

The Circular Economy Preserving, optimising and

ensuring essential resources for our future



Every day, we witness the decline in the linear model of production and consumption. Reducing the risks associated with primary raw material markets, accepting the environmental limitations of extracting the planet's resources, doing more with less through gains in material productivity in production and consumption, growing environmental awareness amongst consumers and new markets in "closedloop" technological and biological components are all driving forces that together propel the transition to a more circular economy that produces less waste and makes better use of the value of manufactured products. The epicentre of this silent revolution lies in the application of scientific knowledge, technological development and business innovation. Given the systemic nature of the change, coordination, cooperation and sharing between economic players, public authorities, academia and non-governmental organisations are critical factors in its success. For all of these reasons, COTEC Portugal has identified the circular economy as a priority. The various case studies presented in this document are examples of

the country's scientific and technological capacity to respond to the problems and overcome the challenges of transition. They also demonstrate that companies such as GALP, TMG Automotive, SECIL, Cerealis, ZARA and Lipor, operating in diverse sectors, are implementing their commitment to contribute to a world which produces less residues and waste while at the same time making better use of resources with fewer negative externalities, thus exacting a more acceptable environmental cost. It is important for companies to realise the urgency and relevance of the strategic decisions to incorporate circularity concepts into their business models, concepts that are crucial to their competitiveness and survival in the medium to long term. As the trustees of today's resources, it is how we project these decisions into the future that will dictate what kind of legacy we leave future generations.

> Francisco de Lacerda, Chairman COTEC Portugal







The resources available to us **ARE NOT INFINITE.**

BID YOU 2016

The World's Population has already surpassed **7 Billion** people. **2636**

The world's population in 2030 is estimated to be

8.5 Billion

The Global Middle Class is set to more than double by 2030 to around 5 Billion people.

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Sources: United Nations, Eurostat and Pordata

people.

DIDDYQU DIDDYQU KARONOQU S.1 Billion S.1 Billion

capita consumption of materials of roughly **16 tonnes.**

Only **5%** of the original value of **Raw Materials** consumed in Europe is recovered through

Recycling and energy recovery from waste.

In Portugal alone, each person produced **4.52KG** of rubbish, +2.5% more than in 2013.

2614

of the value of these materials and the energy used is

Source: European Commission

Dibbio Solution Dibio So

35 to **50%** An office is only used 35% to 50% of the time, even during working hours.



The European Union imports 6 times more materials and natural resources than it exports. of food **is wasted** along the value chain.

Between **39** of the value of **10** the materials used in **75** the steel, plastics and paper industries is lost during the 1st production cycle.

On average, Europe uses materials

ONLY ONCE.



Source: "Growth Within: A circular economy vision for a competitive Europe", Ellen MacArthur Foundation, SUN, McKinsey & Co. (June 2015)

WHAT WILL HAPPEN if we don't do anything?



Resources will continue to diminish. Scarcity of resources, such as fossil fuels, raw materials, water and soil.

Raw material prices will continue to rise.

For example, metal prices rose 170% between 2000 and 2014. The price of rubber rose 260% from 2000 to 2014.



Environmental pressures will tend to increase.

Phenomena such as climate change, loss of biodiversity and natural capital, soil degradation and marine pollution will intensify. The costs to the economy will tend to rise.

On the whole, the linear economy and its continued prevalence costs Europe €7.2 trillion per year in the case of the mobility, food and construction sectors.

Sources: European Commission and "Growth Within: A circular economy vision for a competitive Europe", Ellen MacArthur Foundation, SUN, McKinsey & Co. (June 2015)

WAKE UP CALL'



Is this the world you want to live in?

Is this how you want to continue running your company?

Is this the context you want to raise your children in?



It is proven that:

The attitude of consuming and throwing away will not work in the future.

Economic growth is based on speeding up the transition to a more circular economy.

THE CRCULAR ECONOMY A model of sustainable development d

A model of sustainable development that allows materials to be returned to the production cycle through their re-use, recovery, repair and recycling, thereby ensuring greater efficiency in the use and management of resources, greater sustainability of the planet and greater wellbeing in the planet's population.

Preserve and enhance natural capital by controlling finite stocks and balancing Princip renewable resource flows. Commitment: to regenerate, to virtualise, to replace.

