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MY PLANET

Project TE-24

TOP SECRET

# TE-24 PROJECT





Secret Project TE-24:

In 1956, in the laboratory of The Navigator Company's mill in Cacia, a small group of people were pioneering the techniques that would make it possible to develop the forest-based bioeconomy in Portugal.

They had demonstrated the potential of Eucalyptus globulus fibre, leading to two global breakthroughs: industrial-scale production of Eucalyptus globulus pulp using the kraft method, and the manufacture of printing and packaging papers 100% made from this fibre. This versatile new pulp also offered "interesting prospects" for producing tissue papers, a line of development that was followed up at a later date.



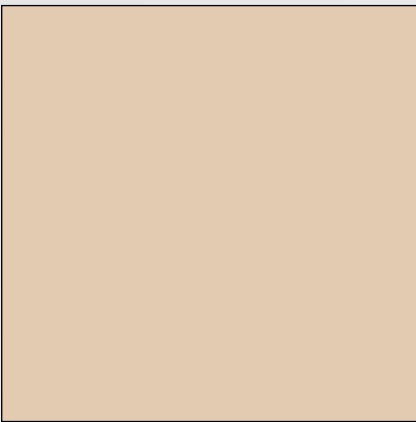


Since then, Navigator has put Portugal's forests, and its eucalyptus in particular, on the map of the global circular bioeconomy.

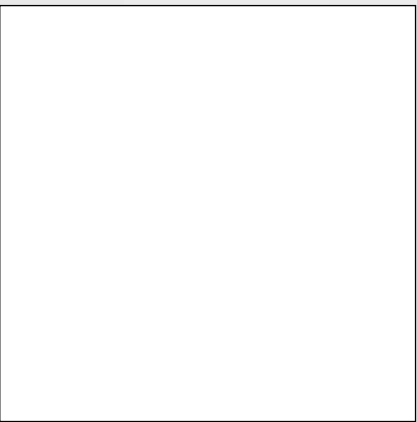
Science and technology are showing the way to a whole new generation of products and solutions obtained from wood, biomass and their components, things which were previously only possible from fossil resources.



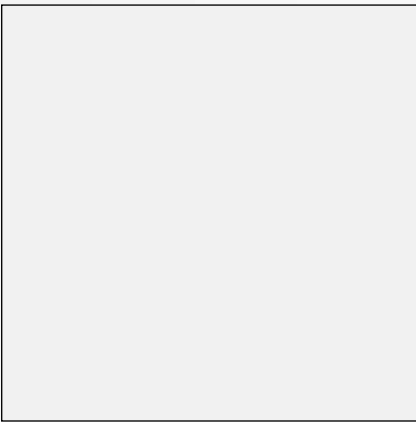
# A SHOWCASE OF FOREST- BASED INNOVATION



UNBLEACHED PULP



BLEACHED PULP



NAVIGATOR

PRINTING  
AND WRITING  
PAPER



gKRAFT

PACKAGING  
PAPER

AMOOS  
CALORIE  
CONTROL  
TISSUE PAPER



AMOOS  
NATURALLY  
SOFT  
TISSUE PAPER



The Navigator Company has been developing strategies for growing and diversifying its business, adapting to new consumer demands and concerns about the future of the planet.

Today, its printing and writing papers, tissue and packaging products, obtained from bleached or unbleached Eucalyptus globulus pulp are nature-based, renewable and biodegradable, recognised the world over for their superior quality.



