STIFTUNG ZENTRUM FÜR NACHHALTIGE ABFALL- UND RESSOURCENNUTZUNG

Activity Report/Annual Report

2023

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Content

Foreword by the President

Implementation of the circular economy requires specific guidelines.

Since 1983, Switzerland has had an Environmental Protection Act (EPA) aimed at protecting humans, animals, plants, their communities, and habitats from harmful or annoying influences. To specify these goals, the Federal Council has issued numerous implementing ordinances over the past 40 years, updating them as needed.

While many provisions of environmental legislation were enacted to remedy existing damage, the EPA and its associated regulations provide guidelines for prevention in many areas. Some measures to protect the environment from harmful influences have been implemented at no additional cost, and there are even examples where taking action has led to long-term financial relief or competitive advantages for those obligated. However, let's be honest, most measures to remedy or prevent harmful influences have incurred costs.

In all these cases, the success achieved over the past 40 years with environmental protection legislation has been based on clear regulations regarding cost allocation and specific guidelines in terms of target or limit values that must be adhered to. Because generally abstract provisions outlined in a law must necessarily be specified with clear guidelines at the regulatory level to be implemented in specific cases.

For those involved in waste management, it is not news that almost everything once brought to market will eventually become waste, with few exceptions. If society as a whole were to embrace Goal 12 of the United Nations's Agenda 2030, which emphasizes responsibility in production and consumption, it would be a key step towards simplifying the handling of unused goods without relying solely on end-of-pipe solutions.

Data published by the Federal Statistical Office on material flows in Switzerland in 2021 indicate that there was a total direct material input of 12.4 tons per person (imports of 5.7 tons and domestic extraction of 6.7 tons). The return of recyclable materials from unused items or waste amounted to approximately 1.4 tons per person in 2021.

Thus, the concept of the circular economy is highly commendable, as it not only avoids harmful or annoying influences but also creates benefits for the future, which often come with associated costs. The greatest challenge in implementing the circular economy lies not primarily in optimizing the recovery of materials from waste but in ensuring that the production of new goods is designed to be more «circular,» meaning more durable and easily recyclable.

To achieve this, abstract goals and regular reporting are insufficient. It requires concrete indicators designed to avoid perverse incentives and, analogous to regulations on legacy issues, clear statements on who bears the costs of circular economy measures when creating future added value that may only benefit much later.

Without these guidelines, the implementation of the circular economy remains at the level of aspiration – this also applies to carbon capture from large point sources.

A sober analysis reveals that, at present, we live in a society characterized by pronounced growth in annual material flows and are far from being a circular society. Therefore, we are all, especially policymakers, challenged if we genuinely intend to implement the concept of the circular economy. The motto is: «governing is foreseeing.»

The following example illustrates the necessity of clear guidelines regarding performance and cost allocation in the implementation of the circular economy:

As the ZAR Foundation, commissioned by eight sponsoring organizations representing about half of Switzerland's sewage sludge volumes, we conducted a feasibility study to determine whether a facility for producing high-quality phosphoric acid could be established at the KEBAG site in Zuchwil based on the Phos4life® technology.

The result, presented to the project partners in April 2023, is clear: the site has many advantages, and such a facility would also be licensable. However, significant investment and operating costs would be incurred to separate heavy metals and pollutants from phosphorus in the sewage sludge.

Many questions arose, such as how much phosphorus should be recovered? Who should pay for it? How does this align with the principle of legality if financed through wastewater fees? The implementation of the project seemed fundamentally challenged.

It is fortuitous that during the deliberation of the Parliamentary Initiative (PI) to strengthen Swiss Circular Economy (20.433), the Council of States in December 2023 added two important provisions regarding phosphorus recovery from sewage sludge to the Environmental Protection Act (EPA). As a performance indicator, the Federal Council will now determine the amount of phosphorus to be returned from municipal wastewater or sewage sludge from central wastewater treatment plants to the economic cycle. Additionally, the EPA will stipulate that the operational and capital costs not covered by product revenues (e.g., phosphoric acid) are to be borne by the polluters of sewage sludge.

With this clarification, approved by both chambers on March 15, 2024, the prerequisites have been created for the implementation of phosphorus recovery from sewage sludge.

This is a good example of the circular economy because for phosphorus, the «resources» for Switzerland's self-sufficiency are in our own waste. Recovering phosphorus in the form of high-quality phosphoric acid from sewage sludge, along with phosphorus-containing ash from animal and bone meal, can supply Swiss agriculture with essential phosphorus fertilizer (triple superphosphate) and contribute to the circular economy.

My gratitude goes to our long-standing donors, who make our work possible, and to all partners who contribute with financial support and/or open collaboration to develop projects such as phosphorus recovery from sewage sludge ash or CO_2 capture from the exhaust gases of thermal waste treatment.

Last but not least, I would like to thank all employees at the three locations – KEZO in Hinwil, KEBAG in Zuchwil, and KVA Linth in Niederurnen – for their tremendous dedication to turning concepts developed on paper into practical realities.

Recently, while visiting one of my daughters at her refrigerator, I noticed a card with this saying: «Doing is like wanting – only more intense.» It fills me with joy that the ZAR Foundation is driven by «doers.»