nc Princip

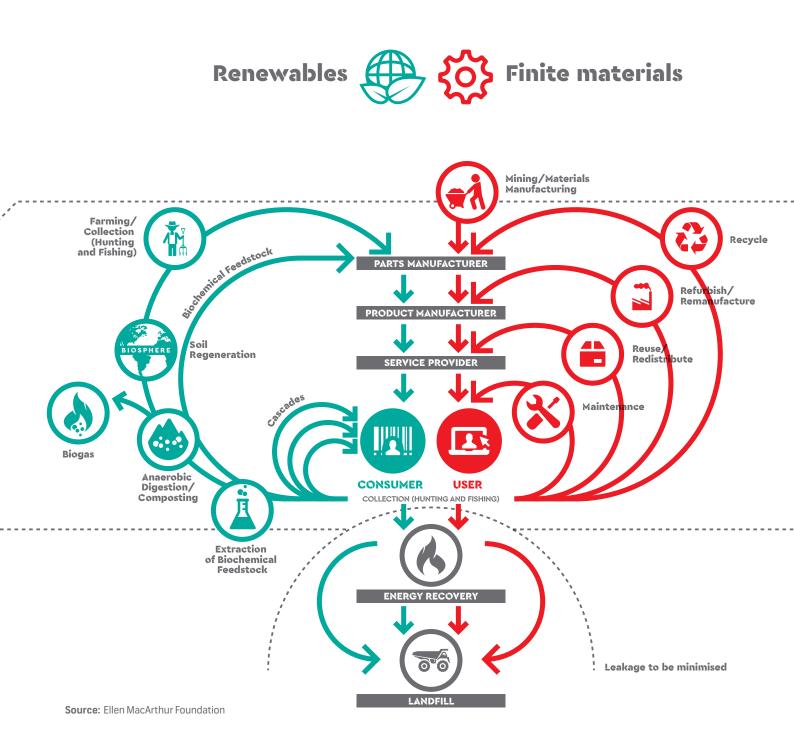
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Princip

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Optimise resource yields by circulating products, components, and materials in use at the highest utility for the longest time possible, both in the technical and biological cycle. Commitment: to regenerate, to share, to optimise, to circulate.

Foster system effectiveness by revealing and designing out negative externalities.



PIONEERS OF THE CIRCULAR ECONOMY

John John Lyle Founder of the Regenerative Design movement (1970s)

Design movemen (1970s)

Walter Stahel Visionary of a cycle-based

economy and father of the term "cradle to cradle" (1970s and 80s)

David W. Pearce and R. Kerry Turner

Authors of one of the first books that referred to the expression "the circular economy" (1989)

Michael Braungart Creator of Cradle

to Cradle certification

Janine Benyus

of biomimicry (1980s and 90s)

Ellen MacArthur Founder of the Ellen MacArthur Foundation,

Founder of the Ellen MacArthur Foundation an organisation created in 2010 to speed up the transition to the circular economy

Gunter Founder of the Blue Economy movement (1990s and 2000s)

What happens if we accelerate the transition to the **CIRCULAR ECONOMY**?

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ECONOMY

EUROPE 1.8 Trillion/year

Greater gains.

In Europe, the adoption of the principles of the circular economy may generate net benefits in the order of €1.8 trillion per year by 2030.

Creation of more and better jobs.

Jobs will be created in every industrial sector, in small and medium enterprises, through innovation and entrepreneurship in the context of a new service-based economy.

Increased GDP.

On the way to developing the circular economy, European GDP could grow 11% by 2030 and 27% by 2050. If we do nothing, it is estimated that GDP will grow 4% by 2030 and 15% by 2050.

Greater family wellbeing.

With higher value creation and more jobs, household budgets will rise.

Source: "Growth Within: A circular economy vision for a competitive Europe", Ellen MacArthur Foundation, SUN, McKinsey & Co. (June

ENVIRONMENT

Reduction of atmospheric carbon dioxide

emissions by half by 2030. They could drop 48% by 2030 or 83% by 2050 in mobility, food and construction systems.



CO2

Higher land productivity.

If Europe opts for the circular economy approach in food systems, the use of synthetic fertilisers could fall 80% by 2050, improving the sustainability of land and the wellbeing of people.

Cut of primary resources

use by 32% by 2030 and 53% by 2050 on current levels.

What resources are we talking about?

Materials for the car and construction industries, land for real estate, synthetic fertilisers, pesticides, water use in agriculture, fuels and non-renewable electricity.

Drop in the cost of time lost in congested traffic

by 16% by 2030 and almost 60% by 2050. A major benefit for the environment and families.

COMPANIES

Business growth.



Achieved through higher revenue by incorporating more services and better value, and through optimising costs resulting from better management of processes and resources by recycling, re-using, remanufacturing and repairing.

More positive organisational cultures

resulting from an improvement in companies' conditions and those of their employees and partners.

Source: "Towards a Circular Economy: Business rationale for an accelerated transition". Ellen MacArthur Foundation (December, 2015)

Lower exposure to the volatility of resource prices.



Since the change to a circular economy implies the use of fewer virgin materials and more recycled ones, it reduces companies' exposure to increasingly volatile prices.

GREATER AND BETTER BUSINESS SUSTAINABILITY IN THE MID TO LONG TERM.



WAYS TO SCALE-UP O O THE CIRCULAR ECONOMY by the Ellen MacArthur Foundation

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An essential characteristic of the circular economy is to be naturally restorative and regenerative. The recovery of materials and products doesn't take place only at the end of their lives but is built into their design (e.g. in the choice of materials or in a design that is easy to dismantle). Companies will need to develop key skills in circular design to facilitate the re-use, recycling and cascade use of products.



A materials structure that preserves value is an essential requirement in the transition to a circular economy.

To create value from used materials and products, it is necessary to collect them and return them to their source. Reverse logistics and processing methods enable these materials to return to the market.

iii (5) New business models

The business model that replaces ownership by payment based on a user licence is crucial. Besides this, the business magazine Fast Company has identified other business models that could contribute to make the circular economy a reality.



Products that are services.

Goods sellers must start to see themselves as suppliers of services: through rental contracts and not through the sale of the property of a product.

Next life sales of materials and products.

