



Po kreativni poti do uspešne prijave projekta – primer odobrene prijave ARIS ter nasveti

*Delavnica za učinkovito pripravo prijav na Javni razpis za (so)financiranje raziskovalnih
projektov v letu 2026 za leto 2027*

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Nasveti pri projektni prijavi ARIS



- Primer projektne prijave **Javni razpis za (so)financiranje raziskovalnih projektov za leto 2025: ANG - Sustainable REcovery of stRategic and critical raw materials from E-waste touchscreens and printed Circuit boards using biopolYmer-based magnetic nanocomposites and their use as electroChemical sensors for Endocrine disruptors in the environment, SURE RECYCLE – J2-70090**

SLO - Trajnostno pridobivanje strateških in kritičnih surovin iz e-odpadnih zaslonov na dotik in tiskanih vezij z uporabo magnetnih nanokompozitov na osnovi biopolimerov ter njihova uporaba kot elektrokemijski senzorji za endokrine motilce v okolju (akronim *SURE RECYCLE*)

- **Temeljni projekt v osnovni vrednosti (Basic Research Project) - 150.000 EUR/leto = 1.7 FTE/leto (2825h)**
- **ERC področje PE8 - Produktno in procesno inženirstvo (Products and Processes Engineering) → statistika odobrenih projektov na lanskem razpisu, manj konkurence, večja možnost pridobitve projekta → pregled podatkov o kapaciteti ERC ved za realizacijo / odvisno od karijerne stopnje**
- **Karierna stopnja: Srednja generacija raziskovalcev (največ 15 let po letu zagovora prvega doktorata, 2c)**
- **Konzorcij sestavlja 6 projektnih partnerjev, in sicer 3 raziskovalne organizacije (FS UM, FKKT UM in IJS) ter podjetje Surovina d.o.o.**

Izhodišča za prijavo – pregled kriterijev in ocenjevalnih indikatorjev³



- **Dobro prebrati razpis in pogoje** za prijavo (<https://www.aris-rs.si/sl/progproj/rproj/razpisi/26/razp-proj-26.asp>)
- Glede na raziskovalno idejo je potrebno **strateško** izbrati **ERC področje** (statistika, manjša konkurenca vendar vsebina projekta sovпада s področjem – **ključne besede**, področje kjer je bilo več odobrenih projektov iz prejšnjih let)
- **Ocenjevalni obrazec in kriteriji** → vse elemente jasno vključiti v opis projekta ter v obrazcu na **DigitalForms** → s tem recenzenta takoj nazorno seznanimo kje smo to vključili
- Za temeljni projekt in podoktorski temeljni projekt so ocenjevalne točke: *Znanstvena odličnost raziskovalcev; Znanstvena odličnost prijave; Kakovost in učinkovitost izvedbe;*
- Opis projekta se glede na prejšnja leta **malo razlikuje**, nekatere točke so združene, **omejitev strani na 12**, prejšnja leta 15 strani → **napisati kratko in jedrnato, tabele slikovno gradivo**

ERC paneli - ERC Work Programme 2026



Lahko si pri izbiri polja glede na vlogo pomagamo s ključnimi besedami glede na ERC polje

Naravoslovje in tehnika (PE)

Physical Sciences & Engineering

PE1 Mathematics

All areas of mathematics, pure and applied, plus mathematical foundations of computer science, mathematical physics, and statistics.

PE2 Fundamental Constituents of Matter

Particle, nuclear, plasma, atomic, molecular, gas, and optical physics.

PE3 Condensed Matter Physics

Structure, electronic properties, fluids, nanosciences, biological physics.

PE4 Physical and Analytical Chemical Sciences

Analytical chemistry, chemical theory, physical chemistry/chemical physics.

PE5 Synthetic Chemistry and Materials

New materials and new synthetic approaches, structure-properties relations, solid state chemistry, molecular architecture, organic chemistry.

PE6 Computer Science and Informatics

Theoretical and experimental computer science, information processing, intelligent systems.

PE7 Systems and Communication Engineering

Electrical, electronic, communication, optical and systems engineering.

PE8 Products and Processes Engineering

Product and process design, chemical, civil, environmental, mechanical, vehicle engineering, energy processes and relevant computational methods.

PE9 Universe Sciences

Astro-physics/-chemistry/-biology; solar system; planetary systems; stellar, galactic and extragalactic astronomy; cosmology; space sciences; astronomical instrumentation and data.

PE10 Earth System Science

Physical geography, geology, geophysics, atmospheric sciences, oceanography, climatology, cryology, ecology, global environmental change, biogeochemical cycles, natural resources management.

PE11 Materials Engineering

Advanced materials development: performance enhancement, modelling, large-scale preparation, modification, tailoring, optimisation, novel and combined use of materials, etc.

Vede o življenju (LS)

Life Sciences

LS1 Molecules of Life: Biological Mechanisms, Structures and Functions

For all organisms: Molecular biology, biochemistry, structural biology, molecular biophysics, synthetic and chemical biology, drug design, innovative methods and modelling.

LS2 Integrative Biology: From Genes and Genomes to Systems

For all organisms: Genetics, epigenetics, genomics and other 'omics studies, bioinformatics, systems biology, genetic diseases, gene editing, innovative methods and modelling, 'omics for personalised medicine.