Franz Adam

President of the Board of Trustees

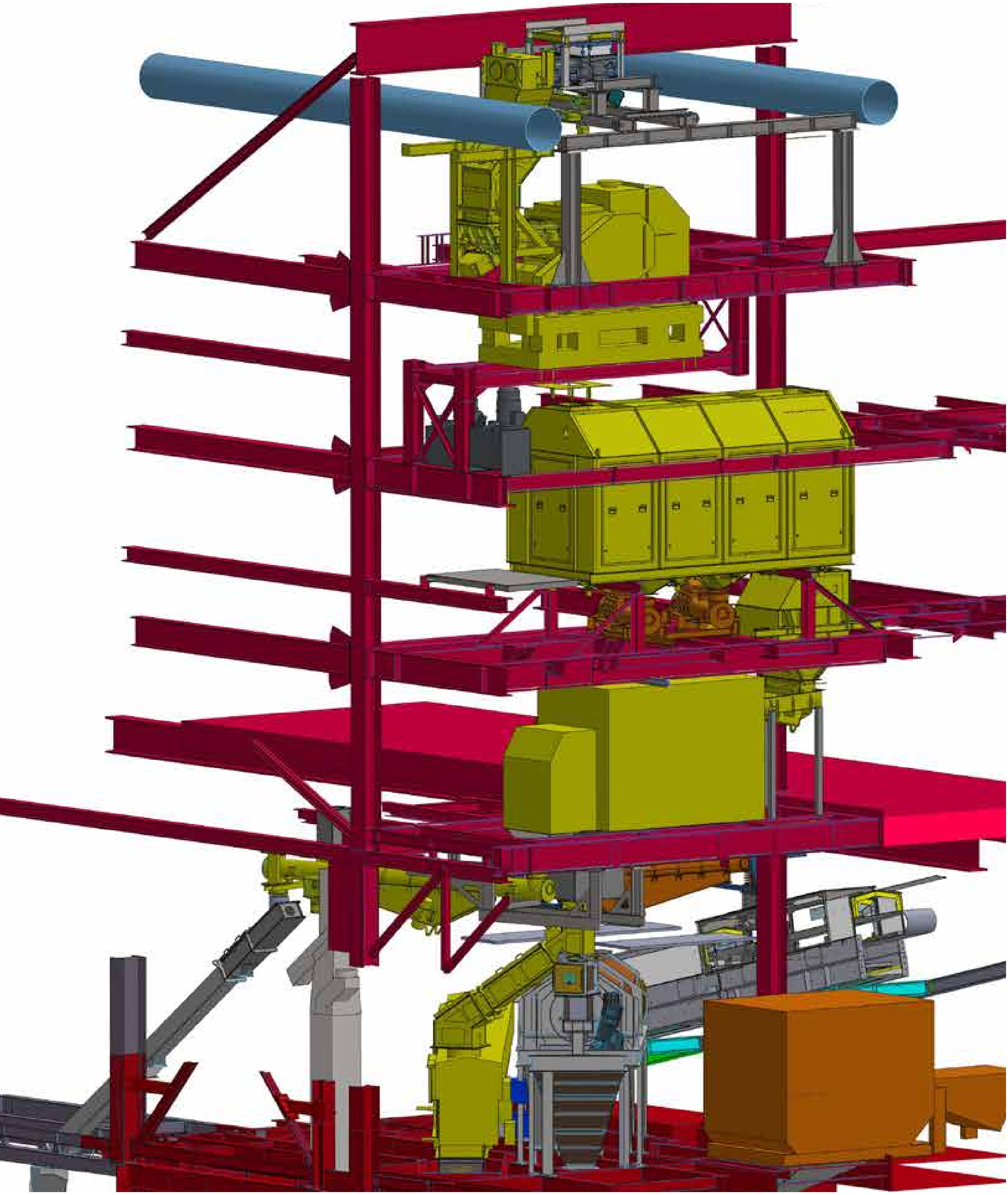
Our Vision

We consider waste as potential resources.

Quality

In demand from the market

Transparent processes



Technical Developments

KEZO Hinwil (ZH)

COMPETENCE CENTER DRY BOTTOM ASH PROCESSING

Experiences with the new processing line 15–30 mm

Due to delays in the delivery of key components, the commissioning of ZAV Recycling AG's new processing line 15–30 mm was only completed at the end of May 2023.

After a brief operational phase, the line had to be shut down again to allow suppliers the opportunity to optimize their equipment to ensure the desired availability of the plant and product quality. Modifications and optimizations could not be completed during the reporting period, resulting in the line being operated for only short periods of time.

Modifications and optimizations had to be made to the trommel screen, the new crusher with automatic gap adjustment, the feed to the non-ferrous metal (NFM) separation, and the stainless steel screening.

Significant differences observed

During the production period throughout the year compared to the existing line, significant differences in the NFM fractions smaller than 15 mm and larger than 15 mm have already been observed, attributable to process optimizations.

The following table shows the annual NFM evaluation by ZAV Recycling AG for 2023 compared to 2022.

For the first time, more NFM metals smaller than 15 mm were separated than those larger than 15 mm. This is ecologically and economically crucial, as NFM metals smaller than 15 mm can be directly fed to the smelter, eliminating the need for a cumbersome pre-treatment of metals.

The reversal in the processing process compared to the existing line – namely crushing, screening, and only then NFM separation – leads to the following advantages:

- Through crushing, all metals smaller than 15 mm are released from the bottom ash matrix of size 15–30 mm and, after screening, are directly fed to the processing line for metals smaller than 15 mm, where NFM smaller than 15 mm is separated most efficiently. This leads to an increase in the quantity of NFM metals smaller than 15 mm and a decrease in the quantity of NFM metals larger than 15 mm.
- Crushing breaks off bottom ash encrustations on NFM metals larger than 15 mm, resulting in significantly better quality of NFM metals larger than 15 mm, at the expense of the total quantity of separated NFM metals larger than 15 mm, as the encrustations are absent
- Due to the magnetization of the stainless steel parts (stainless iron) caused by deformation in the crusher, very clean stainless steel parts can be screened after the NFM separation and returned directly to the stainless steel circuit as stainless steel products.