This business model is applicable to companies capable of recovering and reconditioning their products after use and then putting the same products on the market, thus earning additional income two or three times.

Product transformation.

Not all products can be reconditioned in their entirety, but most have certain components that are of high value. Often the materials themselves have an incorporated energy component which makes them more valuable than their original source.

Recycling 2.0

Innovation in recycling technology (recycling 2.0) is evolving and allows high quality and sustainable products to be made.

EXAMPLES

If industry made mobile phones that were easier to dismantle

improved reverse logistics and offered incentives for the return of handsets, the cost of recovering them could fall 50% per device.



If washing machines



were rented instead of sold, consumers could save around a third per wash cycle and the profits of the manufacturers would be around a third higher.

If **brewers** used

reusable glass bottles, the packaging, processing and distribution costs for beer could be 20% lower.



☑ — □ — Enabling factors

Several conditions can facilitate the transition:

Education

Education can play an important role in raising individual awareness and preparing future professionals for a new economic paradigm, particularly in creating a skills base to promote circular innovation. Governments must encourage the integration of the circular economy and systemic thinking in education programmes at primary, secondary and tertiary level.





Financing



All players in the value chain will need to have access to financing and risk management tools. A stable regulatory environment is crucial for investors and can represent a special incentive if governments declare an intention to promote the transition to the circular economy. Governments can create more financing incentives by underwriting some of the risks associated with innovative business models.

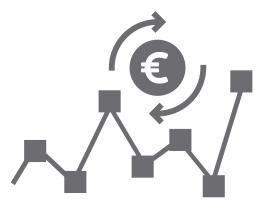


Collaborative platforms

Ēffective collaboration between value chains and sectors is imperative for the establishment of a wide-scale circular system. Partnerships in developing products, transparency and sharing of information enabled by IT, shared collection systems, sectoral standards, aligned incentives and mechanisms for identifying possible partnerships can be set up on collaborative platforms between entire sectors and between companies and policymakers.

Changes to the tax system and economic metrics

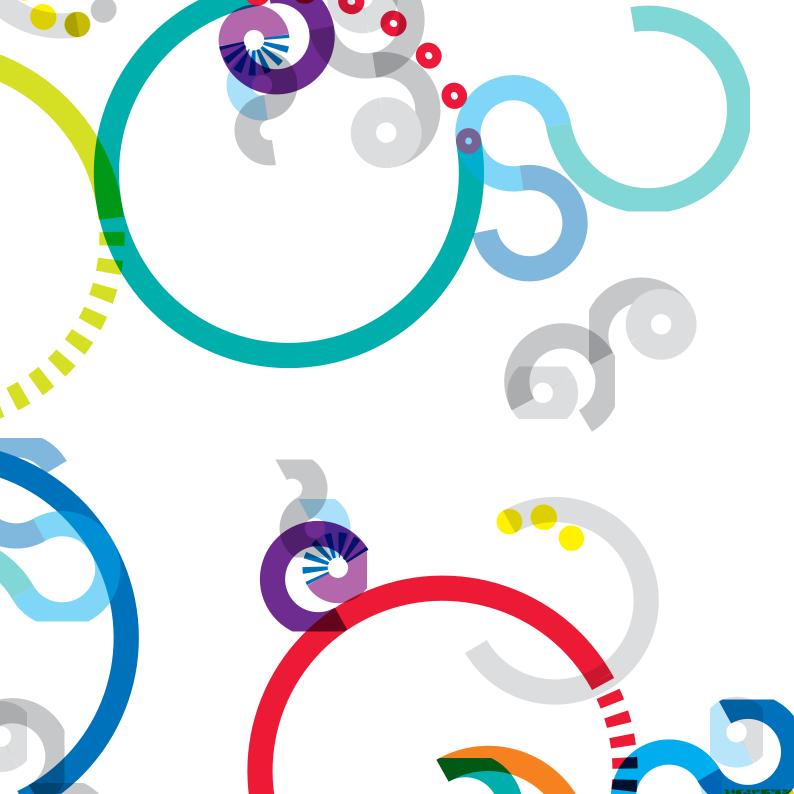
These kinds of measures can help to enable transition to the circular economy. How? By transferring tax incentives from resources to labour; complementing current flow-based metrics, such as GDP, with metrics to measure a country's total stock of assets.



Source: Ellen MacArthur Foundation



Circular Pioneers



Cerealis

Cerealis and sustainable development

For Cerealis, the principles of sustainable development are the basis of the development of its business.

The group's growth over the years has come from its ability to respond to the constant challenges of its sector. This response has helped to make it a reference at the national and international level today.

Grupo Cerealis has established **five operating axes** that associate the management of its business with the social and environmental challenges it deems important.

- > The skills and motivation of its employees
- > Operational quality and efficiency
- > Diversification and innovation
- > The community
- > Environmental impact management

The principles of the circular economy

Embedded in the group's approach to sustainable development, Cerealis has reinforced the transition from the linear model to the use of the key principles of the circular model, in which materials return to the production cycle through re-use, recovery and recycling.

