA

The project "**EU for Green Agenda in Serbia**", with the technical and financial support of the European Union and in partnership with the Ministry of Environmental Protection, is implemented by UNDP in cooperation with the Embassy of Sweden and the European Investment Bank (EIB), with additional funding from the Governments of Sweden, Switzerland, and Serbia.

The Green Agenda for the Western Balkans is the growth strategy for the region, aiming to tackle the challenges of climate change and green transition and assist the Western Balkan countries to align environmental regulations with the European Acquis. The Green Agenda for the Western Balkans is based on the European Green Deal and the Economic and Investment Plan for the region. The objective of the project is to contribute to the efficient, inclusive, and sustainable implementation of the Green Agenda for the Western Balkans and its Action Plan, by building broad engagement and societal participation through policy support and capacity building, piloting actions to support the green transition and scaling up successful investments.

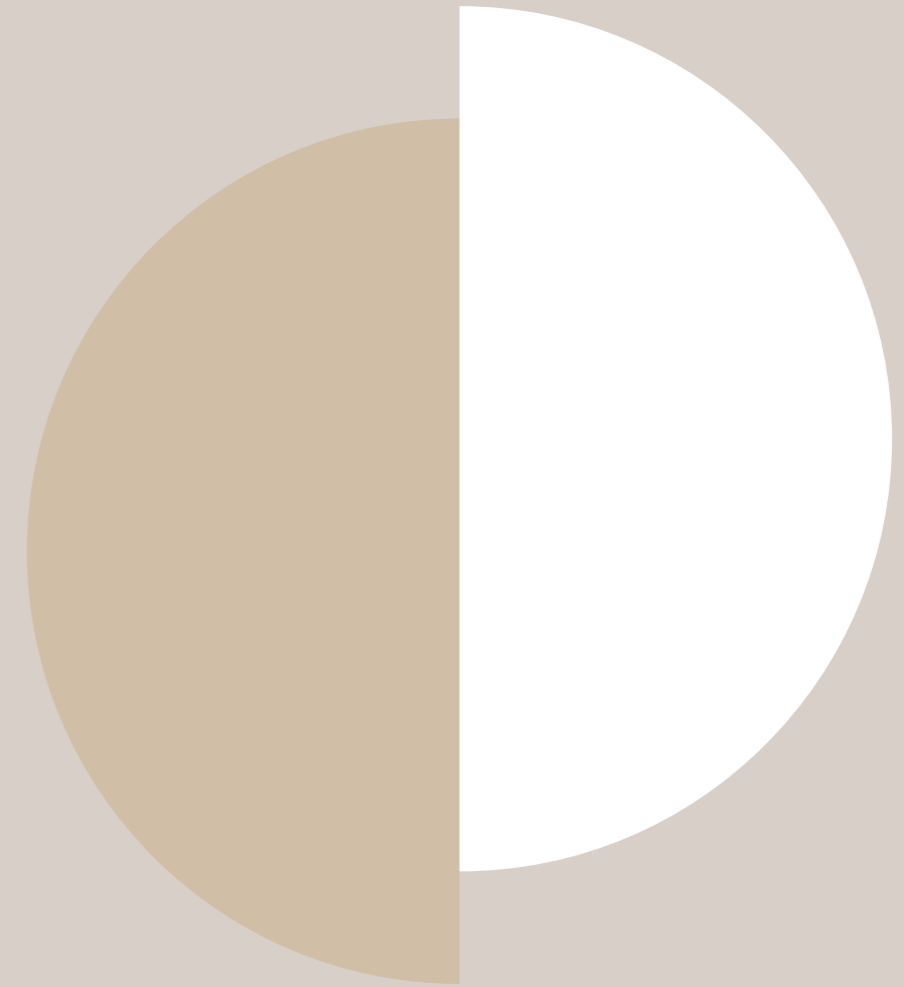
## CIRCULAR COMMUNITIES IN SERBIA

In 2022, a Challenge Call that sought innovative circular economy projects was launched, and it attracted 36 applicants. After acceleration and careful consideration by the UNDP team, Ministry of Environmental Protection, and external experts, **6 pilot projects were selected for co-financing of 265,000 USD**. These solutions reuse old newspapers as new material for graphite pencils and crayons instead of wood or plastic, bio-waste for natural cosmetic products, non-hazardous plastic and metal waste, wooden waste along the Sava River for the production of training equipment for eco-gym, using larvae of the insect *Tenebrio Molitor* to biodegrade plastic and biological waste while producing high protein food for pigs, and producing new biodegradable material BioSol from the remains of fruit and vegetables to be used as a substitute for plastic in the production of oils, bags, cups, etc.