▼ NFM Annual Evaluation of ZAV Recycling AG 2023 compared to 2022

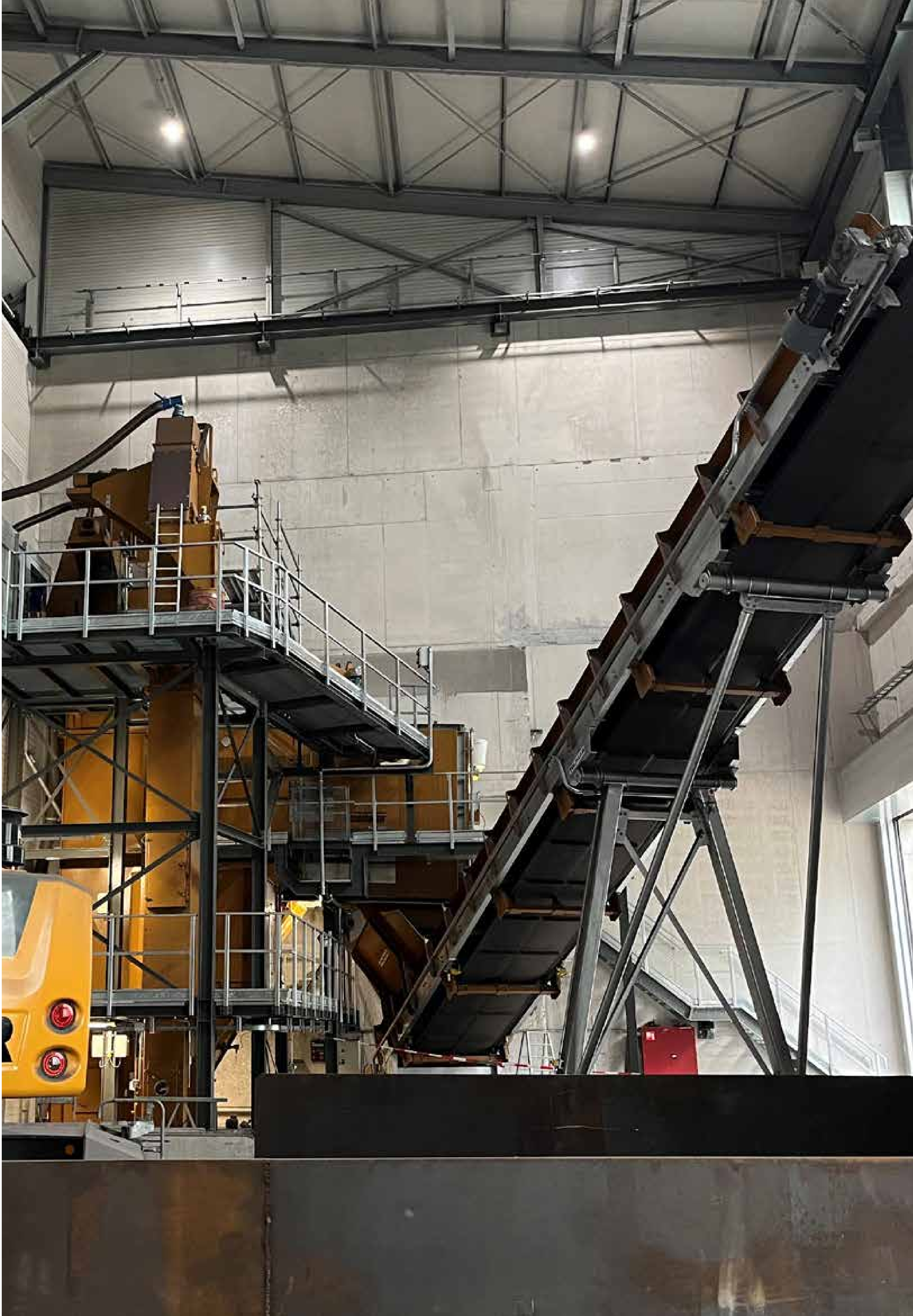
		2023		2022
		Baseline-values	Deviation	
Total aluminum 0,2–15 mm	[%]	1,95	+20,1	1,62
Precious NFM 0,2–15 mm	[%]	0,51	–0,3	0,51
NFM > 15 mm	[%]	2,43	–17,0	2,92
Total NF-metals	[%]	4,88	–2,9	5,05

The pivoting conveyor belt transports the cleaned iron to an intermediate storage area. ►

▲ Non-ferrous metals larger than 15 mm with minimal bottom ash encrustations.

▲ Non-ferrous metals larger than 15 mm with bottom ash encrustations.

▼ Very clean stainless steel metals in the 15–30 mm fraction.



Conversion of the iron separation at ZAV Recycling AG

During the reporting period, in connection with the increase in capacity from 100,000 to 200,000 tons of bottom ash, the iron processing at ZAV Recycling AG had to be reconfigured.

Now, immediately after the overband magnet, the separated iron is fed directly (inline) to a trommel screen via a chute. The mineral encrustations are removed from the iron in the trommel screen, and the mineral and metallic parts smaller than 40 mm are screened out. With another overband magnet, the iron smaller than 40 mm is separated from this mass flow and added to the coarse iron. The mineral fraction smaller than 40 mm is returned to the existing bottom ash circuit. The cleaned iron is transported via a pivoting conveyor belt and stored in the hall for removal.

Once again, the advantages of dry bottom ash and 24-hour operation, which guarantee small throughput rates, are evident: Since commissioning four months ago, no cleaning has been necessary. Furthermore, dust emissions during the shifting of iron scrap or loading of a truck have been almost completely prevented, eliminating the need for secondary measures in the hall.

Optimization of NFM separation and improvement of smelting yield for the aluminum fraction

This project also experienced delays in the delivery of crucial plant components. The installation could only be completed in the last quarter of 2023. Therefore, commissioning is expected to take place in the first half of 2024. Expectations for this expanded plant component are high. We anticipate it will be one of the most significant optimizations in bottom ash processing in the last five years, significantly improving the efficiency of NFM separation while simultaneously enhancing the smelting yield for the aluminum fraction 1–15 mm.

Magnetic bottom ash

Previous studies have indicated that significant amounts of recoverable non-ferrous metals (NFM) are present in magnetic bottom ash. It is

▾ Downstream NFM separators from the separation tables for cleaning the aluminum fraction 1–15 mm.

also known that magnetic bottom ash contains elevated levels of iron and iron oxides. Processing this bottom ash for NFM recovery has a positive effect on the residual metal content in the remaining bottom ash. Simultaneously, the quality of the magnetic bottom ash improves due to the reduction in metal concentration.

During a four-month internship, investigations were conducted to determine whether magnetic bottom ash or parts thereof could be utilized and what process steps would be required. The overarching goal was to prevent potentially recyclable material streams from ending up in landfills.

To achieve this goal, the magnetic bottom ash is initially crushed to break up the bonds and expose the metals. Subsequently, the material is fractionated, and the NFM are separated using eddy current separators. Elemental iron parts are also separated and added to the iron fractions, as they can potentially be marketed. By using magnetic separators, the iron oxide content in the remaining fraction is concentrated up to 60%. The processed magnetic bottom ash meets the specified limits for corrective materials that must be adhered to by cement manufacturers.