LS3 Cell Biology, Development, Stem Cells and Regeneration

For all organisms: Structure and function of the cell, cell-cell communication, embryogenesis, tissue differentiation, organogenesis, growth, development, evolution of development, organoids, stem cells, regeneration, therapeutic approaches.

LS4 Physiology in Health, Disease and Ageing

Organ and tissue physiology, comparative physiology, physiology of ageing, pathophysiology, inter-organ and tissue communication, endocrinology, nutrition, metabolism, interaction with the microbiome, non-communicable diseases including cancer (and except disorders of the nervous system and immunity-related diseases).

LS5 Neuroscience and Disorders of the Nervous System

Nervous system development, homeostasis and ageing, nervous system function and dysfunction, systems neuroscience and modelling, biological basis of cognitive processes and of behaviour, neurological and mental disorders.
— *In humans and all other organisms*

LS6 Immunity, Infection and Immunotherapy

The immune system, related disorders and their mechanisms, biology of infectious agents and infection, biological basis of prevention and treatment of infectious diseases, innovative immunological tools and approaches, including therapies.

LS7 Prevention, Diagnosis and Treatment of Human Diseases

Medical technologies and tools for prevention, diagnosis and treatment of human diseases, therapeutic approaches and interventions, pharmacology, preventative medicine, epidemiology and public health, digital medicine.

LS8 Environmental Biology, Ecology and Evolution

For all organisms: Ecology, biodiversity, environmental change, evolutionary biology, behavioural ecology, microbial ecology, marine biology, ecophysiology, theoretical developments and modelling.

LS9 Biotechnology and Biosystems Engineering

Biotechnology using all organisms, biotechnology for environment and food applications, applied plant and animal sciences, bioengineering and synthetic biology, biomass and biofuels.

Družboslovje in humanistika (SH)

Social Sciences & Humanities

SH1 Individuals, Markets and Organisations

Economics, finance, management.

SH2 Institutions, Governance and Legal Systems

Political science, international relations, law.

SH3 The Social World and Its Interactions

Sociology, social psychology, education sciences, communication studies.

SH4 The Human Mind and Its Complexity

Cognitive science, psychology, linguistics.

SH5 Texts and Concepts

Literary studies, literature, philosophy.

SH6 The Study of the Human Past

Archaeology and history.

SH7 Human Mobility, Environment, and Space

Human geography, demography, health, sustainability science, territorial planning, spatial analysis.

SH8 Studies of Cultures and Arts

Social anthropology, studies of cultures, studies of arts.

Izhodišča za prijavo – ocenjevalni obrazec, kriteriji, kazalniki, kje kaj umestiti v prijavno vlogo (predlog)

Ocena BT	Kriterij	Kazalniki	Največje št. točk	Kje v prijavi vlogi umestiti – predlog glede na novo projektno vlogo
BT 1	Znanstvena odličnost raziskovalcev	<ul style="list-style-type: none"> -Izjemni dosežki -Izkazana sposobnost samostojnega in ustvarjalnega razmišljanja -Sposobnost priprave predloga raziskave in vodenja raziskav 	5	<ul style="list-style-type: none"> - CV/življenjepis → čim več informacij, ekspertizo na področju raziskovalne ideje; projekti; tržni projekti; raziskovalna odličnost; publikacije, citiranost; mednarodno sodelovanje; gostujoče uredništvo, mentorstva; nagrade, platforme, itd.... → POTREBNO JE IZPOSTAVITI ZNANSTVENE IN VODSTVENE SPOSOBNOSTI - Točka 23.2.2. Project management; izpostaviti tudi odličnost celotnega konzorcija; tudi vodje projekta z navedbo vseh projektov konzorcija - V glavnem delu vloge na DigitalForms navesti čim več projektov celotnega konzorcija (seznam raziskovalnih dosežkov) in mentorstva (doktorantom)

Izhodišča za prijavo – ocenjevalni obrazec, kriteriji, kazalniki, kje kaj umestiti v prijavno vlogo (predlog)

Ocena BT	Kriterij	Kazalniki	Največje št. točk	Kje v prijavni vlogi umestiti – predlog glede na novo projektno vlogo
BT 2	Znanstvena odličnost prijave	<ul style="list-style-type: none"> -Ustreznost naslavljanja pomembnih raziskovalnih izzivov - Ambicioznost in izjemnost ciljev (na primer nove metode in pristopi k razvoju področij) -Jasnost koncepta, vključno z interdisciplinarnim vidikom, in ustreznost ciljev -Izvirnost zamisli -Primernost predlagane metodologije raziskave za doseganje ciljev 	5	<ul style="list-style-type: none"> - 23.1.1 The overall idea of the research and contribution to the field → Jasno opredelimo problem in našo rešitev; izpostaviti problematiko, statistiko podkrepljeno s številkami (CAGR); politike, EU strategije, direktive; vpliv na okolje, ekonomijo, zdravje, raziskovalno področje + indikatorji vpliva → predlog za odprave teh slabosti → ideja/motivacija novega raziskovalnega pristopa → jasno opredeliti prispevek na tem področju - 23.1.2 State-of-the-art in the proposed field of research → narediti natančno stanje raziskav, pomanjkljivosti dosedanjih pristopov, naš original prispevek/preseganje problema z idejo projekta → podati v tabeli, kratko in jedrnato → obstoječi EU projekti (CORDIS baza) in kako je naš originalen pristop/prispevek - 23.1.3 Research questions and objectives → podati raziskovalna vprašanja → hipoteze → glavni in specifični cilji+časovnica+DS+ključni kazalniki uspešnosti (KPI – key performance indicators) - 23.2.1 Methodology of the proposed research → Metodologija predlaganega dela naj se opiše natančno