The second project is implemented with financial support from the **Global Environment Facility (GEF): “Reducing the carbon footprint of local communities by applying the principles of the circular economy in the Republic of Serbia – Circular Communities”**, which enabled the development of circular, innovative, and cost-effective businesses and technical solutions that will reduce GHG emissions in local communities by applying the principles of circular economy. These solutions also bring other social, economic, and environmental benefits for the community and its citizens. The creators of innovative ideas are local self-governments and public utility companies, business entities and civil society organizations registered in the Republic of Serbia.

Upon the conducted Challenge Call, the expert jury selected the best 30 innovative ideas, which received mentoring and expert support through the Circular Economy Accelerator, so they could develop into mature projects and manage to obtain the financial resources necessary for their implementation in practice. **The best 10 innovations received financial support of 783,000 USD for realization in 2023.** These solutions save energy by using innovative technologies, produce energy from bio-waste, use bio-waste for composting, use waste alcalis and acids for fertilizer production, reuse textiles, paper, cardboard, and cigarette packs, and substitute consumption of raw materials for new production.

Those innovative initiatives clearly demonstrate that **a wide range of actors in Serbia recognize the importance of saving natural resources and energy, reusing and recycling products, and reducing the amount of waste.** These circular solutions will speed up the green transformation of Serbian economy and society, improving the quality of the environment for the benefit of all citizens.



## EU for Green Agenda in Serbia



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## Pencils and crayons from old newspapers



Implementing partner:  
**NewPen Ltd.,**  
**Smederevska Palanka**

NewPen is the first company in Serbia, as well as in Europe, **which produces graphite pencils and crayons from old, recycled or unread, newspapers, instead of wood or plastic.** This way, they have contributed to environmental protection and trees preservation and decreased the need for wood or plastic additives. Thanks to the project support, the company purchased two new, customized machines, which allowed them to automatize production, resulting in tripling of its production and intensifying the export to the European Union market.

To further spread environmental awareness, the company has organized educational workshops for children. The financial support provided for this initiative was 10,288 US \$.



## Organic waste of Čačak against toxicity

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Implementing partner:  
**Eko Bio Invest Ltd.,  
Belgrade**

This solution has used EU patented process to **test production of biodegradable and certified non-toxic granules from remains of fruit and vegetables** from Čačak potato chips factory and centralized public kitchens for kindergartens. Foils, bags, cups, etc. have been produced from new material – BioSol that has organic origin and is fully soluble – in hot water within less than a minute, and in cold water or on the ground in the period from 25 days to 6 months. This is revolutionary alternative to a flexible, single-use plastics.

The project entailed purchase of equipment, raw material testing, first batch of final products (50 kg of foils and 20 kg of cups) and signing of the initial commercial contracts. BioSol water-soluble articles are protected by the EU patent No 20306069.4, and obtained “OK compost home” certificate, which was renewed through this initiative. The support provided for this solution was 88.200 US \$.





## Biodegradation of plastic - establishing an incubator center - phase 1

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Implementing partner:  
**Belinda Animals Ltd.,  
Belgrade**

Belinda Animals has **constructed the Incubation Center for cultivation of the brood mother of Tenebrio molitor (TeM) larvae. This specific type of larvae is able to biodegrade certain types of plastic, in particular polystyrene (Styrofoam).** By dissolving it, TeM produces a protein-rich substance that can be used as animal feed, primarily for pigs, or as a land fertilizer. The project included procurement of 10 air-conditioned chambers for rearing larvae, vibro sifter sieve, automated system for breeding process monitoring, TeM initial genetic material and substrate for larvae nutrition.

Use of these larvae for biodegradation of plastic on individual farms for production of animal feed, as foreseen by this project, is innovative on a global scale. Although experiments are conducted worldwide, this is the first time that this method for reprocessing plastic waste is used in the region. Financial support provided was 47,342 US \$.

Leading partner:  
**Jelena Miletić, Entrepreneur,  
Medveđa**



## Industrial symbiosis - innovative strategy for sustainability of women social entrepreneurship

This project aimed to **empower rural women in southeastern Serbia and promote resource efficiency**. It achieved this by bringing together women who produce famous Serbian delicacy ajvar from paprika, who have started reusing its remaining bio-waste to create natural cosmetic products. The project led to the establishment of the Network of Industrial Symbiosis of Social Entrepreneurs of Serbia (MISS) by paprika processors from Medveđa and Social Franchise Bio Idea. **They have reused parts of paprika like stalks, leaves, and seeds to make high-quality powder for bio-masks and soaps.**

The project included equipment purchase, training for 100 women, production of 1000 soaps and 500 face masks, and launching of an online platform. **This initiative applied industrial symbiosis through safe and innovative use of bio-waste by turning it into a high-value product.** This initiative was supported with 30,000 US \$.

