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Befesa and the R&D&i

We have a technological commitment to seek and research the most advanced technologies and those that are the most respectful of the environment for waste and water management.

Befesa and the R&D&i

Befesa's R&D&i strategy

Befesa's R&D&i strategy is aimed at obtaining results and the creation of values, through the development of new technologies and always bearing sustainable development in mind.

Befesa's R&D&i strategic plan has the following goals:

- To be a leader and technologically competitive in the recycling industry of aluminum and steel waste.
- Development of new technologies for the management of industrial waste.
- To be a leader in desalting technology and technologically competitive in the processing of residual waters and their re-utilization.

In the area of recycling of aluminum waste, the activities of R&D&i seek to improve the efficient recovery of raw materials and aluminum waste, optimize the operating processes and the quality of the products, as well as develop new and better technologies, which will contribute to the sustainable development.

The R&D&i projects developed by the area of steel

and galvanization waste recycling focus on the design and construction of installations which will make it possible to optimize the efficiency of the processes, as well as the investigations in order to obtain new uses of the recycled material by Befesa.

The area of integral management of industrial waste focuses on the development of new technologies in order to adapt to the continuous evolution of the environmental legislation, giving priority to the management methods based on the hierarchy marked by the re-utilization, the recycling and the valuation compared with treatments for elimination and diversification aimed at new environmental markets, as well as the increase in the number of processable waste products.

In the area of water, Befesa focuses its R&D&i on the optimizations of energy efficiency in the processes of desalting, re-utilization of waste waters, minimizing their costs and their environmental impact, as well as the optimization of the hydraulic infrastructures.

One of the pillars of Befesa's R&D&i strategy is the external collaboration with institutions and universities. Several noteworthy collaborations

include the Euskoiker Foundation and the Escuela Técnica Superior de Ingenieros Industriales of Bilbao, which form a part of the regular activities carried out by the Aula Befesa (Classroom) in training and investigative matters. In the same way, collaborations are undertaken with the Ministry of Industry, Commerce and Tourism; the Innovation, Science and Business Inspectorate of the Junta de Andalucía; the CDTI, Inasmet, the University of Valladolid, the Program for the Promotion of Technical Research (PROFIT), the Corporación Tecnológica de Andalucía, the Laboratorio Inatec, Inesca and Alcan, among others.

The business units and innovation

The series of investments and R&D&i programs have been directed at achieving the objectives, which form a part of the strategic plan.

In the recycling of aluminum waste, the R&D&i projects seek to improve the quality of the melting salts, with a minimization of the production of saline slag; improve the casting of the aluminum and the automatisms of the ingot

casting lines; optimize the recycling of the saline slag, in order to increase the productivity of the process and minimize the costs and finally develop projects aimed at evaluating the Paval as a market product.

The experiences of the steel waste recycling plants will be covered by the R&D&i Department in order to contribute to the design and construction of the new installations for processing steel powder in a more efficient manner. This includes not only the metallurgical and economic point of view of the operation, but also the environmental impact, which these activities might have. Another important front is the development of new technologies for steel powder recycling which will make it possible to develop new products for the construction industry and the cement industry.

The projects for the management of Befesa's industrial waste are aimed at reducing the elimination processes, relying on the recovery and valuation of the energy, as well as consolidating the technological leadership in the management of industrial waste, based on safe and energy efficient environmental processes.

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Befesa Agua projects focus on the optimization and development of desalting by reverse osmosis; the development of the re-utilization system for waste waters and the technologies for urban and industrial waste water for its regeneration; the development of the technology or supercritical oxidation for the elimination of the mud and sludge produced in the depuration and water purification processes, and finally, the improvement of the hydraulic infrastructures under considerations of sustainability for the integral water cycle.

Befesa's R&D&i projects include the construction of the Environmental Technological Centre, which has the purpose of investigating environmental technologies with the water processing and the management of industrial waste, relying on all the necessary means for Befesa's development of R&D&i projects. It is a sustainable centre, not only due to the activities which will be carried out in the centre, but because it will be designed and constructed in accordance with sustainability criteria, without CO₂ emissions. It is programmed for operation in 2009.



