Table of contents

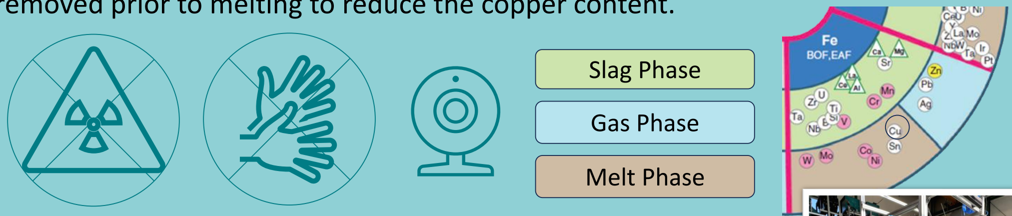
KiRAMET

AI-BASED RECYCLING OF METAL COMPOUND WASTE

KIRAMET takes an ambitious step towards the production of higher quality scrap fractions through the use of AI-based methods in the development of an intelligent recycling platform. The aim of this platform is to improve the recycling process to such an extent that large quantities of scrap can be made available in high-quality, defined and nationally recyclable metal fractions, thus making a significant contribution to climate neutrality and the supply of raw materials.

KIRAMET uses **machine learning** and **computer vision** techniques to discern between copper containing particles and iron particles and remove them as even **miniscule amounts of copper** can make the created steel unfit for most applications.

Once molten, **copper can not be removed from the melt** as it enters neither the gas- nor the slagphase. This means that copper containing particles must be removed prior to melting to reduce the copper content.



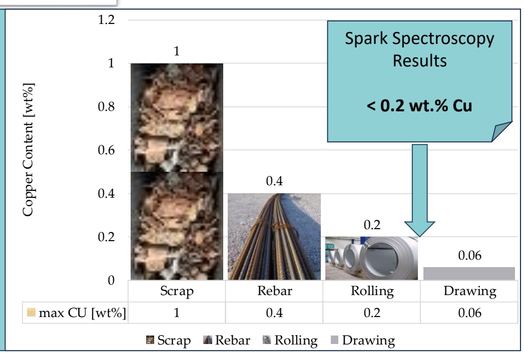
To **test** whether the created method is capable of ejecting copper containing particles in an industrial setting, a **prototype** has been created in **KIRAMET**. This protoype allows for any trained object detection model to be used to **control the high pressure nozzle bar to eject unwanted particles.**

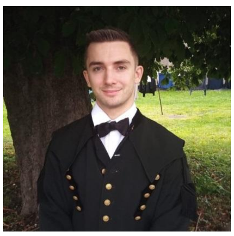
This prototype was already used to sort **batteries**, **textiles**, **scrap** and **lightweight** packaging waste.

For **KIRAMET** it was used to sort approximately **20 tonnes of scrap**.

This scrap was molten down in an **Electric Arc Furnace.** The **spark spectroscopy** showed copper contents **below 0.2 wt.%**, which EN 10025-2 states as the upper limit for use in drawing operations.

This was achieved with **low cost equipment**, **minimal human supervision** and with an **average power consumption** for classification **of 20 Watts**.





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Gefördert durch
Bundesministerium Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie

KiRAMET
KI BASIERTES RECYCLING VON METALLVERBUND-ABFÄLLEN

FFG Forschung wirkt.

GreenPLAST-food

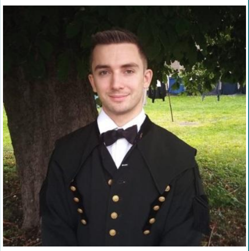
Innovation for Food Packaging Recycling

In the greenPLAST-food project, new processes are being developed to recycle plastic packaging made of PP and PE in such a way that it can be safely used again for food contact – energy-efficient, sustainable and using AI-supported sorting. The aim is to develop an industrially feasible model for a recycling factory.