Izhodišča za prijavo – ocenjevalni obrazec, kriteriji, kazalniki, kje kaj umestiti v prijavno vlogo (predlog)

Ocena BT	Kriterij	Kazalniki	Največje št. točk	Kje v prijavni vlogi umestiti – predlog glede na novo projektno vlogo
BT 3	Kakovost in učinkovitost izvedbe	-Primernost in učinkovitost delovnega načrta, vključno z ustreznostjo dodeljevanja nalog in razporeditvijo sredstev -Izvedljivost znanstvenega pristopa	5	<ul style="list-style-type: none"> - 23.2.1 Methodology of the proposed research → natančen opis delovnih sklopov, trajanje, vodilni partner ter vključeni; namen in povezava s tarčnimi cilji; podamo rezultate in mejnike s časovnico; tveganja in predloge za odpravo teh; feasibility konzorcija (izvedljivost) in KPI - 23.2.2. Project management (including the presentation and role of each member of the research team, work packages, timetable, and risk management) → opis partnerjev, ekspertiza na raziskovalnem področju, in kje bo se njihova vloga odražala; gantogram z glavnimi rezultati in mejniki; Pertov diagram (soodvisnost DS); intelektualna lastnina (IPR); risk management/obvladovanje tveganj; data management plan in načrt ravnanja s podatki – FAIR pristop odprte znanosti; kako bo potekala diseminacija (znanstvene revije, konference, itd.) - 23.2.3 Available research equipment exceeding 10.000 € → tabelarični prikaz z lastnostmi ki jih želimo meriti, oprema, kje se do to odražalo v WP, kaj bomo s pokazali in kateri projektni partner poseduje opremo.

Izhodišča za prijavo – obrazec *opis projekta* aktualnega razpisa in primerjava s prejšnjimi vlogami

DESCRIPTION OF THE RESEARCH PROJECT (Maximum length: 12 pages)

23.1. Background and significance (Maximum length: 5 pages)

23.1.1 The overall idea of the research and contribution to the field

23.1.2 State-of-the-art in the proposed field of research

23.1.3 Research questions (NOVO!!!) and objectives

23.2 Implementation (Maximum length: 7 pages)

23.2.1 Methodology of the proposed research

23.2.2. Project management (including the presentation and role of each member of the research team, work packages, timetable, and risk management)

23.2.3 Available research equipment exceeding 10.000 € → TABELA

Vloga prejšnjih let:

23.1. *Scientific background, problem identification and objective of the proposed research in 23.2.State-of-the-art in the proposed field of research and survey of the relevant literature*

Vloga prejšnjih let:

23.3. Detailed description of the work programme, 23.4. Available research equipment over 5.000 € in 23.5. Project management: Detailed implementation plan and timetable

Izhodišča za prijavo – primeri iz odobrene vloge SURE

RECYCLE

- Na začetku **podan kratek povzetek** o vsebini projektne vloge, **ključne besede** ter **shema koncepta vloge** – na hitro seznanimo recenzenta o čem govori projekt
- Podamo na **slikovit in všečen način kaj je naš glavni pristop k izvedbi projekta in izpostavimo najbolj pomembne aktivnosti, vplivi** (npr. *The overall goal is to strengthen supply chains through efficient metal recovery processes that contribute to environmental protection and promote a circular economy.*)
- **Konsistenčnost, uporabljena terminologija** skozi celotno vlogo

