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In December 2015, the European Commission launched a circular economy package entitled “Closing the loop – an EU action plan for the circular economy”, which sets out guidelines for the transition towards a circular economy in Europe and for the revision of various European Directives on waste and product policy. In the last two years, the World Business Council for Sustainable Development has introduced a number of tools to support the implementation of the circular economy in business. The Ellen McArthur Foundation regularly provides studies, books and videos on the state of the art of the circular economy and, in particular, the role of companies in this model. In December 2017, the “Action Plan for the Circular Economy in Portugal” was launched, which sets out the country’s level of ambition in relation to improving the use of resources and implementing a circular economy.

The concept of circular economy is not new, and is very much linked to industrial ecology and the life cycle analysis of products. Consequently, many companies have carried out in depth work on the reuse of materials and waste. The current agenda for the circular economy thus heralds a greater ambition by companies to really find solutions that can lead to the total elimination of waste to landfill and encourage the effective and efficient use of natural resources. This is a huge challenge that involves technology, innovation, new business models and imagination. Moving from a linear economy to a circular one implies aspiring to zero waste generation from economic activities and being sufficiently creative to identify profitable and truly circular business models. To achieve this, major changes will have to take place. These will include:

- The ability to design products ecologically, in order to use fewer natural resources and to ensure a future use for these same products using other equipment;
The promotion of industrial symbiosis, a process in which waste from one byproduct can be transformed and become part of the production process of another product, thus avoiding landfill and at the same time encouraging waste recovery;

The initiative to identify new businesses that rent rather than purchase equipment, repair, refurbish, and collect surpluses, among others;

The knowledge to understand these new business models in financial terms, so that investors and banks can invest and provide loans for these activities, which have levels of profitability and share structures that are different from those usually considered as good business opportunities;

A system of incentives and stimuli that encourage economic agents to act in harmony, so that we can actually move from a linear to a circular economy.

In view of the fact that the subject of industrial symbiosis is so crucial for companies that are members of the BCSD and for the Portuguese economy, and that there is still a huge lack of knowledge about the real economic, social and environmental potential of industrial symbiosis in Portugal, the BCSD Circular Economy and Industrial Symbiosis Work Group thought that it would be useful to get the answers to the following questions: What kinds of waste are generated, what kinds of by-products are received, in which areas of the country and in what quantities? With a mapping of this kind, it would then be possible to analyze the potential for establishing symbiosis between companies and the respective impact in economic, environmental and social terms.

It is against this background that the “Circular Synergies” study has been undertaken. Based on data collected from 32 companies, which generate 8.3 million tons and 267 types of waste, the study aims to demonstrate the economic, environmental and social impact that might occur in Portugal if it were possible to increase the level of symbiosis between companies.

The potential is huge, but there is still a long road to travel.

Among the 32 companies, around 57% of the waste generated goes for disposal and 43% for recovery. It is necessary and urgent to find a useful destination for the 57% of waste that is still not recovered in any way and which constitutes a financial cost for companies and an environmental cost for the country. Nonetheless, this study shows that the maximum potential for recovery via industrial symbiosis is in excess of 1.1 million tons.

By ceasing to be waste and by being recovered, intermediate consumption of other raw materials would be avoided to an estimated value of 165 million euros. This sum could then be invested in hiring more staff or in increasing capacity (gross fixed capital formation), which might result in the creation of 1,300 new jobs and generate 32 million euros of additional gross value added (GVA) in the economy. These figures are estimates based on input-output matrices, which summarize the commercial exchanges and flows between the various economic agents in the country, and clearly point to the potential of this commitment to industrial symbiosis.

For this potential to be grasped, action has to be taken on various fronts. Consequently, this study also puts forward six recommendations for public policy makers, which we believe can accelerate the transition towards a circular economy.

We would like this study to be seen as an aid towards identifying the potential advantages that result from industrial symbiosis, so that we can together — companies, researchers and public bodies — specify the steps necessary to create a national market in the exchange of by-products.

The BCSD Portugal, as an association of companies that creates value today for a sustainable future and which brings together companies that play an active role in implementing measures that promote sustainable development, intends to continue to promote the issue of industrial symbiosis in partnership with other associations, companies, universities and public entities. Only by working together will it be possible to create a national market for the exchange of by-products that can be successfully implemented in the marketplace.
The circular economy is a key issue for European policy makers and for some European countries, of which Portugal is one. It is crucial not only because it is an essential factor in ensuring the 1.5°C climate change trajectory to which Portugal committed itself in Paris, but also because, in order to ensure in the future the level of comfort and access to goods that we have today, we will have to manage materials (and waste is a kind of material) in a very different way than we currently do. Regardless of whether we talk of “circular”, “green” or “sustainable”, there is no doubt that the current model of economic development has some serious problems: climate change, pollution and limited resources. More than sufficient proof has been provided for this over the last 40 years, from the MIT and its Club of Rome report, Brundtland, to the recent statement at the World Economic Forum that the three greatest risks to the global economy are of an environmental nature.

Policies, the market and culture are key factors in dealing with these problems. Many point to the regulatory environment, its bureaucracy and sluggishness, which are not up to the rapid and immediate responses that industry requires. It is true that we identified this hurdle in the “Action Plan for the Circular Economy” (PAEC), which was addressed by our action number 5, and we wish to work on a solution that satisfies everyone – from the manufacturer who wants to maximize his productive outputs to the licensing body that wants to ensure that the environment is protected.

But industrial symbiosis is not something completely new in our country. In 2009, for example, 31 synergies, involving 38 distinct economic activities, and 21 different kinds of waste (water and energy included), totaling 60,225 tons and an average transportation distance of less than 20km, were identified in the Lezíria region. How many tons of Greenhouse Gases did these synergies help to avoid? What consumption of raw materials was avoided as a result? What were the savings made in euros?

And it is here that we come up against the main barrier: our business culture. In spite of the bureaucracy, legislation does not prevent the existence of symbiosis. But many producers are ignorant of or resist taking advantage of this potential, because they do not have confidence in the subject matter, or because they have difficulty in sharing information to take advantage of the added value.

If we look to find the meaning of the word “synergy” in the dictionary, we find the following: “1. Simultaneous action or effort by various organs or muscles; 2. Collective action or effort = cooperation”. The emphasis is on “collective”, “effort” and “simultaneous”. In fact, the act of cooperating assumes a relationship between at least two different entities. An effort is required by those involved to want to know and to make themselves known; and it is necessary that this effort is reciprocal.

We have to work to make these barriers disappear. It is up to the Environment Ministry to seek to establish a dialogue in relation to the guidelines of the PAEC that have been approved in the Council of Ministers. It is up to companies to set an example, to demonstrate the business case for these synergies and communicate the issue of the environment as well as the economy.

As the African proverb says “If you want to travel fast, go alone; if you want to go far, travel together”. If we want to ensure our future prosperity, the competitiveness and security of our economy (a circular one), we have to work together.
In 2015, resource productivity in Portugal was around €1.10 of GDP per kg of materials consumed, 20% higher than that in 2010. Despite this growth, this was lower than the figure for Europe for the same period (the EU’s material productivity grew by 30%), a fact that puts Portugal currently in the lower half of the European ranking of resource productivity.

There was also a positive downward trend between 2010 and 2016 in the quantity of sectorial waste generated (around 35%), which fell from nearly 12 million to 8 million tons.

Another positive factor was the reduction in waste generation per unit of wealth created. In 2015, waste generation intensity was 0.05 kg per euro of GDP generated, equal to a fall of 30% compared to the figure for 2010, which was 0.07 kg per euro of GDP.

In spite of these positive indicators and trends, Portugal has still a lot of room to improve in terms of efficiency, productivity and circularity, evidenced by the fact that manufacturing industry uses almost 53% of its turnover on raw materials and at the same time spends 40% of its environmental management and protection activity costs on waste management.

So this explains why it is urgent to act not just upstream of production by improving efficiency in the use of resources but also downstream by seeking new solutions and destinations to give to what is produced “out of place”. We will need to work and find new tools to meet the goals of the circular economy plan and contribute towards the different targets set, which aim for a more sustainable future. These are not limited to government policy and legislation: the whole of society will have to be involved.

This project, developed by the BCSD with a number of its member companies, aims to provide answers to this challenge. So it is an ongoing process, shared among everyone, not only to look for answers for what is produced “out of place” and how to reintroduce it again into the economy, but also to seek proposals for action in relation to circularity and how these proposals can become effective as an integrated and viable solution in the day to day life of any company.

The chapters that follow below will demonstrate how it was possible to leverage synergies between member companies of the BCSD in relation to waste and byproducts, but also shows what must be done, so that the results achieved by these companies can also be implemented across the Portuguese business community.
Industrial symbiosis

Collaboration between companies from a range of sectors with the goal of generating competitive advantages for the parties involved by trading materials, water and energy. In the case of waste, in order to make the flow of materials and energy cyclical, industrial symbiosis means waste can be re-introduced into the productive chain as a byproduct after it has been generated.

Byproduct

Any substance or object resulting from a productive process, the main objective of which is not its production, or, in other words, waste produced by one company can be a byproduct of another.