The **greenPLAST-food** project, entitled **"Green Plastic Recycling Factory for Food Contact Materials"**, aims to revolutionize the **recycling of polypropylene (PP) and polyethylene (PE) plastic packaging waste (PPW)** for use in **food contact materials** (FCM). This large-scale collaborative research project aims to develop **innovative, energy efficient, and sustainable processes for PPW recycling,** with a focus on **achieving safe, high-quality polyolefin recyclates** that meet the **decontamination standards.** This will be achieved by **combining AI-based sorting mechanisms, optimized state-of-the-art recycling technologies, and advanced decontamination methods.**

greenPLAST-food establishes a framework and blueprint for the recycling industry. **AI** models will be trained and tested on **an industrial prototype** to assess their ability to detect food-grade plastic packaging. To address **data scarcity in AI-driven waste management,** generative AI will be leveraged to **create, annotate, and curate training datasets from real-world examples.**

The project is structured into seven work packages (WPs) covering both experimental development and industrial research. WP2 and WP3 focus on optimizing and adapting existing recycling technologies for PP and PE waste streams to process high-quality food grade recyclates from pre-sorted PPW. The data generated on optimized unit processes will serve as a basis for the work packages WP4-WP7, which aim to further refine the recycling process, ensuring both technical viability as well as environmental and social sustainability.



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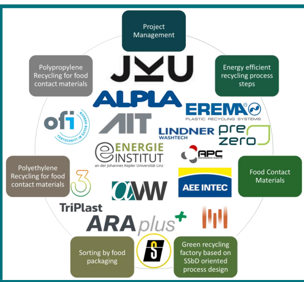


Project	GreenPLAST-food
Funding agency	FFG
Project duration	01.10.2025 - 30.09.2028
Project volume	6.200.000 EUR

FFG Promoting Innovation.
Bundesministerium Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie

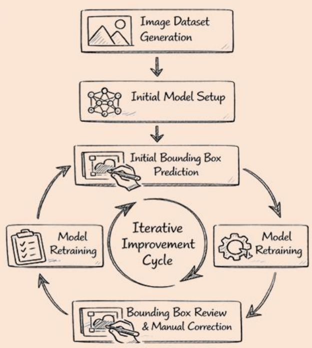
AI-Driven Sorting of Post-Consumer Textiles at Pilot Scale

Hannah Weber, Gerald Koinig, Julian Aberger, Thomas Fink, Alexia Tischberger-Aldrian

Motivation

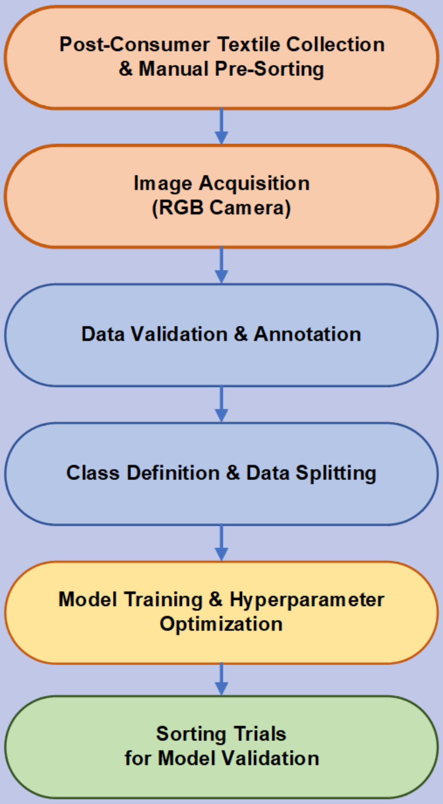
Due to their **diverse properties**, textiles are an essential part of our daily lives. **Rising consumption**, **low prices**, **short product lifecycles**, and the trend of **"fast fashion"** are leading to enormous amounts of waste, accounting for approximately **92 million tons** annually worldwide. Given the sharp increase in waste volumes expected in the future, existing collection, sorting, and recycling systems are increasingly reaching their capacity limits. **Manual sorting**, which has been the dominant method to date, requires significant **time, labor, and financial resources** and proves uneconomical given the low value of used textiles. **Camera-based technologies** combined with **artificial intelligence** represent a promising and **cost-effective alternative** for sorting textiles according to product-specific characteristics.

