STIFTUNG ZENTRUM FÜR NACHHALTIGE ABFALL- UND RESSOURCENNUTZUNG

ACTIVITY REPORT/ANNUAL REPORT 2019

◄ Cover picture

Left: Ready prepared non-ferrous metals (NFM) heavy from dry bottom ash

Right: Finished non-ferrous metals (NFM) heavy from wet bottom ash with subsequent mechanical processing. The very shiny surfaces indicate heavy metal abrasion during preparation (see also page 12).

Content

Foreword by the President

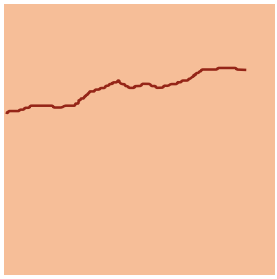
The United Nations (UN) has formulated 17 goals in its Agenda 2030 for sustainable development. With this Agenda 2030, the UN member states - and thus also Switzerland - are called upon to implement the 17 goals at national level.

The fact that the handling of waste was not included as an isolated goal, but rather summarised in goal no. 12 with "responsible consumption and production", is evidence of the visionary nature of the formulation of the goals, since waste is always closely related to consumption and production. If we - as called for in goal no. 12 of Agenda 2030 - (worldwide) strive for a different way of dealing with resources, then there is an urgent need for more responsible consumption and production, which deals much more consciously than today with how goods are produced so that they can be used for longer, use less energy during their lifetime, or lead to lower emissions, and how the valuable materials present in the products can be returned as completely as possible to the material cycle at the end of their life.

Admittedly, if objects are declared as waste for lack of direct use and subsequently dumped in the waste bin or dumpster, it already becomes difficult to comply with the required responsible use of resources. Because we are at the "end" of a user chain. It is late - but not yet too late.

Over the past nine years, the Foundation ZAR, together with many other actors, has shown how innovative methods can be used to recover large quantities of recyclable materials from waste that cannot be directly recycled, in addition to energy, and how these materials can be returned to the material cycle. This contributes to the careful use of resources and leads - compared to primary production - indirectly to a great relief in terms of the environmental impact caused by manufacturing and to a considerable reduction in CO_2 pollution due to the elimination of processes.

It is a pity that in the monitoring published by the Federal Statistical Office (FSO) for the implementation of the Agenda 2030 goals in Switzerland (MONET 2030), one of the 85 selected indicators (see right) only shows the total amount of municipal waste produced, including separately collected waste. This indicator is probably easy to collect. However, it is not suitable in this form to reflect the development in the corresponding sub-goal 12.5, which was formulated as follows for Switzerland according to FSO:. "The impact of waste on the environment is limited. The economic and technical potential of recycling raw materials is exploited".



As long as GDP and the population in Switzerland continue to grow minimally, this curve will also slowly rise, and the indicator will continue to be negative: That›s the wrong message!

This annual report provides information on where the technical potential for recycling waste in the thermal treatment of waste lies and how it can be exploited to promote and maximise the recycling of raw materials. It is good to see that the findings developed by the Foundation ZAR are being put into practice at waste treatment plants in Switzerland and abroad.

After Técnicas Reunidas SA in Madrid had successfully completed the pilot phase of the process development for the production of phosphoric acid from sewage sludge ash, which was supported by the Canton of Zurich, six other major Swiss corporations responsible for the disposal of sewage sludge were persuaded to participate in the financing of a corresponding preliminary project in 2019. The aim of the preliminary project is to clarify under which conditions a plant for the production of phosphoric acid from sewage sludge ash could be realized at the KEBAG site in Zuchwil.

If this project is implemented one day, it would be a showcase project for objective no. 12 for the responsible use of the very valuable resource phosphorus, a beacon project for an innovative infrastructure plant in the sense of objective no. 9 and last but not least a good example of a partnership (objective no. 17), how public institutions of the wastewater industry from Geneva to Zurich together with a non-governmental organisation can develop an innovative project for the careful use of a finite resource.

I wish the statisticians a sharpened view of the intrinsic values of waste and the sharp increase in recent years in the recycling of raw materials from the waste categories covered.

I wish all those who are actively involved in "urban mining" a warm "good luck" and good courage to successfully exploit the remaining potential for the use of recyclable materials from waste by means of innovative approaches to solutions and good partnerships.

Franz Adam

President of the Board of the Foundation

10 Years Foundation ZAR

The circular economy moved to the centre

After nine years of operation, the Board of Trustees has intensively discussed the future of the Foundation ZAR. In addition to revising and updating the vision and strategy, great importance was attached to common understanding and communication. Below is an extract from the new strategy paper of the Foundation ZAR.

Vision

ZAR considers waste as a potential raw material. As an ambassador for a sustainable recycling economy, the Foundation ZAR is committed to thermal recycling for the optimal use of the energy and raw materials contained in waste.

In concrete terms, the Board of Trustees understands this to mean: ZAR sees itself as an active ambassador, so that thermal recycling is perceived as an opportunity for the internationally propagated circular economy and as a measure to protect the climate. The vision is also oriented towards the goals of reducing climate-relevant gases from waste treatment: by recycling metals, large quantities of CO_2 can be saved. In countries that still landfill their organic waste, thermal recycling can make an effective contribution to reducing methane pollution.

Goals

For waste that cannot be directly recycled, the Foundation ZAR develops practical solutions so that the highest possible proportion of the energy and materials contained in the waste can be returned to the economic cycle during thermal recycling. Processes are being developed for non-recyclable residues so that these can be eliminated or removed from the material cycle and deposited with as few emissions as possible.

This is what the Board of Trustees specifically means by this: ZAR is a provider of solutions for sustainable recycling management, with the focus on the recycling of materials from thermal waste treatment and plays a leading role as a development centre in this field. Thermal recycling is a solution approach for all combustible waste that cannot be directly recycled in an effective and ecologically sound manner. The development of solutions is based on both Swiss and international conditions. The Foundation ZAR contributes to the optimisation of thermal waste utilisation as part of the Swiss resource policy and as an element of an internationally aspired recycling economy.