Cerealis sees this movement as a huge opportunity with various associated benefits, from environmental impact, through a reduced need for raw materials, to social impact, through the possibility to improve and prolong relations with the different partners, and, no less important, economic impact, insofar as it represents a boost to creativity in lowering costs. With three environmentally licensed plants, Cerealis has adopted practices of waste reduction, waste recycling, incorporation of subproducts into the value chain, rationalised energy use and policies to reduce dust emissions across all of its production centres. In parallel, it encourages the use in the value chain of products made of recycled materials, such as the sole use of recycled cardboard for breakfast cereals packaging.

A product of the sustainable development plan implemented, the results of the key indicators monitored are the best stimulus to ensure the group continuously prioritises the principles mentioned.

Over the last four years, in a period that has seen an increase in its production capacity, Cerealis has reduced energy use by 12%, the specific use of fuels (toe/t) by 15% and water use per tonne of finished product (m3/t) by 15%. Over this period, Cerealis has reduced carbon emissions per tonne of finished product (KgC02eq/t) by 13% as well as total particulate matter emissions per tonne of finished product (KgPTS/t) by 29%. In terms of recycling, Cerealis has managed to increase the recycling of waste produced by 3%, while simultaneously reducing eliminated waste by 47%.

Cerealis is looking to the future with a sense of responsibility, encouraged by its results, but aware of the huge challenge the environmental pillar represents for the group's sustainable growth. The world is changing: population growth and future energy needs, alongside climate change, are real challenges on a global scale. With a population of 8.3 billion people in 2030, we will need 50% more energy, 40% more water and 35% more food.

galp

At Galp, we are committed to an active and responsible role in promoting a collaborative model for economic development, based on generating sustainable value.

Population rise and higher consumption will have important impacts on the environment, causing competition for resources such as energy, water and food, with a pronounced increase in demand for natural resources anticipated by 2030. Climate change and scarcity of resources, coupled with geopolitical and environmental factors, may affect markets, causing changes in organisations' business models.

Megatrends affecting the future



NEW PARADIGM FOR TRANSITION TOWARDS A MORE SUSTAINABLE GLOBAL ECONOMY Issues such as innovation, risk management and supplier chain management will be key to identifying new and effective solutions that ensure benefits and economies of scale for companies, making them more efficient and optimising production.

At Galp, we believe that a sustainable strategy ensures greater competitiveness and allows us to anticipate and manage opportunities and risk, fostering the safeguarding of long-term value. Therefore, we seek to be players in the development of the economy by creating sustainable solutions at the economic, environmental and social levels.

We have been an active promoter of research, development and the implementation of innovative services and solutions that contribute to the incorporation of circular economy principles into our business models, as well as those of our partners, particularly in production and consumption.

We believe that cooperation and the sharing of experiences are fundamental for value creation, so we seek to act in partnership, through innovation and collaboration networks, fostering close relations between companies in different sectors and the scientific and technological system. We consider this to be a key factor for the success of this collaborative model of economic development that the circular economy represents.

The successful pursuit of the Sustainable Development Goals (SDGs), to which each actor in society must be committed, involves establishing partnership models aimed at promoting consumption that ensures environmental protection and respect for life.



An active and responsible role in promoting a collaborative model for economic development, based on generating sustainable value

Some of our latest Galp projects | Waste turned into raw materials

- > Use of exhausted catalysts in mortars. This project was the result of research as part of a PhD grant undertaken in partnership with ISEL and GALP. The technical feasibility of the solution is proven and it is anticipated that 1,200t/year of catalysts will be incorporated into cement-industry mortars, thus prolonging the life of catalysts through re-purposing when they were judged to be waste.
- Recovering ammonia as a commercial product.
 An internal initiative at the Sines refinery, this project aims to turn an ammonia flow (NH3),), created in the hydrocracker

unit and currently considered waste, **into a new subproduct for sale in the fertiliser sector (estimated production of 2,000t/ year).**

> Use of Hydrocarbon Sludge as fuel for Cement Plants The technological solution under tury aims to use hydrocarbon sludge from the maintenance of refinery enumerican and treatment of industrial effluent as an *energy input for cement plant* furnaces. It is planned to recover 1,500t/year of sludge.





LIPOR towards the circular economy

The waste sector has a preponderant role in the dynamics of the circular economy due to the opportunity it represents upstream, developing cooperative efforts with industry and political decision-makers, and downstream, in the production of high-quality secondary raw materials.

Rising to the challenge of the sustainable and sustained management of municipal waste in Greater Porto, LIPOR has set out the guiding line of its operations until 2020 as the vision of "waste as a resource", following on with the strategy established in its last Strategic Plan (2007-2016).

The adoption of a circular business model, sustained by projects demonstrating supporting circular processes, demonstrates a clear management approach from a regenerative and restorative perspective of waste within the value chain.

Of note for its particular importance is the recovery of organic waste. A case in point is NUTRIMAIS, a natural high-quality agricultural corrective that can be applied to soils, from the perspective of giving back to the "land that which came from it". Certified for organic farming, NUTRIMAIS is 100% natural and the product of composting raw materials (the organic fraction of municipal waste) separated at origin. Of the panoply of circular projects incentivised by LIPOR, of note are approaches at the level of waste production prevention, educational and environmental intervention projects, sustainable public procurement projects and voluntary commitments by the organisation in the area of climate change and biodiversity.