Dataset & Annotation

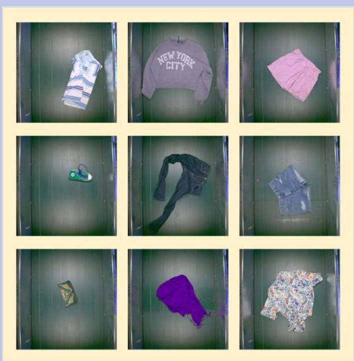


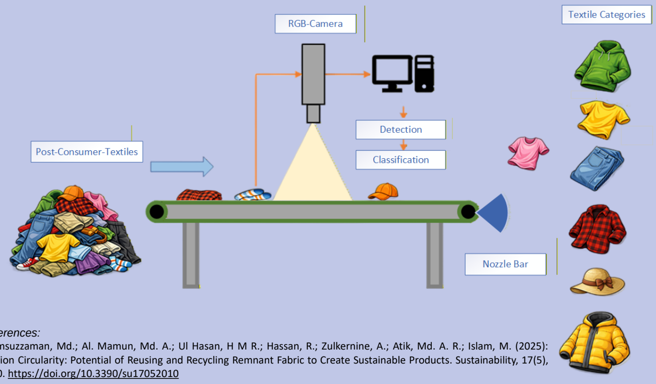
Approximately **2.5 tons** of used textiles from Austrian collection systems were used as **sample material** to generate an **adult clothing dataset**. Using a **semi-automatic annotation tool** developed at the Chair of Waste Processing Technology and Waste Management at Montanuniversität Leoben, iterative training cycles enabled **efficient annotation** of the extensive dataset.

Methodology & Experimental Setup



The goal is to develop an **object-based sorting model** for **the automatic classification** of used textiles by **product type**. Image-based classification systems require **realistic datasets** for this purpose, which replicate real-world **process conditions,** as well as a high **diversity** of relevant textile categories. The generated image data forms the basis for training an **AI-based sorting model**. Following the annotation and validation of the dataset, a one-stage model architecture from Ultralytics was trained for the **detection and classification** of used textiles. This was followed by a comparison of **model performance** with the transformer-based RT-DETR model architecture on a pilot plant scale. For further optimization, model- and data-specific parameters were systematically determined through **hyperparameter tuning**. Finally, the trained model architectures were **validated, compared**, and **tested** for **classification accuracy** under various task scenarios at the **pilot plant**.





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FTI-Initiative Kreislaufwirtschaft

Christian Doppler Forschungsgesellschaft

Bundesministerium Land- und Forstwirtschaft, Klima- und Umweltschutz, Regionen und Wasserwirtschaft

StraTex

FFG Promoting Innovation.

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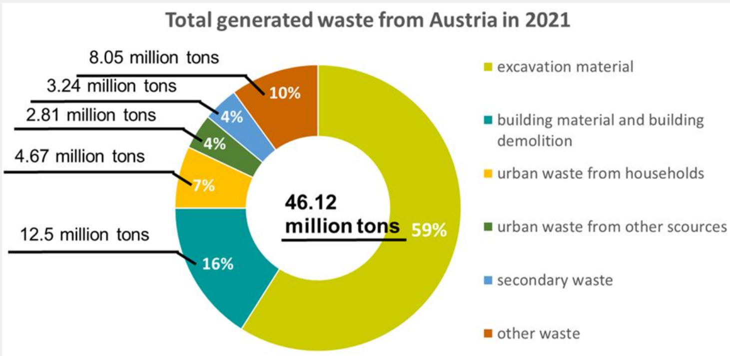
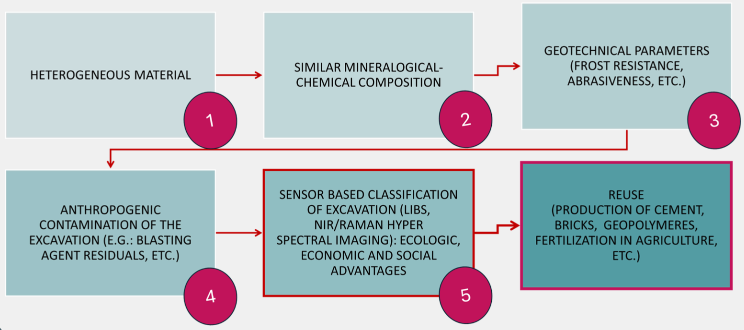
Sustainable use of excavation materials from civil engineering with sensor based classification

