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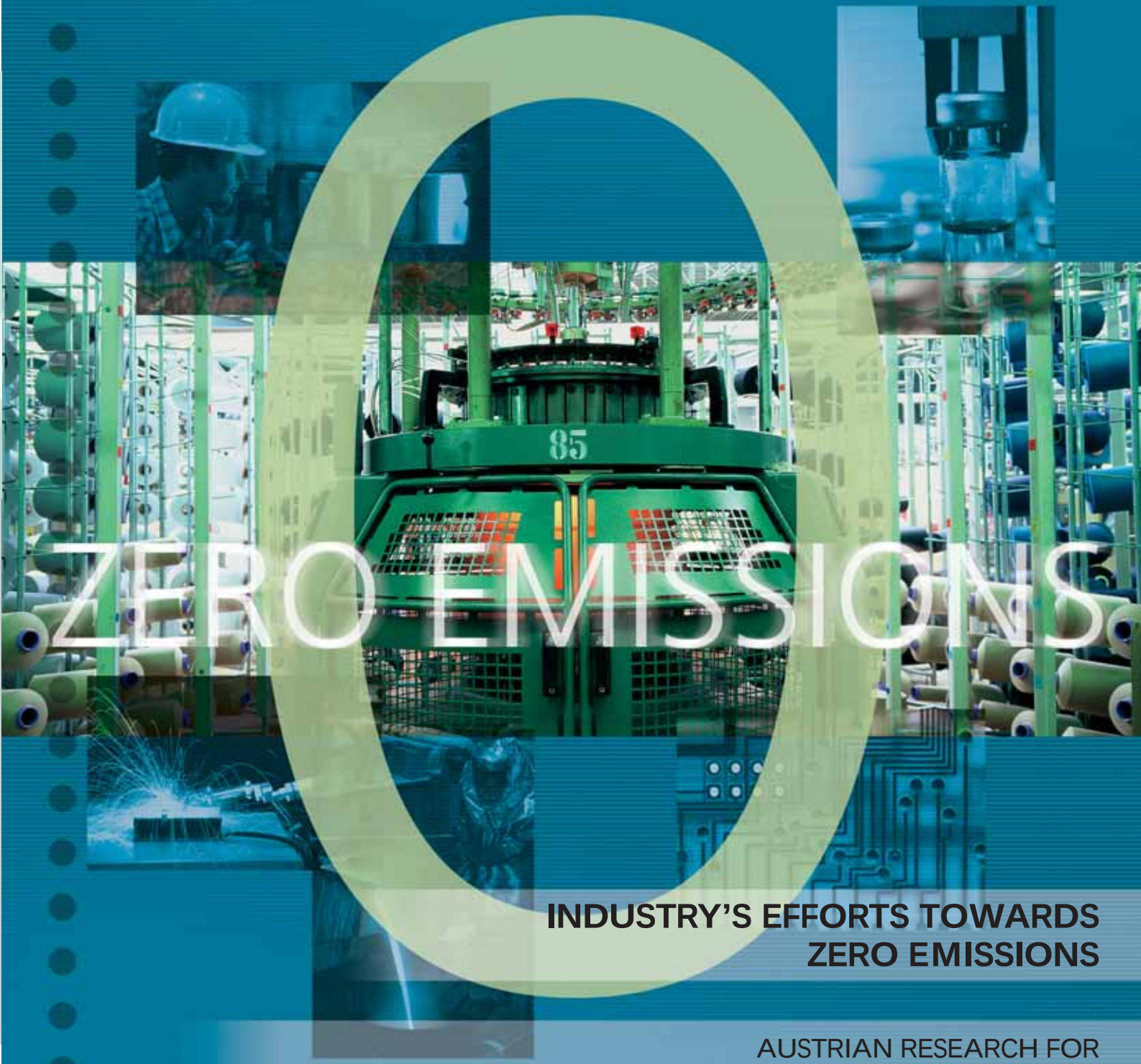