One important goal is to remove non-recyclable materials from the economic cycle and to treat them in such a way that they can be deposited without emissions.

Acquired knowledge and experience is actively passed on in an understandable form.

ZAR discloses the ecological and economic benefits of the solutions developed.

ZAR is active in process development and ensures that identified solutions are also implemented in order to reduce emissions, can be set.

Strategy

The Foundation ZAR develops new solutions in close cooperation with the players in the Swiss waste management sector. It strives for international networking and, with the brand name "thermo-re®", ensures active dissemination of the knowledge gained.

This is what the Board of Trustees specifically understands by this: In order to ensure that the goals set can be implemented with a corresponding broad impact, it is of central importance that active communication and knowledge transfer, adapted to the respective target audience, is practised.

In order to ensure the transfer of knowledge, cooperation with study courses must be intensified, information for authorities must be organized and seminars for "young engineers" must be offered.

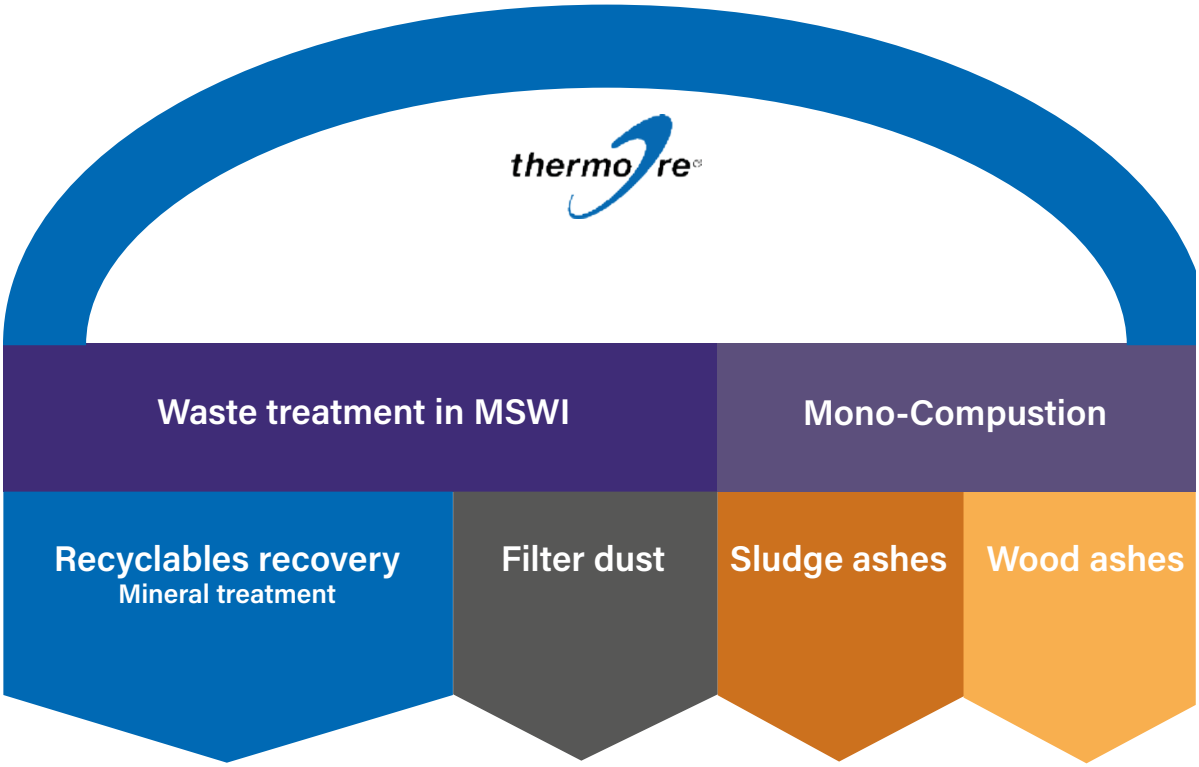


Figure 1: Primary fields of action of the Foundation ZAR

In order to achieve the objectives set, the financing of the activities of the Foundation ZAR has to be ensured through various approaches:

- Acquisition and maintenance of donors
- Project financing for interested parties who are unable to make donations
- Other sources of funding

In order to consolidate these efforts, the aim is to achieve a stronger anchoring in politics, society, business and science - this requires a corresponding transfer of knowledge.

For various topics, e.g. treatment of residual slags, cooperation with potent technology partners should be sought.

To improve the acceptance and perception of the Foundation ZAR and its work in the industry.

Certificates for substances that are returned to the material cycle.

The primary fields of action are shown in Figure 1.

Knowledge Transfer

The declared goal of making acquired knowledge and experience of the past years available in an understandable form led to the implementation of a knowledge database in the website. Suitable information can thus be searched for and displayed quickly and according to requirements. Access depends on the status of the user (employee, foundation board, technical advisory board, donor). With search and filter functions, the new "ZAR-Wiki" is a practical application to access the foundation›s knowledge.

Anniversary Event*)

The Foundation Centre for Sustainable Waste and Resource Management ZAR is taking its 10th anniversary as an opportunity to report on what thermal recycling means and what can already be achieved with this concept today. We would also like to show what potential could be realized in the future with thermal recycling in terms of the circular economy and climate protection.

Appropriate visions, clear strategies and concrete measures are needed so that we can gradually move closer to the goals of Agenda 2030 for sustainable development, which Switzerland helped to shape and co-sign.

In our civilisation, we have spent several decades on real estate, infrastructure buildings, means of transport, furnishings, clothing, etc. vast quantities of goods have been imported, consumed and accumulated in our "warehouses". Add to this the fact that, in addition to everyday needs such as food and clothing, we tend to follow an "inner measure of value" and decide for the new, the more beautiful, the better and the bigger. In this way we consume additional goods, for the production of which in turn the corresponding resources and the necessary energy must be provided. These goods, in turn, we place in our "warehouse".