Listed below are the R&D&i projects of the business units and the investments made during 2008:

Investments in R&D&i	2008 (€)
Aluminum Waste Recycling	
● Reinventing the aluminum cycle: processing and preparation of the raw materials	82,668
● New processes for the improvement of the technology: development of techniques for recycling aluminum	451,920
● New materials and recycling products: give added value to Paval and the improvement of new alloys	163,365
● New treatment of dust collective residue, phase III	0
Steel and Galvanization Waste Recycling	
● Pilot plant for the energy and chemical use of the waste gases of the process	60,180
● Study on the reduction of the concentration of sulphides and fluorides in the waste dumping	35,326
● Obtaining of new products from the purified waelz oxide (D-L.W.O. ®)	53,912
● Industrial proof for obtaining ceramic products from Ferrosita	48,290
Industrial Waste Management	
● Energy valuation of WDF	117,763
● New materials for the construction from the waste products	96,280
● Remediation of contaminated earth from NHW and other sub-products	79,395
● Valuation of waste of fragmenters of vehicles no longer in use	28,979
● Preparation of fuel for the vitrification plant using plasma	76,042
● Valuation of organic industrial waste	9,410
● Development of oxygenated additives derived from glycerin for its use in fuel	197,406
● Catalytic reforming of glycerins	156,663
● Production of thermoplastic compounds reinforced with fiber glass	29,608
Water	
● Project for a highly efficient desalting pilot plant	433,000
● Study of the phenomenon of the dilution of saline water	82,100
● Elimination of EDAR sludge by means of supercritical oxidation	238,100
● Development of desalting by means of renewable energies (DeReDes)	72,800
● Advanced waste water processes for their re-utilization (TRASOS)	192,500
● Development of advanced pre-processing systems for the desalting	83,000
● Development of an integrated control system for large desalting plants	117,200
● Hydrous management systems	11,400
● Environmental Technology Centre	1,344,600
Total amount of investments in R&D&i	4,261,907

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Aluminum Waste Recycling

- Reinventing the aluminum cycle: processing and preparation of raw materials.

The goal of this project is to recover the aluminum from materials up until now not used due to the difficulties involved and obtaining a larger amount of metal recovered than what is customary, due to a better recycling process. The work carried out to manage the so-called SPL's by Befesa Escorias Salinas (Befesa Saline Sludge) should be highlighted for it has led to a patent and the corresponding trials in a pilot plant of this waste. The study has also been carried on the aluminum recoverable from complex metal-plastic-cellulose materials. This project has been carried out as part of the Aula Befesa, which is an agreement for the scientific, technological and educational collaboration signed with the Escuela Técnica Superior de Ingeniería of Bilbao.

- New processes for improving the technology: development of techniques for aluminum recycling.
This project includes three processes. The first has the goal of analysis and study of the

behavior of the melting elements in the fusion of the aluminum. In order to do so, the rotary oven has been used, numerous fusion tests have been carried out and improvements have been incorporated into the processing of the gases of the oven. The second is the study of reactivity of the saline sludge, which has been carried out in collaboration with the University of Valladolid, in order to predict by computer the progress of the saline sludge reaction and prove that the model works with a pilot plant. And finally, mention should be made of the work carried out for the use of the energy produced by the gases in the steam boiler and the saving of the corresponding energy. This project tries to save natural gas used in the plant to produce steam and in the drying of the salts and the Paval.

- New materials and recycling products: give added value to the Paval and the improvement of the alloys.

This project includes several tasks. One of them is the metallurgical improvement of the aluminum alloy with a high content of iron for moulding by injection, which is carried out at Inasmet. It is also contemplated in another job for the use of secondary alloys for the moulding

of the prices with high mechanical responsibility, which is carried out in collaboration with the industries of the sector. And finally, the Ecoretech sub-project, which is a development for new applications of Paval/BFA for street furnishings, developed by Befesa Escoria Salinas in combination with other companies and technological centers.