Opportunities for industrial symbiosis

- Exchange of byproducts among companies
- Sharing of the management of common services
- Cost reduction: lower consumption of raw materials, sharing of waste management infrastructure
- New revenues from the sale of waste and byproducts
- Environmental benefits: reduced use of virgin raw materials, avoidance of landfill and reduction in CO₂ emissions
- Leverage of industrial estates
- Collaboration among stakeholders in a given region
- Creation of new business opportunities
- Job creation

Exchanges

Forms of energy:
- gases and steam
- hot water

Types of water:
- waste water
- chilled
- de-mineralized waters

Types of material:
- bio-mass
- non-metallic minerals
- metallic minerals

Imagine a region of a country where town council and business waste is used by the local economy in an organized and harmonious way. Imagine a city, its gardens, an agricultural area and an industrial estate. A city where its citizens separate waste appropriately, knowing that they are contributing towards the quality of the gardens and to the quality of agricultural and food products. A city where companies trade waste between themselves in a closed production cycle. Ashes, sludge, steam, heat and gas are examples of possible transactions between companies. Water, energy and waste management services are shared among companies. This is the concept of industrial symbiosis. This illustration is just a starting point for what could be done in various regions across the world.
EXECUTIVE SUMMARY

RELEVANCE OF THE STUDY

Resource productivity and waste recovery indicators show that Portugal falls below European averages in these areas, based on reference to the major strategic plans for resource management in Portugal, namely the National Waste Management Plan, The Urban Waste Strategic Plan or the Commitment to Green Growth. It is therefore important to identify the environmental, social and economic benefits associated with the efficient use of resources and waste recovery, in order to advance and increase our knowledge of the potential for industrial symbiosis in Portugal.

OBJECTIVES

In view of the fact that BCSD Portugal members have over time worked on projects that go towards meeting the objectives of the circular economy, the “Circular Synergies” study sought to identify synergies for waste and byproducts among BCSD member companies, as well as putting possible industrial symbiosis projects into practice, based on the following objectives:

- Map the quantities of waste generated and received, and by-products from participating companies;
- Identify industrial symbiosis opportunities among participating companies and the rest of the economy;
- Assess the potential environmental, social and economic impact of the symbioses identified, and the potential of setting up symbioses among participating companies;
- Put forward a number of recommendations and opportunities for action by local and central government to support the transition to a circular economy and industrial symbiosis.

METHODOLOGY

To assess the potential for industrial symbiosis, qualitative and quantitative data for the year 2015 were collected from 32 BCSD member companies. The data were treated on a confidential basis. A data base was created to consolidate the data and ensure consistency and standardization. The data set was characterized in terms of the quantities of waste produced and received, as well as the production of byproducts. Also detailed were the specific waste types produced and received, as well as byproducts, and the current final destinations of waste among this group of companies.
Opportunities for industrial symbiosis and new operations were identified from the waste streams produced and received. The analysis was carried out across the whole of Portugal and by region: North, South and Center. To assess the indirect impact of promoting industrial symbiosis, an input/output analysis model was used, simulating the impact throughout the economy of a change in current waste management practices. Based on the main challenges that exist to set up waste flows between companies, recommendations for action by central and local government were made.

The data set of the “Circular Synergies” study involved a population of 32 companies covering 51 different economic activity codes, which produce about 8.3 million tons of waste from 267 waste types, and involving 22,314 waste transactions (transportation and shipping for treatment).

MAIN FINDINGS

- Currently, 57% of reported waste is disposed of, with only 43% being recovered.
- The six waste categories with the greatest potential for becoming alternative raw materials are: “biodegradable waste”, “bottom ash, slag and boiler dust”, “septic tank sludge”, “oily water from oil/water separators”, “green liquor sludge” and “aqueous washing liquids and mother liquors”. 59% of waste from these categories – equivalent to 210 thousand tons – is currently disposed of.
- It is estimated that by implementing industrial symbiosis for these 210 thousand tons of waste, 95 thousand tons of intermediate consumption – the consumption between companies – and about 1 million tons of domestic raw material extraction could be avoided. This avoidance is estimated to yield savings of 42 million euros. The availability of this sum to increase final demand could generate around 12 million euros of GVA (gross value of production minus the cost of consumption in the production process) and around 450 new jobs.
- Taking into account the waste generated and received by the participating companies, there exists an effective direct transaction potential of 17 thousand tons – about 0.2% of the total waste produced – relating to edible oil and fat, textile packaging and batteries and accumulators. It is in the northern and southern region areas of Portugal that the greatest opportunities for the exchange of these waste streams can be found.
- In Portugal, 1 million tons of waste are currently disposed of annually (2015). Although this figure may be an underestimate, if it was managed through industrial symbiosis, an environmental benefit of an estimated reduction of around 5.5 million tons of domestic raw material extraction might be achieved. At a social and economic level, the avoided intermediate consumption is equivalent to an estimated 165 million euros, which, by increasing final demand, could generate 32 million euros in GVA and 1,300 new jobs.
- Six priority actions aimed at speeding up the transition to industrial symbiosis are recommended, namely: regulatory changes to facilitate waste transactions; encouraging green procurement; increasing knowledge of industrial symbiosis in companies; facilitating tax and financing conditions; promoting collective platforms for resource management; and communicating results. These actions also include 14 proposed initiatives.
THE STUDY
THE STUDY

CIRCULAR SYNERGIES

The objective, which prompted the creation of the Circular Economy and Industrial Symbiosis Work Group, was to leverage synergies for waste and byproducts between member companies of the BCSD Portugal. The “Circular Synergies” project arose against a background, in which waste management, aimed at recovering and (re) incorporating waste into the economy, has become one of the focal points of European and Portuguese public policy. It is also important because, given that the percentage of recovered waste in Portugal is lower than the European average, it is a priority to now consider waste as a valuable resource, and work on synergies between companies which decide to undertake industrial symbiosis projects.

“Circular Synergies” was carried out in four stages: mapping of waste generated, waste received, and byproducts produced by BCSD member companies; the identification of opportunities for industrial symbiosis; the evaluation of the environmental, social and economic potential of industrial symbiosis; and lastly the preparation of a range of actions to accelerate the transition to a circular economy and industrial symbiosis.

STARTING POINT

“CIRCULAR SYNERGIES”: SUMMARY OF PARTICIPATING COMPANIES

<table>
<thead>
<tr>
<th>32 COMPANIES</th>
<th>51 ECONOMIC ACTIVITIES</th>
<th>267 KINDS OF WASTE</th>
<th>22,314 WASTE TRANSACTIONS – TRANSPORT AND DISPATCH FOR TREATMENT</th>
</tr>
</thead>
</table>

8.3 MILLION TONS OF WASTE GENERATED IN 2015

DESTINATIONS FOR WASTE GENERATED

<table>
<thead>
<tr>
<th>57% DISPOSAL</th>
<th>43% RECOVERY</th>
</tr>
</thead>
</table>
WASTE GENERATION MAPPING

MAPPING OF WASTE GENERATION IN 2015
Council | Waste | Quantity

**01** CACIA (NORTH)
- Locally treated effluents, not covered by code 03 03 10
  - Waste Code 03 03 11
    - 42,421 t
- Ashes, sludge and dusts from boilers (excluding dusts covered under code 10 01 04)
  - Waste Code 10 01 01
    - 16,713 t
- Lime mud waste
  - Waste Code 03 03 09
    - 31,819 t

**02** MAIA (NORTH)
- Paper and cardboard
  - Waste Code 15 01 01
    - 698 t
- Mixture of urban waste and equivalents
  - Waste Code 20 03 01
    - 1,386 t

**03** FARO (SOUTH)
- Paper and cardboard packaging
  - Waste Code 15 01 01
    - 18,318 t
- Kitchen and canteen biodegradable waste
  - Waste Code 20 01 08
    - 170,020 t

**04** TROFA (NORTH)
- Non-recyclable household waste
  - Waste Code 20 03 07
    - 65,008 t
- Mixture of urban waste and equivalents
  - Waste Code 20 03 01
    - 83,806 t

**05** LISBOA (CENTER)
- Metal
  - Waste Code 20 01 40
    - 18,494 t
- Mixture of urban waste and equivalents
  - Waste Code 20 03 01
    - 132,228 t

**06** ESTARREJA (NORTH)
- Mixture of urban waste and equivalents
  - Waste Code 20 03 01
    - 132,228 t
- Paper and cardboard
  - Waste Code 15 01 01
    - 163,502 t

**07** FIGUEIRA DA FOZ (CENTER)
- Locally treated effluent sludge not covered by code 03 03 10
  - Waste Code 03 03 11
    - 45,346 t
- Lime mud waste
  - Waste Code 03 03 09
    - 31,819 t
- Green liquor sludge (from recovery of cooking liquors)
  - Waste Code 03 03 10
    - 28,449 t

**08** SETÚBAL (CENTER)
- Locally treated effluent sludge not covered by code 03 03 10
  - Waste Code 03 03 11
    - 45,346 t
- Other non-specified waste
  - Waste Code 03 03 99
    - 132,228 t
- Rejected fibers, fiber sludge, filters and coatings from mechanical separation
  - Waste Code 03 03 10
    - 28,449 t

**09** SINES (SOUTH)
- Boiler ashes, slag and dusts (excluding dust from boilers covered by code 10 01 04)
  - Waste Code 10 01 01
    - 6,378 t
- Calcium based reaction waste, in solid form, originating from desulfurization of combustion gases
  - Waste Code 10 01 05
    - 41,532 t
- Locally treated sludge not covered by code 10 01 04
  - Waste Code 10 01 21
    - 2,069 t

**10** ALMADA (CENTER)
- Paper and cardboard
  - Waste Code 20 01 01
    - 71,808 t
- Mixed urban waste and equivalents
  - Waste Code 20 03 01
    - 5,949 t
- Paper and cardboard packaging
  - Waste Code 15 01 01
    - 698 t

**11** CASTRO VERDE (SOUTH)
- Rejected acid generators from sulfate processing
  - Waste Code 01 03 04*
    - 3,176,344 t
- Metallic mineral extraction waste
  - Waste Code 01 01 01
    - 148,989 t
- Ferrous metals
  - Waste Code 16 01 17
    - 1,386 t

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**Subtitle:**
The 11 councils where waste production is highest and the respective Top 3 types of waste generated.