INDUSTRY'S EFFORTS TOWARDS ZERO EMISSIONS

AUSTRIAN RESEARCH FOR LOW-WASTE AND LOW-EMISSIONS IN INDUSTRIAL PROCESSES WITHIN THE "FACTORY OF TOMORROW" SUBPROGRAM

bmvit
Austrian Federal Ministry for Transport, Innovation and Technology

T O P I C

ZERO EMISSIONS RESEARCH WITHIN THE AUSTRIAN "FACTORY OF TOMORROW" SUBPROGRAM

In 1999, the Austrian Federal Ministry of Transport, Innovation and Technology (bmvit) launched the "Austrian Program on Technologies for Sustainable Development", which aimed to effectively stimulate the restructuring of the economy towards sustainability. Various research and development projects as well as demonstration and diffusion measures, which give new impetus to innovation in Austria's economy have since been supported within the scope of a number of subprograms.
The "Factory of Tomorrow" subprogram aims to encourage trend-setting pilot projects in the field of sustainable technology development. Model examples include innovative manufacturing processes, future-oriented products or exemplary enterprises. Innovative development should focus primarily on the fields "technologies and innovation in production processes", "use of renewable raw materials", and "products and services". The "Factory of Tomorrow" subprogram is being financed from the Federal government's special funds for technology development on recommendation of the Council for Research and Technology.

■ One of the most important cornerstones of a sustainable society consists in an industry that uses zero waste, zero emissions processes. These processes require complete recycling or re-use of all raw and auxiliary materials that are not contained in the final product as well as of all operating materials and energy flows. The goal of this kind of production is to extract only those materials from the natural environment that form part of the final product or of by-products. In addition, a sustainable economy also requires that the whole product life from the extraction of raw materials to the disposal of the product be taken into account. Finally, it will be essential to develop a multitude of innovative services, which would make it unnecessary to own certain products.

All these aspects have often been included in the catch phrase of "Zero Emission". So far, there is no final definition and no generally accepted method to implement "Zero Emissions". However, a number of strategies have been developed, which address the problem of reducing or preventing waste and emissions in industrial production. It has become apparent that there is no single or preferable path to attain the abovementioned objectives, but that only a combination of technological, organizational, and sociological measures and the use of different approaches will lead to success.

International research activities such as the ZERI initiative of the University of the United Nations (UNU) use a holistic approach to realize the zero emissions objectives; various pilot projects are being conducted, predominantly in developing countries.

In Austria, several projects are being realized within the "Factory of Tomorrow" subprogram; researchers investigated the fundamentals of the zero emission approach and also entered into a close cooperation with Austrian enterprises in order to demonstrate possibilities and routes towards implementation.

PROJECT 1

ZERIA I und II –
Zero Emissions Research in Austria

RNS – Institute of Resource Efficient and Sustainable Systems, Graz University of Technology
Project Authors: ao. Univ. Prof. DI Dr. Hans Schnitzer, DI Gernot Gwehenberger et al., Graz 2000 and 2003

The first part of the ZERIA project worked out the fundamentals and definitions and also analyzed first possibilities for the practical application of waste-free, zero emissions processes and technologies. Already existing approaches and strategies were also analyzed.
ZERIA II builds upon these results and aims to develop an integrated strategy that combines different methods in a targeted manner and adapts them to the special needs of Austria's industries. The strategies developed in this process will yield a set of tools for use in practical applications.

PROJECT 2

ZERMEG I und II –
Zero Emission Retrofitting Method for Existing Galvanizing Plants

STEMUM GmbH, Graz
Project Authors: Dr. Johannes Fresner, et al., Graz 2003 and 2004

Within the ZERMEG I and II projects, researchers developed a method permitting to systematically optimize existing galvanizing plants. The plants can be retrofitted or converted in such a way that they can be operated with a considerably reduced chemicals input and on the basis of closed cycles. Pilot plants served to test these methods in practice. The second part of the project aims to fine-tune the methods and to develop strategies for the dissemination of results.

ZERIA: FUNDAMENTALS AND METHODS IN ZERO EMISSIONS PROCESSES

Today's ideals in the industry are modern and innovative processes that aim to reduce emissions and waste by an efficient and careful input of raw materials. The necessity of using zero emission processes becomes evident if one considers the true costs caused by waste and emissions generated in manufacturing processes. The waste produced has to be purchased in the form of raw materials and has to be accounted for in overall production costs (personnel, equipment, disposal). This demonstrates the great potential for savings, which could be realized through the prevention and recycling of emissions.