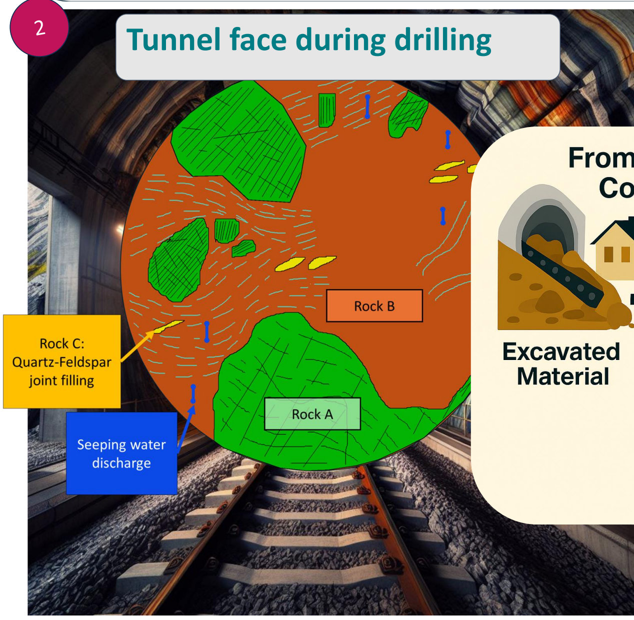
*Most excavation material in Austria is disposed of in landfills. According to the latest national assessment, Austria operates **1,158 landfills**, of which **980 are dedicated to excavation material disposal** (Austrian Waste Status Report 2025). The NNATT project (Sustainable Use of Tunnel Excavation Material with Sensor-Based Classification) addresses this challenge by enabling sensor-based material classification (LIBS, NIR and Raman) on a continuously running conveyor belt and promoting utilization, thereby conserving primary resources, reducing landfill dependency, shortening transport distances, and improving sustainability in the construction sector.*



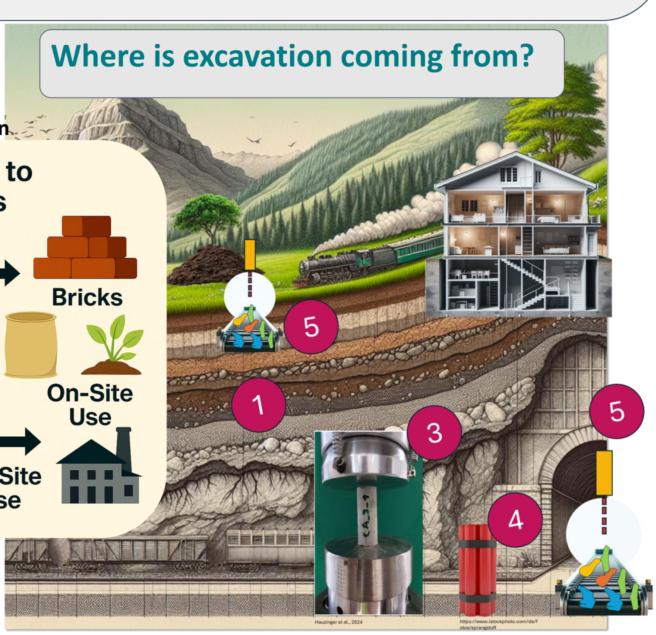
Why is the classification of excavation a challenge?



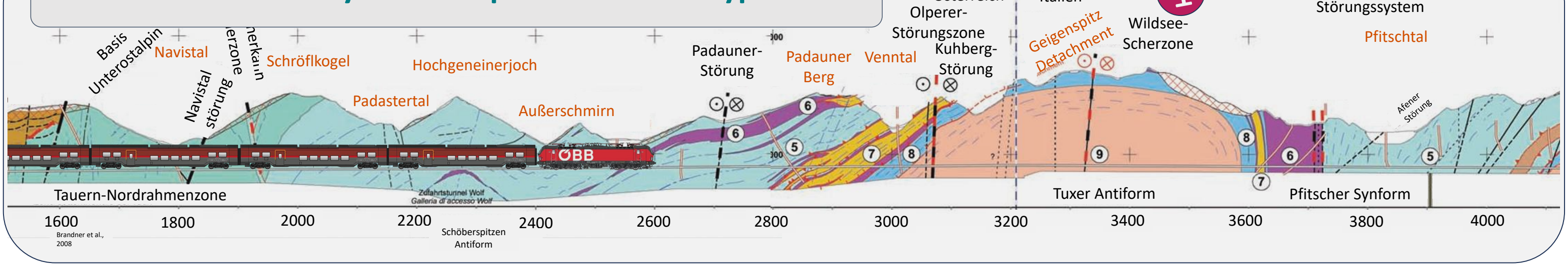
Tunnel face during drilling



Where is excavation coming from?



Brenner tunnel - every colour represents a rock type



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Development of digital, sensor-based methods for waste-characterisation

With the Digital Waste Research Lab as the Chair's own infrastructure for developing digital characterisation methods.