- **Všečen akronim**



- **Logo**

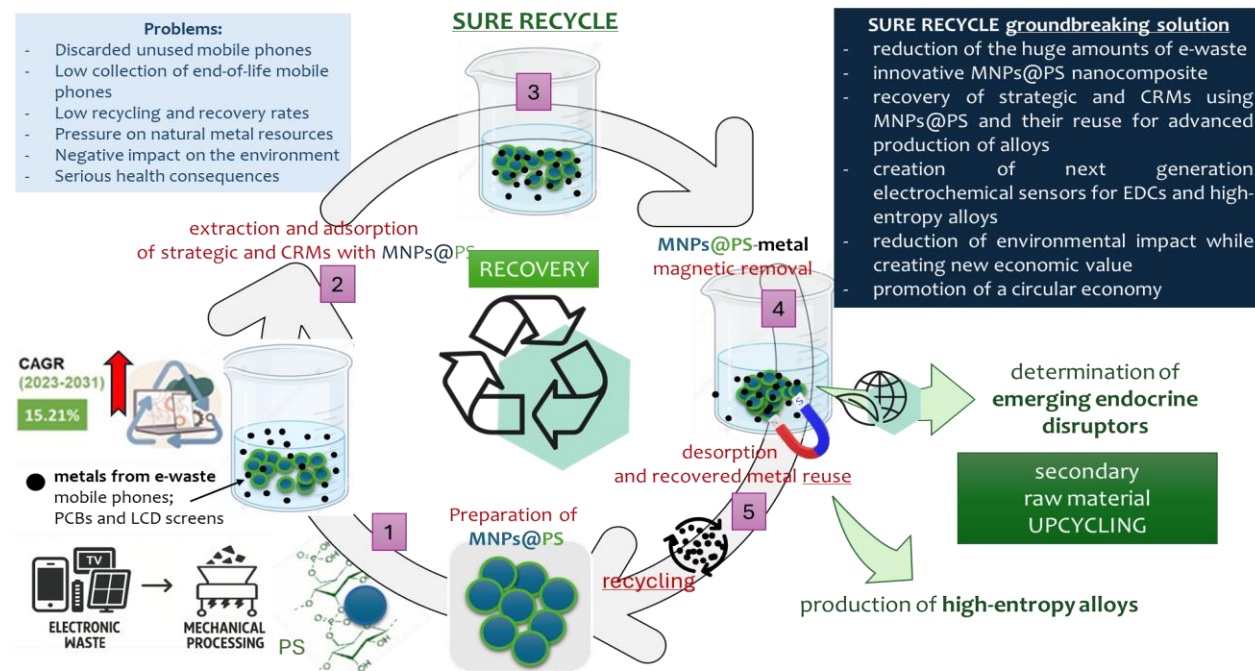


Fig. 1: The overall proposed project approach.

Izhodišča za prijavo – primeri iz odobrene vloge SURE

RECYCLE

23.1. Znanstvena izhodišča ter predstavitev problema in ciljev raziskav (glede na lansko vlogo)

- **EU dokumenti, prioritete EU** (https://commission.europa.eu/priorities-2024-2029_en) **direktive, akcijski načrti, politike** → prebrati je bilo potrebno številne dokumente in jih **podkrepiti z referencami glede na problematiko + statistiko** → vključitev **problemskega drevesa**

Primer iz projektne vloge – **udaren problem**

SCIENTIFIC BACKGROUND AND PROBLEM IDENTIFICATION: Currently, electronic waste (e-waste) is the fastest growing segment of solid waste in the world (~50 Mt/year, 3- 5% growth/year)¹⁻³. Every year, millions of electrical and electronic devices are disposed of because they are outdated or no longer work. If not disposed of properly, **these discarded devices pose a significant risk to the environment and human health**. In the European Union (EU) alone, around 13.5 million tons of electrical and electronic equipment are put on the market every year, resulting in the collection of around 4.9 million tons of e-waste - equivalent to around 11 kilograms per person². With rapid technological advancements and expanding markets, forecasts predict that **the amount of e-waste generated will increase to 74.7 million tons by 2030 and an alarming 110 million tons by 2050⁴**.

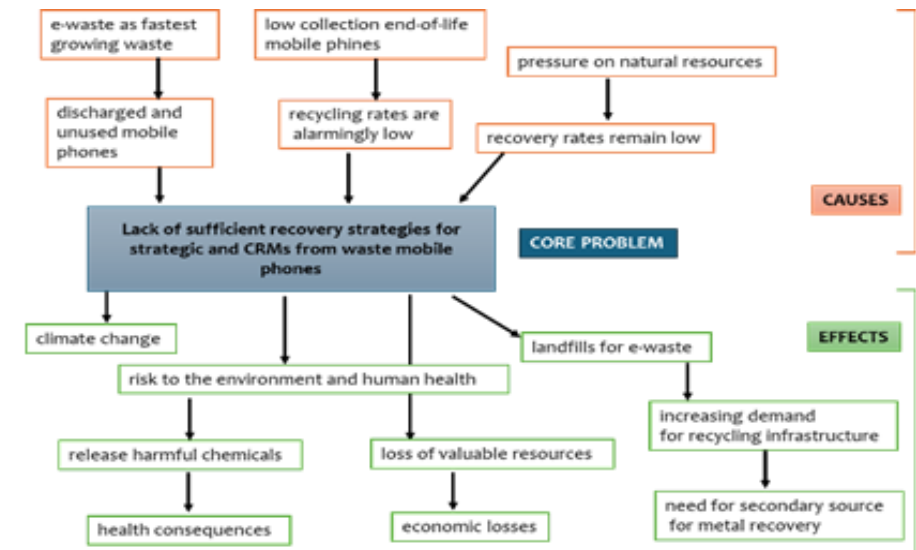


Fig. 2: Problem tree associated with problem of e-waste.

Izhodišča za prijavo – primeri iz odobrene vloge SURE RECYLCE

23.1. Znanstvena izhodišča ter predstavitev problema in ciljev raziskav (glede na lansko vlogo)

- Slabosti dosedanjih pristopov (Fundamental challenges) → **slabosti dosedanjih rešitev, vrzeli, naš ambiciozen pristop**

Despite the recognized recycling potential of waste mobile phones, the current recycling rates are still alarmingly low. This underutilization poses a significant risk to the sustainability of both ecological ecosystems and the mobile phone industry. Failure to effectively recycle these devices not only exacerbates resource depletion but also contributes to environmental degradation, highlighting the urgent need for improved recycling strategies and technologies.