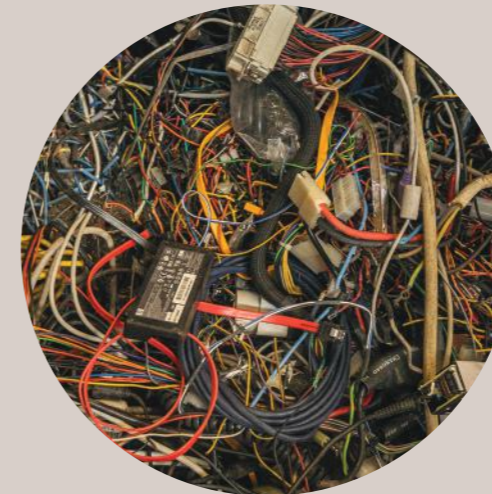




## Recycling of plastic and metal waste - phase 2

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Implementing partner:  
**Connect Clean Roma Group,  
Novo Miloševo**



The aim of this initiative is to **appropriately reuse the non-hazardous plastic and metal waste from old cables and small electronic household appliances**, and consequently, by reducing the dioxins and furans significantly improve the air-quality. **Plastic, rubber, copper, brass and aluminum from waste have been reused for production of the high purity granules.**

The project has also focused on improving the socio-economic position of the Roma community, by establishing a form of social entrepreneurship through ecological cooperative and providing official employment for individual informal Roma waste collectors through cooperation agreements. The financial support provided was 52,011 US \$.



## ECO-GYM

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Implementing partner:  
**NGO Centre for Development of Youth Entrepreneurship,  
Belgrade**



Aiming to **reduce negative impact of wooden waste along the Sava riverbank** on water, air and soil, this solution **collected wood fragments from river driftwood** and produced training equipment out of them. The items were assembled, standardized, and used to create an eco-gym in a designated park space in the municipality of Vršac. In total, **12 pieces of training equipment** have been produced, certified, and placed on the mulch along the accompanying boards with instructions for use.

Life cycle of saved wood was extended with reusing, natural resources are preserved because no trees are cut down and project carbon footprint is reduced, compared with alternative steel gym production. This initiative was supported with 37,037 US \$.



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## Reuse of waste alkali and acid dilutions

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Implementing partner:  
**Elixir Zorka – Mineralna đubriva Ltd.,  
Šabac**



The solution contributes to the management of hazardous waste, with the innovative use of waste alkali and acid dilutions in the production process of fertilizers. The importance of this project is reflected in the fact that the Republic of Serbia does not have a facility for the treatment of hazardous waste, nor a facility for the storage of special streams of industrial waste, such as solvents, waste oils, alkali and acid dilutions.

A certain amount of **scrubbing liquid has been replaced by dilutions of waste alkali and acids, in the amount of 40,000 tons per year.** This project has affected the reduction of demand and production of hydrochloric, phosphoric and sulfuric acid, as well as ammonia water in the amount of **148,679 tons of CO2 equivalent annually.** The solution was supported by 150,000 US \$.

## Green supply chain management

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Implementing partner:  
**Mivaka Ltd.,  
Belgrade**

The initial component of this innovation improves primary livestock production and establishes the necessary circumstances for subsequent effective processing of manure into high-quality solid organic fertilizer. It converts non-hazardous organic waste from farms into a raw material suitable for further processing.

This innovation has two segments. The first segment is the **"Terra bedding" mat used in livestock farming for animal growing, fattening, and exploitation**. The second segment describes how the manure is completely transformed into a **solid organic fertilizer called "ToroChick" without the use of any additives** and with the least amount of manipulation operations.

This innovative solution is example on the circularity of the sectors of agriculture and fertilizer production by converting non-hazardous organic waste from farms into a raw material suitable for further processing.

The support provided was used to improve the transportation system at the chicken farm and composting site in Čenej, **by installing the belt conveyer, which has increased the production of the final product by 12% and reduced the use of fossil fuels by 11%**. The estimated **carbon footprint reduction is 6,500 tons of CO2 equivalent per year**. This innovation was co-financed by 79,000 US \$.

## Incirculate with compost

Implementing partner:  
**PUC "Gradsko zelenilo",  
Novi Sad**

The innovation includes the **treatment of green waste, the construction of the tank for the collection of leachate and pipelines for the recirculation of technical water, as well as the increase of the compost field's capacity. The existing compost field of 5,000 square meters has been expanded to 10,000 square meters.**

As opposed to being disposed of in an unsanitary landfill, **Novi Sad's green waste from public areas is now used in a facility for the production of compost. This contributes to maintaining the city's greenery, while saving financial resources that would otherwise be spent on fertilizer purchase. Separate collection of green and garden waste from households will be introduced gradually. This approach composts an estimated 5,000 tons of green waste annually.**

These activities help manage bio-waste, lower GHG emissions, and increase financial savings on waste disposal and water usage. The solution was supported by 156,000 US \$.