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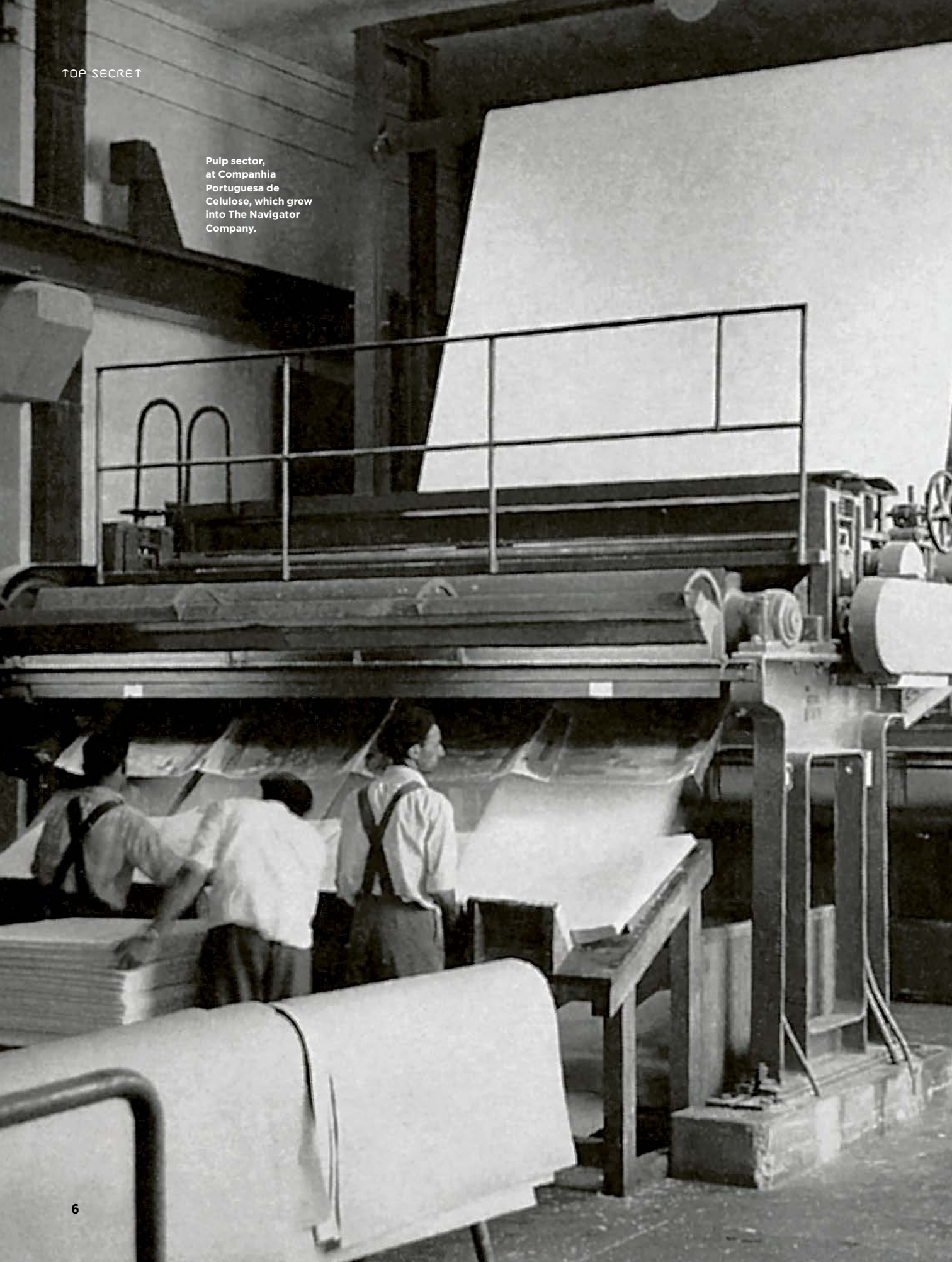
# BIO CHANGE