Associated with LIPOR's involvement in the circular economy theme is a research, development and innovation (R&D&I) strategy that represents our commitment to what we regard as a responsible business attitude aligned with the 2030 sustainable development goals.







Dá forma às ideias

Secil is heavily committed to the paradigm of the circular economy

Secil is heavily committed to the paradigm of the circular economy, with its factories, guarries and cement plants suitably adapted to recover and integrate secondary raw materials and alternative fuels into their production processes.

Secil and its affiliate companies run countless projects that relate to the circular economy, such as the incorporation of demolition and construction waste into the production of

cement and concrete, the production of recycled aggregate, sequestration of the carbon emitted by plants through the production of micro-algae for food and cosmetics purposes, the use of RDF and plant and animal biomass as an alternative fuel for cement kilns, and the development of compound cements with lower clinker content and therefore less carbon intensive.







Technology and Quality Hand in Hand

Since it was founded in 1937, TMG has stood out due to the philosophy of its founder: "Technology and Quality Hand in Hand".

TMG Automotive, as part of this group, has integrated these principles into its sustainable growth strategy since its beginnings.

This vision has been a key factor in the company's evolution, underlying the constant acquisition of cutting-edge technology and highly qualified human resources, thereby enhancing its competitiveness and ensuring its continued success.

The result is a culture of excellence in which innovation and continuous improvement is cultivated, facilitating adaptation and reaction to constantly changing global markets. Only by evolving can one survive in the complex car market. And this can only be achieved through flexibility and change. This is the challenge organisations face today.

The traditional economic cycle of "extract, transform and eliminate" has long been questioned in the car industry, TMG Automotive's natural market.

Sustained innovation, as an embedded (and certified) process, has led to the growing use of materials with a lower "environmental footprint", the development of

"environmentally friendly" solutions and the introduction of the concept of cradle-to-cradle lifecycle analysis in new product development.

This methodology has moved the company naturally towards the circular economy, whose pillars are:

- > To conserve and maximise natural capital;
- To optimise the production of resources maximising the working life of products;
- > To develop the overall effectiveness of the system.

PVU, a recently launched material, is based on the concept of "Design to minimise waste and prolong the lifecycle of products on the market". TPOs, launched in the mid-2000s, reduce weight and allow for final recycling and product re-use. Besides products, TMG "runs projects focusing on the company's energy efficiency" which, coupled to environmental certification, ensure the transversal alignment with the pillars referred to.



R&D PROJECTS APPLIED TO THE CIRCULAR ECONOMY



associação para a competitividade da indústria da fileira florestal



Carbon Footprint Label

As a means of raising the visibility of the carbon-capture capacity of forestry products and demonstrating the respective environmental gains, we have developed a carbon footprint label, with financing from COMPETE, that informs consumers about the amount of carbon dioxide equivalent (CO2eq) captured or emitted by a specific forestry product. To help communicate the concept of carbon capture and clarify the role of forestry products as carbon stores, the character Arvatar was created. Featuring on the new ecolabel, Arvatar is designed to "teach" or "remind" people about the concept of carbon capture and storage in a fun way. The Certifica+ project, financed by COMPETE, launched us on one of the biggest global challenges facing forestry products, where sustainability has a key role in opening markets and ensuring they remain competitive and value what we produce and allows us to ensure that the raw materials used in the forestry industry promote "lower" environmental impacts, one of the aims of the circular economy. As part of the cluster strategy, one of our priorities was to intensify the arguments for global competition, stressing those stemming from compliance with the principles of environmental sustainability and the role of future generations.



















Waster PRO

The BioREFINA-Ter project is a complex and multi-disciplinary project divided into 4 stages, from industrial research to industrialisation. The aim is to develop integrated, locally developed and multi-purpose (multi raw-material) biorefineries based around a decentralised concept that allows non-recovered or inefficiently recovered mass flows (woods and agroforestry and urban untilled land) to be converted into high value-added products. In this biorefinery concept, priority, following the value-cascade concept, is first given to recovering the most valuable mass flows to produce bioproducts (green chemicals, drugs, biopolymers, etc.), followed by the production of advanced biofuels (for land, marine and air transport) and finally the generation of electrical and thermal energy. A laboratory-scale biorefinery system has already been developed, through which bio-oil (or green oil) has been created, and now a pilot biorefinery with an input capacity of 100 kg/h of multi raw materials is at the completion and construction phase.

The Serra da Estrela cheese sector is an important industry in the Beira Serra region, but it has an environmental and economic problem related to the effluents created during the production process. It is not economically viable to install current technology in dairies where the cheese is made, and furthermore it is also limited in that it does not recover the content of this important mass flow.

Moreover, due to the high organic load, the municipal waste treatment plants are not equipped to handle this effluent. The WasteWaterPro project represents the development of an advanced system for treating and recovering Serra da Estrela cheese effluents based on micro-organisms for the production of high value-added products (cosmetics, nutraceuticals and food). It has already been possible at the laboratory scale to create a system with the capacity to treat and recover 90% of the organic load and to produce a nutraceutical derived from the microorganisms used.









Environmental product declaration registration system, a contribution to the circular economy.

The `DAPHabitat' system (www.daphabitat.pt) is an environmental product declaration registration programme created as part of the Sustainable Habitat Cluster strategy. Its aim is to identify and reduce negative environmental impacts resulting from production activities in the Habitat value chain, based on a lifecycle perspective for the products and services used in this value chain.