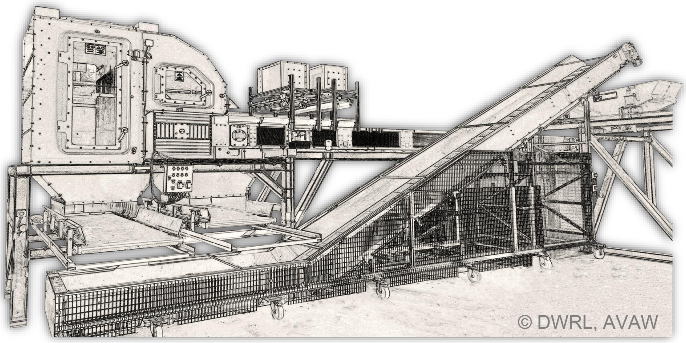
Conventional Sorting Analysis

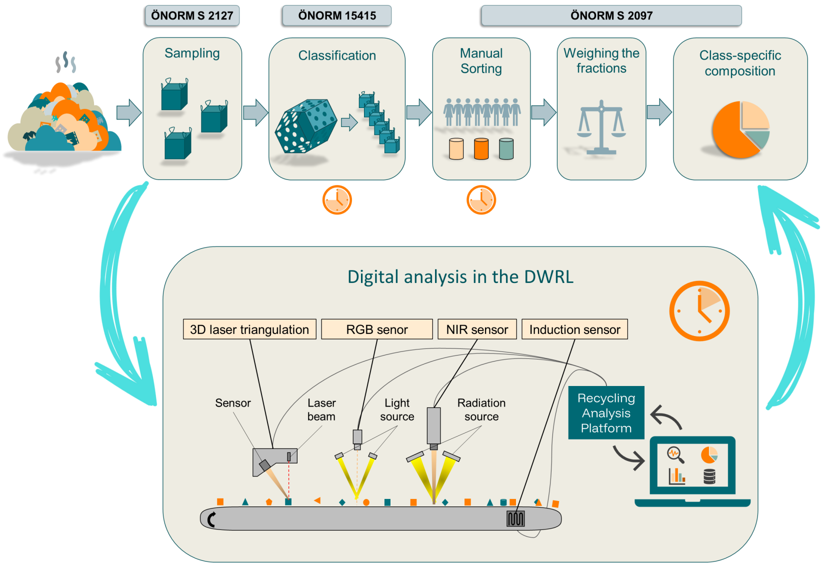
Currently, sorting analyses for solid, heterogeneous waste (e.g. municipal and commercial waste) are carried out using standardised manual methods. Due to the high degree of heterogeneity in the material mixtures [1, 2], this involves a considerable investment of staff time and resources, which leads to delays in the availability of results.

Digital Sorting Analysis

Due to the high time and effort involved in conventional methods and the accumulation of errors across all process steps [3], there is increasing demand to develop innovative digital approaches for sorting analyses as the waste management sector goes through the digital transformation.

To this aim, the Digital Waste Research Lab (DWRL) at the Chair of Waste Processing Technology and Waste Management (AVAW) at the Technical University of Leoben offers a modular, expandable research infrastructure at a near-industrial level.





- **Customisable multi-sensor systems:**
  - NIR, RGB, 3D laser triangulation, Induction and RFID
- **Data processing via the Recycling Analysis Platform:**
  - Real-time synchronisation, visualisation and complex data fusion at the particle level
- **Process flexibility:**
  - Analysis of individual objects
  - Circulation of sample volumes of up to 10 m³
  - Continuous material flows of several tonnes (industrial scale)

Objectives & Outlook

- Development of a standardisable method for digital sorting analysis
  - Particle size distribution
  - Material composition
  - Contaminant content
  - Mass flows
- AI-based object re-identification for multiple analyses
- Multisensory data fusion at object level
- Establishment of a multimodal material database

Benefits & Impact

- Digital, real-time and resource-efficient sorting analysis
- From real-time analytics to a learning process: on-time material data as the key to optimising machinery, plant operations and output quality
- High-resolution material database as an enabler for intelligent control algorithms in waste treatment plants – "Smart Waste Factory"
- Improvement of reproducibility through the reduction of subjective factors

Research Questions

- What is the representative set of parameters for the machines used?
- How does material need to be fed into the facility to achieve comparable results to those obtained using conventional methods?
- Can object re-identification during multiple analyses generate a significant increase in particle information?
- How should fused material data be further processed and evaluated for characterisation?
- How should a standardised database for fused, material-specific simulation data look like?