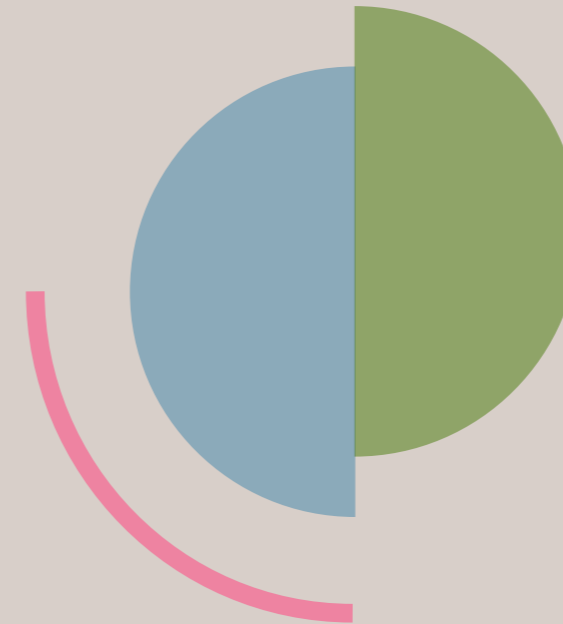
## Green roof of my school

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Implementing partner:  
**The City Municipality of Stari grad,  
Belgrade**

The solution involves the construction and installation of the green roof on the terrace of the elementary school "Drinka Pavlović", with high potential for replication on other school buildings across the city. It contributes to **energy efficiency, pollution reduction, climate change adaptation, durability of materials, and an extended life cycle through the greening of school roofs** in the City Municipality of Stari grad in Belgrade.

The construction of green roofs increases the percentage of greenery in the central urban municipality and reduces the runoff of storm water because greenery and soil absorb it. The roofs last longer because their exposure to high temperatures and water is reduced, and the insulation of the schools is also ensured. The return on investment is fast, and in addition to economic savings on energy consumption for cooling and heating, it includes the preservation of resources, protection of the environment, and reduction of the urban heat island effect. Finally, this green roof has a **strong educational component** and benefit. This initiative was co-financed by 25,000 US \$.



## Circular IOT systems as technological solutions for future

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Implementing partner:  
**Bitgear Wireless Design Services Ltd.,  
Belgrade**

**Internet-of-Things (IoT) modular, sensory devices** for the digital transformation of business serve the users as tools for getting the necessary insight into the current situation in the field, which allows a decrease in operational costs with an increase in efficiency in areas such as waste management.

Through its own line of products, Bitgear places **battery-powered telemetry and alarm IoT devices with low energy consumption that provide long-range wireless communication** with quick and easy installation in the field. **"IO-Guard"** is a solution intended for surveillance of infrastructure in remote and temporary locations with no network coverage or internet connection (construction sites, industrial infrastructure, etc.). In order to overcome the problem of a potentially large number of false alarms, an **"IO-Eye"** device has been developed that provides **verification through photography in the event of alarm detection**. In its mode for periodic sending of photographs, the **"IO-Eye"** device can also be used for **optimization of transportation of (recyclable) waste, which provides a significant decrease in expenses and diesel fuel combustion**.

The devices in the IO-Elements series have a modular design, which allows repairs. The business model is based on **selling an integral service: the lease of equipment and the use of software**. The systems **"IO-Guard"** and **"IO-Eye"** was piloted, tested and marketed. The support provided amounts to 37,000 US \$.





## Kutijice.com

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Implementing partner:  
**Deto Ltd. Graphics Company,  
Pančevo**

This innovative idea **contributes to reducing the technical surplus of paper left after printing in the printing house**, due to the standardization of raw material formats and processing machines. This anomaly is responsible for losses in the approximate amount of 15-20% of raw materials (and often much more) through all stages of production, and in the last one, it is removed from the finished product and sent for recycling. This innovative solution, however, discovers a method to reuse that technical surplus of paper through the design, production of the new paper products (mostly packaging) and their placement on the market. For this purpose, a **web-shop platform was developed and launched**. The concept is that certain valuable items should be included and rescued from recycling on the margin of the paper or cardboard.

Because they were manufactured from waste at the expense of the items whose margin they were cut, the pricing of these products is much cheaper than in regular production when they were finally launched.