The processed magnetic bottom ash was submitted to a cement plant for evaluation. There is a fundamental possibility to utilize parts of the magnetic bottom ash. However, when used as an iron corrective material, elements that are not subject to limits but are relevant to cement plants in the consideration of freight for clinker production must also be taken into account.

Therefore, it still needs to be confirmed that the magnetic bottom ash can be used as a corrective material in cement production without negatively impacting quality.

CO_2 storage potential of bottom ash

During the reporting period, the Secondary Raw Materials Department of the University of Bern and company neustark ag intensively investigated the CO_2 storage potential of the four bottom ash fractions of ZAV Recycling AG.

Furthermore, the Secondary Raw Materials Department evaluated measurement methods for determining the CO_2 storage potential in the bottom ash fractions and conducted initial comparisons between natural and forced carbonation.

The following conclusions were drawn from the research:

Secondary Raw Materials Department

- TIC (Total Inorganic Carbon) is a suitable method for determining the CO_2 storage potential of bottom ash (difference method).
- By regularly moistening the bottom ash near saturation (20%) and circulating it, large parts of the CO_2 storage potential can already be exploited in a «natural» manner within two weeks with effort (personnel, energy, equipment, and space).
- The investigations have revealed the following CO_2 storage potentials for the bottom ash fractions::
  - Bottom ash dust > 0,2 mm: app. 45 kg CO_2/t bottom ash
  - Fine bottom ash 0.2 – 1,2 mm: app. 35 kg CO_2/t bottom ash
  - Coarse bottom ash 1,2 – 15 mm: app. 7 kg CO_2/t bottom ash
  - Magnetic bottom ash 0,2 – 15 mm: app. 0 kg CO_2/t bottom ash

◄ Mobile pilot plant by neustark ag

neustark ag

The company neustark ag conducted experiments with a mobile pilot plant using a mixture of bottom ash dust and fine bottom ash on the premises of KEZO. To ensure optimal CO_2 absorption in the mixture, the bottom ash (bottom ash dust and fine bottom ash) must be slurried, carbonated with CO_2, and then dewatered.

Decision

The ZAR Foundation has considered the implementation of the carbonation process proposed by neustark for bottom ash dust and fine bottom ash at the ZAV Recycling AG site. However, due to initial estimates indicating very high costs (CAPEX and OPEX) per ton of CO_2, and the challenging assessment of process availability in continuous operation, the Technical Advisory Board recommended to the ZAR Foundation Board of Trustees to refrain from further development work in the area of CO_2 storage in bottom ash for the time being.

Publication

New publication «Waste to energy, indispensable cornerstone for circular economy: A mini-review» with consideration of works and developments of the ZAR Foundation.

Thermal waste treatment has been a significant topic in waste management over the past four decades. Despite the long history of waste incineration, dating back to 1874, and despite being one of the most researched and optimized technologies in waste management, there are still controversial opinions about this technology today. It is insufficiently known or recognized in politics, society, and even among experts that thermal waste treatment is indispensable today to fully achieve the goals of a sustainable circular economy.

Prof. Emer. Dr. Paul Brunner, former head of the Institute of Waste Management and Resource Management at the Vienna University of Technology, as well as former member of the technical advisory board of ZAR, and Dr. Leo Morf (head of the technical advisory board of ZAR) have taken this opportunity to address this topic in an article for a special issue commemorating the 40th anniversary of the scientific journal «Waste Management and Research» (WM&R).

This short peer-reviewed article summarizes, based on relevant literature, the history, objectives, challenges, and achievements of thermal waste treatment over the past 150 years.

Download (in German only)

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HYDROMETALLURGY COMPETENCE CENTER

SwissZinc

In 2023, the open legal issues regarding SwissZinc could not be conclusively resolved. Within a SwissZinc forum, the current status and the interplay between antitrust, procurement, and environmental legal frameworks were explained by the SwissZinc Board of Directors. The decision regarding further steps will be communicated in the second quarter of 2024.

Phosphorus Recovery

By the end of April 2023, the completed feasibility study for implementing the Phos4life process at the Emmenspitz site was presented to all project partners, their political representatives, and representatives of the Swiss Federal Office for the Environment (BAFU) during a conference. Additionally, a business plan was developed, examining the economic implementation of the project along with associated opportunities and risks. Subsequently, the project partners decided against immediate continuation of the project and the establishment of a sponsorship, citing insufficiently defined legal frameworks for phosphorus recovery and its financing.

To attain planning certainty in this regard, a request for amending the Environmental Protection Act (EPA) was submitted through the Commission for Environment, Spatial Planning and Energy (ESPEC) of the Council of States as part of the ongoing parliamentary initiative to «strengthen Swiss circular economy.» After UREK-S approval, the entire Council of States also accepted the clarification of the Environmental Protection Act by the end of 2023, referring the matter back to the National Council. During the spring session of 2024, the final discrepancies were resolved, and the amendment to the USG was accepted and thus adopted by both chambers.

With this groundbreaking step, the necessary legal framework for implementing phosphorus recovery in Switzerland is now in place. The next major step will be the establishment of a corresponding sponsorship.

FLUWA Platform/ «Filter Ash» Activities

In 2023, the knowledge exchange within the «FLUWA Platform» was successfully continued with two events. Concurrently, metal recovery at two FLUWA plants was optimized in anticipation of the introduction of mandatory metal recovery according to the Waste Management Act (VVEA) from January 1, 2026. Additionally, the commissioning of a new FLUWA plant was supported.

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Dr. Andreas Bernhard
Development engineer

Fine Gozdzik
Chemical laboratory assistant

KVA Linth, Niederurnen (GL)

CO_2 COMPETENCE CENTER

At the CO_2 Competence Center at the KVA Linth, fundamental research on carbon dioxide capture at Swiss waste-to-energy plants, as well as its transportation, utilization, or storage, is being conducted. The primary objective is to support and advance the implementation of this technology in Switzerland. The progress of the contractually agreed work packages is illustrated in the table below.