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**Legend:**
- Waste Code 02 02 04
- Waste Code 01 01 01
- Waste Code 03 03 02
- Waste Code 03 03 11
- Waste Code 10 01 01
- Waste Code 03 03 10
- Waste Code 03 03 09
- Waste Code 20 03 01
- Waste Code 01 03 04*
- Waste Code 03 03 11
- Waste Code 10 01 01
- Waste Code 03 03 01
In 2015 the southern zone of the country generated the greatest quantity of waste (58.2%), mainly from those produced in Castro Verde (40.3% of the country total) and in Faro (13.2%). In the northern zone (35.6%) the main waste producing areas are in the councils of Maia, Trofa and Estarreja (14.4%, 12.8% and 3.3% respectively). The vast majority of councils produce below 20 thousand tons, with the smallest concentrations being in the Central zone and the Autonomous Regions (Madeira/Azores) (6.0 and 0.2% respectively).

### TOP 6 WASTE CATEGORIES IN PORTUGAL BY QUANTITY

<table>
<thead>
<tr>
<th>WASTE</th>
<th>QUANTITY GENERATED</th>
<th>PERCENTAGE OF THE TOTAL ANALYZED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rejected acid generators from sulfate processing</td>
<td>3.176 kt</td>
<td>38.5%</td>
</tr>
<tr>
<td>Mixture of urban waste and equivalents</td>
<td>1.485 kt</td>
<td>18.0%</td>
</tr>
<tr>
<td>Locally treated effluent sludge</td>
<td>951 kt</td>
<td>11.5%</td>
</tr>
<tr>
<td>Paper and cardboard packaging</td>
<td>571 kt</td>
<td>6.9%</td>
</tr>
<tr>
<td>Paper and cardboard</td>
<td>335 kt</td>
<td>4.1%</td>
</tr>
<tr>
<td>Biodegradable kitchen and canteen waste</td>
<td>186 kt</td>
<td>2.3%</td>
</tr>
</tbody>
</table>
In 2015 the northern zone of the country had the highest concentration of quantities of waste received: 16.6 thousand tons (93.2% of the total waste received by participating companies). Analyzing the numbers by council, Ilhavo received the greatest quantity of waste (91.5%), followed by Sines (5.4%), Santa Maria da Feira (1.5%) and Campo Maior (0.6%).
In 2015, of the 32 companies which responded to the survey, there were 14 which produced sub products, 6 of which accounted for the majority. Despite the fact that the most of the companies did not identify the origin of their byproducts, the town councils of Matosinhos (4.3%), Ílhavo (1.8%) and Estarreja (0.1%) were the main producers.

<table>
<thead>
<tr>
<th>TOP 6 BYPRODUCTS PRODUCED IN PORTUGAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>BYPRODUCT</td>
</tr>
<tr>
<td>QUANTITY PRODUCED</td>
</tr>
<tr>
<td>Coal burning fly ash</td>
</tr>
<tr>
<td>Gypsum</td>
</tr>
<tr>
<td>Locally treated effluent sludge</td>
</tr>
<tr>
<td>Boiler ashes, slag and dust</td>
</tr>
<tr>
<td>Reel sockets</td>
</tr>
<tr>
<td>Green liquor sludge</td>
</tr>
</tbody>
</table>
INDUSTRIAL SYMBIOSIS OPPORTUNITIES

In addition to the waste that makes up the Top 6 most produced by participating companies, it is possible to identify the Top 5 which have the potential for exchange in the context of industrial symbiosis. The potential is linked to factors such as: the specific type of waste, demand, the ability to incorporate a given waste into existing processes, and the need to find the most appropriate destination for treatment and recovery.

**TOP 5 WASTE PRODUCTS WITH POTENTIAL FOR EXCHANGE IN THE CONTEXT OF INDUSTRIAL SYMBIOSIS**

<table>
<thead>
<tr>
<th>WASTE</th>
<th>QUANTITY GENERATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boiler ash, slag and dust</td>
<td>162 kt</td>
</tr>
<tr>
<td>Glass packaging</td>
<td>84 kt</td>
</tr>
<tr>
<td>Food oils and fats</td>
<td>73 kt</td>
</tr>
<tr>
<td>Plastic packaging</td>
<td>65 kt</td>
</tr>
<tr>
<td>Organic halogenated solvents, washing fluids and mother liquors</td>
<td>11 kt</td>
</tr>
</tbody>
</table>

**TOP 3 WASTE PRODUCTS WITH REAL POTENTIAL FOR INDUSTRIAL SYMBIOSIS**

<table>
<thead>
<tr>
<th>WASTE</th>
<th>QUANTITY GENERATED</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food oils and fats</td>
<td>17,276 t</td>
</tr>
<tr>
<td>Textile packaging</td>
<td>14,9 t</td>
</tr>
<tr>
<td>Batteries and accumulators</td>
<td>2,5 t</td>
</tr>
</tbody>
</table>

Based only on the generation and reception of waste declared, 17 thousand tons of the 8.3 million tons of waste generated could be directly traded between the responding companies. On the assumption that industrial symbiosis will occur primarily on a regional basis, it will be in the northern and southern zones of the country that flows of this waste between member companies of the BCSD will take place. In order to increase the total waste traded, the methodology used in the “Circular Synergies” study sought to explore opportunities for 210 thousand tons of the most produced waste and which is sent for disposal (59%).

**WASTE SENT TO LANDFILL BECAUSE NO INDUSTRIAL SYMBIOSIS SOLUTION HAS BEEN FOUND FOR IT**

<table>
<thead>
<tr>
<th>WASTE</th>
<th>INDUSTRIAL SYMBIOSIS SOLUTIONS TO EXPLORE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodegradable waste</td>
<td>Anaerobic digestion, fertilizer</td>
</tr>
<tr>
<td>Boiler ash, slag and dust</td>
<td>Construction, cement, agriculture and asphalt</td>
</tr>
<tr>
<td>Sceptic tank sludge</td>
<td>Paper industry, fertilizer/compost</td>
</tr>
<tr>
<td>Water based solvents, washing fluids and mother liquors</td>
<td>Paint manufacture, alternative fuels</td>
</tr>
</tbody>
</table>
IMPACT OF INDUSTRIAL SYMBIOSIS

By creating industrial symbiosis networks for the 210 thousand tons of waste that currently continue to have no recovery solution, this would have an impact at a national level that would be a relevant starting point to accelerate the transition to a circular economy.

"210 thousand tons of waste that currently continue to have no recovery solution"

At an environmental level, the management of 210 thousand tons of waste would allow 95 thousand tons of intermediate consumption (including imports) and around 1.18 million tons of domestic resource extraction to be avoided. At a social and economic level, this translates directly into a figure of 42 million euros, a sum which could be made available to increase final demand - through for example an increase in consumer spending and gross fixed capital formation — and create a positive multiplier effect in the economy, generating an estimated 11.5 million euros of GVA and around 450 new jobs. These are net figures: in other words, the fall in activity in some sectors, such as raw material extraction, has already been taken into account.
In order to evaluate the impact for Portugal of industrial symbiosis for the whole of the country, the “Circular Synergies” study used as a reference point the total of non-urban waste which in Portugal is sent to landfill: according to the Instituto Nacional de Estatística (INE) (The National Statistics Institute), a total of 1.1 million tons were disposed of in 2015. This figure was considered as the maximum potential for recovery via industrial symbiosis and for avoidance of raw material consumption.

At an environmental level, the management of 1.1 million tons of waste would allow an estimated reduction of around 5.45 million tons of domestic raw material extraction. In social and economic terms, this could directly translate into an avoidance of intermediate consumption of 165 million euros, which would be available to increase final demand, creating a positive multiplier effect in the economy and generate 32 million euros in GVA and around 1,300 new jobs.

1.1 million tons of non-urban waste disposed of in 2015
(source: Instituto Nacional de Estatística (INE) - The National Statistics Institute)
ACTIONS TO ACCELERATE THE TRANSITION IN PORTUGAL
Despite the significant potential, synergies between companies are very often made more difficult because of various kinds of barriers. The BCSD Portugal has encouraged the identification and discussion of these barriers with its member companies and various government entities. As a contribution towards accelerating the transition towards industrial symbiosis in Portugal, the BCSD has identified six priority action areas and 14 initiatives in which the involvement of government with companies is crucial.

One of the barriers consistently identified by companies is the difficulty of getting a decision from the relevant government departments, as to whether a specific substance may be considered as a sub-product. Efforts at coordination between the government and companies should be made under the terms of Article 44 of the General Regime for Waste Management (RGGR), and a faster channel of communication should be set up with procedures that allow an efficient response to be given about the criteria governing whether substances can be considered as byproducts or for Cessation of Waste Status (FER).