The ZERIA I and II projects explored possible strategies towards an implementation of zero emission and waste-free production technologies in Austria. Methods that have already been tried and tested include Cleaner Production, the use of renewable raw materials and Ecodesign. Approaches such as upsizing (i.e. transformation of raw materials that are not utilized in the production process into products that yield high value added) or integrated Bio Systems (utilization of biogenic waste and emissions for the production of fertilizer, animal feed, etc.) also aim towards zero emissions processes. The strategy of an ecological industry designs industrial production on the model of natural eco-systems and develops concepts for the creation of "Eco-Industrial Parks" where waste from one line of production is used as a valuable raw material in other processes.

However, none of these actually successful strategies applied alone will be able to realize zero emissions. All approaches use the same tools, though (analysis of true costs, life cycle analysis, material flow analysis, environmental management systems) and meet with the same barriers. For this reason work within the project consisted in a targeted search for possibilities to combine individual approaches and to develop an integrated strategy.

The starting point has to be a detailed material and energy balance for the industrial process in question. In developing approaches to zero emission processes the emission flows into the different media of the environment (water, soil etc.) can be considered separately. Researchers on the ZERIA project differentiate between emissions into the air and water, energy emissions (waste heat and noise), and solid waste. Hazardous waste and composite materials form still another category. In order to attain a comprehensive strategy the different methods of avoidance or utilization and the different media are arranged in a matrix; then researchers try to find zero emission solutions for each of the resulting pairs in the matrix (emission into a medium - method) and subsequently compare combinations of various methods. According to the zero emission concept there basically are two approaches to eliminating a given type of emission:

- Prevention in the production process (modification of the process, innovative processes, replacement of raw materials by non-hazardous and renewable raw materials, etc.)
- Internal or external recycling (after adequate conditioning, if necessary)

Considering this, there is a number of feasible approaches for each emission flow to come closer to zero emissions. This "hierarchically" arranged compila-

Case Studies in the Austrian Industries

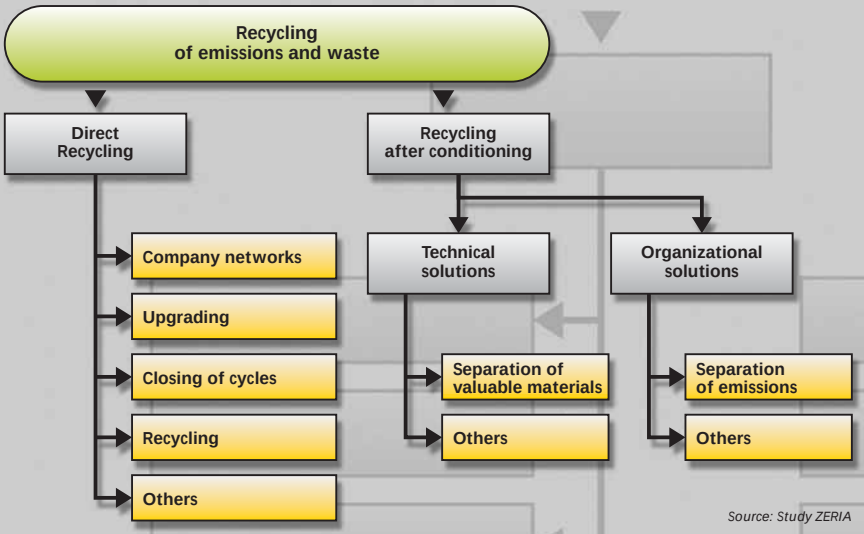
1 Marienhütte Ges.m.b.H.

The Marienhütte is a steel and rolling mill producing some 3000,000 tons/yr. of steel from scrap. The steel works had already implemented a number of environmental projects and by using various environmental technologies achieved a high degree of waste avoidance regarding its material flows. The biggest problem, so far unsolved, consists in an excessive water and energy consumption in the steel melting process. The business has already taken measures in the past to optimize energy flows in the plant. Thus the steel works have been feeding waste heat into the district heating system of Graz; the space heating system for the premises at Marienhütte and two neighboring businesses also uses waste heat from the plant. The ZERIA project developed proposals for further improvement: Using waste heat from the arc furnace in combination with a supplementary gas fired boiler to operate a steam turbine for power generation.

No satisfactory solution has been found for the optimization of water cycles so far; further research and development will be needed in this field.

2 SCA Laakirchen, Paper Mill

Possible approaches towards zero emissions focus on the recycling of residue generated in the treatment of raw materials such as ashes from biomass, fibers, and bark. Ashes could be used as filler in the cement industry or as fertilizer in forestry. Fiber residue could also be used in cement industry or in the manufacture of ecological building materials; bark could be used in the manufacture of chipboards or insulation materials.