- Izpostavimo na koncu **novost in kje presegamo stanje raziskav – novelty – where we are beyond state-of-the-art ter prednosti**

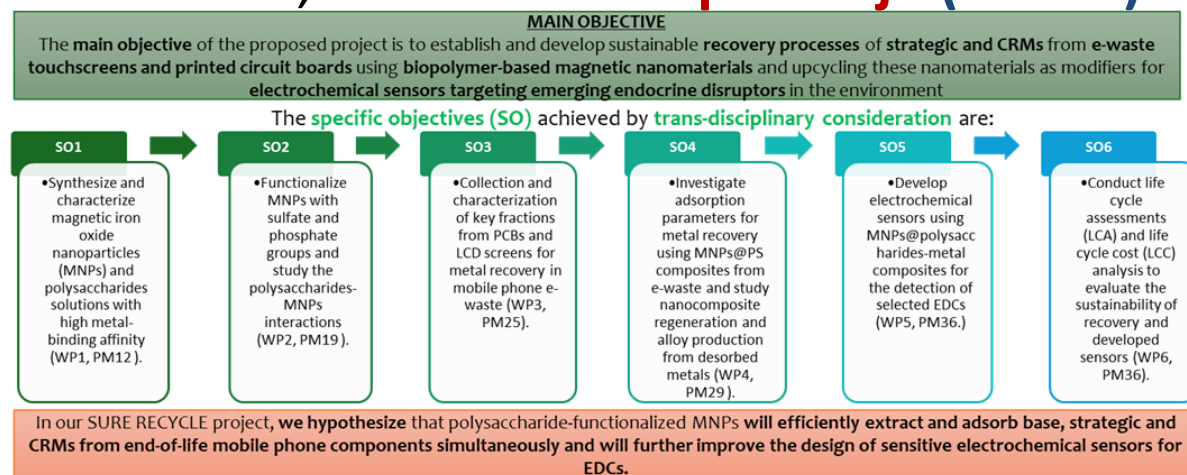
MOTIVATION: SURE RECYCLE introduces an environmentally friendly method using **MNPs functionalized with PS** in an aqueous solution that facilitates the **simultaneous extraction and adsorption** of metals from PCBs and LCD screens, while enabling their **efficient removal** by magnetic force (**magnetic nano-hydrometallurgy**). The proposed project highlights the effectiveness of sustainable PS with sulphate and phosphate groups in the recovery of metals from PCBs and LCD screens and promotes environmentally sustainable metal recovery strategies in the face of the escalating e-waste crisis. Furthermore, this study underlines the importance of **recycling metals, studying their integration into alloys** and explores the potential for **upcycling** these valuable resources into sensors.

- **Splošna shema projekta in povezava DS med sabo – Pertov diagram**

Izhodišča za prijavo – primeri iz odobrene vloge SURE RECYCLE

23.1. Znanstvena izhodišča ter predstavitev problema in ciljev raziskav (glede na lansko vlogo)

- **Glavni cilj, specifični cilji** (Merljiv/izvedljiv/dosegljiv/realističen (S.M.A.R.T. metoda)) – povežemo z časovnico in DS, raziskovalna vprašanja (**NOVO**) + hipoteze



- **Slednje globalnim smernicam in naš doprinos**

In line with the Critical Raw Materials Act of 2024 and the European Union's Strategic Agenda for Critical and Strategic Raw Materials, our project aims to support the EU's ambitious goals for sustainable resource management. **We want to contribute to two key objectives set by the EU: 1) Improve recycling capacities to recover at least 25% of CRMs from recycled sources. 2) Increase domestic production to ensure that at least 65% of CRMs come from the EU.**

Izhodišča za prijavo – primeri iz odobrene vloge SURE

RECYLCE

23.2. Pregled in analiza dosedanjih raziskav in relevantne literature (lanska vloga)

- Pregled in analiza dosedanjih raziskav in relevantne literature → **NATANČEN PREGLED RELAVANTNE LITERATURE**

Magnetic nanohydrometallurgy (MNHM) is an innovative extraction technique mainly used for the recovery of metal ions⁷³. In contrast to traditional pyrometallurgical methods, which involve high-temperature treatments that lead to environmental pollution, or conventional hydrometallurgy, which relies heavily on toxic and flammable organic solvents and extensive chemical processing, MNHM conforms to the **principles of green chemistry**⁹⁰. Although MNHM is still in its infancy, it represents a promising advancement of conventional hydrometallurgical processes. This method utilizes the principles of coordination chemistry found in modern extraction processes. **Specially developed superparamagnetic nanoparticles** are used to capture, transport, trap and process metal ions using an external magnetic field. The nanoparticles used in this process can be fully recovered and enable cyclic operation, eliminating the need for organic solvents and intensive chemical treatments^{90,91}. For example, one study demonstrated the effective recovery of Cu from e-waste using a sorbent consisting of activated carbon modified with MNPs impregnated with α -benzoinoxime. This synthesized sorbent proved to be effective for trapping and recovering Cu ions, even from complex sample matrices⁹². Another study focused on a magnetic composite sorbent made from electrospun polyacrylonitrile nanofibers decorated with magnetite particles. It was successfully used to recover critical metal ions such as Ga, In and Ge from targeted e-waste samples by MNHM²⁹.