We all have a simple recipe for the things we no longer use: we declare the objects as waste. Whenever possible, we recycle the waste directly. With the proportion of directly recycled waste, we in our civilisation are still a long way from the often formulated demand that, on the one hand, organic goods be returned to the biological cycle and, on the other, that technically manufactured goods and products be completely recycled in their own cycle. There are various reasons why many wastes can no longer be directly recycled. These are, for example, organic materials that are contaminated with anthropogenic pollutants, or goods that have been assembled from a wide variety of material groups in the manufacturing process - to name but two.

Even though many have a divided relationship to the "element fire": Applied in a controlled manner, it is the key to releasing energy from waste that cannot be directly recycled and making materials accessible for reuse. What is important is that in thermal waste treatment with a holistic concept, the energy produced is used efficiently and that the metallic and mineral recyclable materials or the phosphorus from the sewage sludge ash are returned to the economic cycle to the greatest possible extent.

For many people, the idea that a reduction in climate-damaging gases can be achieved by "burning waste" may seem downright absurd. This is not the case:

- With an efficient use of the energy released during waste incineration, the use of fossil fuels can be substituted and thus indirectly reduce CO_2 emissions.
- If metals or phosphorus are recovered from the incineration residues and reused as valuable materials, this reduces environmental pollution and thus also CO_2 emissions because, in contrast to primary production, less complex processes are required to provide secondary raw materials.

With the internationally registered trademark thermo-re®, the Foundation ZAR has a clear concept and a label that demonstrates how the thermal treatment of waste that cannot be directly recycled can achieve a large gain in value and a reduction in the overall environmental impact. A positive message and a contribution both to the recycling economy and to climate protection.

Franz Adam, President of the Foundation ZAR

*)Foreword from the conference documentation of the anniversary conference in Bern on 23 January 2020

10 years Foundation ZAR - Milestones

2005

- First trials with dry bottom ash discharge in the KEZO on furnace line 2

2008

- Commissioning of the fine bottom ash sorting plant for non-ferrous metals

2010

- Foundation „Centre for Sustainable Waste and Resource Management ZAR“ established
- Commissioning of the dry bottom ash discharge of KEZO furnace line 3 (50% of KEZO bottom ash)
- Commissioning of the non-ferrous metal preparation (for fine bottom ash1-3 mm)
- Trademark registration „thermo-re®“

2011

- 1st information event in Zurich: ZAR's contribution to „Urban Mining“
- Optimization of screening in continuous operation > 0.15 mm
- Successful completion of the product development for the aluminium granules (0.7-3.0 mm and 3.0-5.0 mm) First delivery to smelters and precious metal smelters

2012

- 2nd information event in Hinwil: „Applied Resource Strategy
- Commissioning finest bottom ash treatment (02.-1.0 mm)
- Commissioning NE treatment (0.2-1.0 mm)
- Commissioning of melting furnace: Determination of the composition of the non-ferrous precious fraction is now possible.

2013

- Start of detail engineering of the industrial bottom ash treatment plant
- Foundation of ZAV-Recycling AG
- Competence expansion „wet chemical processing“ in cooperation with KEBAG AG, Zuchwil

2014

- Publication of the volume of methods: Practical methods for sampling, sample preparation and analysis over the entire spectrum of residue fractions in thermal waste treatment
- Completion of detail engineering of the dry slag preparation plant
- 3rd information event in Solothurn: „Successful resource strategy
- Development of the „ZAR double-nosed screen“

2015

- Commissioning of the dry bottom ash processing plant of ZAV Recycling AG for 100 000 t/y of bottom ash
- Preparation of a special bottom ash compartment at the Chrüzlen landfill with the company Wiedag, Oetwil am See, for a landfill monitoring of dry bottom ash
- Start of project phosphorus recovery from sewage sludge ash. The goal is the production of technically pure phosphoric acid.
- Start SWISSZinc project: Exploitation of the Swiss zinc potential in filter ashes.

2016

- The challenge „24-7-52" of the dry bottom ash processing plant begins!
- 4th information event: „Dry bottom ash - from the idea to the implementation".
- The Phos4life® process is launched (with the partner Técnicas Reunidas S.A.)
- Foundation of SWISSZinc AG by the VBSA

2017

- Successful start of Phos4life® piloting - 24-hour operation of the pilot plant
- SWISSZinc process : 28 out of 29 Swiss waste incineration plants say yes to a national plant at the site of Emmenspitz, canton Solothurn
- Start of a longer-term landfill monitoring (mass balance, ammonia emissions)
- 5th information event in Zurich „P-Mining - The cycle of materials closes".

2018

- Successful approach of „stainless steel separation by the exclusion method". No more capital and operating cost intensive stainless steel sensor separation machines!
- Optimised material feed to the non-ferrous separators: Installation of buffer silos
- Adjustment of the grain size of the fine fraction from 12 mm to around 15 mm in order to further increase added value.
- First slag washing trials: investigation of the influence of TOC content and ammonia formation potential

2019

- ZAR wiki: Implementation of a knowledge database in the website www.zar-ch.ch
- Development of a new test plant/test method for the determination of the NFM content in bottom ash
- Increased focus on the ecological assessment of metal recovery

2020

- ZAR anniversary event in Bern: „Thermal recycling as an opportunity for our circular economy"
- Publication series 1: Industrial bottom ash processing - status and objectives (D. Böni)
- Publication series 2: Landfill Chrüzlen monitoring and emission prognosis of the dry bottom ash compartment (Dr. G. Weibel)
- Development of a new measuring method for the residual metal content in the bottom ash


Deponie


aufbereitete
Schlacke
ZAV


draht
Flachwalz-
produkte

Technical Developments

NFM residual content: the key to success

The non-ferrous metal (NFM) residual content has been known as a limit value since the Ordinance on the Prevention and Disposal of Waste (VVEA) came into force. However, its great ecological and also economic importance is not noticed.

Years ago, the Foundation ZAR already made great efforts to determine the residual metal content in bottom ashes smaller than 2 mm (see ZAR Methods Volume, S. Skutan and R. Gloor, supported by Dr. Leo Morf, © March 2014).