Source: Study ZERIA

The development of this system is based on the experience and special requirements of Austrian enterprises, which were identified by means of a questionnaire. The survey has shown that zero emissions and waste-free processes meet with great interest. Participating enterprises considered process water and solid waste to be the most important problems in this context.

tion of methods, guidelines, practical experience, and theoretical findings is then represented in a "decision tree". Depending on the actual situation in a given facility this checklist will yield several combinations of methods, which then are judged as appropriate, less suitable or unfeasible. This tool helps to assess the potential for the implementation of zero emission and zero waste processes at a given production facility. The project researchers worked out decision trees for process water and energy flows in greater detail, which may serve as exemplary approaches.

3 AURO Naturfarben GmbH.

The production range of this company comprises the manufacture of natural paints and varnishes, the steam distillation of ethereal arolla pine oil, and the refining of larch resins. Potential for optimization has been identified for the process of steam distillation; researchers developed two technically improved variants to close cycles and to reduce fuel oil consumption. However, one financial barrier to the implementation of both approaches consists in the insufficient rate of utilization of the plant. Therefore, expanding the production of ethereal oils would have a positive effect. Concerning resin refining, researchers recommended the use of solar energy to heat or preheat the resins.

4 EYBL International AG

The case study of this textiles manufacturer for the automotive industry (seat covers, car interior and roof linings, etc.) highlighted a potential for emission reduction in the fields of solid waste, exhaust air, and effluent.
At present for instance, only dry textiles are being sold to other enterprises for recycling. New methods of treatment for wet textiles waste from the production process would permit to recycle these as well. Concerning exhaust air / energy the use of various new technologies could result in improvements (e.g. waste gas cleaning unit for the moist exhausts including heat recovery or an autothermic post-combustion plant, etc.); installation of a membrane filter could reduce wastewater by 90%, in addition this would result in considerable energy savings.

5 Berglandmilch reg.Gen.m.b.H.

Approaches towards zero emissions concentrated on three areas: Prolonging the useful life of the cleaning lye in the existing Cleaning in Place (CIP) unit, investigating the potential use of the separated water generated by the reverse osmosis plant in the process, and alternative treatment methods for the milk serum generated through the process. Researchers discussed all three problems and worked out possible solutions.

ZERMEG: OPTIMIZATION OF EXISTING GALVANIZING PLANTS FOR LOW-EFFLUENT AND LOW-WASTE OPERATION

Electroplating is an important process in modern industry, which permits to produce durable metal surfaces that prolong the service life of components through protection against corrosion. This contributes to the conservation of resources and the protection of the environment. However, the plants cause considerable environmental impacts on account of the high water consumption and the chemicals used in the process. These substances travel into the effluent to some extent and have to be removed at great expense.

Researchers on the ZERMEG project developed a method to optimize existing galvanizing /electroplating plants. The recommended measures optimize the processes involved in such a way that

- effluents are reduced to the fullest extent possible and contain only a low pollutant concentration
- as many substances from the bath as possible can be recycled in the plant
- unavoidable waste from the processes can be recycled as byproduct in other firms

The method consists of a methodological approach, a computer program calculating the theoretically ideal quantities of water and chemicals needed (ZEPRA), checklists for options, and databases with appropriate technologies for the prolongation of the useful life of baths and for closed cycles.

The in-house analysis and optimization comprises the following stages:

- Analysis of the actual situation: measuring water consumption and chemicals input, ascertaining of chemicals drag out, definition of the rinsing criterion
- Reference calculation of the theoretical water consumption and chemicals input, interpretation of deviations in practice
- Definition of possible external use and safe disposal
- Definition of possible recycling
- Evaluation of options
- Optimization of effluent treatment

The method has already been successfully applied in ZERMEG I pilot projects. In some cases specific water consumption was reduced by 80 to 95% and a considerable reduction of the specific chemicals input was achieved. Eloxal Heuberger was the most important partner in the project; they supported the development of the project and helped to implement theoretical results in practice.