**M**obilising mankind for the transition from the current linear fossil-based model to a circular bioeconomy, beneficial to nature and climate neutral, is not just a pressing need, it is inevitable. In this shift from one model to another, carefully managed forests are a key ally for the sustainable future of our society, as a source of bio-based and renewable products, able to substitute fossil resources with countless advantages. The Navigator Company - a forest-based venture and mentor of the My Planet project - is fully aware of this potential, thanks to 70 years of experience in obtaining materials, energy and products from renewable biological resources. Starting with the pioneering TE-24 project that we explore on the following pages, research and innovation have been part of the company's DNA, leveraging the forest-based bioeconomy. Paper is a bioproduct par excellence: natural, renewable, and recyclable. In this edition, we

look at three distinct paper products, starting with UWF (uncoated woodfree paper) used for printing and writing. We will then turn to tissue, where Navigator has developed innovative napkin and kitchen roll products, and then to packaging, represented by the company's gKraft paper, used for wrapping and envelopes. The history of the forest-based bioeconomy is now entering a new and exciting phase. Advances in scientific research and the experience acquired from industrial applications of this knowledge have made it possible to obtain new biomaterials, biofuels and biochemicals from cellulose, opening the way to a shift from the current fossil-based paradigm. Join us on a journey through the story of this new bioeconomy, from its early origins, in 1956, when scientists discovered the potential of Eucalyptus globulus, through to the innovative projects of today and tomorrow, stopping off to look at sustainable forest management and the hi-tech products already on the market. ●



Pulp sector,  
at Companhia  
Portuguesa de  
Celulose, which grew  
into The Navigator  
Company.



# The secret project that laid the foundations for the bioeconomy in Portugal.

A laboratory, the firm belief in the value of scientific and technological research, and an endeavour that brought us a new generation of bioproducts based on *Eucalyptus globulus*. Sounds familiar? What you might not realise is that this happened in Portugal, way back in January 1947. This is the story of how it all started.

**T**he bioeconomy founded on R&D started under wraps. The mission was called “Project TE-24” and was undertaken secretly in 1956 in a laboratory at the Cacia mill of Companhia Portuguesa de Celulose, the predecessor of The Navigator Company. Its revolutionary findings took the world’s pulp and paper sector by surprise and led to two global breakthroughs. Navigator’s Cacia mill was the global pioneer in industrial-scale production of *Eucalyptus globulus* pulp using the kraft method, and in the manufacture of printing and packaging papers 100% made from this fibre. Behind this innovation lay the ground-breaking research of a small

group working under the radar. Challenging the received wisdom of the day, this five-strong team examined the potential for using *Eucalyptus globulus*, a species then naturalised in Portugal for more than a century, “for producing raw and bleached pulps in Cacia”, exploring the “characteristics of these products when used to make paper”. This was the origin of “Project TE-24”, led by Joaquim von Hafe, then Head of Laboratory Services, with the help of his assistant, Carlos Alves Valente, together with Dulce Capelo Pires Veloso, Maria Adília de Almeida Beirão and António Rodrigues Teixeira, not to forget the support from their colleagues in production, especially,



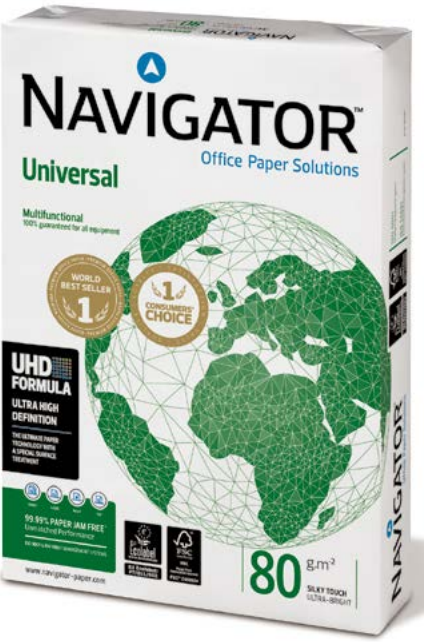
Luis Rolo, then Head of Operations at the Chemical Pulp Mill. Reporting to the Board of Directors in December 1956, this research project yielded unprecedented findings. The pulps achieved excellent scores for whiteness, opacity and bulk, “with good levels of strength and formation, pointing to their suitability for manufacturing several types of paper, in the general category of printing and writing papers”, as we may read in the final report. “These are no mere filler pulps, because the good mechanical properties obtained make it possible to dispense, partly or entirely, with stronger bleached pulps which are sometimes included in the composition of those types of paper in order to increase their mechanical strength”, the authors of the research went on to report. This document, preserved in The