- New process for dust collector residues, phase III. The goal of this project is to design a process and test pilot equipment for processing powders

through hose filters in any aluminum refinery. In 2008 equipment has been started up in the pilot plant in Valladolid. Dust collector from the collections of the aluminum factories will be processed and tested, which up until now were intended for the dump areas of toxic and dangerous materials. It is a new environmental service, which will be launched for the aluminum refineries. The market to which this investigation is directed makes the work and the results obtained very interesting. The project has been financed by the CDTI.



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Steel and Galvanization Waste Recycling

- Pilot plant for the energy-chemical use of the residual gases of the process.

This project pursues, as the final goal, the continuous obtaining of the final product (D-L.W.O.[®]), of similar quality to the current one, by means of the self-consumption of the bicarbonate-carbonate produced from the residual gases of the process with the subsequent minimization of the CO₂ emissions to the atmosphere. Throughout 2008 a new process flow has been designed, consisting of a preparation tank containing a waelz oxide solution – extracted from the sedimentation chamber – with water, for its subsequent conduction and transfer to equipment for absorbing CO₂ coming from the chimney. At the end of this period, the project is in the

phase of reception, assembly and setting into operation of the leading components of the installation, prior to the initiation of the first vacuum tests.

- Obtaining of new products from the purified waelz oxide (D-L.W.O.[®]).

Investigation was continued along the lines initiated in 2007 for the lixiviation of the purified waelz oxide (D-L.W.O.[®]), with other lixivate agents, both acidic as well as basic, other than the ammonium carbonate, with the purpose of obtaining highly pure zinc oxide (ZnO) (99,99%) and other new products of a greater added value, such as the metal zinc. The conclusion was reached that the lixiviation tests in an acidic medium lead a priori to much more promising results, and so future investigations should be centered on this channel.



- Study of the reduction of the concentration of sulphides and fluorides in the waste dumping. In the resolution of the concession of the Integrated Environmental Authorization, the Basque Government encouraged Befesa Zinc Aser, S.A. to carry out a project aimed at evaluating the technical-economic feasibility of different alternatives for the reduction of the content of sulphides and fluorides in the waste dumping, which the Company creates. At the end of this project, it has been shown that the sulphides are eliminated easily by adding hydrogen peroxide (H_2O_2), and its dosage could be controlled with the measuring of the redox potential of the waste dumping. This solution has already been implanted successfully in the treatment process of the effluent. As regards the fluorides, it has been proven that their elimination would mean reaching levels of waste dumping which are potentially limiting, as a large volume of reagents would be required and great amounts of residue would be produced which would make its industrial application unfeasible.
- Industrial proof of the use of Ferrosita® for obtaining ceramic products. A technical evaluation and environmental study.

Different life-size ceramic pieces have been made on the scale of a pilot plant with different mixtures of clay with Ferrosita® and the corresponding studies of the physical, chemical and mechanical characteristics of the units manufactured were made.

The first three projects are being carried out in collaboration with the Euskoiker Foundation and the Escuela Técnica Superior de Ingenieros Industriales de Bilbao, forming part of the actions being undertaken by the Aula Befesa in formative and investigative matters. For the fourth project, the advice of the Chemical Engineering and Inorganic Chemical Departments of the University of Cantabria has been requested.



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Industrial Waste Management

- New Materials for construction from the waste materials.

The present project, initiated in the year 2006, is aimed at evaluating the inorganic industrial waste, currently managed by the company, through its safe incorporation into construction materials (i.e., Bricks, mortar, acoustic and/or thermal insulation, etc). In order to do so, it relies on the collaboration of the Solid State Chemical Group of the University of Seville, which furnishes its knowledge and experience in the stabilization of waste in silicon matrices, by means of mild hydro-thermal processes. The specific goals of the project support the general business strategy and centre their efforts on the search for sustainable development, directly applied to the scope of the industrial waste.