In particular, and despite the fact that the terms of the FER (Articles 44 A and 44 B of the RGGR) are based on European Directives and directly make reference to community criteria for the FER, flexibility exists for EU members to define specific criteria, something which should be done by the Portuguese government, in cooperation with Portuguese companies. The criteria for the existence of a market or demand for the byproduct should also be made more flexible, to the extent that market surveys for the material in question should be required rather than firm commitments to buy and sell. Action 5 presented in the Circular Economy Action Plan (PAEC) which has now been approved (Decision of the
In order to improve the environmental performance of companies, government can stimulate the market with rules for acquiring goods and services that use criteria based on greater environmental efficiency, such as has been proposed for green public procurement in the PAEC. It can also take on a role as a catalyst for change in the more effective use of resources.

Turning once again to the example of the Green Deal or Circular Agreement, agreement should be reached between neighboring countries or those in close geographical proximity, so that barriers can be removed for certain kinds of waste, the movements of which should, as far as possible, be standardized, and specific regulatory frameworks created that might in the future constitute exceptions to the general MTR framework.

The National Strategy for Green Public Procurement (ENCPE 2020) seeks to make a contribution in this respect, by specifying the scope and methodology for defining criteria and the quantifiable objectives to reach by 2020. One important objective, for direct and indirect public administration, is to include environmental criteria in 60% of pre-contractual procedures for the inclusion of circularity criteria in public tender documents.

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The experience of the BCSD’s Circular Economy and Industrial Symbiosis Work Group however indicates that this figure is below 60%, and so it is important that a stimulus is given to creating the right conditions for direct and indirect public administration to accelerate the implementation of environmental criteria. Portugal could even aspire to going beyond the European Union procedures in this area (European Union Green Public Procurement Criteria), by identifying new types of goods and services that would be suitable for green procurement, such as, for example, waste management services, maintenance services for public areas, and specific construction materials, among others. Portugal could also encourage, both internally and within the EU, the adoption of circularity criteria, going beyond the current set of environmental criteria that are more focused on voluntary systems or other sectorial approaches.

**CERTIFICATION OF PRODUCTS THAT INCLUDE RECYCLED MATERIALS**

Currently, quality or environmental certifications can be limited in relation to the incorporation of recycled materials into the product. This situation is a barrier to circularity that needs to be handled using standard procedures, with preference being given to the characteristics of the products rather than the materials included. Also, the creation of incentives within support programs such as the Environmental Fund for the certification of more circular products is essential.

**Increasing knowledge in companies**

**ENCOURAGING ACTIONS TO INCREASE AWARENESS AND PROVIDE TRAINING AIMED AT IMPROVING RESOURCE MANAGEMENT**

A significant part of the Portuguese business community is still not aware of the opportunities and benefits that arise from more circular and sustainable practices. So, with the goal of encouraging an improvement in knowledge in these areas, training and communication events should be encouraged to bring together Public Administration and business associations (as suggested in various transition actions and proposals presented in the PAEC), covering opportunities such as:

- Substituting primary for secondary raw materials;
- More efficient use of material resources, focusing on durability, reuse and the repair of goods and equipment;
- Best practices for the hiring and supply of goods and services (green procurement in companies);
- Shared management for more efficient use of assets.

Companies from a range of different sectors of economic activity should be involved (for example logistics companies), which are less familiar with these concepts and which can have a disproportionately greater impact towards improving the environmental performance of certain sectors of activity. In addition, actions should be taken by businesses, using the National Scientific Technological System, to facilitate the implementation of innovative solutions to help build the circular economy.
MAKING CHANGES TO FISCAL POLICY

For change to happen, a fiscal policy will be needed that is in line with the expectations of businesses, which will need support, since the financial system currently lacks any kind of adaptation to the new reality of the circular economy. Some examples of potential fiscal incentives are:

- Reduction in VAT on the sale of green and circular products (3% to 5% less);
- Reduction in VAT on the acquisition of products produced from innovative processes and that incorporate recycled raw material.

SET UP OF A FUND FOR THE CIRCULAR ECONOMY

The main building blocks of such a fund would be:

- Long term funding (for periods of 5 years or more): funds from the Environmental Fund, private banks, IAPMEI credit lines, the European Investment Bank or other European sources, such as the Juncker plan. The fund could be open to everyone, who would get certain tax benefits by investing in it;
- Risk cover, using mutual guarantees;
- Training of sales people and analysts for them to market the fund and analyze projects.

The above measures would foster:

- Lower interest rates for financing projects;
- Increased knowledge in the banking sector;
- Minimization of risk;
- Tax advantages for businesses and savers.

As for projects financed through the fund:

- Each project would have a logo and certification called “Green and circular project”, which would be awarded by a specialized organization. The award process should not take longer than 30 days;
- Each project would be analyzed in financial terms. The risk analysis would include in the financial analysis the specific characteristics of green and circular projects;
- There should be clear tax advantages for businesses and savers.

Advantages for economic agents:

- Entrepreneurs: would have access to capital for green and circular projects with lower rates of interest;

Facilitating tax conditions and financing

WORKING WITH SPECIALIST ENTITIES, TOOLS SHOULD BE DESIGNED TO SUPPORT IMPROVEMENT IN THE ENVIRONMENTAL PERFORMANCE OF COMPANIES. THESE COULD, FOR EXAMPLE, TAKE THE FORM OF ENVIRONMENTAL BENEFIT CALCULATORS, CHECKLISTS TO SUPPORT WASTE CLASSIFICATION, AND GUIDES FOR ACCOUNTING FOR AND REDUCING WATER AND CARBON FOOTPRINTS, ETC.
DIGITAL PLATFORMS

Portugal has its own legal framework for Organized Waste Markets, which establishes rules applicable to transactions in these markets and to their respective operators. The decree law involved has financial and administrative incentives for waste producers/holders and organizations that recover waste, some of which are today outside its scope (e.g. support for launching digital platforms through funding from part of the waste management tax revenues). More significant is the administrative incentive, which states that users, signed up to a negotiating platform authorized by the APA, are exempt from obtaining a license for non-hazardous waste recovery operations, in accordance with Article 23 of the Waste Management General Regime, or in other words, as long as they are covered by the technical standards approved by the APA.

As a means of strengthening the incentive to create and use digital platforms for organized waste markets, changes to the legal framework could be envisaged, perhaps involving reviewing or creating new incentives of a financial nature, using for example Environmental Fund support.

CREATING A LEGAL FRAMEWORK FOR INDUSTRIAL SYMBIOSIS

Despite the importance of industrial symbiosis to sustainability and the circular economy, as well as to industrial competitiveness, the concept has not been mentioned in national legislation, with the exception of certain strategic documents, such as the National Waste Management Plan 2014-2020. A legal framework should however be developed and should be integrated into current legislation for industry to ensure it is effective. Important quick wins that could be achieved in this area are the integration of the concept of industrial symbiosis with that of the Responsible Business Zone, and legislation to recognize the concept, such as that which already exists for Competitiveness Clusters.

SETTING UP AND COMMUNICATING CIRCULARITY INDICATORS IN PORTUGAL

Despite the undeniable relevance of the circular economy model, there are still a number of shortcomings both in terms of understanding what the circular economy means and how to quantify it. This issue has led various authors and institutions to propose circularity indicators, but these have had little impact since they have not been systematically used by organizations such as Eurostat.

However, in view of the importance of indicators to track progress already made and in the future, it is recommended that indicators are defined that allow the level of circularity in Portugal to be measured, and that these are published in the Environmental Status Report.
These could focus on different areas (e.g. water and energy resources), but they would at least present a specific focus for businesses so that they can implement indicators that are relevant to their own organizations and include them in their reporting. In the future, the positive results demonstrated by these indicators and the metrics defined could be used at an international level, in particular in a European context.

ENCOURAGING AND PUBLISHING STUDIES OF BEST SECTORIAL PRACTICES

In line with what was suggested in the section “promoting knowledge in businesses”, it is recommended that benchmark and sectorial best practice studies be undertaken in areas with the greatest potential leverage and replication throughout the supply chain (e.g. the construction sector).

These sectorial studies would assist companies to assess their progress, to define objectives and strategies in order to improve efficiency and environmental performance, and to identify new practices and activities to increase competitiveness and achieve sustainable growth. Here, government, working with technology centers and business associations, would be well placed to promote and publicize such studies through their business eco-systems.

PUBLICIZING SUCCESS STORIES

The ECO.NOMIA portal of the Portuguese government has been promoting examples of best practices in sustainability and circularity since it was set up. It is proposed that this means of communication be strengthened by more continuous follow up of the case studies, highlighting the environmental, social and economic impacts, and the factors that have led to their success, or, on the contrary, the obstacles that have hindered them. This idea of follow up over time will allow lessons to be learned of great use and benefit to new businesses and companies that decide to introduce circular products, services and strategies.
IN CONVERSATION WITH

Before companies can change their behaviour, they must understand what the circular economy is, what it means for their business and how to get started. Although the WBCSD has many member companies that have been thinking about the circular economy for some time, there are many companies still trying to answer these preliminary questions. The aim of these publications is to highlight member companies which are pioneers of the circular economy, demonstrate what concrete business steps that they took and share their case studies.