Navigator Company’s historical archives, is remarkable for the way it demonstrates the versatility of the public obtained from Eucalyptus globulus, pointing out that it was also suitable for packaging papers, in particular for “bags, packaging and inner and outer liner sheets for cardboard boxes, etc.”. It also mentions the “attractive prospects for use in manufacturing oate de cellulose”, the French term for tissue paper, highlighting that: “Sheets of 15 g/m2 prepared in the laboratory lead us to expect that the oate de cellulose made from bleached eucalyptus pulp will be soft to the touch, a quality highly appreciated in this product and which we believe will be easier to obtain from this pulp than from pine pulp”. Printing and writing papers, as well as packaging and tissue paper from

Eucalyptus globulus pulp: the report’s conclusions were more than ground-breaking, they were truly visionary. They pointed to what would become standard practice in the decades that followed, exploiting the potential of this raw material for a variety of paper applications. The findings of Project TE-24 proved to be disruptive throughout the industry. Eucalyptus pulp (short fibre) showed the world that, unlike other short fibres, such as Scandinavian birch, this was no filler pulp of low commercial value, when compared to other Nordic long fibres, but rather a true alternative to these.

**The urgent need for an alternative to pine**  
The findings of this study were all the more relevant when, at the mill operated by Companhia Portuguesa

de Celulose, the equipment acquired from the United States under the Marshall Plan, which had been designed to deal with southern pine and did an adequate job in producing raw pulp from maritime pine (Pinus pinaster, the species used in Portugal), proved problematic when trying to produce bleached pulp for high quality papers. “When it came to bleaching our Pinus pinaster, because of its higher lignin content and the pigment in that lignin, the fact was that the bleaching plant was undersized and unsuited to the process. So the pulps we got were merely semi-bleached, meaning poor quality and a low price, difficult to place on the European market”, as explained by Manuel Gil Mata, a former director of the Portucel Soporcel Group, in the magazine Pasta e Papel, in 2011. It was therefore essential to find alternative fibres, and eucalyptus proved the biggest surprise. The findings from the Project TE-24 made the leap almost immediately from the laboratory to the mill. The first industrial batch was produced very soon afterwards, on 4 January 1957, when Eucalyptus globulus pulp was manufactured for the first time in the world using the kraft method on an industrial scale. Surprisingly, only around three weeks later, on 29 January, the world’s first printing and packaging papers were produced using 100% Eucalyptus globulus pulp. The markets were exceptionally quick to embrace this new solution from Cacia, thanks to the high-quality standards. Pulps produced in Portugal from Eucalyptus globulus quickly achieved international success, and in the same year, 1957, the leading English paper manufacturer, Albert Reed & Co., became a client. At the same time, the paper made from this pulp became widely sought after in Europe, from the revered printing presses of Hachette in France, to the British paper manufacturer Tullis Russel, which switched to using the pulp for its premium printing papers, staying loyal to Eucalyptus globulus until 2015, when the group discontinued its paper-making operations. ●



Navigator is today the leading European manufacturer of printing and writing paper and the world leader in the Premium segment.

**The first industrial batch was produced on 4 January 1957, when Eucalyptus globulus pulp was manufactured for the first time in the world using the kraft method on an industrial scale.**



Paper selection hall, at Companhia Portuguesa de Celulose.