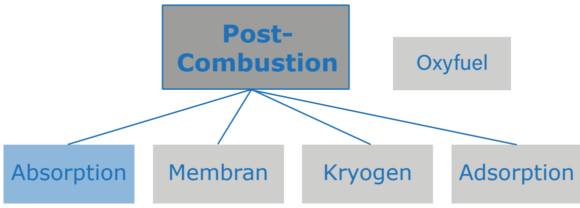
Work Packages	Progress
WP1: Set-up of competence center	100%
WP2.1: Risk analyses	0%
WP2.2: Environmental monitoring	30%
WP2.3: Process monitoring	40%
WP3: Optimization of AGR	35%
WP4.1: Heat integration	20%
WP4.2: Utilization	10%
WP4.3: Storage	30%
WP5: Pre-project	5%
WP6: International logistics	10%
WP7: Legal matters and permits	20%
WP8: Financing	15%

▲ Progress in the work packages, November 2023

Separation process

In the field of process monitoring, various CO_2 capture processes are being evaluated for their suitability at waste-to-energy plants. In the initial phase, all potentially applicable types of capture processes were considered. This involved conducting literature searches, attending conferences and trade shows, engaging with operators of pilot or full-scale plants, holding discussions with numerous technology suppliers, and conducting feasibility studies with selected partners.

Together with the advisory group, it was decided that the CO_2 Competence Center would continue to monitor the development of all processes, but



▲ Various types of CO_2 capture processes

would focus on two selected absorption processes for the time being, which appear to be realistically implementable. The processes based on other principles are partially interesting for application at waste-to-energy plants, but they are not yet ready for deployment due to their low level of technological maturity. The two absorption processes under detailed consideration are amine scrubbing and the Hot Potassium Carbonate (HPC) process.

Amine scrubbing is the most established absorption-based capture process. It requires a significant amount of heat but relatively little electricity. The main challenges lie in its approval and acceptance, operation, workplace safety, and emissions due to potential degradation and the formation of carcinogenic substances in the washing solution.

Another absorption process is the Hot Potassium Carbonate (HPC) process. Depending on the design, it requires less or no heat input but more electricity than amine scrubbing, as the flue gas stream needs to be compressed. If no critical additives are used, no additional emissions challenges are expected.

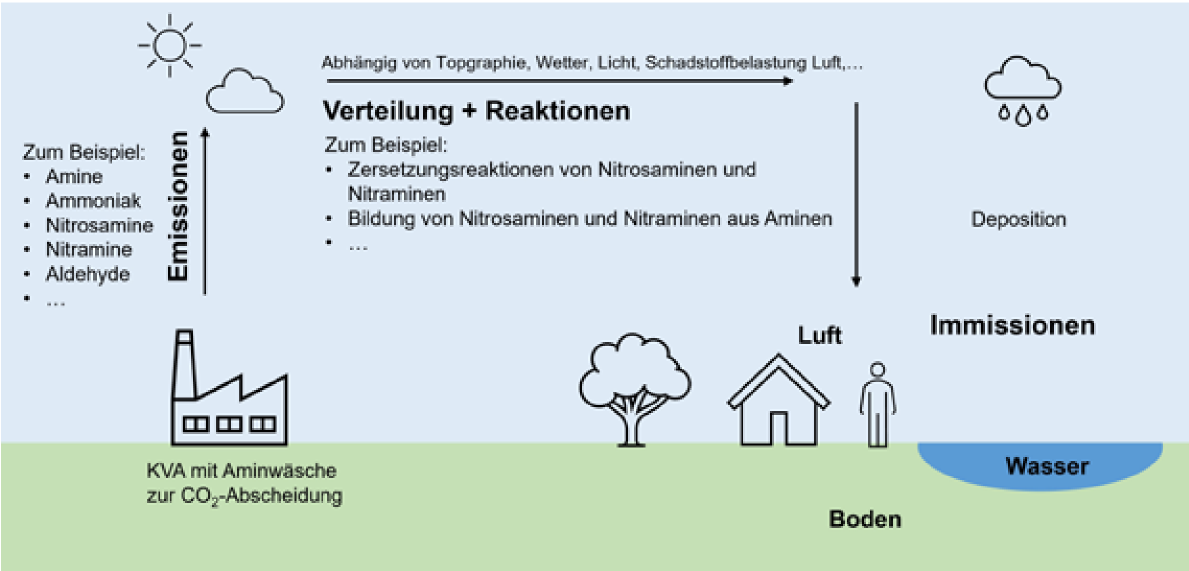
Both processes have been established in the petrochemical industry for decades, but their application to flue gases from combustion processes is limited in experience.

There is not yet enough information available for a well-founded comparison of the processes in terms of costs, space requirements and energy integration into the overall system with the waste incineration plant and district heating network. For this reason, the preliminary project for the Linth waste incineration plant is being developed in parallel for both processes in order to enable an in-depth comparison. With the HPC process, KEZO also plans to build and operate a pilot plant for several years in order to generate experience with the process in the actual application of MSWI clean gases, reduce risks and optimize the design. It will capture around 1000 tons of CO_2 per year and supply it to the surrounding greenhouses. The plant is scheduled to go into operation in 2025 and will be operated by KEZO. The CO_2 Competence Center will closely support the project.

Environment

The «Environmental monitoring» work package deals with emissions from the CO_2 capture process and their analytical recording, distribution and environmental impact.The focus here is on the amine process, as this is where the greatest challenges in terms of environmentally relevant emissions are to be expected.This topic is breaking new ground in Switzerland, as the licensing authorities are confronted with completely different environmentally relevant species, for whose monitoring neither limit values have been defined nor suitability-tested and validated analytical methods are available. A regular exchange between the Competence Center and the relevant authorities (Federal Office for the Environment, FOEN, cantonal authorities) has been established.

Visit to the HPC pilot plant at the Stockholm Exergi wood-fired power plant in Stockholm. The pilot project is being scientifically supported by Prof. Matthäus Bäbler's group at KTH Stockholm.