It was soon found that the error in the determination of residual metal in the fine fraction of the bottom ash was too great with the usual sample preparation methods to reveal weak points in the preparation plant and implement optimisation measures. Only with the method developed by the engineering office Stefan Skutan for the gentle comminution of the mineral fraction and screening of the finest elementary metals could more reliable statements be made about the "free" non-ferrous metals and those "trapped" in the small slag agglomerates.

In 2019, various experiments for determining the residual metal content were carried out, with sample preparation using a jaw crusher and, in parallel, a needle hammer. The determination of residual metal was carried out using the same method. The differences between the two sample preparation methods and the resulting non-ferrous residual content in the bottom ash were surprisingly large. Figure 2 compares the residual metal contents of the sample preparation methods.

On the basis of the sample preparation method used today (jaw crusher), the following statements can be made:

In the 1-8 mm range, more than 100% more non-ferrous metals are found with the gentle crushing method. Since metals cannot simply be lost, the missing non-ferrous metals were probably crushed to less than 1 mm in the jaw crusher. This means that they will fall out of the 1-8 mm viewing system. A carry-over into the mineral fraction would also be possible.

Although the needle hammer uses much less energy to expose the metals from the bottom ash agglomerates, we assume that metal parts are

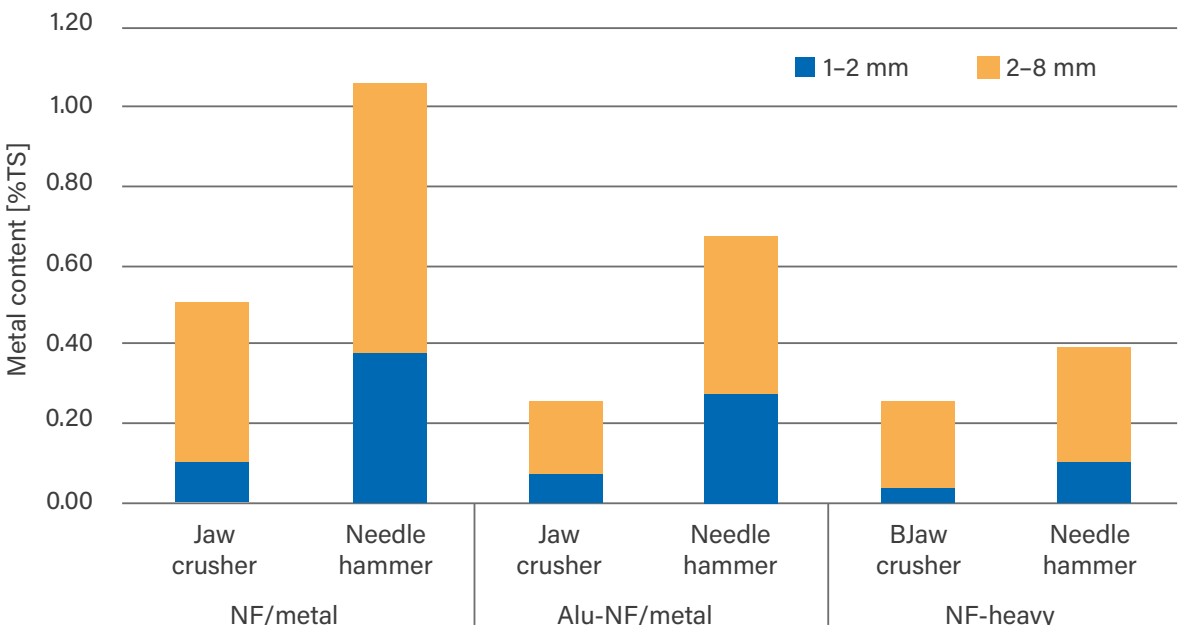


Figure 2: Residual metal contents depending on the sample preparation method

also crushed with the needle hammer and thus they partly fall out of the observation perimeter of 1-8 mm. This leads us to the hypothesis that the effective NFM residual content could be even greater.

Negative effects of this circumstance are, among other things, additional burdens on the landfill site and a worse ecological balance in the material cycle of these metals.

New measurement method

The effective residual metal content in the processed bottom ash is also crucial for the further development work of the Foundation ZAR for the reasons mentioned above. For this reason, the development team of Foundation ZAR decided to develop a new measurement method with which the residual metal content can be determined efficiently and very reliably even in large bottom ash samples.

Based on the circulation principle successfully used in the ZAV Recycling AG treatment plant, it was decided to build a test unit (see photo on page 14) using the same principle as part of the new method. The sample material is passed over an eddy current separator until no more NFM is separated.

In a second step, using the induction divider developed years ago by the Foundation ZAR (see photo on page 17), the separated NFM are subsequently separated from the carried along minerals (5-25%) in order to determine the effective quantity of NFM. The sum of the effectively separated NFM per handling in relation to the sample quantity gives the residual metal content. As neither jaw crushers nor needle hammers are used in this method, it is assumed that the residual metal content will be even higher.

Commissioning of the new test facility is planned for the first quarter of 2020.

Since we already have to assume today that the residual metal content in the processed bottom ash is much higher than previously assumed, the old results and conclusions must be re-examined and adjusted accordingly.This will also be done in 2020 within the framework of a Bachelor›s thesis and a Master›s thesis by a student at ETH Zurich

Magnetic bottom ash

In 2018, intensive trials were carried out to reduce the NFM residual content in the magnetic bottom ash (see Annual Report 2018). It was demonstrated that by reducing the magnetic strength of the neodymium magnet, the NFM residual content in the magnetic bottom ash could be significantly reduced and that these magnetic NFM particles can be separated from the slag with the eddy current separator. These clear test results led to a corresponding modification of the processing plant of ZAV Recycling AG .

Due to the weaker magnetic force of the neodymium magnets, the proportion of magnetic bottom ash in the total slag was reduced from 35% to around 25%. The proportion of processed bottom ash increased accordingly. In order to determine the residual metal content in the processed bottom ash and the magnetic slag, several samples were taken at different times each day for four weeks.