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AVW Abfallverwertungstechnik & Abfallwirtschaft
Department für Umwelt- & Energieverfahrenstechnik

Clean Dregs

Valorization of Residues from Kraft Pulp Mills: Improved Dewaterability, Chemical Recovery, and Utilization Pathways

Generation and Handling of Green Liquor Dregs – Status Quo

The Kraft process is the dominant chemical pulping method for producing pulp from wood. In this process, wood chips are cooked in a "white liquor" solution containing sodium hydroxide (NaOH) and sodium sulfide (Na_2S), which dissolves lignin and separates the cellulose fibers. The spent cooking liquor, known as "black liquor", is concentrated and burned in a recovery boiler. The smelt produced in the boiler is dissolved in water to form "green liquor," which is typically clarified in a sedimentation tank. The clarified green liquor is then causticized with calcium hydroxide ($Ca(OH)_2$) to regenerate white liquor (see figure 1).

The sedimentation residue – referred to as "green liquor dregs (GLD)" – is removed from the chemical recovery cycle after usually undergoing multi-stage dewatering.
The generation of GLD amounts to roughly 4–20 kg per ton of pulp. GLD typically consist of process chemicals (Na, S), calcium carbonate, unburned carbon and non-process elements (NPE; e.g., Al, Si, Mg, P, Cl, etc.). At present, the majority of GLD is disposed of via landfilling, which incurs costs. Only a small fraction is currently subjected to recovery, yet this option likewise also involves costs rather than providing any economic return [2].

From Waste to Resource: Project Objectives for GLD Utilization

The motivation of Clean Dregs lies in reducing the costs of landfilling and recovering process chemicals in order to close internal cycles and increase the efficiency of pulp production. For this purpose, GLD from three Austrian pulp mills are comprehensively analyzed with regard to their chemical, physical and mineralogical properties, to identify process parameters affecting these characteristics.
Figure 2 schematically illustrates the overarching project objectives.
The increase in dry content of the generated GLD (A), the separation and recovery of process chemicals (B) and the removal of contaminants (C) should lead to a residue that can be utilized for material recovery (D).
While previous research has mainly dealt with the utilization of "as-is" GLD, Clean Dregs aims to develop solutions for the material recovery of dewatered and further processed GLD.
The focus is on the development and experimental testing of process strategies, which are intended to result in an industrially feasible solution for the entire pulp and paper industry in Austria.

Quantities of GLD
Globally: 0.7-2.1 Mt/y [3]
Austria: ~15,000 t/y

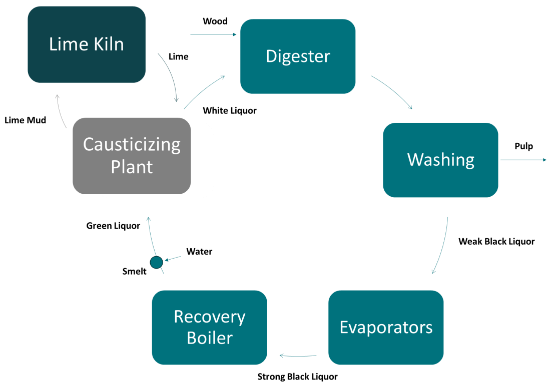

Figure 1: Schematic of the Kraft recovery cycle [1]

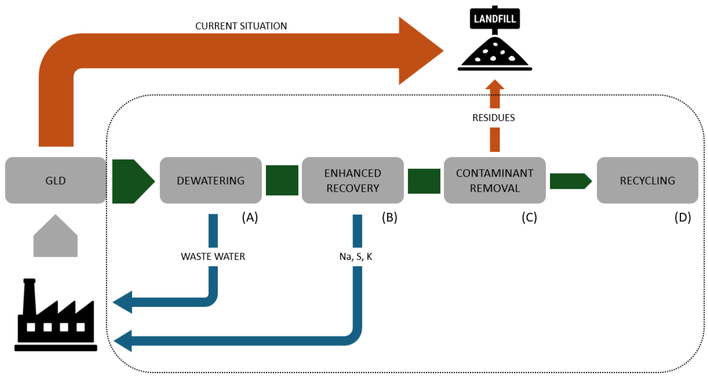

Figure 2: Current handling of GLD vs. Clean Dregs concept and project objectives

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[3] Novais, R. M., Carvalheiras, J., Senff, L., & Labrincha, J. A., 2018. *Construction and Building Materials, 184*, 464–472. https://doi.org/10.1016/j.conbuildmat.2018.07.017