## A lasting legacy

Almost seven decades on from Project TE-24 - bold and unassuming in equal parts, overturning the received wisdom of the day - a firm commitment to research and innovation remains a core feature of Navigator’s identity. In line with this tradition, the Company is today at the forefront of the forest-based bioeconomy, drawing on the unique properties and versatility of Eucalyptus globulus to develop a new generation of bioproducts that offer an alternative to using fossil raw materials. The repercussions have been felt throughout the company and beyond. Without the pioneering endeavours in Cacia, the industry would not have enjoyed such success in Portugal, as the country’s pine fibre falls short of the quality standards for premium papers. In Portugal, the pulp and paper sector accounts for 4.5% of exports and 43% of forestry sector exports (figures from INE), placing its products in 170 countries. And The Navigator Company, successor

to Companhia Portuguesa de Celulose, is today Europe’s leading European manufacturer of printing and writing paper and the world leader in the Premium segment, as well as Europe’s top producer of bleached eucalyptus kraft and the 5th largest in the world. The successful industrial application of Project TE-24 was also crucial in creating this unique cluster in the country, dominating all the stages in the value chain, from R&D in plant production and forestry through to global marketing of internationally prestigious brands, such as the Navigator Office Paper brand - Portugal’s best-selling brand worldwide. A cluster still of enormous socioeconomic importance, especially in the countryside. There would also not be such a thriving world market in eucalyptus fibres, which currently account for more than 70% of short fibres, more than 40% of total cellulose fibres and more than 25 billion dollars of sales each year. ●





# THE TREE THAT GIVES BACK

It has brought life to land left unused for generations. It has restored a livelihood and motivation to rural communities. It has attracted day-trippers, but also forestry experts with cutting edge techniques. It has yielded new opportunities and funding to promote and conserve biodiversity. Eucalyptus globulus has brought new life to the Serra d'Ossa uplands and the Odemira region, where responsibly managed planted forests have shown how generously this species pays back the care bestowed on it. It's the source of the forest-based bioeconomy in its fullest form: a symbiotic relationship between nature and humanity.



# The all-terrain eucalyptus

Nurturing eucalyptus forests where it is difficult for other species to pay their way, reducing the area of land which has been abandoned or under no type of management, is a way of bringing economic, social, and environmental benefits to areas of Portugal where much of the population has drained away. In the Serra d'Ossa uplands and in Odemira, forestry practices adjusted to each soil-climate combination make it possible to do this successfully.

**A**t eight in the morning, the mist has yet to clear in São Luís, in the municipality of Odemira, but Filipe Sousa, a forestry officer from the Forestry Support Services run by RAIZ – Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture), and his colleague Rui Baião, have already arrived at the Vale de Beja estate, owned by The Navigator Company, ready to start work on another soil and climate zoning project. This is a technique used to stratify and classify the productive potential of land, in accordance with its soil characteristics and climate conditions, based on its suitability for eucalyptus in Portugal. RAIZ developed the technique more than 20 years ago and is still at the forefront of advances in this area worldwide. Zoning is the foundation of Navigator's forestry venture, enabling the company not only to respect any environmental

(or other) restrictions, but also to bring out the best from each type of terrain, boosting the value of the land. Rather like we do with our own homes or gardens, when we decide what plant to choose for a given place, with more or less sunlight, Navigator selects the most suitable trees and adjusts the forestry techniques to the conditions identified in the zoning exercise. It's on altogether another scale, but the principle is the same. Because the aim is to produce wood to supply the pulp and paper industry, Eucalyptus globulus is the species chosen from the outset and can offer good yields even in relatively infertile soil and regions with poor potential for other species. Even so, many of the decisions can be adjusted to the local conditions, boosting these yields through sustainable means. "It's very important to have the data provided to us by Zoning", says António

Consists of a series of assessments conducted in the field to survey the main variables (soil and climate) that determine its suitability for planting and managing eucalyptus. It also involves yield estimates for future forests and provides warning of any risks of biotic and abiotic factors which, if they occur, could compromise the success of the plantation.

*Eucalyptus globulus* is remarkably adaptable, even on land more problematic for forestry species. Some examples of this can be found in the rocky areas of the Serra d'Ossa.