ONE OF THE KEY FINDINGS OF YOUR “CIRCULAR ECONOMY AND ENVIRONMENTAL PRIORITIES FOR BUSINESS” REPORT IS THAT THE FOOD AND CONSTRUCTION SECTORS ARE THE TWO BIGGEST PRIORITIES. WHAT CAN THESE TWO SECTORS START BY DOING?

That’s correct. The construction and food sectors represent two of the biggest circular opportunities for mitigating environmental impacts, especially in relation to greenhouse gas emissions, water consumption and land use. One of the first things companies can do is think about how a circular mind set and approach can help deliver corporate and sustainability objectives. Whether it’s improving profitability, enhancing competitiveness, risk mitigation or reducing GHG emissions, the circular economy can be used to meet those goals. Then, a circular vision has to be established to integrate that “circular mind set” within the company. Finally, companies will want to begin with pilot projects, learn from those experiences and go forward based on the lessons learned.

WHAT ARE THE KEY PRINCIPLES THAT COMPANIES MUST IMPLEMENT IN ORDER TO ACHIEVE A LARGE SCALE TRANSITION TO THE CIRCULAR ECONOMY?

The best place to begin a large-scale transition is to start small. Rome was not built in a day. Nor will any company achieve a transition from a linear model to one that is wholly regenerative. A company must identify its priorities and understand how a circular economy can help them reach them. Only then will they manage to identify the correct strategies to achieve their
objectives. It will be a dynamic, continuous learning process, given that various changes will need to be implemented across the organization.

**WILL WASTE PRODUCT EXCHANGES AND TRANSACTIONS BE THE RIGHT PATH FOR INDUSTRIAL SYMBIOSIS?**

Perhaps. This is a challenging question as it depends on geography, economic factors, and access to information. In some locations, waste product transactions may continue to thrive for decades as they provide the best platform for identifying and procuring secondary raw materials. However, it is possible that some waste transaction platforms, which act on a stand-alone basis, may become obsolete as secondary raw materials begin to be exchanged more like virgin raw materials. Commodities like copper, timber and oil, are traded using regional and global indices, and have specific fixed prices that fluctuate over time based on supply and demand. Creating, for example, a global market for secondary raw materials would require the adoption of quality standards for each material, transparency, real time updates and accessibility of information, end-of-life material collection, and finally improvement in waste processing technologies and classification. However, under this scenario, companies would begin to understand the value of their waste products and be able to even sell them in free markets rather than local ones.

**CAN YOU DESCRIBE THE GENERAL PROFILE OF COMPANIES THAT ARE LIKELY TO HAVE MORE SUCCESS WITH THE CIRCULAR ECONOMY?**

At the WBCSD, we have not noted a specific profile of the companies that take advantage of the circular economy. Companies committed to a circular economy range across different industrial sectors, countries, levels of maturity and size, among other factors. However, there is one factor that is consistent across all pioneering companies in the circular economy: leadership. In all of them, the CEO and the executive leadership identified this opportunity early on, leading to changes internally.

**Bio**

Brendan Edgerton is circular economy manager at the World Business Council for Sustainable Development (WBCSD) in Geneva, Switzerland. Since he arrived at the WBCSD in 2015, he has developed the project MarketplaceHUB.org and written the Practitioner Guide to the Circular Economy and 8 Business Cases to the Circular Economy. Brendan Edgerton is the representative of the 2017 WBCSD Leadership Program and, as such, is giving training in Germany, the USA and Mexico. He was also a member of the 2016-2017 committee of the WBCSD Leading Women Awards. Brendan has an MBA from the Yale School of Management, a masters in environmental management from the Yale School of Forestry & Environmental Studies and has a degree from the University of California Santa Cruz. Brendan’s professional career has always been linked to sustainable development. He worked at Walt Disney Imagineering, leading evaluation and life cycle projects in hotels and theme parks. Through the Environmental Defense Fund’s Climate Corps program, he was in the Office Depot, identifying and proposing renewable energy and energy efficiency projects for the company’s portfolio. In 2014, the television network channel SHOWTIME highlighted his work in the documentary “Years of Living Dangerously”. Before finishing his degree, Brendan Edgerton worked as a green building consultant in Los Angeles, California, where he managed around 15 LEED certification projects and ran his own business selling environmentally friendly products for home and office.

“There is one factor that is consistent across all pioneering companies in the circular economy: leadership.”
WHAT ARE THE MAIN RISKS OF THE LINEAR ECONOMY FOR GALP?
An economic model, based on a linear process of extraction, transformation, use and disposal, means an increase in the risk of accelerated loss of resources and of inefficiency, which at the end of the day results in a direct competitive disadvantage. The accelerated loss of resources means greater exposure to the volatility of raw material prices, putting negative pressure on financial results. Such a scenario is even more important when we consider that Europe is highly dependent on imported raw materials.

The environmental and social impact resulting from a linear model can and should be mitigated by the adoption of a more efficient new model with new opportunities and one that creates circularity.

WHAT ADVANTAGES DOES THE CIRCULAR APPROACH BRING TO GALP?
The redesign of processes and products, the development and implementation of new business models and the optimization of resource usage would be inherent requirements of a sustainable strategy. For this reason, adopting a circular approach represents a unique opportunity for our company’s future development, contributing towards building a greater resilience of the business and higher levels of innovation.

Focusing on the circular economy is therefore a sustainable strategy, which ensures greater competitiveness and enables risks to be anticipated and managed, stimulating long term value protection and innovation throughout the value chain.

HOW ARE THE PRINCIPLES OF CIRCULARITY IMPLEMENTED IN THE COUNTRIES IN WHICH GALP DOES BUSINESS?
Galp does business in various countries, in particular in Portugal, Spain, Brazil, Angola, Mozambique, São Tomé and Príncipe, among others. Each country presents a different challenge, which is dependent on its context, dynamics, state of development, institutions and communities. Neither pre-defined nor universal solutions exist that are appropriate to all the countries in which we operate. We therefore have different business and also different circularity opportunities in each country.
For example, in Africa we aim to begin by implementing the basic principles of the circular economy for the management, treatment and recovery of waste. On the other hand, on the Iberian peninsula and in Brazil, where there already exists a greater awareness of the circular economy, the main challenges are those concerning production and responsible consumption, as well as the sustainability of cities and communities, and we seek here to improve process efficiency in order to minimize consumption of energy and materials, and to maximize the utility of products.

This challenge is particularly relevant in Portugal in refinery activities, since these consume a significant quantity of materials and generate waste. We believe that the work that we have been doing to improve the eco-efficiency of the refining system and to reuse and recycle sub-products are excellent examples of implementing the principles of circularity.

**IF YOU COULD ALTER A PUBLIC POLICY TO ACCELERATE THE MOVE TOWARDS THE CIRCULAR ECONOMY, WHAT WOULD IT BE AND WHY?**

Accelerating the transition towards a more integrated circular economy will only become a reality with the contribution of all parties involved and by developing strong synergies at a business and industrial level. Simply setting targets, for Portugal and for Europe, for waste recovery or establishing restrictive quotas for extracting resources will not, I believe, be the right path. On the contrary, building tools and mechanisms that facilitate the implementation of circular solutions is essential and must be more efficient. In this respect, the national action plan for the circular economy has already identified financing as being one of the obstacles to transforming linear business models into circular ones.

Thus, awarding incentives based on criteria of merit and consequently of a fiscal nature, as well as access to dedicated funding, would enable technological development and innovation to be accelerated in this area. At the same time, a strategy would have to be followed of government policies that encourage collaborative platforms which make possible the development of new business models and the design of new processes and products, including also legislative changes for waste products that encourage their recovery via industrial symbiosis.

**HOW CAN PORTUGAL ACHIEVE A CIRCULAR VISION AND THINKING ABOUT BUSINESS?**

Business models that are based on a circular economy maximize the utility of products and minimize losses throughout the value chain, and in which the concept of “waste as a resource” feature strongly. Implementing a circular approach therefore is a guarantee of innovation and the long-term resilience of companies, in addition to the environmental and socio-economic benefits.

This vision and business thinking will only be possible with a strong sense of commitment and partnership between government, companies, town and city councils and NGOs, especially through agreements that eliminate barriers and support innovation, such as, for example, the “Innovation Deals” that have already been set up in Europe.

As in all these major issues, Galp leads the way by acting as a catalyst of this change. Moreover, circularity is something that is intrinsic and natural to Galp and reflected in its slogan “Energy creates Energy”.

Adopting a circular approach represents a unique opportunity for our company’s future development, contributing towards building a greater resilience of the business and higher levels of innovation.
WHAT ARE THE MAIN RISKS OF THE LINEAR ECONOMY FOR JERÓNIMO MARTINS?
The linear economy is linked to waste generation. This means that, at various points along the value chain of a product, there are resources that are not being used effectively and very often end up as rubbish.

In a business based on efficiency, waste means losses, and that is why at Jerónimo Martins we work every day to reduce costs and maximise the use of essential resources. For us, it makes sense to identify opportunities to reduce waste, seeking whenever possible to reintegrate it into the value chain, in a continuous effort to fight litter. In short, on one hand, we tackle waste generation and, on the other, we seek to reuse and recycle as much as we can.

There is also a growing public concern about the way we approach our business among consumers, not only in terms of financial performance but also, and most importantly, in regards to our sustainability policies.