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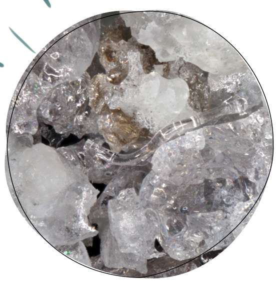
Recycling of Mineral Wool Waste

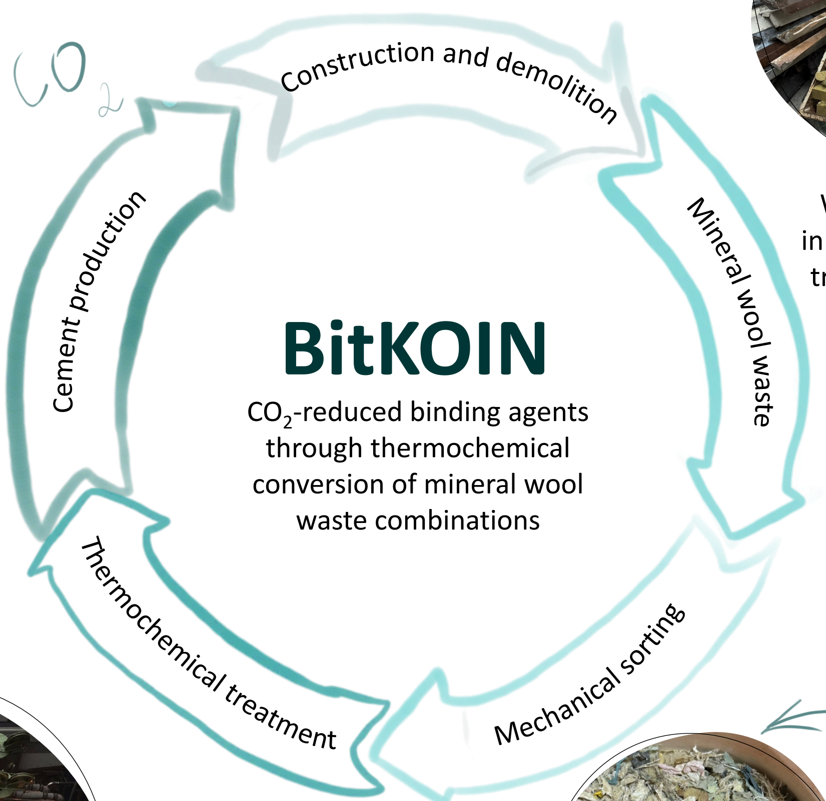
Open-Loop Approach for the Building Industry

The resulting binder can be integrated into cement production, reducing CO_2 emissions and reliance on virgin raw materials.

Austria generates approximately 20 000 tons of mineral wool waste annually from construction and demolition activities.

97 % of mineral wool waste is currently landfilled in Austria.





We suggest an innovative way of treating mineral wool waste.

The collected waste undergoes volume reduction and impurities removal to prepare it for further processing.

Thermochemical treatment, up to 1500 °C, of mineral wool waste and other residues to generate a reactive binder component for the building industry.

Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie. Die Bestandsaufnahme der Abfallwirtschaft in Österreich. Wien, 2025.

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Project Partners

FFG, SAINT-GOBAIN, TU Graz, ROHRDORFER, PORR, HOLCIM

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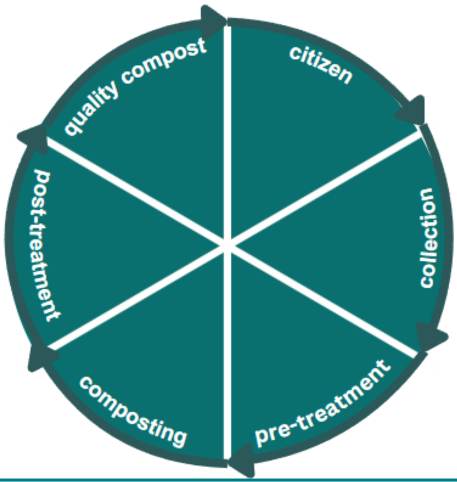
Plastic Free Compost

A cycle-oriented approach for a sensor-based ejection of plastics to produce quality compost



Did you know…

- …that bio-waste must contain an impurity content of less than 3 wt% regarding the OS to be suitable to produce quality compost?
- …that future legal requirements are possibly going to demand an impurity content of less than 2 wt% regarding the OS?
- …that the EU has defined recycling rates of 60 % (2030) and 65 % (2035) for municipal waste? Bio-waste is one of the most essential factors in achieving the recycling targets.
- …on average, 128 kg of biowaste is collected per inhabitant per year in Austria?