Aires, Southern Region coordinator of Navigator’s Forestry Production and Operations Department, who has joined the team from RAIZ this morning. “In view of the findings of this preliminary study, we’ll adjust all the forestry practices, from soil preparation, to planting and fertilising”, he explains. But that’s not all. The choice of the eucalyptus clone to be planted is also based on the findings: “In Odemira alone, where the Company manages 15,464 hectares of forests, 14 different clones are use”, he tells us. Soils that present no apparent differences, within the same property, may actually present varying levels of potential fertility, in the light of the zoning analysis. “The Vale de Beja estate, for example, is a real mix. In an area of 763 hectares, 36 distinct zones have been identified, resulting from the combination of two types of climate and 27 different soil types”, António Aires told us.

In the meantime, Rui Baião, from the Technical Forestry Support Team at RAIZ, has revealed a soil profile, at one of the sites chosen, digging with a spade to a depth of 50 cm. This gives us a vertical cross-section in which we can see the different horizons (layers) and characteristics of the soil. Filipe Sousa then examines, in the palm of his hand, what to a layman looks like just a handful of earth.



Rui Baião and Filipe Sousa, from the Technical Forestry Support Services at RAIZ.

“In areas with poorer soils, as found in so many parts of southern Portugal, eucalyptus plantations, combined with the use of good forestry practices, can undoubtedly improve the soil quality.”

Filipe Sousa, forestry officer at RAIZ



Field materials used by the RAIZ Technical Forest Support Services team, when gathering data for the soil and climate zoning survey.



Filipe Sousa assesses the soil in the palm of his hand.



Filipe Sousa logs data for the zoning survey.

# The art of naming clones

Choosing the eucalyptus clone best suited to a given area, in the light of the zoning survey, is a crucial step towards ensuring optimum yields from a plantation. The development of new clones is one of the research areas at RAZ, which currently has approximately 40 thousand in its data base. When they leave the laboratory for the forest, the time has come to give them a name.

“The name helps with communication and it’s a way of bringing the people involved in creating the clones closer to the people who are going to use them in the field”, says José Araújo, manager of the Genetic Improvement Programme at the RAIZ research institute. “In marketing and forestry management, it would be cumbersome to identify from day to day using the nine-digit numerical code assigned to each of them”, he explains.

The first step towards baptising the clones is to draw up a list of suggestions, sometimes using a theme, such as mountain ranges or rivers. The list is then voted on by staff at RAIZ and in Navigator’s Forestry Production and Operations sector. The Company has forests planted with eucalyptus trees named Estrela, Atlas and Sado. There’s also a Barão, “after the estate where it was created”, and a Tuga (slang for Portuguese), “because it’s tough and resilient”, says José Araújo. “Normally, we don’t choose people’s names, because the clone might not be a success. The only exception was Goes”, he recalls – “our first clone incorporated in the production process, 1998, and named as a tribute to Ernesto Goes, an important figure in Portuguese forestry.”

Although the numerical code might look soulless, it actually tells a story: the three digits in the middle are a kind of “surname”, as they represent the combination of the father and mother of that specific clone. ●



António Aires, Southern Region coordinator for the Navigator Forestry Production and Operations Department.



Clones just arrived from the Espirra Nurseries, for reforestation of an estate managed by Navigator in the Serra d’Ossa.