To ensure reliable comparability, the analysis and evaluation were carried out using the same methodology as for the detailed evaluations of the 2017 sampling, but deviations due to changes in slag quality cannot be ruled out.

Figure 3 shows the comparison between the residual metal contents of the bottom ash and magnetic slag fractions and the forecast values based on the preliminary tests. It is remarkable that the residual metal loads in the magnetic bottom ash in all fractions (violet bar) were significantly reduced compared to the 2017 study. This corresponds to the expectations from the preliminary tests. The fact that the residual metal load in the processed bottom ash increased sharply in 2019 (blue bar) indicates a deterioration in the efficiency of the eddy current separator due to the addition of magnetic slag, which was not expected to this extent. Thus, the benefit of reducing the residual metal in the magnetic bottom ash was more than compensated by the increase of residual metal in the processed bottom ash.

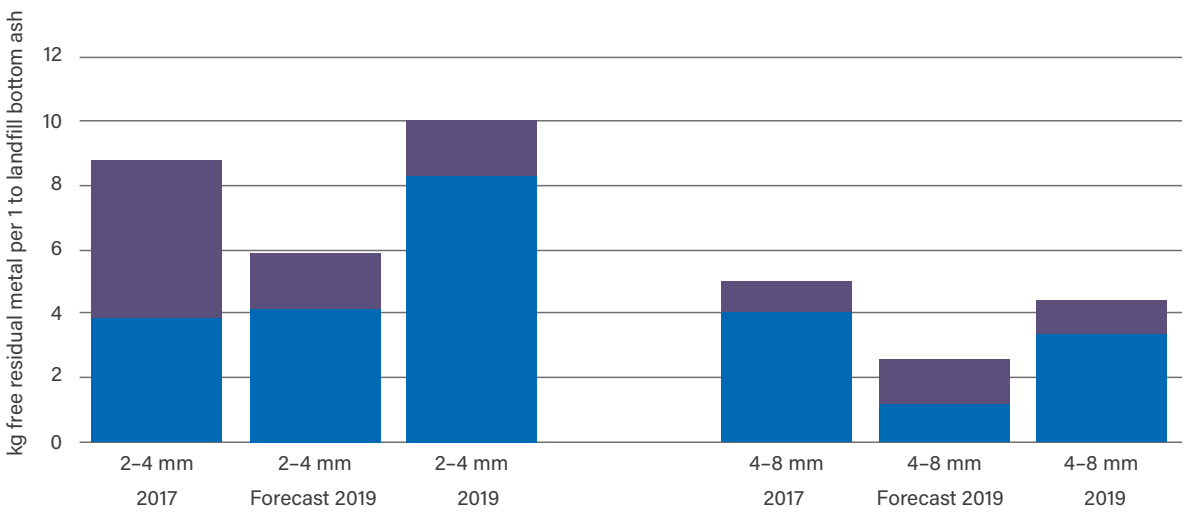


Figure 3: Lost “free” NF-metal in the treated and magnetic bottom ash

The significance of the NFM for the climate

The study by the Ecological Systems Design ESD department of the ETH Zurich on the ecological evaluation of metal recovery from dry bottom ashes of ZAV Recycling AG was the first to provide a more detailed basis for the environmental impact of dry discharge and bottom ash processing beyond the system boundaries.*) The relevance of metal recovery is very high.

Figure 4 shows that metals amounting to 777 kg CO_2-eq per tonne of bottom ash are currently separated and returned to the metal cycle in the slag processing department of ZAV Recycling AG.

With the capacity expansion and the associated optimisation of the plant, this potential can be increased by a further 14% to 882 kg CO_2-eq per tonne of bottom ash. If it were possible to separate all metals from the bottom ash, the potential would be 1000 kg CO_2-eq per ton of bottom ash.

The great environmental impact is surprising and shows the huge ecological potential of the thermo-re® process in the light of the current climate debate. The question therefore arises as to whether there are other system optimizations in the existing system of municipal waste management that can increase the net environmental credits by more than 25% and as such are also economically acceptable?

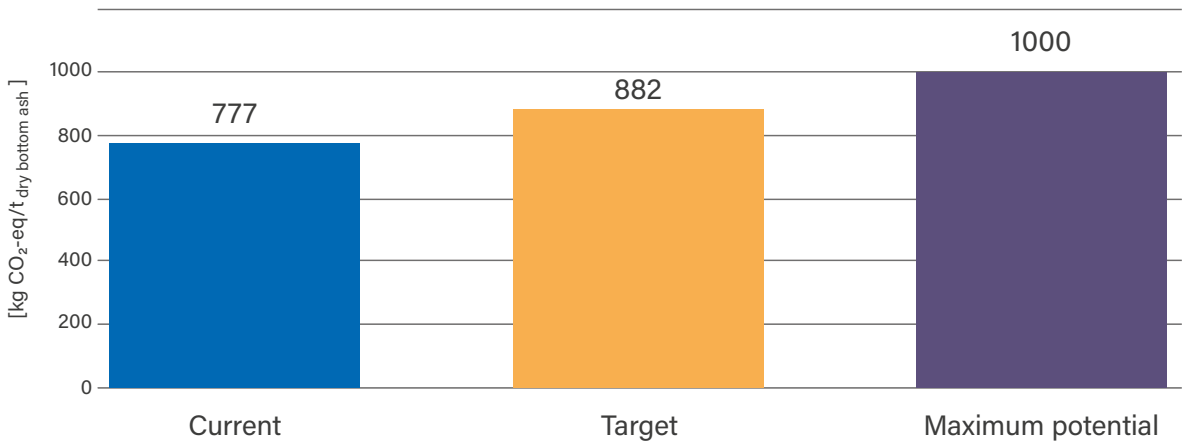


Figure 4: $C0_2$-compensation by recovery of metals from the dry bottom ash*)

*) *Source: Jonas Mehr, Dr. Melanie Haupt, Prof. Stefanie Hellweg, ETH Zurich, Institute for Environmental Engineering, Group Ecological System Design, John-von-Neumann-Weg 9, CH- 8093 Zurich, Study on the ecological assessment of metal recovery from dry bottom ash from MSW incineration plants of ZAV Recycling AG, 1 January 2020*

SwissZinc

The large-scale implementation and commissioning of the SwissZinc process is planned for 2025. On the way there, legal and strategic issues are currently of particular relevance, which will have an influence on the future business form. An important step in this direction was taken in May 2019 with the examination of the SwissZinc project›s conformity with competition law, which should provide clarity on its further design by summer 2020.