Their incorporation in construction materials by means of safe environmental solutions will make it possible to reduce the consumption of non-renewable raw resources and materials, while it also allows for the re-incorporation of waste into the chain of value of society.

- Development of oxygenated additives derived from glycerin for their use in liquid fuels.

The project initiated in the year 2007 is aimed at using raw glycerin, which is a surplus product in the biodiesel production plants, by means of its transformation into extra added value products. In particular, this project seeks the synthesis of tertbutylic ethers from glycerin, to be used as oxygenated additives for diesel fuels. For their development, the R&D&i Department of BGRI relies on the collaboration, on a sub-contracting basis, of the Tekniker Research Foundation, as well as the Research Group on Thermal Engines and Machines of the University of Seville. The use of the large surpluses of non-purified glycerin, without a current market in Spain, through its transformation into new products of extra added value, will improve the cycle of the bio-diesel life, supporting the sustainable development and the reduction of the negative environmental impacts.



- Energy valuation of the WDF (waste derived fuels).

The efforts made by the R&D&i in past years have resulted in the obtaining of a waste derived fuel, Comat, originally designed for cement industry companies and their de-classification as dangerous waste. This circumstance opens the doors to other possibilities for energy valuation in thermal process, which are less energy intensive and which comply with the current norms in force on matters pertaining to the valuation of residue. The present project, initiated in 2008, focuses on detecting the necessary technical innovations for energy valuation of this fuel in conventional solid fuel boilers and the adaptation to the new regulative framework recently approved in the European Union. The use of energy from waste products, the object of the project, will achieve the scope of a sustainable development applied to the scope of the waste, recovering the energy contained in them and limiting the consumption of non-renewable primary resources.

- Valuation of waste from the fragmentation of vehicles no longer in use.

This project has been initiated by the R+D Department during the year 2008. The fragmented waste is waste with a high potential for energy use. However, certain insurmountable difficulties arise for its direct valuation, due to operational problems associated with the difficulty in handling them and compacting them. The project seeks its valuation by its direct mixing with an ideal matrix of organic waste. This solution will achieve an important synergy in the improvement of the possible thermal use of both typologies of waste, as well as the adaptation to the European standards for alternative fuel sources and to the REACH catalogue. The project is combined with Befesa's environmental policy and relies on the use of the resources contained in the waste and the promoting of sustainable development. In addition, it represents an important initiative in the field of normalization of fuels derived from waste. It is expected that this will help to promote the use of alternative materials, both in fuel applications as well as in new materials, while always seeking a sustainable development directly derived from the minimization of the consumption of primary materials.

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- Production of thermo-plastic compounds reinforced with fiber glass.

The goal of the research is to achieve a final product, based on recycled materials, which has the same technical characteristics as the compounds manufactured with virgin materials and so the study has centered on the identification and design of a productive process suitable for the mixture and processing of the product to be manufactured. In order to do this, an industrial installation has been set up for the production of polypropylene reinforced with fiber glass, with a component of this latter material between 20% and 40%, in order to attain a final production of 7,000 – 8,000 Tn, which would be intended mainly for the automotive industry and for the home appliance sector. The product will be obtained

by mixing polypropylene and additives, together with fiber glass, in variable percentages, in relation with the needs or requirements of the potential clients. The process will incorporate recycled materials, whose competitive advantage is the lower purchasing cost of the materials, which will be used compared with the virgin products, which are currently used in the manufacture of these compounds at present.



Water

- Project for a top efficiency desalting pilot plant. The goal is to reduce the energy consumption of the desalting to values below the 2.5 kWh/m³ of water produced. The membranes of reverse osmosis and the energy recovery systems have been studied and developed for this purpose, as well as the improvements in the process which will make it possible to minimize energy consumption. The project receives a subsidy from the Board of Innovation, Science and Business of the Junta de Andalucía, and from the Ministry of Environmental Protection.