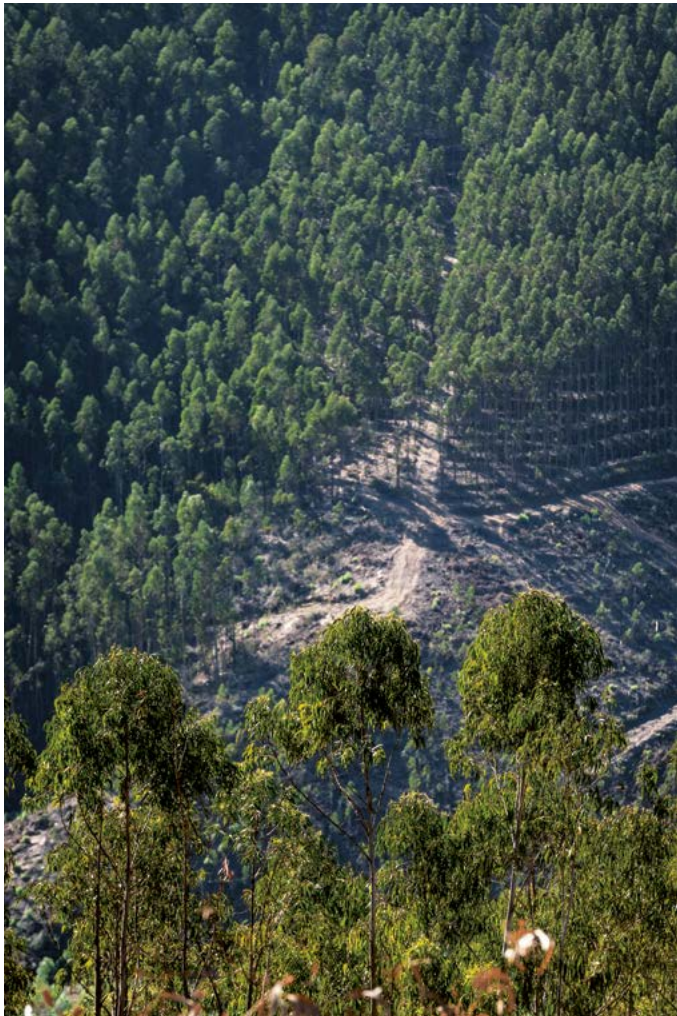


Human intervention can boost or undermine the fertility of soils. “Although we’re in an area of sand and sandstone, which results in underdeveloped soils, with poor fertility and water retention”, he explains, “we can see that organic matter has accumulated here, thanks to the forestry practices used in managing eucalyptus”. This and other data obtained from the visual and tactile analysis is logged in a form, on the tablet that Filipe Sousa has brought with him.

“On this property, the soil was correctly tilled, on the basis of a previous zoning study, and this succeeded in creating a good volume of earth for the roots, with more organic matter and better water retention. We can see this from the good root distribution of the plants”, he adds. “In a more heavily compacted soil, the roots wouldn’t be able to drill down. And in a more inert soil, they would be limited, because in soils that are poor in organic matter and nutrients and less able to retain water, they would be less developed”, the forestry officer explained. Soil conditions, combined with topographical factors such as altitude and exposure, which can improve or worsen the average climatic conditions in the region, determine the potential for eucalyptus production on a particular piece of land, and this potential can differ considerably from that of other areas nearby. But human intervention is also a decisive factor. That is why responsible and sustainable forest management is so important. “Sometimes, poor tillage can ruin the potential for crops on a piece of land, and eucalyptus is wrongly blamed for this, just because it’s what was planted there before”, says Filipe Sousa. “However, the result would be the same whatever the species,

“If we know more about the soil, we’ll be better able to care for it, making sure it’s sustainable.”

**Cláudio Teixeira, coordinator of  
Technical Forestry Support Services at RAIZ**



# The self-irrigating eucalyptus

One feature of *Eucalyptus globulus*, which enables it to adapt well to areas with a drier climate, is its ability to irrigate itself.

The Alentejo is a region with relatively low rainfall, but in areas closer to the sea or at higher altitudes (such as in the Serra d’Ossa and the area around Odemira), the damp air at night is skilfully exploited by this species. “The moisture condenses on the eucalyptus leaves, which are long and hanging, pointing downwards, and so the droplets run down the leaves and drip on to the ground . It’s as if it were watering itself, and this ends up benefit the other species around its base”, explains António Aires. “Eucalyptus is able to make the most of this phenomenon, known to experts as ‘concealed precipitation’, much more than with most other species”, he adds. ●

Eucalyptus is unusually effective at using the moisture condensing on its leaves to “water” itself.



and this is true for either forestry or agricultural species. In these cases, it was human action that ruined the potential productivity of the soil, undermining the viability of future crops”, he explains.