The provided support was used for the support of the web-shop platform, purchase of equipment, and the development of printing tools for new products. The proposed solution is estimated to contribute to reducing total CO2 equivalent emissions of 4,140 tons per year, and significant reduction in water consumption (the critical resource in paper recycling). It also decreases the need for logistics, transport, sorting, packaging, and processing, and contributes to forest conservation. This initiative was co-financed by 15,000 US \$.



## From old to new - paper recycling

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Implementing partner:  
**Association for the Support to People with  
Developmental Disabilities "Naša kuća",  
Belgrade**

This solution contributes to reducing the use of plastic and non-degradable packaging by making new products from empty cigarette packs and other wastepaper and cardboard, using old Japanese technology. It also contributes to the preservation of raw materials, saves energy, and reduces the generation of waste through repeated use and recycling. Implementing the project idea, employment conditions will be created for people with developmental disabilities. Engaging them in the manual production of paper and cardboard products supports them in developing a higher degree of personal independence.

The solution included the development of bio-additives that make the paper waterproof, recyclable, and biodegradable and purchase of equipment for the manual and semi-automatic production of paper products from paper waste, including paper food delivery containers.

Further on, the campaigns to collect paper and cardboard are organized, a training programme for working in the production of paper products was developed, and cooperation with other organizations established. It is expected that the adopted approach will be upscaled to local communities across Serbia and contribute to the inclusion of a larger number of people with developmental disabilities. The support provided amounts to 27,000 US \$.



## Reuse of textile waste

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Implementing partner:  
**City of Novi Pazar**

For several decades, Novi Pazar has been a textile center, with around 80 textile product manufacturers, mainly focused on denim. 1.5% of the total annual textile production is textile waste, which amounts to about 60 tons of this waste. Currently, clothing manufacturers must hand over textile waste to authorized operators and pay a collection fee. This system often leads to unreported waste amounts, with much of it ending up in landfills or being burned. Burning textile waste and resulting air pollution have long been issues in the city, especially with rising energy prices leading many smaller workshops and households to burn textile waste in their furnaces.

The project foresees proper handling of textile waste - primary selection – that leads to controlled waste management and separation at the source. **Collection, transport, and temporary storage of textile waste by the operator of PUC "Gradska čistoća" reduces the creation of illegal dumpsites and prevents its inadequate disposal or combustion.** To motivate companies to hand over all quantities of textile waste, an agreement was made with the PUC on free collection of textile waste from all companies in the city territory for two years. Another agreement was reached with a waste operator to **manage all collected textile waste in the first phase**, while city representatives continue seeking new local solutions for its use. This initiative was supported with \$70,000.





## Fruit waste for cleaner air and GHG emission reduction

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Implementing partner:  
**PUC "Osečina"**

Previously, four fuel oil boiler rooms were utilized to run the Public Utility Company (PUC) "Osečina," which is in charge of district heating in the municipality, using coal and 2200 tons of fuel oil annually. Boilers powered by fossil fuels were switched out for hardwood biomass boilers at the PUC's initiative.

The innovative proposal suggests **producing heating chips from trimmed orchards left over from growing raspberries**. Since the area produces fruit, **pruned waste is currently burned in the fields**. The PUC intends to gather the trash from clipped fruit and make chips for heating.

This would be **the first instance of trimmed orchards being utilized to make chips for heating in Serbia**. Through a total installation of **2.85 MW of renewable energy, the project would save 4,653 tons of CO2 equivalent annually**. Wooden chips in excess would be sold. The project's financial outcomes are excellent, and the funded activities will improve PUC's routine operations. Ash produced from burning wood chips and trimmed waste will be used as fertilizer. This initiative is co-financed by 94,000 US \$.




By replacing two old boilers, the estimated reduction in CO2 equivalent is 4,200 tons per year.

## Decrease of pollutants and GHG emissions by installation of a new boiler room

Implementing partner:  
**NEKTAR Ltd.,**  
**Bačka Palanka**

The company that produces juice previously used a fuel oil boiler room with two boilers, consuming 2200 tons of fuel oil annually. To address financial and environmental concerns, they **constructed a 9.2 MW gas and biomass boiler room, which has enabled them to produce biomass – wood chips for fuel, from purchased wood and dried fruit residues.** Leftover fruits from juice production are used to supply the boiler room entirely.

Thanks to the project support, the company bought a dryer for fruit residues. The purpose of the boiler room is to produce the saturated steam required for technical processes. The existing boilers operate at a production rate of about 12 t/h during the months of June through December, when fruit processing technology demands are at their peak. Recuperation of condensate is, during the summer months, approximately 75–80%. Ash, as a product of burning biomass, is used as fertilizer. Recirculation is further achieved by recuperation. By replacing two old boilers, the estimated reduction in CO2 equivalent is 4,200 tons per year. The solution was supported by 130,000 US \$.