- Study of the phenomenon of dilution of the saline water. The goal is to develop a system of dilution of the saline water of the desalting plants which will make it possible to guarantee that any environmental impact will be reduced as much as possible. In order to do so, a special simulation tool is being developed validated with experimental data obtained from a scaled physical model. The project receives a subsidy from the Board of Innovation, Science and

Business of the Junta de Andalucía, and from the Ministry of Environmental Protection.

- Elimination of sludge from WWPP using supercritical oxidation. The goal is to prove the technical and economic feasibility of the technology of supercritical oxidation for the elimination of the sludge from the WWPP (waste waters purification plant), for which a pilot plant has been designed and constructed. The Board of Innovation, Science and Business of the Junta de Andalucía, and the Ministry of Environmental Protection have subsidized this project.
- Development of the De-salting Project with Renewable Energies (DeReDes). The goal is to carry out a systematic study of



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the possible combinations of desalting technologies and of the possible sources of renewable energies. The technical and economic feasibility of the different combinations have been analyzed bearing in mind the possible venues for the location of this type of plant. Three concepts of desalting plants with renewable energies have been designed. The project receives a subsidy from the Ministry of Industry, Commerce and Tourism, from the Program for the Promotion of Technical Research (in Spanish, PROFIT) and from the Ministry of Environmental Protection.

- Advanced processing of waste waters for their re-utilization (TRASOS).
The goal is to develop the ideal technologies, which will make it possible to regenerate the

water in terms of the type of waste water to be processed, and the quality required according to the final reuse foreseen. Physical-chemical technologies, membrane technologies, biological processes and electrolytic technologies are being developed and pilot laboratory plants are being used for this purpose.

- Development of advanced systems for the pre-processing for desalting.

The goal is to develop the water processing system for regular seawater which will make it possible to guarantee that the quality of the water entering the reverse osmosis membranes is ideal according to the type of sea water and bearing in mind its possible seasonal variations. Physical-chemical technologies for the biological process and membrane technologies are being



developed. The project receives a subsidy from the Board of Innovation, Science and Business of the Junta de Andalucía, and from the Ministry of Environmental Protection.

- Development of a control system for large desalting plants.

The goal is to develop an integrated control system which will make it possible to optimize the operation of the desalting plants and maximize their availability and which would include a tool for assisting in the decision. The project receives a subsidy from the Board of Innovation, Science and Business of the Junta de Andalucía, the Technological Corporation of Andalusia, the Ministry of Industry, Commerce and Tourism and the Program for the Promotion of Technical Research (in Spanish, PROFIT).

In order to centralize the research activity of Befesa Water in 2008 work has been initiated in Dos Hermanas (Seville) on the Environmental Technology Centre which is intended to become a reference research centre on a national level for matters related to water and environment. It will be a sustainable centre, not only for the activity which will be carried out in this Centre, but also because it will set up a Centre without CO₂ emissions, among other things. The Centre will represent an investment of almost 2 M€ and a capacity for 50 researchers, and it will have a surface area of 1,700 m² and a warehouse of 2,200 m², with laboratories for the characterization of water, experimental areas for desalting, water processing, waste, hydraulics and systems. It will also have a control room from which it will be possible to monitor the operations of the plants operated by Befesa.



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Latin America

- Study of technical feasibility for the construction of an in situ processing plant in the Campana plant.

The process for the final disposition will be carried out in secure filling areas of this plant out-of-doors, which will result in the generation of lixiviates, as a result of the precipitations registered in the region. These lixiviates will be stored in reservoirs constructed for this purpose and re-circulated to the filling area for the humidification of the ashes and waste disposed, thus avoiding their dispersion. The expansion of

the operating area and as a result of the surface area containing the waste exposed and an increase in the volume of the precipitations registered, has led to the need to carry out a study for the construction of an in situ processing plant, which will use the three pre-existing reservoirs as their main installation. This project is being developed in collaboration with the National University of San Martín of Argentina. This project will minimize the risks involved in the processing of the lixiviates and will reduce the processing costs of the treatment which called for its derivation to authorized operators.