The initiative works as a communication and eco-innovation tool that stimulates the efficient use of resources in production processes, aimed at the economic and environmental optimisation of materials, products and construction systems, thereby contributing to the circular economy, for example, by promoting the recovery of waste as alternative raw materials in products. An eco-innovation and ecodesign support tool, the system is also internationally recognised by the ECO Platform (www.eco-platform.org), a European association that brings together all operators of registration programmes of which the DAPhabitat system is a board member.

GYPCOR K – an example of a circular economy product

GYPCORK board is a perfect example of the circular economy, resulting from the industrial synergies of various manufacturing sectors. Already available on the market, it is a Habitat value chain solution that combines two high-quality Portuguese products in one: Gyptec Ibérica plasterboard made in Figueira da Foz, using FGD plaster, a subproduct of the Sines and Pêgo power stations, as its raw material, and expanded cork agglomerate, an excellent renewably sourced thermal and sound insulator made by Amorim Isolamentos using a 100% natural process that produces no waste.

The product is a partition and wall-cladding solution that contributes to energy efficiency in buildings and is a sustainable and efficient product. More information at: http://gyptec.pt/sustentabilidade.php or http://gyptec.pt/ documentos/Placa_Gypcork.pdf





Cerámica F. Santiago 🗎

Recovery of waste from fluorescent lamps in ceramic materials

CTCV

A study by the Ceramics and Glass Technology Centre (CTCV) aimed at assessing the possibility of incorporating waste, in the form of glass fragments from the recycling of fluorescent lamps (Ambicare), in ceramic building materials (brick – material provided by F. Santiago), in environmentally satisfactory conditions and with no effect on the quality of the final products.

The production of ceramic products incorporating this waste is a good way for the ceramics industry to contribute to more sustainable construction, bearing in mind that it implies the reduced extraction of raw materials, i.e. the clay needed to make bricks, and cuts down on the waste sent to landfill. It thus contributes to better management and savings of natural resources and consequently of associated environmental impacts, providing a sustainable solution for the disposal of this waste. It is necessary to control the environmental impacts to avoid the transfer of pollutants and crossover effects.



WEBER.COL flex L – Adhesive mortar with re-used sand

This mortar (WEBER.col flex L) has a high content of aggregate (sand) re-used from fluidised bed boilers for biomass in the paper and pulp industry. It is an example of the industrial synergy between these two important sectors of the economy. It is used as an adhesive for ceramics, natural stone and large and mid-sized hydraulic mosaics on facades, flooring and exterior and interior walls. It was developed as part of the Sustainable Habitat Cluster strategy through the cooperation of Saint-Gobain Weber, TheNavigatorCompany and support from Aveiro University and RAIZ.









CORK-A-TEX

Recovery of cork waste (dust) in textile substrates

Development of eco-friendly textile substrates incorporating cork, contributing to the sustainable nature intrinsic to the products. Different products were developed, namely textile thread Ne 30, 80% cotton/20% cork.

To reach these goals, a consortium was set up consisting of SEDACOR, a company specialising in cork processing, TÊXTEIS PENEDO, a company that specialises in producing and selling home textiles, and the organisations SCT, CITEVE and FEUP, who provided support with industrial research and experimental development.



PET blankets – use of recycled PET (plastic bottles) in fibres for the textile industry

Production of blankets from 100% recycled polyester from the waste of plastic (PET) bottles from the urban circuit (postconsumption). The bottles are turned into polyester thread via cutting, polymerisation and extrusion processes. The company buys the thread and then weaves, cards, laminates and manufactures it to produce the blankets. The process can also include dyeing and finishing. The environmental impact is positive, not just because it preserves a non-renewable resource (oil), but also because it uses less energy (33% and 53% lower) and represents lower CO2 emissions (54.6% less).

Project developed by the company Têxteis Penedo with collaboration from CITEVE.









BeNature Project

The BeNature Project was promoted by the company António Nunes de Carvalho, S.A part of a consortium consisting of one other enterprise – Conforsyst (footwear) – and three organisations from the national scientific and technological system – Leather Industry Technology Centre (CTIC), Portuguese Footwear Technology Centre (CTCP) and the Faculty of Science and Technology, New University of Lisbon (FCT–UNL). The project arose out of the need to develop biodegradable leather, a gap in the market. Although a natural material, leather is chemically processed in tanneries, making it non-biodegradable. The challenge was to chemically stabilise the leather to create a material with excellent physical and mechanical resistance, but which would fully decompose when composted, allowing it to be used to produce an organic fertiliser with appropriate chemical and nutritional

Verica Project

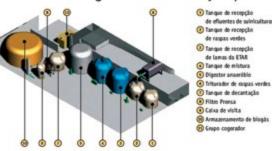
The Verica (Energy Recovery from Tanning Industry Waste) Project was promoted by the Leather Industry Technology Centre (CTIC) in partnership with INETI, Luságua, Anox, Instituto Nacional da Água and AUSTRA – Associação de Utilizadores do Sistema de Tratamento de Alcanena. Its aim was to develop the treatment of a solid waste abundant in the tanning industry, rich in natural skin fat, by anaerobic digestion. Other types of waste from the agro-industry were also tested.