In addition to the project documentation published in April 2019, an external, independent review and plausibility check of the SwissZinc project was commissioned on the initiative of seven MSWIs. The team of experts under the leadership of Ramboll Switzerland came to the gratifying conclusion that "the results of the SwissZinc project to date are plausible and no incalculable risks are discernible. The SwissZinc process is ecologically much better than current recycling and the treatment costs are comparable. Taking into account the recommendations made in this report, the authors advocate moving on to the next phase of the project". Thus, the agreement of all Swiss MSW incineration plants on the further joint approach, the execution of the construction project, could be won. This should therefore begin next year and be completed by spring 2022, so that the final decision on construction can then be made on the basis of the cost estimate, which is available with greater accuracy.

Another particularly pleasing aspect is the federal government›s financial contribution within the framework of environmental technology promotion, which provides a good practical example of how the National Resources Strategy can be implemented.

Phosphorus recovery

Phos4life preliminary project at the Emmenspitz site

Following the successful completion of the pilot phase of the Phos4life process in 2018, the next stage on the road to commercial-scale implementation has been tackled. The feasibility of the Phos4life process is to be investigated in a preliminary project for a plant with approx. 40 000 t/a sewage sludge ash input at the Emmenspitz site (Zuchwil, Solothurn) and the influence on the economics of the process is also to be determined.

The project was financed by an inter-cantonal funding agency*), which together represents about one third of the sewage sludge produced in Switzerland.

Results on the feasibility and economy of a large, regional phosphoric acid production plant from sewage sludge ash and the completion of the current preliminary project are expected by the end of 2020.

*) Members:

- EPURA SA (Lausanne)
- erzo (Entsorgung Region Zofingen)
- Kläranlagen des Kantons Zürich
- REAL (Recycling Entsorgung Abwasser Luzern)
- Saidef SA (Posieux/Hauterive, FR)
- Services Industriels de Genève (SIG)
- ZASE (Zweckverband der Abwasserregion Solothurn-Emme)

Residual bottom ash

According to Swiss waste legislation, the processed residual slag (approx. 85% of raw slag) must today be deposited on a slag compartment. In order to conserve valuable landfill space and primary resources, a lower-maintenance landfill (landfill type B) and partial recycling of this residual slag should be promoted. This requires an improvement in the quality of specific fractions. Last year, the Foundation ZAR therefore carried out various studies on the deposition and quality improvement of mineral residual slag.

Deposition with low maintenance requirements

Since October 2018, the Foundation ZAR has been operating an online monitoring system for the Chrüzlen dry slag compartment. The slag A deposited there consists of the two processed slag fractions 0.3-2 mm and 2-12 mm and corresponds to approx. 60% of the total bottom ash of ZAV Recycling AG. After one year of intensive monitoring, a first positive conclusion can be drawn. The installations installed provide reliable measurement data and there were no significant operational disturbances. Due to the short deposition time and the continuous installation of a partial stream of the dry bottom ash, general statements on the deposition behaviour of the total slag based on the existing monitoring data are difficult. The emissions of bottom ash A via the gas and leachate path are in typical ranges as known from wet slag dumps in the early years. Concentrations in the centre of the compartment very rarely exceed 15 ppm ammonia and there are no overall health concerns regarding the ammonia concentration in the vicinity of the landfill. It can be expected that the situation will improve significantly with the completion of the slag dumping and the recultivation of the compartment. In the case of pollutant discharge via leachate, it is difficult to identify concentration trends due to the low age of the compartment. On average, 35% of the infiltrated precipitation is discharged as leachate and a decreasing trend for the concentrations of ammonium, nitrite, copper and DOC is already visible. The measured DOC concentrations in leachate have been developing since 2016 from very high annual averages of ±600 mg/l to values averaging 180 mg/l in 2019. This trend corresponds to a normal development of young landfills as known from wet slag compartments. In order to verify these findings, further projects are being carried out in the landfill area.

Recycling

In addition to the study of the deposition behaviour of dry bottom ash, the focus since 2019 has been on the development of principles for the recycling of partial fractions of the residual slag. Possible applications for the recycling of the residual slag are being sought both in Germany and abroad. In addition, the extended processing of suitable partial fractions is being investigated in a laboratory study. The focus here is on the coarse fractions (2-15 mm), which account for approx. 75% of the residual slag. In addition to dry mechanical tests such as screening, magnetic and optical separation, the study also includes wet chemical tests to determine suitable conditions for potential washing of partial fractions of the residual slag. With an annual volume of the coarse fractions (coarse slag and magnetic slag) of about 60 000 tonnes, efforts to produce an inert fraction are already desirable for some percent of the bottom ash.

Public

Visitors

The ZAR team guided 28 groups with about 400 guests through the facilities in 2019. The complex processes (thermal utilization and slag preparation) were explained and specific questions answered.

Half of the groups came from Europe, Asia or Africa, but interest also remains high among Swiss organisations. Often it is not only the technology but also the environmental policy challenges in the various countries that give rise to exciting discussions.

Publications in progress

"Industrial Bottom Ash Processing – Status and Objectives" , Publication series of the Foundation ZAR, No. 001
January 2020, Daniel Böni
"Landfill Chrüzlen - Monitoring and emission prognosis of the dry bottom ash compartment" Publication series of the Foundation ZAR, No. 002
April 2020, Dr. Gisela Weibel

Presentations/Events

At the "Odor Vision 2019" symposium at the UMTEC in Rapperswil in June, the ZAR team presented technical developments in electronic aids for determining odor nuisance at landfill sites and how to deal with them. The landfill monitoring of the Chrüzlen test compartment was presented with the thematic focus on ammonia emissions, with emphasis on the comparison of passive collector monitoring and the electrochemical measurement series of ammonia.