- **Pregled projektov**

While numerous EU research projects have focused on the recovery of strategic and CRMs from various sources of e-waste (Table 1), **most have primarily targeted the recovery of metals from e-waste generally rather than with EoL mobile phones specifically**. This project **stands out by an innovative upcycling** of these complex nanomaterials. Furthermore, it uniquely employs a sophisticated combination of PS and MNPs to simultaneously extract, adsorb and remove metals from actual e-waste. This approach not only highlights **the novelty of our project**, but also fills a significant gap in current research, **as there have been no projects to date that have addressed the application of recycled materials in the development of advanced sensors for emerging environmental pollutants**.

EU research projects (Cordis-based)	State-of-the-art	Progress beyond state-of-the-art (Expected original results of SURE RECYCLE)
TARANTULA, (ID: 821159)	Recovery of tungsten, niobium and tantalum occurring as by-products in mining and processing waste streams	Recovery of various strategic and CRMs using magnetic nano-hydrometallurgy and upcycling to sensors

Izhodišča za prijavo – primeri iz odobrene vloge SURE ¹⁴

RECYCLE

23.2. Pregled in analiza dosedanjih raziskav in relevantne literature (lanska vloga)

- Jasno izpostavimo novosti in original prispevek**

Description of the expected degree of originality or scientific innovation of the project

The approach of SURE RECYCLE is **complex and novel** by

The infographic consists of a dark blue background with six white circular icons numbered 01 to 06. Each icon is followed by a white-bordered text box containing a description of a specific aspect of the project's novelty or innovation.

- 01** This project presents a novel magnetic nanoadsorbent combining magnetic iron oxide nanoparticles (MNPs) with polysaccharides (PS) based on the principles of green chemistry. This innovative material will be specifically developed for the extraction and adsorption of metals from end-of-life LCD screens and printed circuit boards (PCBs). Key benefits of this approach include: (i) will enable rapid magnetic separation for efficient recovery, (ii) will provide uniform distribution in the application medium, (iii) will provide a variety of specific adsorption sites that improve extraction and adsorption capacity, (iv) will achieve high recovery efficiency of metal adsorbates, (v) will support multiple application cycles, thus reducing waste, (vi) and will minimize energy consumption and resource use during the adsorption process.
- 02** The fundamental project will explore the interactions between MNPs and polysaccharides and will provide insights into their synergistic effects on metal adsorption processes.
- 03** We will investigate various factors affecting the extraction and adsorption of critical raw materials (CRMs), base and strategic metals from mobile phone e-waste using the MNPs@PS system.
- 04** The development of an effective and non-destructive regeneration technology for the adsorbent will enable recycling and significantly reduce the cost of recovery while promoting sustainability. In addition, advanced metal alloys will be produced from desorbed metals by thermal treatment.
- 05** The project aims to develop original nanomaterial-based sensing technologies for endocrine disrupting chemicals (EDCs) using metal-enriched MNPs@PS. This progress will lead to the creation of next-generation electrochemical sensors tailored for practical applications. In addition, these sensors will be integrated into automated, portable online devices, increasing analytical reliability.
- 06** We will evaluate the sustainability of the newly developed electrochemical sensors and recovery processes and ensure that they meet environmental standards while providing reliable performance.

All of this will be achieved in **an interdisciplinary way** by combining engineering nanomaterials with analytical, physical, colloidal and surface chemistry by outstanding consortium partners

Izhodišča za prijavo – primeri iz odobrene vloge

SURE RECYCLE

- 23.3. Podroben opis vsebine in programa dela raziskovalnega projekta → **namen/cilj (Aim/Objectives), trajanje, vključenost partnerjev, povezava s specifičnimi cilji, natančen opis metodologije, rezultati + časovnica, mejniki + časovnica, tveganja, ukrepi za odpravljanje tveganj, lahko tudi KPI, etc.**

WP3: Disassembly, mechanical processing and comprehensive characterization of key components from PCBs and LCD screens using advanced analytical techniques (FS UM-LMF and Surovina, duration PM 12-25)