▲ Overview (German only)

The ongoing investigations can be divided into three core topics:

1) Emissions

Low emissions of amines, ammonia, aldehydes, nitrosamines, nitramines and other compounds must be expected during amine scrubbing. There are still no emission limits for some of the substances in Switzerland. Emissions can be minimized by the choice of amines, post-cleaning stages, the condition of the washing solution and the appropriate choice of operating parameters. Measuring emissions is technically demanding, as very low values must be ensured. The Competence Center has joined a project on this topic in which a pilot plant is being operated at the Amager Bakke waste incineration plant in Copenhagen and emissions are being measured using various analysis methods under different operating conditions and with the use of different amines.

2) Dispersion

The distribution and chemical transformations of the emitted species in the atmosphere must be modeled using dispersion calculations in order to be able to estimate the resulting pollutant concentrations in the environment (air, water, possibly soil). Atmospheric chemical reactions must also be taken into account, as some of the compounds are not stable: Nitrosamines can be decomposed in the atmosphere, but at the same time they are also newly formed from emitted amines. For this modeling, no commercial software could be found that could depict the complex topography in Switzerland. The development of a corresponding model was therefore commissioned from the Graz University of Technology. The model will be used for the first time at the waste incineration plant in Horgen (ZH).

3) Immissions

Switzerland does not yet have any limit values for amines, nitrosamines or nitramines in terms of emissions (air, water, soil). Corresponding target values are currently being developed by the FOEN. It is essential to measure the resulting emissions in order to know background concentrations before a plant is commissioned, to validate dispersion modeling and assumptions and for monitoring during operation. Corresponding measurements are not available for plants in operation abroad. The measurements are technically challenging. According to experts, the expected concentrations in soil cannot be measured using current methods. In water, initial background measurements have been organized in collaboration with the Swiss Federal Institute of Technology Lausanne (EPFL); even there it is difficult to achieve the necessary detection limits. The possibilities for air measurements are currently being clarified and appropriate partners are being sought.

Approval

Investigations into the operational approval of CO_2 capture facilities are underway. There is periodic exchange with the Air Pollution Control and Chemicals Division of the Federal Office for the Environment (FOEN), the Office for Waste, Water, Energy and Air of the Canton of Zurich, and the Department of Environmental Protection and Energy of the Canton of Glarus. Additionally, collaboration in this area exists with Entsorgung Zimmerberg in Horgen, which is currently planning a separation using amine washing. Also, the permit requirements for a gaseous CO_2 pipeline with a pressure of approximately 20 bar are currently being examined. The CO_2 Competence Center has also been given the opportunity to participate in the national working group on CCS/NET of the FOEN regarding overarching legal issues.

Status report

More detailed information, including on the work packages not mentioned here, can be found in the 2023 status report of the CO_2 Competence Center on the websites of the ZAR Foundation and KVA Linth.

Author: Daniel Marxer, Stefan Ringmann, Walter Furgler

Download status report

Team KVA Linth/ZAR, Niederurnen

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Public Relations

KEZO Competence Center, Hinwil

Interest from Switzerland and abroad was also very high in 2023. Numerous delegations were welcomed and informed about the ongoing development projects as well as the 24/7 operation of bottom ash processing at ZAV Recycling AG.

Visitor groups/guided tours

- AIK Technik AG, Sursee
- BELIMO Automation AG, Hinwil
- Dr. Daniel Chambaz, Genève
- Comstil, Spanien
- Covanta Holding Corporation, GB
- Covanta Holding Corporation, USA
- Delegation from Korea
- Delegations from Japan
- Enefit Green, Estland
- Energie Wien, Austria
- HEV Wetzikon greater area
- Hitachi Zosen Inova, Japan
- Kiwanis Club, Zürcher Oberland
- Magaldi Power S.p.A, Salerno Italy
- NOAH AS, Norwayen
- Onyx Taiwan
- Renergia Zentralschweiz AG, Perlen
- Stiftung Auto Recycling Schweiz
- SC+P Sieber Cassina + Partner AG, Bern
- Stahl Geralfingen AG
- Veolia S.A, France

Conferences

- Bremen IBAX Meeting, Germany
- Ruhr Symposium Duisburg, Germany

KEBAG Competence Center, Zuchwil

Visitor groups/guided tours

- Gäste Mittlerer Osten
- Hitachi Zosen Inova
- Hitachi Zosen Inova, Covanta USA
- NOAH AS, Norwegen
- P4L-Tagung in Olten
- Prof. Sakai etc., Japan
- SECO, Unido Study Tour 2023
- City of Wien, Wien Energie etc.

Conferences

- CEWEP, Conference in Brescia, Italy, European Association of Waste-to-Energy Plantsn
- University of Bern Conference
- VSoA, Solothurn Association of Wastewater Authorities

CO_2-Competence Center, KVA Linth

Contributions/Presentations

- Energy Research Talks Disentis
- FORMI Continuing Education
- Stakeholder Event Netherlands
- Tri-Nation Conference Würzburg (VBSA)
- VBSA Climate Fund Event Bern

Trips abroad

- Pilot plant at KVA Amager Bakke, Copenhagen, project on emission measurements
- Stockholm University and HPC pilot plant at Stockholm Exergi in Stockholm
- Amine pilot plant Andritz / Rohrdorfer Zement in Rohrdorf
- HPC pilot plant at a German waste incineration plant
- Academic CCS conference TCCS-12 in Trondheim
- Visit and exchange of experience with Wien Energie in Vienna

Foundation

Excerpt from the foundation certificate

Art. 2 Purpose of the foundation

The purpose of the foundation is to promote a sustainable materials policy for the treatment and recycling of waste. It promotes the further development of state-of-the-art technology and supports the corresponding development activities which are to take place in the immediate vicinity of the waste-to-energy plant of the Zweckverband Kehrichtverwertung Zürcher Oberland KEZO in Hinwil/ZH or its legal successor. The foundation can also support the commercial exploitation of the findings.

With a broad Swiss sponsorship and cooperation with interested parties, it is intended to ensure that the knowledge gained is incorporated into plant development and plant construction in Switzerland or abroad.

The purpose of the foundation can be extended to activities with similar objectives at a later date.