# Circular vouchers

In November 2022, the Public Call for the Improvement of Cooperation Between Academia and Businesses in the Field of Circular Innovations was announced by UNDP. Out of over 40 applications, the 12 best innovations received “circular vouchers” worth 10,000 US each, as an incentive for further development, leading to practical implementation.

These innovations envisage the use of bio-waste in energy production, composting and manufacturing of new products (cosmetics, paint, varnish, ecological adhesives), as well as wastewater treatment in wood processing industry to make innovative bio-products. Some of the solutions propose using new technologies (artificial intelligence, software and applications) to decrease the emission of pollutants from thermal power plants, optimisation of electricity consumption, as well as transition from fossil fuels to renewable energy sources. The voucher winning ideas also include production of biodegradable bags from natural materials and breeding of insects whose larvae can decompose plastic. All these innovations were proposed by renowned scientific and research institutions in Serbia.



# Revalorization of waste - use of waste eggshell and used cooking oil for biodiesel and pellet

Scientific-research organisation: **Faculty of Technology and Metallurgy, University of Belgrade**  
Company: **Melange Ltd. New Belgrade (eggs processing company)**



# 01

## GOAL

reducing the use of fossil fuels by adding biodiesel in the transport sector and using enriched pellets for heating purpose, reducing pollution of aquatic ecosystem by waste oils.

## PROCESS

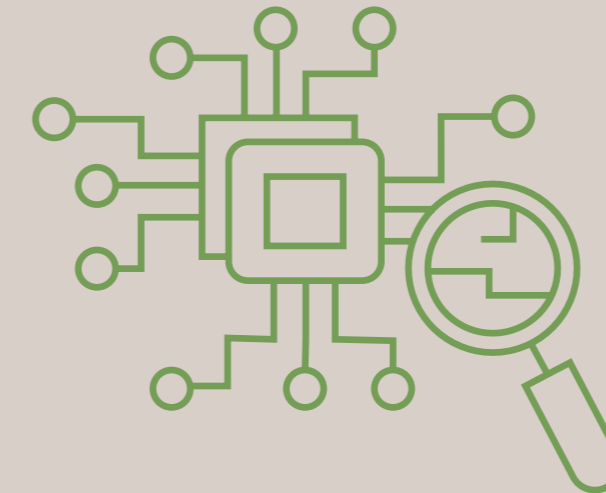
waste eggshells will be used as a catalyst in the biodiesel production from used cooking oil and bioethanol. Further, the production of pellets from waste biomass with the addition of crude glycerol obtained in the biodiesel production will be optimized.

## RESULT

thermodynamic characterization of the obtained biodiesel necessary for its further use and comparison with binding European standards.

# Development of AI model for predicting emissions of polluting materials from TPP “Kolubara”

Scientific-research organisation: **Nuclear Institute „Vinča“**  
Company: **PC “Electric Power Industry of Serbia” (JP EPS)**



## GOAL

development of reliable artificial intelligence (AI) models that enable monitoring of environmental impacts of TPP. By adjusting the input parameters of boiler operation, the possibility of reducing pollutant emissions from TPP “Kolubara” is estimated to be up to 20%.

## PROCESS

three advanced machine learning (ML) models will be developed by scikit-learn python library on the created database. Models will have values of technical/elementary analysis of lignite, TPP unit power output and steam production as input parameters.

## RESULT

develop ML models to predict pollutants emissions based on the experimental testing of the emissions from TPP “Kolubara”.

# 02

## Algae in function of GHG reduction

Scientific-research organisation:  
**Faculty of Biology,  
University of Belgrade**

Company:  
**Biotech Engineering Ltd.**



# 03

## Extraction & encapsulation of bioactive components from waste resources from raspberry processing

Scientific-research organisation:  
**Faculty of Chemistry,  
University of Belgrade**

Company:  
**Aleksandra Rašković PR  
Production of  
cosmetics AMELLES**

### GOAL

production of high-quality compost, with GHG and water vapor reduction.

### PROCESS

a system consisting of two bioreactors, the first for aerobic degradation of organic matter (composter) and the second for growing algae (photobioreactor). CO<sub>2</sub> from composting is consumed in the photobioreactor, for accelerated growth and cultivation of algae, and the oxygen produced by the algae is consumed to speed up the composting process to 14 days.

### RESULT

improvement of the existing original solution of „green composter“ by testing large photobioreactor in open space, using the sunlight.



### GOAL

rational use of waste from fruit processing, containing valuable compounds: oils, polyphenols, enzymes, vitamins, and minerals, with antibacterial, antifungal, anti-inflammatory and antioxidant potential in cosmetics.