Anniversary event

A successful review and outlook on new challenges: Recycling management, carbon capture, phosphorus recovery, thermo-re® etc. - the topics were manifold, which the Foundation ZAR brought closer to the 170 participants in the Kursaal Bern with its lectures. Speakers from Switzerland, Germany and Austria examined the current topics from a variety of angles.

Programm January 23rd, 2020

Greatings BAFU (FOEN)
M. Chardonnens | irector Federal Office for the Environment, FOEN

Circular ecomony: A key to achieving global sustainability goals?
Dr. W. Haas | Institute for Social Ecology, University of Natural Resources & Applied Life Sciences, Vienna

The thermo-re® principle: Energy / Metals / Minerals and CO_2
D. Böni | Managing Director, Foundation ZAR

Waste management: How do we close the CO_2 cycle?
Dr. R. Quartier | Managing Director, VBSA

CO2 potential of waste management - estimates for Switzerland and the activities of the ZAR
Dr. H. Gablinger | Head of Sales Anaerobic Digestion, HZ Inova AG

limate protection: The key role of Swiss MSWIs
W. Furgler | Managing director, KVA Linth

Phosphor-Mining
Dr. S. Schlumberger | Head of Competence Center Hydrometallurgy, Foundation ZAR

No circular economy without thermal recycling
U. Martin | Managing director, Martin GmbH

Products from the thermo-re® processs
D. Böni | Managing director, Foundatio ZAR

NF-precious metals - Results of the upcycling
J. Zervos | Melting Plant Engineer, Lunen Recycling Centre, Aurubis AG

Certirec – Importance for iron recycling
A. Stäubli | Process Engineering and Life Cycle Assessment Division, UMTEC

Fine bottom ash – a potential raw material for cement production?
Prof. Dr. R. Deike | Institute of Metal Technologies, University of Duisburg-Essenn

thermo-re® 2.0 – Roll-out
Dr. S. Schlumberger | Head of Competence Center Hydrometallurgy, Foundation ZAR

Impressions on pages 10-11 and www.zar-ch.ch,
Downloads of the presentations on www.zar-ch.ch

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..

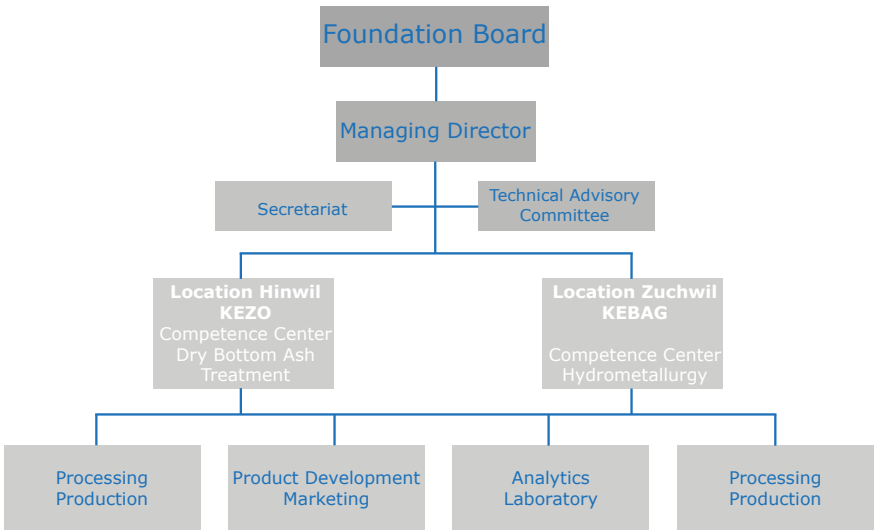
Founders

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	Foundation for Auto Recycling Switzerland SARS, Managing Director
Dr. Gablinger, Helen	Hitachi Zosen INOVA AG, Head of Sales Anaerobic Digestion
Dr. Girod, Bastien	Member of the National Council, President VBSA
Juchli, Markus	KEBAG AG, Director
Martin, Ulrich	MARTIN GmbH, Owner
Morgan, Kurt	KIBAG RE AG, Managing Director

Technical Advisory Board

Dr. Morf, Leo (Vorsitz)	AWEL, deputy section head, sewage sludge, Waste incineration plants, biomass power plants (with waste wood)
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
Dr. Eggenberger, Urs	Institute for Geology, University Bern
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. Zeltner, Christoph	Stahl Gerlafingen AG, Gerlafingen

ZAR-Team

Location KEZO, Hinwil

Böni, Daniel	Managing Director
Di Lorenzo, Fabian	Projekt manager – Metalic raw materials
Dr. Weibel, Gisela	Projekt manager – Mineralic raw materials
Böni, Frauke	Secretariat

Location KEBAG, Zuchwil

Dr. Schlumberger, Stefan	Head of Competence Center Hydrometallurgy
Dr. Bernhard, Andreas	Development engineer (from 4/2020)
Fromm, Stephan	Project Manager

Donors

In alphabetical order

Bau-, Verkehrs- & Energiedirektion Kanton Bern BVE	Bern
Direction générale de l'environnement DGE, Etat de Vaud DGE	Lausanne
ERZ Entsorgung + Recycling Zürich	Zürich
EWB Energie Wasser Bern	Bern
Hitachi Zosen INOVA AG	Zürich
KEBAG AG	Zuchwil
KEZO Kehrichtverwertung Zürcher Oberland	Hinwil
KIBAG RE AG	Rotkreuz
MARTIN AG für Umwelt- und Energietechnik	Wettingen
Pöyry Schweiz, AG	Zürich
Renergia Zentralschweiz AG	Perlen
SAIDEF Fribourg SA	Fribourg
SARS Stiftung Auto Recycling Schweiz	Bern
SATOM AG	Monthey
Trumag Aufbereitungstechnik AG / STAG AG	Frutigen
Verband KVA Thurgau	Weinfelden
WIEDAG AG	Oetwil a.S.
Zweckverband für Abfallverwertung im Bezirk Horgen	Horgen