ZERMEG II continued these activities in greater detail. It has been shown that a comprehensive zero emissions concept requires in-depth investigation of the degreasing and pickling and etching processes used in surface treatment plants. The second phase therefore focuses on the preparation of reference data on these processes. For this purpose, literary research was used to identify factors influencing the quality of pickling and degreasing processes; these factors were then prepared for incorporation in the model calculations. Different pickling processes were analyzed in order to ascertain in how far theoretical calculations correlated with practical experience in the plant. Another focus was on new approaches to bath management and to prolonging the useful life of the bath. Harmful contaminations should be cleared out in such a way that they can be used as raw material in other trades. As was the case in the first phase, the partners in industry implement the results of these investigations directly in practical applications.

Galvanizing

Galvanizing refers to the process of coating materials with metal by means of electro-chemical deposition. The purpose is to improve surfaces and to **protect them against corrosion**. The process requires a clean surface of the material. Therefore, any soiling such as oil, grease, coolant, and abrasives that stick to the surface have to be removed by means of chemical treatment. **Degreasing** is the first wet chemical stage in all treatment. **Pickling** serves to remove remaining traces of grease and dirt as well as the natural oxide layer. Both, pretreatment and the galvanizing process use a cascade of chemical baths. After each process bath the work pieces are rinsed with water in order to avoid **drag out** of metal, salt, and acid residue into the following process bath.

At present, the method is being applied in five other galvanizing plants.

Inclusion of new project partners considerably increases the number of applications for the ZERMEG method. Practical experience together with a documentation of the case studies, the guidelines, and a calculation program will be entered in a comprehensive database, which is available at the ZERMEG homepage (www.zermeg.net) and which permits interested enterprises to analyze their plants themselves.

IMPLEMENTATION OF THE ZERMEG METHOD IN AUSTRIAN ENTERPRISES

1 Eloxal Heuberger

The company anodizes aluminum surfaces, i.e. the surface is converted into an oxide layer thus protecting the aluminum against corrosion and abrasion. The range of anodized components includes profiles for building facades, windows and solar installations as well as various smaller parts for a number of different applications. Using the ZERMEG method helped to highlight weak points in the production process and to develop and implement approaches to the optimization of individual stages in the production process.
The results achieved so far have shown that the chosen approach is the right one. Water consumption was reduced by 95% and the input of acid and caustic solution was cut by 50%.
These improvements are attributable to the following measures:

- Better understanding of the processes in the baths and of the concomitant production stages in the enterprise
- More accurate modeling and calculation, thus improved know-how in the firm
- Optimization of degreasing processes
- Minimization of metal loss in pretreatment
- Optimization and prolongation of the useful life of baths
- New technologies for bath management
- Identification of new routes for recycling

2 Mosdorfer-Knill GmbH

Research in this galvanizing plant focused on the identification of the ideal acid consumption for the pickling process (etching of the surface in an acid bath). This step is necessary to achieve a clean surface on the metal parts prior to the galvanizing process. Optimization of processes resulted in a 50% reduction of the specific acid consumption per surface area. The ultimate objective consists in achieving a thorough recycling of used acids by further improving acid management.

3 Rotoform GMBH

One line of production of this company consists in the manufacture and processing of printing forms for the graphic trade. The steel cylinders of rotogravure printing units are cleaned, plated with nickel or copper, surface milled, engraved or etched, chromium-plated and polished at the facility. Technical modification of the rinsing processes involved in production resulted in substantial improvement. Water consumption of the unit was reduced by 40% and acid input by 30%, while production increased by 25% within the same period.

FIGURES / DATA / FACTS

PROJECT SPONSORS

All Projects were conducted within the scope of the “Factory of Tomorrow” subprogram.

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Project Authors: ao.Univ.Prof.DI Dr. Hans Schnitzer, DI Gernot Gwehenberger, et al., Graz 2000 and 2003

Zermeg I und II –
Zero Emission Retrofitting Method for Existing Galvanizing Plants
STENUM GmbH, Graz
Project Authors: Dr. Johannes Fresner, et.al., Graz 2003 and 2004
Cooperation partners (a. o.): Heuberger Eloxal (Josef Mair, H. Oberlerchner), Mosdorfer-Knill GmbH (Franz Solka), Rotoform GmbH (Dr. Michael Hofer)

INFORMATION PUBLICATIONS

The final reports on the abovementioned studies have been published in issues 21/2000 and 21/2003 of the bmvit series “Reports on Energy and Environment Research” and are available from: www.NachhaltigWirtschaften.at

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