VERICA achieved very positive results given the high production of methane in biogas, which was used to produce energy. The technology proved its technical and financial viability.

characteristics for use in farming. This goal was fully achieved and the project became a commercial success for the companies involved.



Diagrama da instalação piloto





PÓLO DE COMPETITIVIDADE E TECNOLOGIA DA ENERGIA





The MAESTRI (Energy and Resource Management Systems for Improved Efficiency in the Process Industries) project is a European project financed by H2O2O and coordinated by ISQ. Its aim is to develop an integrated energy and resources management system for industry based on innovative methodologies to characterise the efficiency of industrial processes, industrial synergy, and strategies to incorporate eco-efficiency principles and continuous improvements throughout an organisation. All of these are combined in a platform based around the internet of things, in order to simplify its implementation and ensure the integrated control of improvement processes. MAESTRI began in September 2015 and will last for a total of 48 months, involving 15 partners in 5 European countries. The general aim of the ALENTEJO CIRCULAR project is to encourage economic actors in the Alentejo in the olive oil, wine and pig-rearing sectors to adopt the circular economy model, in an attempt to promote an interest and raise awareness about this theme, discuss the barriers and opportunities identified, and establish the basic conditions for future circular economy projects in these same industries. The project was conducted as a partnership between the ISQ and the University of Évora and was approved by the Alentejo 2020 Steering Committee, under the application to the Collection Action Support System – SIAC Qualification. It began on 1 November 2016 and will run for a total of 24 months.







ZYPHO - Heat Exchanger Syphon

ZYPHO is a compact and highly efficient heat exchanger that is fitted to the bottom of a shower tray. It absorbs the thermal energy from the drain water and uses it to pre-heat the cold water, allowing energy consumption to be cut by up to 40%.

The product was developed in partnership by the company EIDT and INEGI. Its aim was to develop the mechanical and thermal aspects of the product, to support the production of a prototype and to undertake testing of the prototypes.

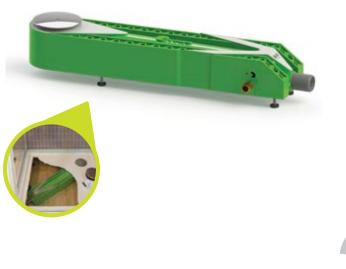
An R&D&I project is currently underway that aims to optimise the existing product, increase its thermal efficiency and lower its production costs.

Optimisation of Systems for Recovering Energy from Landfill Biogas

Aware of the relevance and importance (in the context of energy and environmental sustainability) of the existence and correct operation of energy recovery systems for biogas generated by sanitary landfills, and given the knowledge of the existence at landfills of various technological problems associated with their operation (specifically in terms of the corrosion of mechanical components) which, associated with others (biogas composition, in particular), lead to lower yields, INEGI has worked with companies within the Global Environment Facility (GEF) to study the optimisation of systems to use biogas from

landfills to generate electricity.











Eco-Efficient Road Surfaces

The sustainable development of society is an increasingly important goal in terms of defining new strategies associated with the building and restoration of existing heritage, namely to ensure the effective management of important built assets in Portugal, amongst which a high-quality road network. This project on road surfaces, developed in partnership with UM, advocates the recycling and use of foamed bitumen as a key material in the transition to a circular economy. In fact, the building solutions developed reveal various benefits, not only at the financial and social level, but also at the environmental level and even in the performance of new surfaces (bituminous mixtures) that can incorporate up to 50% recovered (waste) materials from restored roads.





SECIL Britas – Green aggregate/recycling of demolition waste

SECIL provides a circular-economy service based on collecting, treating and recovering construction and demolition waste. Increasing numbers of developers, promoters, architects and engineers aim at construction solutions incorporating circular economy principles, either as a result of environmental awareness or the need for green certification, LEED[®], or suchlike.

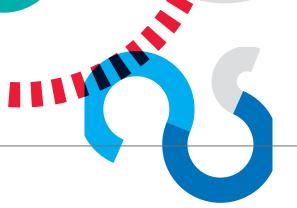
SECIL provides this service in the Greater Lisbon and Algarve markets, where it collects waste and supplies aggregate that is as reliably graded and consistent as SECIL is known for. The service can be tailored to a project/client's needs and can even include mobile crushers for on-site demolition and sorting of materials.

Besides the service already provided, SECIL also runs the A_{gregates} 3R's project, in partnership with the Higher Technical Institute (IST), intended to broaden the range of waste while maintaining the quality standards of the aggregate for mortars and concrete, ensuring the right percentage of recycled material without compromising the correct technical quality standards for the product.

SECIL's quarries and cement plants are ideal places for the circular economy, acting as reception and recovery points for construction and demolition waste.

The economies of scale made possible by the high number of SECIL collection points all around the country ensure the optimisation of shipping logistics and the reintroduction of this

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materialix

Strengthen cluster management excellence along the industrial new materials value - chain

The main aim of the **MATERIALIX** project is to reinforce the excellence of cluster management as a means of providing **greater value added services** to its members (with special focus on **SMEs**)), also contributing to the development of a **European meta-cluster in the clean technologies & green materials sector.**

Led by **POOL-NET** (a representative of National Engineering & Tooling Cluster), the consortium consists of a group of **4 clusters/business networks**, differently positioned representatives of the **European moulds & plastics industry**, faced with similar challenges and covering the whole value chain in clean tech & green materials.

www.eu-materialix.com



waste in new aggregates for sustainable building and promote economic, social and environmental benefits that respond to the aims of the circular economy, providing the customer with a new, innovative and environmentally responsible service.