Financial Report

Income Statement

	2019 [CHF]	2018 [CHF]	Budget 2019 [CHF]
Income			
Donations	552 500.00	662 500.00	642 500.00
Other Income	1 295.00	2 275.00	0.00
Subsidies AWEL	0.00	620 000.00	0.00
Support contributions BAFU	14 857.00	30 900.00	10 000.00
Service revenues	792 886.32	224 566.69	1 027 436.00
Total Income	**1 361 538.32**	**1 540 241.69**	**1 679 936.00**
Personnel expenses			
Wages third parties	450 384.93	534 874.47	564 000.00
AHV/IV/EO/ALV/third parties	68 543.21	104 954.03	141 000.00
Other personnel expenses	10 300.73	778.21	15 000.00
Training and further education of employees	9 800.00	0.00	2 000.00
Total personnel expenses	**539 028.87**	**640 606.71**	**722 000.00**
Other operating expenses			
Material costs	1 607.34	56 056.22	57 000.00
Analysis costs	34 854.17	63 359.77	75 000.00
Expenses for third-party services	18 983.39	192 567.33	540 000.00
Expenses for new screen development	8 292.61	0.00	0.00
Expenses PHOS4LIFE	188 923.90	0.00	0.00
Expenses Projects	34 585.44	500 000.00	0.00
Project reserves	389 632.99	0.00	0.00
Rent expense KEBAG	65 000.00	65 000.00	85 000.00
Administration & IT costs	19 744.98	9 809.71	30 000.00
Advertising	311.70	2 230.00	3 000.00
Representation expenses	286.83	2 718.98	5 000.00
Fee Board of Trustees	0.00	5 000.00	5 000.00
Costs Board of Trustees	5 314.90	1 962.10	5 000.00
Costs Technical Advisory Board	30.05	674.00	0.00
Other operating costs	7 086.13	8 401.66	32 000.00
VAT from subsidies	3 271.35	-65 911.01	0.00
Total Other operating expenses	**777 925.78**	**841 868.76**	**837 000.00**
Total Operating Expenses	**1 316 954.65**	**1 482 475.47**	**1 559 000.00**
Operating result before depreciation & interest	**44 583.67**	**57 766.22**	**120 936.00**
Depreciation and value adjustments	**0.00**	**23 595.36**	**0.00**
Operating result before interest	**44 583.67**	**34 170.86**	**120 936.00**
Financial expenses	**497.05**	**207.80**	**0.00**
Financial income	**0.00**	**0.00**	**0.00**
PROFIT/LOSS FOR THE YEAR	**44 086.62**	**33 963.06**	**120 936.00**

Balance Sheet

	31.12.2019 in CHF	%	31.12.2018 in CHF	%
Assets				
Cash and cash equivalents	**1 085 297.48**	**79.9%**	**283 573.74**	**33.3%**
Raiffeisenbank Uster, current account	1 085 111.03		283 387.29	
Raiffeisenbank Uster, investment account	186.45		186.45	
Trade accounts receivable	**233 364.00**	**17.2%**	**561 773.48**	**66.0%**
Receivables donor contributions	245 000.00		255 000.00	
Receivables subsidies/support contributions	0.00		134 250.00	
Receivables third parties	38 364.00		71 674.70	
Receivables FTA	0.00		150 848.78	
Del credere	-50 000.00		–50 000.00	
Accrued income and prepaid expenses	**39 636.00**	**2.9%**	**5 200.00**	**0.6%**
Prepaid expenses TA	39 636.00		5 200.00	
Current Assets	**1 358 297.48**	**100.0%**	**850 547.22**	**100.0%**
Movable assets	**–**	**0.0%**	**–**	**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	**–**	**0.0%**	**–**	**0.0%**
TOTAL ASSETS	**1 358 297.48**	**100.0%**	**850 547.22**	**100.0%**
Liabilities				
Trade accounts payable	**101 656.24**	**7.5%**	**–**	**0.0%**
Accounts payable to third parties	72 328.45		–	
Accounts payable KEZO	29 327.79		–	
Short-term interest-bearing liabilities	**16 541.52**	**1.2%**	**–**	**0.0%**
Value added / revenue taxes	16 541.52		–	
Deferred income	**951 055.39**	**70.0%**	**605 589.51**	**71.2%**
Accrued expenses and deferred income	61 422.40		105 589.51	
Deferred Projects	889 632.99		500 000.00	
Short-term liabilities	**1 069 253.15**	**78.7%**	**605 589.51**	**71.2%**
Endowment capital	100 000.00		100 000.00	
RESERVES				
Project reserves	144 957.71		110 994.65	
Annual result	44 086.62		33 963.06	
Equity capital	**289 044.33**	**21.3%**	**210 994.65**	**19.1%**
TOTAL LIABILITIES	**1 358 297.48**	**100.0%**	**850 547.22**	**100.0%**

Bericht der Revisionsstelle

zur eingeschränkten Revision an den Stiftungsrat der

Stiftung Zentrum für nachhaltige Abfall- und Ressourcennutzung Zürich

Als Revisionsstelle haben wir die Jahresrechnung (Bilanz, Erfolgsrechnung und Anhang) der Stiftung Zentrum für nachhaltige Abfall- und Ressourcennutzung für das am 31. Dezember 2019 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 bei der geprüften Stiftung 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 nicht dem Gesetz und der Stiftungsurkunde sowie den Reglementen entspricht.

PricewaterhouseCoopers AG

Marcel Aeberhard	Markus Bommeli
Revisionsexperte Leitender Revisor	Revisionsexperte

Zürich, 03. April 2020

Beilage:

- Jahresrechnung (Bilanz, Erfolgsrechnung und Anhang)

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