T3.1 Collection, disassembly and mechanical processing: In this task we will collect mobile phone waste samples from a waste management company. Mobile phone waste from different categories will be sourced from company and project partner Surovina. The collected samples will undergo a series of cleaning, disassembly and characterization processes to isolate the main components for further analysis. Upon arrival at the laboratory, the phones will be thoroughly cleaned with ethanol, followed by deionized water and then dried with hot air. Manual disassembly of specimens into components and sub-assemblies will be performed using standard tools and equipment, including: Cordless screwdriver, scissors, pliers, scalpels, dremel multitool with grinding and cutting attachments, hammer, precision screwdriver set and an electric tile saw. The phones will be disassembled by hand to remove the main components: PCBs, LCD screens, casings, electronic components (such as cameras and speakers) and batteries. **Only the PCBs and LCD screens will be kept for later examination.** The components will be manually separated from the PCBs, including diodes, resistors, capacitors and plastic components, which will be physically disassembled and removed to preserve only the bare PCB components. Prior to the detailed physical and chemical analyzes, the selected components will be cut into pieces of approximately 1 cm² using tools such as pliers, scissors and a dremel. **The resulting pieces will be then grounded** in liquid nitrogen, freezing the samples for 15 minutes at -196 °C while they rotate in a closed system at 150 rpm (cryomilling). This process aims to achieve a particle size of ≤150 μm, which is optimal to ensure efficient release of metals from non-metallic and ceramic materials¹¹⁷. Similarly, waste from LCD screens will also serve as a primary raw material. First, the screens will be carefully removed from old mobile phones. The polarizing film will be removed from the glass LCDs. The polymer frames that protect the structure of the LCD screen (which do not adhere to the ITO) will be removed manually. The polarizing polymer film that has firmly adhered to the glass surface will be then removed by soaking it in a suitable solvent (e.g. acetone). The screens will then be processed in an automatic mill. To optimize the exposure of the metal elements and improve their dissolution, **the resulting powder will be sieved through a 0.0445 mm mesh, as previous research has shown that particle sizes of less than 0.0445 mm allow for better metal release**⁸³. **T3.2 Characterization of key components:** When characterizing the main components of PCBs and LCD screens from end-of-life mobile phones, **various advanced analytical techniques will be used to determine** them. TGA and infrared spectroscopy (FTIR) will be used to evaluate the organic fraction. Scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDS) will provide insights into the morphology, while XRD will elucidate the mineralogical composition. In addition, with DLS we will determine the particle size distribution. Prior to performing metal analysis by ICP-OES, all ground samples will undergo pre-treatment in a muffle furnace at 600 °C for 1 hour to remove the polymer content. Metal analysis will be performed by analytical company Ikema and by X-ray fluorescence (XRF). Inductively Coupled Plasma Optical Emission Spectrometry (ICP-OES) will be used to quantify and identify the metals present. In this method, precisely weighed, milled samples of 0.1 g each will be leached with aqua regia (2 mL conc. HNO₃ and 6 mL conc. HCl). The solid/liquid ratio will be set to 1/80 to achieve complete leaching of the metals. The leaching process will be carried out on a heating block at a temperature of 90 °C for 2 hours without stirring. The samples will be cooled to room temperature, quantitatively transferred to 25 mL volumetric flasks and diluted.

D3.1: A report describing the manual disassembly process, mechanical processing (PM 22). **D3.2:** The result of all characterization analyzes performed on the PCBs and LCD screens, including elemental composition, organic content, morphology, mineralogical composition and metal composition. (PM 25). **M3.1:** Successful collection of mobile phone waste samples from Surovina, successful dismantling of the collected phones with the main components (PM 22). **M3.2** Successful completion of all methods for characterization of PCBs and LCD screens (PM 25). **R:** Differences in the composition of mobile phone waste from different categories can affect the reproducibility and reliability of the results and the insufficient size of the particles for extraction of metals. **RM:** Develop standardized procedures for the collection and categorization of mobile waste to ensure uniform quality. Check the samples regularly to ensure that they are of an appropriate size for extraction before proceeding with the analysis. **Involved groups:** Leading FS UM-LMF and Surovina d.o.o., involved FS UM-LCPP

Objectives/cilji → WP/delovni sklopi → deliverables/rezultati

Izhodišča za prijavo – primeri iz odobrene vloge

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23.3. Podroben opis vsebine in programa dela raziskovalnega projekta

- Preliminarna dela/Ekspertiza → **ekspertiza konzorcija za uspešno dosego ciljev predlaganega projekta (ocenjevalni kriterij)**

Feasibility of the project/Preliminary work: Our preliminary investigations **have laid a solid foundation for the successful implementation of this project**, which focuses on the synthesis and preparation of magnetic-based nanocomposites with specific properties, electrochemical sensing, adsorption, etc. The consortium has extensive expertise in several areas, including:

- Preparation and characterization: enormous expertise in the synthesis and characterization of magnetic-based polysaccharides and nanomaterials^{115,122,123,121}. This includes the synthesis, functionalization and comprehensive characterization of magnetic nanoparticles (MNPs) in combination with biopolymers with the aim of effectively removing heavy metal pollutants from difficult environmental systems^{124,125,126}.
- Expertise in the application of advanced analytical methods for detailed characterization and interaction studies^{127,128}.
- Utilization of waste as secondary raw materials for products with added value¹²⁹.

This collective knowledge equips us with the necessary tools to overcome the challenges associated with developing an optimal analytical platform for metal recovery technologies. It also supports the development of a novel nanocomposite-modified electrochemical sensor for the determination of EDCs in environmental systems and method validation. The integration of our preliminary results with ongoing research efforts ensures that this project is not only feasible, but also capable of making a significant contribution to environmental remediation technologies. By leveraging our established methodologies and collaborative expertise, we are confident in our ability to achieve the project objectives effectively.