### PROCESS

extract and encapsulate bioactive components from waste obtained in raspberry processing: oil and polyphenols, encapsulated to develop innovative serum, cream and soap.

### RESULT

development of a technical solution with application in the cosmetic industry, obtaining the Čuvarkuća label.

# 04

# Bioton-bio-pigments from waste for industry of coating and painting

Scientific-research organisation:  
**Institute for Chemistry,  
Technology and Metallurgy,  
University of Belgrade**

Company:  
**Fero Promet Ltd.,  
Užice**



# 05

## GOAL

high performance alternative for available antibacterial / antifungal painting program (95 to 100% biobased) allowing to reduce fossil consumption (80-90% decrease in carbon footprint) and harmful chemicals release in the environment.

## PROCESS

a broad spectra of organic waste such as meat offcuts, spent coffee grounds, cocoa bean shells, and secondary bioplastics residues, will be used for a production of bio-pigments.

## RESULT

bio-pigments of different colours (red, pink, purple and blue family) will find the industrial application with the collaboration of JUB d.o.o. company, where obtained bio-pigments will be validated through application in paints and coatings preparation.

# Bio-Polyols from agricultural and industrial waste (AIW) for new circular production of ecological adhesives (glues)

Scientific-research organisation:  
**Faculty of Agronomy in Čačak,  
University of Kragujevac**

Company:  
**Tetragon,  
Čačak**



## GOAL

innovative green technologies related to the AIW management for development of advanced eco-friendly adhesives.

## PROCESS

new technological procedures for silica nanomaterials extraction from AIW and flying ash using green chemical route, which will allow to control the size and shape of nanoparticles which will be measured by scanning and transmission electron microscopy.

## RESULT

developing bio-based silica nanofillers and polyols for adhesive systems, as an alternative to fossil fuel-based polymers in adhesives.

# 06

# Solid State Transformer - development of isolated system for monitoring and diagnostic of electro-energy system

Scientific-research organisation:  
**Faculty of Electrical  
Engineering, University of  
Belgrade**

Company:  
**Meter&Control Ltd.,  
Belgrade**



# 07

## GOAL

a solution that, based on data analysis and system diagnostics, optimizes electricity consumption for end consumers, while providing galvanic isolation and less material usage 5x, for households and distribution power system.

## PROCESS

optimization of electricity consumption by the end user, and the many times lower consumption of heavy materials.

## RESULT

develop a prototype solution - hardware and software, which delivers electricity from the power system to the consumer with savings of at least 15% on a daily basis.

# Modular compact trigeneration system of net zero energy con- sumption - “energy cube”

Scientific-research organisation:  
**Faculty of Mechanical  
Engineering, University of Niš**

Company:  
**ALFA KLIMA Ltd.,  
Knjaževac**



## GOAL

net zero energy housing, decentralized energy production, hospital operation rooms and clean rooms, greenhouses, plastic houses, container housing units and remote location facilities.

## PROCESS

“Energy Cube” integrates energy processes providing electricity, heating and cooling using solar energy. It is a modular mobile solution, suitable for outdoor use, which integrates photovoltaics, air-water heat pump, energy storage (electric, heat), with possibility of integration of hydrogen fuel cells with smart internet based automatic control.

## RESULT

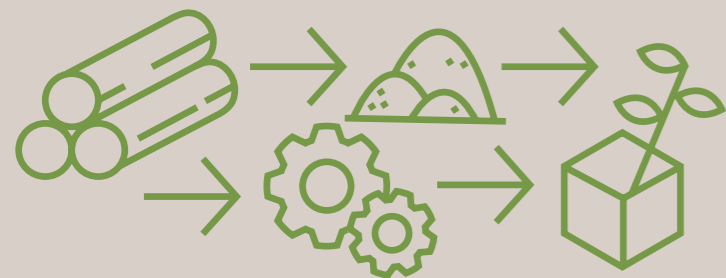
development and proof of concept of the “Energy Cube”.

# 08

# Condensate from hydrothermal treatments of wood - waste as resource for innovative bioproducts

Scientific-research organisation:  
**Faculty of Forestry,  
University of Belgrade**

Company:  
**Microtri Ltd.,  
Belgrade**



# 09

## GOAL

to fully utilize all the material created in production of wooden elements for furniture or construction.

## PROCESS

extract chemical compounds from condensate created during the processes of hydrothermal treatments of wood.