We reserve the right to change the purpose of the foundation in accordance with Art. 86a ZGB (Swiss Civil Code). The foundation does not pursue any commercial purposes and is not profit-oriented.

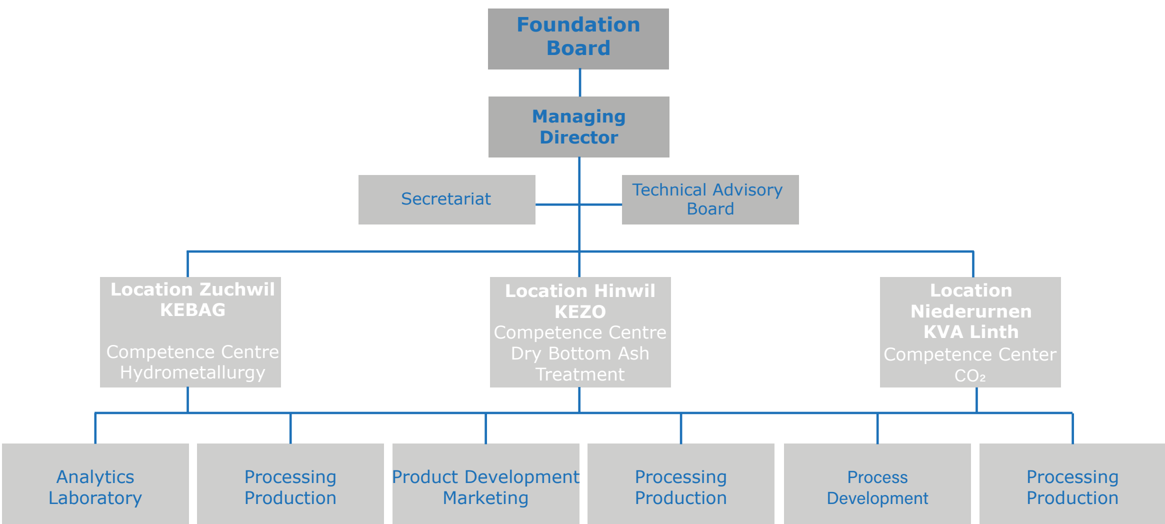
Founders

VBSA
Verband der Betreiber Schweizerischer Abfallverwertungsanlagen
(Swiss Association of Waste-processing Plants)

Kanton Zürich
Baudirektion, Amt für Abfall, Wasser, Energie und Luft (AWEL)
Department for Waste, Water, Energy and Air of the Canton of Zurich)

KEZO
Zweckverband Kehrichtverwertung Zürcher Oberland, Hinwil
(Association of Waste Disposal for the Zurich Oberland, Hinwil)

Organisation Chart



Foundation Board

Adam, Franz (Präsident)	Senior Consultant
Dr. Fahrni, Hans-Peter (Vizepräsident)	Senior Consultant
Christen, Daniel	SARS Stiftung Auto Recycling Schweiz, Managing Director
Furgler, Walter KVA Linth	Managing Director
Dr. Gablinger, Helen	Hitachi Zosen INOVA AG, Director Product & Marketing Energy from Waste
Juchli, Markus	KEBAG AG, Director
Marti, Jakob	Former Head of the Environment, Forestry and Energy Department (Glarus)
Martin, Ulrich	MARTIN GmbH, Owner
Morgan, Kurt	NEROS NEROS Network Mineral Resources Switzerland, Managing Director
Steiner, Peter	KVA Thurgau, Chairman of the Executive Board

Technical Advisory Board

Dr. Morf, Leo (Vorsitz)	AWEL, Waste Management Section, MSWI Sewage Sludge Disposal
Bolliger, Markus	Jura Cement AG, Wildegg
Budde, Ivo	Hitachi Zosen INOVA AG
Prof. Dr. Ing. Deike, Rüdiger	Institute of Metal Technologies, University of Duisberg-Essen
Prof. Dr. Hellweg, Stefanie	ETH Zürich, Institute for Environmental Engineering, Zurich
Dr. Ing. Koralewska, Ralf	MARTIN GmbH, Munich
Dr. Liechti, Jürg	Neosys AG, Gerlafingen
Dr. Ing. Warnecke, Ragnar	GKS - Gemeinschaftskraftwerk Schweinfurt GmbH

Separated zinc from non-ferrous metals ►

Donations

AIK Technik AG	Sursee
ERZ Entsorgung + Recycling Zürich	Zürich
Hitachi Zosen INOVA AG	Zürich
KEBAG AG	Zuchwil
KEZO Kehrichtverwertung Zürcher Oberland	Hinwil
KVA Linth	Niederurnen
Magaldi Industrie s.r.l.	Salerno (I)
MARTIN AG für Umwelt- und Energietechnik	Wettingen
Renergia Zentralschweiz AG	Perlen
SARS Stiftung Auto Recycling Schweiz	Bern
SATOM AG	Monthey
Verband KVA Thurgau	Weinfelden
Wiedag Recycling und Deponie AG	Oetwil a.S.
ZAV Recycling AG	Hinwil
Zweckverband für Abfallverwertung im Bezirk Horgen	Horgen

Project contributions CO_2 Competence Center

Bundesamt für Umwelt BAFU	Bern
VBSA Klimafonds	Bern
KVA Linth	Niederurnen
KEZO Kehrichtverwertung Zürcher Oberland	Hinwil
Stiftung Glarner Kantonalbank	Glarus