Dosežki/objave na področju tematike predlaganega projekta

Izhodišča za prijavo – primeri iz odobrene vloge

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- 23.4. Razpoložljiva raziskovalna oprema (nad 5.000 €) potrebna za izvedbo projekta → **TABELA**

The methods of analysis for the properties to be investigated are clearly summarised in **Table**, showing how they are integrated into the project proposal SURE RECYCLE by correlated WP.

Table 3: Characterisation of physicochemical properties.

Properties to be investigated	Characterization method	Project Partner	WP
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Capabiliy block	Key equipment	Primary outputs	Partner(s)	WP(s)
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Izhodišča za prijavo – primeri iz odobrene vloge

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- 23.5. Upravljanje projekta: podroben načrt uresničevanja in časovna razporeditev → **Pertov diagram; Gantov diagram; interdisciplinarnost + komplementarnost; opis projektних partnerjev + odlični dosežki ter njihova vloga v projektu in katerih DS; mednarodno sodelovanje/vključenost tujih raziskovalnih organizacij**

The project consortium consists of **6 partners from SLO**: Faculty of Mechanical Engineering, University of Maribor **FS UM**, including two laboratories: **Laboratory for characterization and processing polymers (FS UM-LCPP)** and **Laboratory for Materials Forming (FS UM-LMF)**; Department of Materials Synthesis (**JSI-MS**) and Department for Nanostructured Materials (**JSI-NM**) from Jožef Stefan Institute **JSI**, **Faculty of chemistry and chemical engineering UM (FKKT UM)** and waste management company **Surovina d.o.o.**, which will work in a **complementary and transdisciplinary way**. The individual expertise of the partners is **highly complementary to the proposed nanomaterials, recovery, recycling and sensing schemes** and hence to the collaborators. Each participating team would bring recognised expertise in the field of synthesis of magnetic (nano)materials (JSI-NM, biopolymers (polysaccharides), surface chemistry, physical chemistry (adsorption and recovery), electrochemistry, environmental protection, LCA and LCC analyses, etc. These subsciences together in the intersection and as a union can provide **the solution to our project problem and achieving the ambitious project goals**.

Expertise of the partners and their role for a successful project implementation

The objectives and expected results of the project are defined based on the expertise of the partners, who are **highly regarded with outstanding achievements**. Moreover, their achievements are reflected in outstanding publications on specific topics: magnetic nanoparticles, (nano)material synthesis, functionalization and characterization, interactions, adsorption/desorption phenomena, structural and surface material properties, electrochemistry, evaluation of the sustainability of processes, etc. with **clear feasibility of the project**.

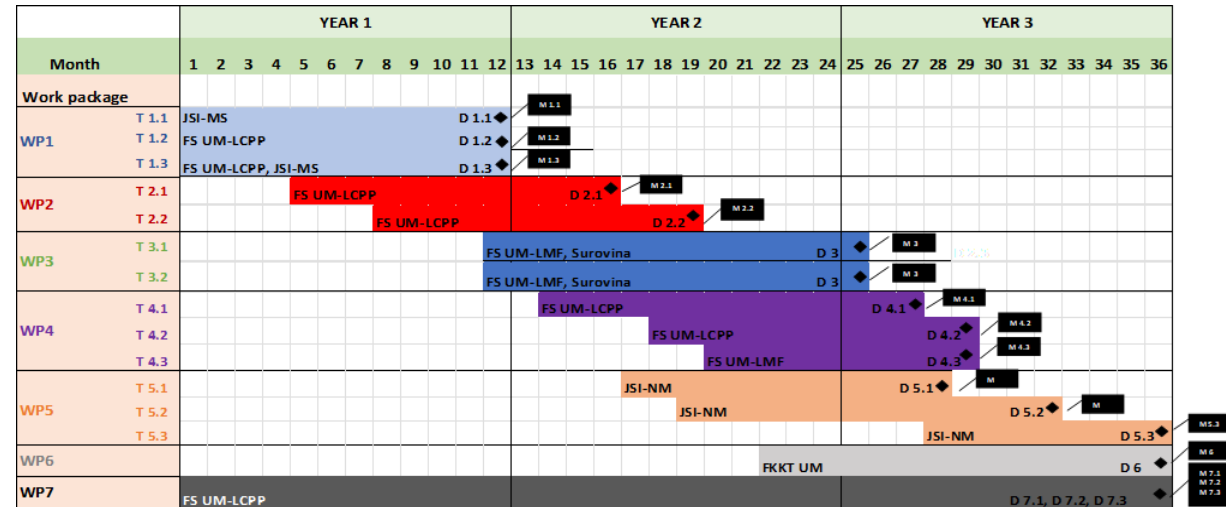


Fig. : Project action-timing in months - Gantogram.

Izhodišča za prijavo – primeri iz odobrene vloge

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- **NASVETI**

- **Izbira raziskovalnega področja!** – glede na razpisane kapacitete
- Glavna on-line vloga: Dva do pet najpomembnejših raziskovalnih dosežkov – **povežemo z implementacijo DS**
- Obseg vključenosti glede na naloge posameznega partnerja (število ur) → **realna možnost tudi izvedljivosti** (ne preveč obsežne aktivnosti..)
- **Konsistenčnost, kratkost, jedrnatost skozi celotno vlogo**
- **Tabele, slikovni prikaz**

Želim čim več uspešnih vlog!



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