Integrated recovery of agro-food subproducts for human and animal consumption.

www.portugalfoods.org/valorintegrador

The agro-food industry generates a high volume of subproducts with important economic and environmental impacts that on the whole continue to lack a recovery solution due to the absence of an integrated approach. The aim of the VALORINTEGRADOR Project was thus to establish the integrated recovery of protein- or polysaccharide-rich subproducts from various food industries by developing an approach consisting of shared processes capable of maximising the recovery of products used in human and animal food. The consortium brought together suppliers of subproducts who assessed their potential use in developing new products, joined by organisations from the national scientific system to support the extraction and creation of high-value parts, demonstrate the in vitro potential, apply in food formulations, clinically validate the potential of the ingredients in human food and validate their use in animal feed. The consortium also included a company to construct a prototype for integrated recovery equipment. In terms of the results of this R&D project, the outcome was a set of valuedifferentiated and validated ingredients for human food and animal feed, prototype food and feed incorporating the most promising ingredients, and a pilot demonstrator incorporating the integrated recovery processes applied to the various subproducts.



PRODU TECH

PRODUTEC H PSI -PPS 5 Project | Development of tools to characterise and improve the eco-efficiency of a production system

The main aim of the project (Compete-NSRF financing no. 13849) focused on developing and validating innovative tools to characterise eco-efficiency – ecoPROSYS© – Eco-Efficiency Integrated Methodology for Production Systems – incorporating different modules (environmental performance assessment, LCA, LCC).

In developing ecoPROSYS, 4 R&D organisations were involved: INEGI (the coordinating body), IST, CENI and ISQ. The methodology was transposed to commercial software for multi-sectoral applications by the companies SISTRADE SA (ECOManager software) and Microprocessador SA (PowerGest ecoPROSYS software).

Organisations involved in developing the project INEGI, ISQ, IST, CENI, CEVALOR, CITEVE, CTIC, CATIM, CENTIMFE (SCTN)/SISTRADE, TEGOPI, MICROPROCESSADOR, IDEPA, SONAE INDÚSTRIA (companies)

PRODUTEC H PSI PPS 5 Project | Integration of concentrated solar thermal technologies for direct thermal energy applications in industrial processes

This project (Compete NSRF financing no. 13849) aimed to demonstrate the use of concentrated solar thermal technologies for direct thermal energy applications in industrial processes. The inherent development of supporting technologies under this project (efficient transfer systems and heat, automation and control management) that enable integration created an innovative process that was unique in Portugal and leveraged effective gains in terms of the eco-efficiency of production processes and the consequent reduction in energy costs and carbon footprint. The pilot demonstrator and validating unit of the new solutions was the responsibility of the company SILAMPOS SA. Concentrated solar panels installed on the demonstrator system at SILAMPOS.

Organisations involved in developing the project INEGI; ACONTROL; TEGOPI; SILAMPOS; CTIC

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Eco-efficiency software – SISTRADE ECOManager $^{\otimes}$ and Microprocessador Powergest ecoPROSYS $^{\otimes}$



Solar concentrator panels installed in the demonstrator system at SILAMPLOS



NANIGATOR

ECOCEL + Development of mortars

Use of excess sand from fluidised bed boilers for biomass combustion used to make mortars.

Description: the sand purged from the fluidised bed boilers are washed and sifted as specified by the client for inclusion in materials for mortar.





NUTRIMAIS

NUTRIMAIS is an organic agricultural corrective produced by the composting of raw materials separated at source. NUTRIMAIS is a LIPOR product certified for use in organic farming and is the result of the tunnel composting of forestry residues, residues unfit for consumption or processing (meat/ fish, fruit/vegetables, dairy products, bakery products), wood materials, biodegradable kitchen and canteen waste, duly sorted at source market waste.

Granulated NUTRIMAIS for Organic Agriculture is a concentrated product which reduces shipping costs and facilitates its use on the ground.

NUTRIMAIS IS USED IN FARMING TO IMPROVE THE PHYSICAL CHARACTERISTICS OF THE SOIL:

> Less compacting | Greater aeration

 > Greater clumping (closer binding between fine soil particles to create clumps)
 > Greater capacity to retain water and plant nutrients

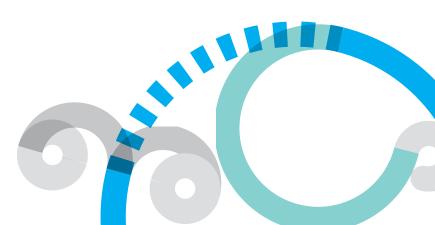


Innovative bioplastic products using waste water and sludge

Veolia has created a pilot plant in Brussels, Belgium, that uses an innovative microbial degradation process that makes it possible to recycle the carbon found in waste water in the form of biopolymers.











Circular Pioneers













CO-FINANCING:







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www.cotec.pt