This does not necessarily mean that today’s consumer is prepared to pay more for sustainable products, but rather that, under comparable conditions, customers will be more inclined to choose companies that have a better environmental or social performance.

WHAT ADVANTAGES DOES THE CIRCULAR APPROACH BRING TO JERÓNIMO MARTINS?
Our offer comprises more than 7,000 Private Brand products every year, available at our more than 3,700 stores in the three countries where we operate. With the size of our operations, we know that if we address the packaging of these products in a sustainable manner, we can make a real difference.

For this reason, in 2009, we began a packaging eco-design project in partnership with our Private Brand suppliers. With this project, we seek solutions that reduce the quantity of raw materials used, promote the incorporation of recycled products, while ensuring that they are recyclable. The actions proposed may also involve a redesign of the shape of the packaging that allows us to optimize our transport processes. Overall, we have avoided every year the consumption of around 2.5 thousand tons of materials and the emission of 475 tons of carbon regarding goods transportation.
HOW ARE THE PRINCIPLES OF CIRCULARITY IMPLEMENTED IN THE DIFFERENT COUNTRIES IN WHICH YOUR COMPANY OPERATES?

Food distribution makes up more than 90% of our business, so this is our core activity and, as a consequence, fighting food waste is one of our main focuses of attention. We have learned that the biggest source of waste is with our producers, manufacturers and consumers, while retailers are responsible for around 5% of total food waste. This reveals the importance of working together in a common effort to fight food waste.

For us, this has meant building partnerships with our suppliers to incorporate into our products (such as take-away soups or packaged salads) non-calibrated fruit and vegetable products, which previously had no commercial value or sell them at a lower price. Through this initiative, and last year alone, we managed to reintroduce more than 13.6 thousand tons of food products. At the same time, we have promoted the donation of food products to social institutions which serve hundreds of people in need. In 2017, we donated around 10 thousand tons of food to more than 500 of these organizations.

Raising awareness among our staff and customers to prevent and minimize waste generation is another of our actions. It is for that reason that we publish best practice articles in the magazines “Sabe Bem” of Pingo Doce, and “Kropka TV” of Biedronka, as well as providing recycling points in our stores for products that are not normally collected by city and town councils. In 2017, we sent more than 600 tons of waste for recovery that had been deposited in our recycling points.

IF YOU COULD CHANGE A PUBLIC POLICY TO ACCELERATE THE CIRCULAR ECONOMY, WHAT WOULD IT BE AND WHY?

Any transformation comes from the education of people and the easiest way to achieve this is among the younger generation. Children and young people have enormous energy, which we have to know how to leverage and use in order to promote the adoption of more aware and sustainable behavior. To achieve this, the engagement of schools is essential.

IF YOU COULD CHANGE A PUBLIC POLICY TO ACCELERATE THE CIRCULAR ECONOMY, WHAT WOULD IT BE AND WHY?

Through a constructive debate, involving all stakeholders, with the goal of identifying the barriers and developing synergies that facilitate the adoption of this model. The support of official bodies for the circular economy, promoting the adoption of sustainable management models and the development of tools to facilitate the country’s transition, are important. Portugal has taken important steps in this direction and it is now a question of accelerating the pace of implementation.

The support of official bodies for the circular economy, promoting the adoption of sustainable management models and the development of tools to facilitate the country’s transition, are important.
WHAT IS THE PROFILE OF COMPANIES THAT ARE MORE LIKELY TO HAVE SUCCESS WITH INDUSTRIAL SYMBIOSIS?
Industries such as manufacturing, engineering, construction, chemicals, heavy metals such as iron and steel, mining, agriculture and utilities have benefitted from this cross-sector approach.

WHAT ARE THE CHALLENGES AND OPPORTUNITIES OF IMPLEMENTING INDUSTRIAL SYMBIOSIS PROJECTS AT A EUROPEAN LEVEL?
The opportunities for implementing industrial symbiosis across Europe have never been better. There is now strong evidence, based on the NISP (National Industrial Symbiosis Program) and other programs, that the approach is effective and gives a very high return on public investment in economic terms as well as providing environmental and social benefits.

Where perhaps Europe needs to go in future is to more systematically and formally encourage links and learning between programs in different countries and promote cross border synergies. Given that the scientific base already exists, Europe could also use more of its budget on implementation.

BESIDES LEGAL ISSUES, WHAT ARE THE MAIN DIFFERENCES BETWEEN THE FIVE CONTINENTS IN IMPLEMENTING INDUSTRIAL SYMBIOSIS PROJECTS?
We have already developed capacity building projects on industrial symbiosis in over 30 countries. Some of the cultural differences we encountered included attitudes to data sharing, the propensity to create unnecessary bureaucracy, the need to allow many government agencies to have their say/give speeches, which universally is a ‘turn-off’ for companies engaged in the process, and, of course, there was a significant difference to be found between “command” economies and “control” economies.

HOW IS BREXIT AFFECTING THE DEVELOPMENT OF INDUSTRIAL SYMBIOSIS IN THE UK?
At a national and regional government level, large amounts of resources (office time) are being used on Brexit that could be used instead on industrial symbiosis type activities. There is, however, a growing realization that to compete on a global stage with other European countries, it is necessary not only to improve productivity (including material productivity) but also innovation, which is where industrial symbiosis may move up the priority list.
THE NISP MODEL WAS MADE PART OF THE EUROPEAN COMMISSION’S “ROADMAP FOR A RESOURCE EFFICIENT EUROPE”. IN PRACTICE, WHAT ARE THE SECRETS OF THIS MODEL?
The five key success factors we have identified behind NISP (apart from hard work) have been the following:

• The all size, all sector engagement model: be true to its cross-sector roots but also ensure that companies of all sizes are engaged i.e. micro, SMEs and major corporate companies.

• Full time practitioners with industrial experience: as involvement is the key to success, we understood that full time employees with industrial experience made involvement easier both for companies and the employees themselves.

• Having a holistic vision, dealing not only in materials but also in energy, water, logistics, empowerment, asset management, experience or knowledge sharing: once a business has become engaged, it seems sensible not to limit the conversation to the specific issue of waste.

• Using data and ICT tools to good effect: NISP amassed so much data that to manage it effectively and use it to help identify synergies, we had to create our own bespoke ICT support tool called Synergie®.

• Lifetime of investment: having the certainty that investment in the program was long-term enabled NISP to focus on ‘quick wins’ and on synergies that demand innovation efforts that might take years to develop.

WHAT WAS THE MOST CHALLENGING NISP PROJECT AND WHY?
International Synergies did not so much have technical challenges in implementing NISP but did face a number of challenges. In terms of interfacing with Government, we found that government is predominantly organized in silos (and for that matter industry as well). Cross-sector associations tend to be lobbying agents for a range of fiscal and legal matters but not for resource efficiency, so something as cross cutting as industrial symbiosis did not seem to have a natural home.

Because NISP investment originated from landfill taxes, in the early days it was viewed as and ‘end of pipe’ solution to waste problems. However, the full range of benefits were not fully understood. The strength of the program in delivering against so many agendas (jobs, carbon, innovation, regional development, green growth, waste etc.) was also a weakness as it didn’t ‘fit’ comfortably under the wing of a single department but several.

Bio
Peter worked for 18 years in the aerospace industry as a sales manager in GEC Marconi, Smiths Industries and Meggitt Aviation, and also as an environmental consultant for Shell. He founded the BCSD-UK and then International Synergies, through which the National Industrial Symbiosis Program was created and implemented in around 30 different countries. The NISP, financed by the UK government between 2005 and 2013, is an international network of industries that share best practices, experience and knowledge about the efficiency of resources, and is the basis for the creation of mutually beneficial partnerships. It has a free membership system, more than 12,500 business members, 90% of which are SMEs or micro companies, and is present in 30 different countries, including South Africa, Australia, China and France. Peter was recognized as “Leader in Sustainability 2014” in the “Sustainability Leaders” prizes.

Manufacturing, engineering, construction, chemicals, heavy metals such as iron and steel, mining, agriculture and utilities have benefitted from this cross-sector approach.
GIVEN THE PROJECTS ALREADY COMPLETED BY FIBRENAMICS, WHICH REGIONS OF THE COUNTRY HAVE THE GREATEST POTENTIAL FOR INDUSTRIAL SYMBIOSIS?
To effectively implement industrial symbiosis, two distinct factors are necessary: technological capacity (strengths) and growth drivers (opportunities). Starting with opportunities, the North has seen an increase in business investment in innovative activities (product, process, organizational methods and marketing), encouraging an increase in production that has the potential for transactions and international trade, and a change in the productive profile of the economic and business community. A notable feature is the recent growth in stronger ties between the scientific and business communities, potentially leveraging applied innovative technologies in different business environments.

In the North lies probably the greatest productive technological strength in the country with almost all industrial sectors and areas represented, and it holds the promise of an infinity of symbiosis possibilities, not just at an industrial level but also for university/company symbioses.

WHAT WAS THE MOST CHALLENGING INDUSTRIAL WASTE APPLICATION PROJECT THAT FIBRENAMICS HAS EVER WORKED ON? WHY AND HOW DID YOU SUCCESSFULLY SOLVE IT?
One of the sectors with which we were working came up with a major challenge, but at the same time one which was full of opportunities: the mining industry. We were challenged by a group of companies to find a solution, basically to find ways to recover the huge amounts of waste that this industry produces. As a matter of interest, in some kinds of mining activities, only 20% of materials extracted end up in the final product.