Introduction

In the project “Plastic Free Compost“ eight partners worked on improving the quality of bio-waste and the compost that is derived from it over the course of three years along the different phases of the composting cycle shown above.

Methods

In the area of organic waste collection, various behavioral intervention measures were implemented in three Styrian municipalities, and their effectiveness was evaluated. To study plastic disintegration, a defined amount of specific plastic products was added to pre-sorted bio-waste from households, which was then subjected to a ten-week composting process using various compost turners. During pre-treatment, various shredding units and screening machines were compared in different combinations through large-scale trials. The investigations into sensor-based sorting were conducted on a pilot plant scale.

Results

A rapid measurement method for determining the contamination level of bio-waste at the vehicle level was developed and applied. The quality of biowaste in densely populated areas was reduced by up to 67% through the targeted distribution of paper bags. Large-scale trials conducted on the disintegration of plastics demonstrate an increase in the number of objects as mechanical stress during processing increases, as well as the greater relevance of plastic films (LDPE bags) compared to rigid plastic products (PP pots) in terms of contaminant issues. With the developed preparation scheme, it is possible to remain below the 2 wt% threshold even on heavily contaminated collection routes. The results serve as the basis for the pre-treatment plant of Holding Graz. The technical suitability of sensor-based sorting for pre- and post-cleaning has been demonstrated.

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GRAZ Holding
AWV Leoben – Die Steirischen Abfallwirtschaftsverbände
Poschacher Kompost Zukunft auf gutem Boden
AWV Mürzverband – Die Steirischen Abfallwirtschaftsverbände
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Poster Exhibition 2026

The circularity center of the future

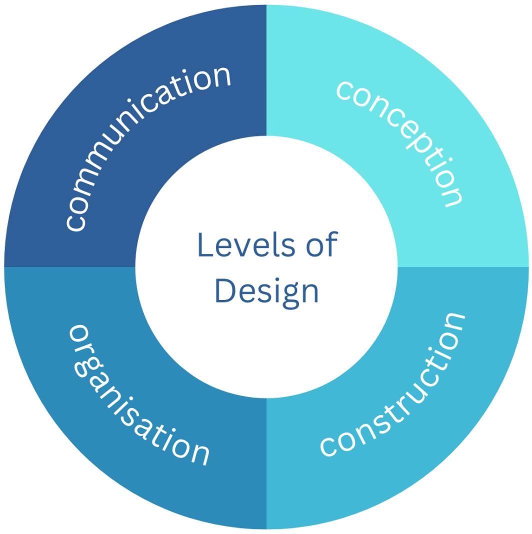
Transformation from waste collection centers to the circularity center of the future

Introduction

Waste collection centers, resource parks, recycling yards, or waste collection points serve as an important interface between citizens and the waste management sector. For the largely outdated recycling yard infrastructure currently in place in widespread areas of Austria a future-oriented, innovative concept for transforming them into the circularity centers of the future was developed. This research was carried out in a master's thesis as part of the project "Transcircular Salzburg". The findings are intended to serve as a foundation for the practical implementation of circularity centers in interested municipalities.

Methods

The development of the overall concept included assessing the current state of technology in several federal states of Austria through research and visits in existing facilities, generating new ideas via workshop, elaborating the concept itself, and emphasizing aspects of waste psychology and sociology. Additionally, an interview with a psychologist focused on sustainability took place.



Results

The examination of the intended changes happened on the levels of conceptual design, building/construction, organisation and communication. On the conceptual level, a catalog of requirements for such circularity centers was developed, which can be applied to facilities of various sizes.

A distinctive feature of the construction level is the use of sustainably produced building blocks, for example the "futureBloc" developed by Salzburg Wohnbau GmbH. Further elements are the choice of the location, the implementation of existing building structures and the zoning of the site.

From an organisational perspective, key factors include a functional and straightforward design, the determination of the number of collected fractions, opening hours, partnerships, and the selection of suitable containers.

On the communication level, elements of "nudging" derived from psychology and sociology are to be implemented as well as social activation, public relations, the use of colors and event concepts.

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Move mountains