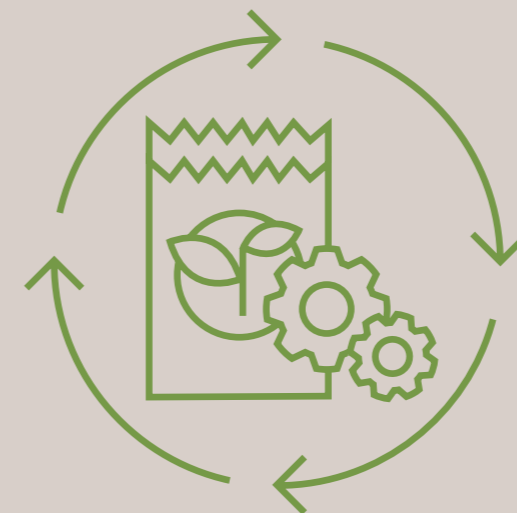
## RESULT

condensate will be sampled (for different wood species, types and duration of steaming) in wood industry companies, and the chemical composition and biological activities of individual components will be examined in detail. A portfolio will be created of condensate-originated chemical compounds that can replace their non-renewable equivalents in various products.

# Optimization of parameters for production of biodegradable and compostable bags

Scientific-research organisation:  
**Faculty of Technology,  
University of Novi Sad**

Company:  
**Polyplast – packaging  
Novi Sad**



## GOAL

to reduce dependence on non-renewable fossil fuels, and the harmful consequences of non-biodegradable plastic disposal on the living world.

## PROCESS

By using materials based on polylactide and starch, which are biodegradable biopolymers, and „green“ plasticizers based on glycerol and citrate esters, instead of proven toxic phthalates, the entire process is placed in an ecological framework.

## RESULT

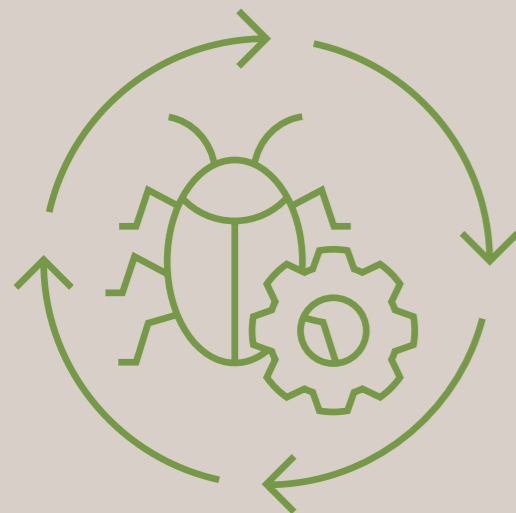
optimize the parameters of the production of biodegradable and compostable bags.

# 10

# Potential of insects in development of Serbian agriculture

Scientific-research organisation:  
**Institute for biological research „Siniša Stanković“, University of Belgrade**

Company:  
**Belinda animals Ltd.**



# 11

## GOAL

alternative sources of protein-rich food to protect the environment and ensure sustainable development.

## PROCESS

the cultivation of *Tenebrio molitor* (mealworm) larvae on agricultural farms and by food manufacturers. The nutritional composition of this insect's larvae is similar to fishmeal and can be an excellent alternative protein source for animals/aquaculture. The mealworm's advantage is its ability to break down organic waste and plastic. Larval frass (feces with unused food and exuviae) can be used as a high-quality organic fertilizer.

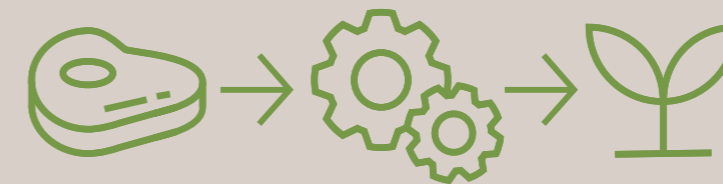
## RESULT

environmental awareness among farmers and plant/animal food manufacturers and to encourage them to establish *T. molitor* larvae "farms". By implementing this Initiative on only 1% of agricultural farms in Serbia, reduction of CO<sub>2</sub> emissions will be reduced for 348430 tons/20 years.

# Compromise between the production of quality pig meat and protection of environment through ecologically sustainable and economically competitive technological process

Scientific-research organisation:  
**Faculty of Agriculture, University of Belgrade**

Company:  
**Suvobor Koop NN Ltd.**



## GOAL

to address environmental concerns, reduce emissions, and optimize economic efficiency.

## PROCESS

the project foresees crossbreeding different groups of pig breeds, specifically Duroc meat breeds and indigenous Moravian breeds, to create hybrids that are genetically inclined to adapt to a free farming system.

## RESULT

food utilization directly from nature and secondary products of agriculture and the food industry, in accordance with the very principles of a circular economy. The resulting crossbred pigs would possess carcass qualities that meet market requirements while being ecologically competitive and economically profitable. Additionally, this process aims to reduce pollution, specifically the equivalent of carbon dioxide emissions (CO<sub>2</sub>), by approximately 50.7%.

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