So, the opportunity had to be seized urgently and the potential was infinite. The raw material (waste), over and above being abundant, had excellent characteristics and properties from a technological point of view, in addition to flexibility in shape and grain size.

We applied our Fibrenamics development and innovation methodology to these companies, from which resulted a range of products that will soon be launched on the market. The methodology is focused on the market (it begins and ends here).
and is made up of eight phases: (1) preliminary studies, (2) product design, (3) technology study, (4) prototype production, (5) validation under actual usage conditions, (6) optimization of prototypes, (7) certification trials and (8) disclosure of results.

Using this circular methodology, we managed to bring products to market and to get a momentum moving with our partner, creating a true industrial symbiosis.

**HOW CAN COMPANIES AND TECHNOLOGY CENTERS WORK TOGETHER IN THE CIRCULAR ECONOMY AND ON SYMBIOSIS?**

For a true university/company symbiosis, we think that a favorable environment has to be created for: opportunities for interaction between the parties involved, building confidence; a clear and transparent recognition of the competencies and roles of each stakeholder in the relationship; joint creation and analysis of trends and strategic alignment; creation of various types of values; and the generation of notoriety and visibility. Above all, we think that a pragmatic vision focused on results should exist among the stakeholders.

**A notable feature is the recent growth in stronger ties between the scientific and business communities**

**IF YOU COULD CHANGE A GOVERNMENT POLICY IN ORDER TO ACCELERATE THE MOVE TOWARDS INDUSTRIAL SYMBIOSIS, WHAT WOULD IT BE AND WHY?**

An area of special interest that we think can be improved in government policy would be the introduction of laws that are more focused on a multi-sectorial vision of symbiosis and strategic involvement: something that can break with the one to one sectorial approach and that can underpin the creation of more circular value systems, in contrast to the usual linear ones.

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**Bio**

Raul Fangueiro is currently professor and senior researcher at the School of Engineering at the University of the Minho, and is mentor and coordinator of the Fibrenamics International Platform (www.fibrenamics.com). He has had more than 150 articles published in international scientific magazines, 400 conference publications, 40 books and 20 patents. He is scientific coordinator of various Portuguese and international research projects on fibrous materials and advanced composites, in areas such as construction, architecture, transport, medicine, sport, protection, among others. He is a specialist in the European Technological Platform and a member of the editorial board of various leading international scientific magazines in fibrous and composite materials.

Fibrenamics, which has more than 250 partners, is a platform dedicated to activities relating to product development, promotion, recovery research and technology transfer in advanced materials based on fiber. It was recently recognized by the European Commission as a success story in University/business collaboration.

An area of special interest that we think can be improved in government policy would be the introduction of laws that are more focused on a multi-sectorial vision of symbiosis and strategic involvement

**To effectively implement industrial symbiosis, two distinct factors are necessary: technological capacity and growth drivers**
WHAT ARE THE MAIN RISKS OF THE LINEAR ECONOMY FOR EDP?
EDP evaluates risks and does not operate in a strictly linear economy, given that it has decided on an investment strategy focused on the production of renewable energies, and forecasts that, through to 2020 it will achieve a specific reduction in waste of around 20% compared to 2015. In addition, a study carried out by EDP to assess the circularity of its activities in Portugal concluded that in 2014 more than 89% of its waste was reused or recycled.

In this context, procurement management, using parameters to optimize and manage materials, will be one of the areas requiring greater attention, since the global environment of a scarcity of raw materials is likely to result in an increase in costs for companies in the future. On the other hand, if we look at waste as potential new products, we can identify new opportunities for recovery with direct benefits for the company and the environment.

WHAT ADVANTAGES DOES THE CIRCULAR APPROACH BRING TO EDP?
This is a more holistic approach to the efficient management of resources and brings a new way of looking at things and different dynamics. Thinking outside the box of one’s own strict area of activity will be necessary and requires the involvement of the entire supply chain, leveraging the efficiency and competitiveness of the company and its partners. These new perspectives often encourage innovative solutions to be identified and this is a major advantage of adopting this approach.

HOW ARE THE PRINCIPLES OF CIRCULARITY IMPLEMENTED IN THE DIFFERENT COUNTRIES IN WHICH YOUR COMPANY OPERATES?
As an example, since 1987, EDP in Portugal, working with the cement industry, has made fly ash and very recently slag a secondary raw material for the construction industry. The gypsum produced by the desulphurization system at the Sines power station is also used mainly to produce gypsum board but also in agriculture for soil remediation.

In Spain, in one of the company’s thermal power plants, EDP uses...
gases from the steel industry as an additional fuel. Doing this leads to a clear environmental improvement, since a gas, previously discharged directly into the atmosphere resulting in a wasted energy, has been harnessed.

In the marketing and sales area, digitalization has made a very significant contribution to dematerialization. Electronic invoicing for example now covers two million customers in Portugal and Spain.

IF YOU COULD CHANGE A PUBLIC POLICY TO ACCELERATE THE MOVE TOWARDS THE CIRCULAR ECONOMY, WHAT WOULD IT BE AND WHY?

To us, it seems essential to remove the bureaucratic red tape involved in the reclassification of waste materials, which today represents a very heavy burden. Stimulating circularity happens when the economic rationale exists for it and so it will also be important to create significant and real economic and fiscal incentives that help companies to make this concept a reality. Finally, encouraging the development of platforms for sharing best practices is always a means of boosting interest in the issue and stimulating future collaboration.

HOW CAN PORTUGAL ACHIEVE A CIRCULAR VISION AND THINKING ABOUT THEIR BUSINESSES?

Geographical distribution is an important variable because physical proximity facilitates exchanges of ideas and very often makes them economically more attractive. A more regionalized vision of the subject, taken up at a municipal level, may help to promote this thinking.

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Circular economy thinking outside the box of one’s own strict area of activity will be necessary and requires the involvement of the entire supply chain, leveraging the efficiency and competitiveness of the company and its partners.

It would be important to create meaningful economic and fiscal incentive mechanisms that would help companies to incorporate circularity.
CASE STUDIES
The purpose of AVE – Environmental Management and Energy Recovery, set up by Cimpor and Secil in 2003, is to manage and recover materials and energy from waste in the cement industry via co-processing. The process involves the use of waste – prepared beforehand and identified as viable – as alternative fuel in the ovens of the cement factories and/or as a secondary raw material in the production of clinker. For waste producers and operators, AVE offers an environmentally sustainable final destination. For the cement industry, it offers a solution that increases competitiveness by reducing energy costs. As a result, co-processing also contributes towards reducing the energy dependence of the country.

Between 2005 and 2013, co-processing at AVE avoided the consumption of 520 thousand tons of petroleum coke, with a value of around 90 million euros. 1.5 million tons of CO$_2$ emissions were also avoided – this reduction arose mainly from the use of alternative fuels, which meant that more than 1.4 million tons of waste could be recovered rather than being sent to landfill. The specific emissions per ton of clinker in Portugal performed better than the European average.
The strategy for managing non-hazardous industrial waste produced at the Celbi factory is focused on recovery, as opposed to controlled landfill. Over the years, Celbi has progressively reduced the amounts of waste sent to landfill, by adopting internal and external recovery measures. Composting is one of these.

At Celbi, organic waste — coming from its forests, secondary treatment of effluents and primary treatment and screening (fibrous materials) — makes up around 30% of the total waste produced in the manufacturing unit. Composting is seen as an environmentally sustainable alternative and is technically viable, allowing the potential of the organic nature of this waste to be harnessed.

The composting unit at Celbi, built in 2005, has already processed more than 300 thousand tons of organic waste. Since composting has the advantage of transforming waste into materials of interest for agriculture and forestry or for soil conversion, the product that results from the process is similar to earth, rich in organic material, and is used as fertilizer in the forests owned by the Altri Group.

There are two main benefits. On the one hand, the composting process adds value to organic waste, and does not conflict with the functioning of Celbi’s manufacturing process. On the other, the fertilizer produced returns a considerable quantity of nutrients to the soil, thus increasing its fertility and productivity. It is a circular process that unites two of the companies of the Altri Group.
CIMPOR’s Souselas factory has had a Waste Derived Fuel (WDF) supply plant since 2012. Together with other group factories in Portugal, this plant has contributed to the National WDF Strategy for 2009 to 2020, and complements the Portuguese Strategic Plan for Urban Solid Waste (PERSU II). The project has important synergies with the recycling and landfill avoidance policy.

CIMPOR has thus played a part in the country’s solution for dealing with urban waste in the WDF area via co-processing. The process has environmental and economic advantages, since it substitutes the use of petroleum coke in factories with agricultural, urban, industrial and construction and demolition waste.

The high levels of humidity in WDF, which was a factor explaining the fall in energy efficiency in oven 3 at the Souselas factory, led to the acquisition of new pioneering equipment in Portugal: a dryer. Before being put into the main burner of the oven, the WDF goes through a drying process. This is achieved by a thermal exchange between the cleaned warm air, coming from the excess air of the clinker cooler, and the humid WDFs. In its turn, the air coming out of the dryer with a temperature of around 40°C, is once again directed to the cooler chimney from where it exits to the atmosphere.