Financial Report

Income Statement

	2023 [CHF]	2022 [CHF]	Budget 2023 [CHF]
Income			
Donations	530 000.00	540 000.00	470 000.00
Other Income	1 130.00	180.00	0.00
Subsidies BAFU	327 200.00	100 000.00	200 000.00
Service revenues	579 594.68	782 045.37	481 000.00
Total Income	**1 437 924.68**	**1 422 225.37**	**1 151 000.00**
Personnel expenses			
Wages third parties	524 630.10	391 039.52	778 600.00
AHV/IV/EO/ALV/third parties	112 588.82	80 925.72	194 400.00
Other personnel expenses	19 115.05	19 691.99	0.00
Training and further education of employees	0.00	0.00	0.00
Total Personal expenses	**656 333.97**	**491 657.23**	**973 000.00**
Other operating expenses			
Material costs	2 216.82	61.32	117 000.00
Analysis costs	3 832.51	15 583.01	61 000.00
Expenses for third-party services	16 503.37	16 367.81	0.00
Expenses for bottom ash	120 507.30	79 140.00	147 000.00
Expenses PHOS4LIFE	103 399.20	401 959.64	0.00
Expenses CSS	221 102.36	16 770.37	600 000.00
Expenses Projects	0.00	10 373.70	84 000.00
Project reserves	262 096.21	218 223.11	-996 000.00
Rent expense KEBAG	0.00	65 000.00	65 000.00
Administration & IT costs	12 841.78	11 405.74	65 000.00
Advertising	0.00	4 612.12	5 000.00
Representation expenses	789.89	1 334.98	2 000.00
Costs Board of Trustees	6 005.20	4 686.27	5 000.00
Costs Technical Advisory Board	171.71	0.00	1 000.00
Other operating costs	1 803.12	11 279.83	50 000.00
VAT from subsidies	14 298.98	116 221.49	0.00
Total Other operating expenses	**765 568.45**	**973 019.39**	**206 000.00**
Total Operating Expenses	**1 421 902.42**	**1 464 676.62**	**1 179 000.00**
Operating result before depreciation & interest	**16 022.26**	**-42 451.25**	**-28 000.00**
Depreciation and value adjustments	**0.00**	**0.00**	**0.00**
Operating result before interest	**16 022.26**	**-42 451.25**	**-28 000.00**
Financial expenses	**258.50**	**191.99**	**0.00**
Financial income	**15 362.50**	**0.00**	**0.00**
PROFIT /LOSS FOR THE YEAR	**31 126.26**	**-42 643.24**	**-28 000.00**

Balance Sheet

	31.12.2023 [CHF]	%	31.12.2022 [CHF]	%
Assets				
Cash and cash equivalents	**2 608 323.00**	**92.1%**	**1 887 618.34**	**87.8%**
Raiffeisenbank Uster, current account	2 608 323.00		1 887 618.34	
Trade accounts receivable	**5 376.88**	**0.2%**	**163 130.00**	**7.6%**
Receivables donor contributions	0.00		140 000.00	
Receivables third parties	0.00		23 130.00	
	5 376.88			
Accrued income and prepaid expenses	**219 531.45**	**7.7%**	**100 000.00**	**4.6%**
Prepaid expenses TA	219 531.45		100 000.00	
Current Assets	**2 833 231.33**	**100.0%**	**2 150 748.34**	**100.0%**
Movable assets	**0.00**	**0.0%**	**0.00**	**0.0%**
iCAP 7600 ICP-OES Duo (analyzes equipment)	87 789.84		87 789.84	
Spectro Blue 138491	60 217.92		60 217.92	
Vibrating disk mill	22 109.83		22 109.83	
Value adjustments of tools and equipment	-170 117.59		-170 117.59	
Fixed assets	**0.00**	**0.0%**	**0.00**	**0.0%**
TOTAL ASSETS	**2 833 231.33**	**100.0%**	**2 150 748.34**	**100.0%**
Liabilities				
Trade accounts payable	**10 064.85**	**1.2%**	**10 064.85**	**0.5%**
Accounts payable to third parties	0.00		1 587.74	
Creditor FTA, value added tax	34 271.65		8 477.11	
Short-term interest-bearing liabilities	**0.00**	**0.0%**	**0.00**	**0.0%**
Value added / revenue taxes	0.00		0.00	
Deferred income	**2 556 014.87**	**90.2%**	**1 928 864.94**	**89.7%**
Accrued expenses and deferred income	509 849.67		144 795.95	
Deferred Projects	2 046 165.20		1 784 068.99	
Short-term liabilities	**2 590 286.52**	**91.4%**	**1 938 929.79**	**90.2%**
Endowment capital	100 000.00		100 000.00	
RESERVES				
Project reserves	111 818.55		154 461.79	
Annual result	31 126.26		-42 643.24	
Equity capital	**242 944.81**	**8.6%**	**211 818.55**	**9.8%**
TOTAL LIABILITIES	**2 833 231.33**	**100.0%**	**2 150 748.34**	**100.0%**

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An Stiftungsrat der

Stiftung Zentrum für nachhaltige Abfall- und Ressourcennutzung ZAR, Hinwil

Brüttisellen, 03.04.2024

Bericht der Revisionsstelle zur eingeschränkten Revision

Als Revisionsstelle haben wir die Jahresrechnung (Bilanz, Erfolgsrechnung und Anhang) der Stiftung Zentrum für nachhaltige Abfall- und Ressourcennutzung ZAR für das am 31.12.2023 abgeschlossene Geschäftsjahr geprüft.

Für die Jahresrechnung ist der Stiftungsrat verantwortlich, während unsere Aufgabe darin besteht, die Jahresrechnung zu prüfen. Wir bestätigen, dass wir die gesetzlichen Anforderungen hinsichtlich Zulassung und Unabhängigkeit erfüllen.

Unsere Revision erfolgte nach dem Schweizer Standard zur Eingeschränkten Revision. Danach ist diese Revision so zu planen und durchzuführen, dass wesentliche Fehlaussagen in der Jahresrechnung erkannt werden. Eine eingeschränkte Revision umfasst hauptsächlich Befragungen und analytische Prüfungshandlungen sowie den Umständen angemessene Detailprüfungen der beim geprüften Unternehmen vorhandenen Unterlagen. Dagegen sind Prüfungen der betrieblichen Abläufe und des internen Kontrollsystems sowie Befragungen und weitere Prüfungshandlungen zur Aufdeckung deliktischer Handlungen oder anderer Gesetzesverstösse nicht Bestandteil dieser Revision.

Bei unserer Revision sind wir nicht auf Sachverhalte gestossen, aus denen wir schliessen müssten, dass die Jahresrechnung sowie der Antrag über die Verwendung des Bilanzgewinns nicht dem schweizerischen Gesetz, der Stiftungsurkunde sowie den Reglementen entspricht.

baumgartner & wüst gmbh

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(Prüfungsleitung)

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