By reducing the humidity of the WDF to between 30 and 40%, it is possible to magnify the thermal substitution in the main burner of the oven, enabling co-processing of up to 7.0 tons per hour of WDF with an average humidity of between 10 and 15%, in addition to an increase in burning efficiency after the drying operation. In addition, there is also a gradual reduction in the thermal consumption of the oven, with a corresponding fall in production costs and CO₂ emissions. The dryer has made an important contribution towards optimizing the co-processing activity.
Slag is a waste product from coal power stations and historically has mainly been sent to a specific landfill site at the Sines power plant. Since slag is considered as a source of aggregates for road building and for concrete products, and since EDP already had experience in using this material for other reuse applications, EDP decided to focus on a process that would lead to the classification of slag as a byproduct.

The biggest challenge facing EDP was to find customers who would use the slag produced on a regular basis. In Portugal, the demand for this product is very limited, a factor that has made the transition of this waste to a byproduct difficult. Nonetheless, EDP found a number of international partners interested in the slag, for example MATRIX and Robert Muller.

In October 2015, EDP submitted the process to the Portuguese Environmental Agency for approval, and in 2017 obtained classification of the byproduct coal slag for: clinker production; use as light aggregate in the manufacture of construction materials; and use as aggregate in the manufacture of concrete and road paving.

Currently, EDP exports around 35 thousand tons of slag per annum. This initiative, in addition to a number of environmental advantages, such as avoiding the extraction of raw materials by replacing them with slag, has direct advantages by reducing waste management taxes, the deposit of slag in landfill and landfill operating costs. The next challenge of this project will be to reduce the logistics costs of exporting the slag.
Galp’s refining activity in Portugal has a high public profile. Because of this, recovering waste from this activity is very important to Galp. The Fluid Catalytic Cracking (FCC) unit at the Sines refinery produces over 1,000 tons of used catalysts as a waste product each year, and has significant management and treatment costs.

The ECO-ZEMENT research project, supported by Galp between 2012 and 2015 via a partnership with the “Instituto Superior de Engenharia de Lisboa (ISEL)”, Portuguese higher education polytechnic institution of engineering, arrived at the conclusion that the catalyst has physical and chemical properties that mean that it can be incorporated into products from the cement industry. The aim therefore was to recover, environmentally and economically, this waste from refining activity. Currently, the main challenge of the project concerns the start-up of the sales and marketing phase for this byproduct, since its use in the cement industry is new and no established market exists.

No capital investment is associated with the project as no significant changes are required to the infrastructure and logistics operations being used. The environmental return comes from the use of waste from one industrial sector as a raw material in another sector. In economic terms, in addition to the savings in management and treatment costs of the waste, it is expected that the sale of catalysts to cement manufacturers will yield a profit for Galp. Incorporating the catalyzer in products from the cement industry also represents a technical and economic benefit for this industry, as compared to the materials currently being used.

ECO-ZEMENT was a winner in the 10th edition of the Green Project Awards Portugal in the Research and Development category. ECO-ZEMENT is still a pilot project, but it is probable that the commercial development phase will begin soon so that Galp Energy creates even more energy.
Used cooking oils (UCO) are a source of waste that have negative impacts on the environment and can contaminate soil and water. In 2009, Jerónimo Martins began the “Storing Oils” project, which goal is to collect and send this kind of waste for recovery.

The company began by acting on two fronts: creating an appropriate infrastructure and making consumers and staff aware of the issue. UEO collection points were provided in 340 Pingo Doce stores, ensuring that 80% of the company’s total store chain was covered. Consumers take their UEO in sealed plastic bottles and deposit them in the “Storing Oil” in their Pingo Doce store. These are later transported from the stores to Distribution Centers (DCs), maximizing efficiency as a result of reverse logistic processes implemented by the Group.

At the DCs, the UCO are collected by a waste management operator who ensures that the oils are sent for bio-diesel production. The advantages are:

- Reuse of waste and its conversion into bio-fuel, reducing the level of extraction and consumption of fossil fuels;
- Reduction of fuel consumption, through reverse logistics processes for collecting the UCO;
- Minimization of environmental impacts associated with the inappropriate disposal of this kind of waste.

The project has seen increasing involvement of everyone, proven by the more than one thousand tons of oils recovered. At the same time, the Group collects used cooking oils from its Take Away products and staff restaurants, by sending them for recovery. Since 2010, more than 1,920 tons have been sent for recovery, the vast majority of them to produce bio-fuels.
Nutrimais is a 100% natural organic agricultural corrective produced from the composting of food and green waste separated at source. Due to the careful selection of raw materials, Nutrimais is certified as organic by SATIVA.

The strategy of separate collection and subsequent organic recovery of bio-waste is one of LIPOR’s contributions towards achieving the goals of national policies in Portugal – PERSU2020 – and Europe – circular economy package. Since LIPOR was set up in 1982, composting has been one of the cornerstones of the policy of integrated waste management. The opening of the Organic Recovery Plant took place in 2005.

The quality, both in terms of the careful selection of the organic material for composting, and the compost produced, is a key aspect of the viability and success of the Nutrimais project. The application of the organic material on soil brings improvements in its characteristics, such as, for example, its porosity and its ability to retain moisture. Nutrimais also acts as an agent preventing soil degradation, helping to minimize erosion, compaction, salinization and desertification.

In 2016, around 10.4 thousand tons of Nutrimais were produced, as a result of the recovery of almost 48 thousand tons of organic waste. In the same year, the application of more than 10 thousand tons of compost on the soil enabled the equivalent of 5.9 thousand tons of organic material to be introduced.
Steel grit is a product used in shipyards to scour ships’ hulls. In the 1990s, this process was carried out with grit contaminated with TBT (tributyltin oxide), a toxic, bio accumulative and bio amplifiable component that exists in maritime paints. Since no solution to this problem existed at the time, the grit was sent to landfill.

In 1992, after discovering that Lisnave used steel grit, the Environmental Engineering and Innovation Society (SEIA) analyzed potential uses of this waste and made a proposal to Secil for removing it from cement ovens. In 1993, after analyzing the composition of the grit and discovering the attraction of using it because of its iron oxide content — an essential element for balancing the composition of the cement - Secil began to recover this material.

Since then, steel grit has been used in the Secil-Outão, Maceira-Liz and Cibra-Pataias factories. Up to the end of 2016, 744,436 tons had been consumed. The reuse of steel grit is an example of symbiosis between three different companies: SEIA, Lisnave and Secil.
4 STEPS TOWARDS A MORE CIRCULAR ECONOMY
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**1. LEADERSHIP**
Adopting circular approaches in businesses means leadership and involvement at the very highest level in the company, since this kind of systemic change always depends on the will of business leaders to mobilize their staff to “make it happen”.

**2. INNOVATION IN COMPANIES**
The search for collaborative models based on the concept of industrial symbiosis can happen through different kinds of projects, such as: the use of collaborative platforms; identifying opportunities for substituting raw materials with waste products; the set-up of new businesses based on existing waste; and the extension of the useful life of equipment.

**3. INNOVATION IN GOVERNMENT POLICY**
Government policies can act to decisively influence the transition towards a more circular economy. The implementation of industrial symbiosis projects will be facilitated by changes to government policies and by a greater government flexibility to respond to companies on issues such as the declassification of waste products, end of waste status or cross border movements of waste.

**4. RELATIONSHIPS**
Developing joint projects with companies, technology centers and universities in the search for new applications for byproducts or to adapt their characteristics and functionalities, is a way of stimulating activity between the business and academic worlds, of building knowledge about the circular economy and industrial symbiosis, and so increasing the capabilities of the human resources involved in these areas.
Companies that are part of the Industrial Symbiosis and Circular Economy Work Group at the BCSD:

Companies that completed the Circular Synergies questionnaire:

- Altice Portugal
- Altri
- Ambimed Sterycicle PT
- Amorim Cork Composites
- ANA Aeroportos de Portugal
- Celoplás
- CGD
- Cortadoria Nacional de Pêlo
- CTT – Correios de Portugal
- CUF
- Delta Café
- EDP
- Efacec
- Esporão
- Eurest
- Euro Separadora
- Ferpinta
- Ferrovial
- Galp
- Gestamp Aveiro
- Hidurbe
- Hovione
- Jerónimo Martins
- Lidergraf Sustainable Printing
- LIPO
- Metro de Lisboa
- Nestlé
- Prio Biocombustíveis
- Siemens
- Soja de Portugal
- Solvay
- Sominor
- Sonae MC
- Sumol + Compal
- The Navigator Company
- Transtejo
- Tratolixo
- Unicer
BCSD Portugal – Business Council for Sustainable Development

The BCSD Portugal – Business Council for Sustainable Development brings together and represents companies that actively commit to sustainability, and is one of the facilitators in Portugal in the transition towards a low carbon economy, which puts value on eco-systems and generates well-being in society.

By developing projects across companies that stimulate sustainable development, the BCSD is an influential and inspiring player in building new business models that are competitive, innovative, responsible, sustainable and inclusive. By intervening in the development of public policy, the BCSD stimulates collaboration between the business community, political decision makers and civil society. With wide representation among industry sectors, the BCSD has more than 90 companies as members, which employ directly more than 270 thousand people. The sales turnover of non-financial sector members of the BCSD make up 38% of Portugal’s GDP, equal to more than 65 thousand million Euros, and GVA (Gross Value Added) of between 6 and 8% of GDP.