**Eucalyptus that improves soils and increases water retention**  
“Forestry practices based on zoning data allow the roots of plants to reach wider, enabling them to obtain more nutrients and water, and also increase water retention in the soil. Dry leaves and twigs that fall from the crown of trees decompose over time, increasing the quality of organic matter available. And all this helps to boost fertility. The soil is improved by planting eucalyptus, if the right techniques are chosen”, explains Filipe Sousa. In other words, just as human intervention can undermine the potential of the soil, it can also do the

opposite, and make it more fertile. Cláudio Teixeira, coordinator of the Technical Forestry Support Services at RAIZ, confirms this: “Zoning tells us more about the soil and how we should work with it, applying the best forestry practices in each case. This results in an increased volume of soil that the roots can penetrate, reducing the soil’s resistance to root development, by loosening heavily compacted matter and letting air in. The soils is then able to provide more water to the plant. All this serves to improve the fertility of the soil over time, as we have confirmed in the areas managed by Navigator. Soil fertility evolves positively, and the difference is visible after a 12-year cycle.” Filipe Sousa’s expert conclusion is simple: “If we know more about the soil, we’ll be better able to care for it, making sure it’s sustainable.” ●

# A fertile soil is also made of air

Almost everyone knows we can “kill” a plant with too much water. But few of us are aware of why exactly over-watering is harmful. The fact is that the roots of plants need oxygen, and too much water in the soil means not enough air. “A really productive soil should be 50% air (25% macropores and 25% micropores)”, says António Aires. “The oxygen has to reach the trees’ roots.. There are always problems when the soil gets waterlogged, squeezing out the air”, he explains. ●

# Renting to nurture

For 57 years, woodlands have helped care for the lands of the House of Bragança.



The wealth of history in the Serra d’Ossa uplands stretches beyond the Bronze Age archaeological remains, in Castelo Velho, which The Navigator Company has helped to preserve. The largest property managed by the Company in that region of the Upper Alentejo covers an area of 1,868 hectares belonging to the Herdade do Canal, an estate with a long history. “The estate has belonged to the House of Bragança, Portugal’s royal dynasty, since the fifteenth century”, explains Hugo Carvalho, the institution’s agent in Vila Viçosa. “The House of Bragança has extensive land holdings and much of the income used to maintain it has been secured down the centuries from farming and forestry”, he continued. Herdade do Canal is an example of this. “Cork oaks and traditional agriculture, with wheat fields, livestock and other activities, were the estate’s mainstay for centuries”, Hugo Carvalho tells us. Until the mid-twentieth century, when things changed. “In the nineteen sixties, when farming was abandoned in the region, other ways had to be found to keep the estate

profitable. This was when the first contacts were made with the then Socel, for the land to be used to cultivate eucalyptus. The first lease was signed in 1966. The areas of montado - cork oak savannas - have been preserved, and cork is harvested to this day. But the areas that fell into disuse and were left unmanaged were let to Navigator’s predecessor, which still cultivates them today”, Hugo Carvalho explained. “In our view, the company’s careful forestry management brings advantages, not just for the estate’s profitability, but also for the environment. The land is being used and the forests are cared for, preventing erosion and deterioration of the soils, as we have seen over decades”, he continued. He added: “Communications between the two organisations is very good, with regular contacts and cooperation. We often make use of Navigator’s technical expertise. They know the estate sometimes better than we ourselves, which is only natural, as they are there every day”. ●

“Navigator’s careful forestry management brings advantages, not just for the estate’s profitability, but also for the environment.”

Hugo Carvalho, agent for the Fundação da Casa de Bragança

Sixteenth century pelourinho, in Estremoz marble, at Herdade do Canal.



1850 map of the Herdade do Canal.

Photograph by kind permission of Casa de Bragança.



Soils that present no apparent differences, within the same property, may actually present varying levels of potential fertility.



# The many lives of planted forests

What might a eucalyptus plantation, a Bonelli's eagle, a trail runner, Bronze Age archaeological remains and an oak (*Quercus faginea*) have in common? All have benefited from responsible management of planted forests, where yields are not the only concern.

**A** hike through the woodlands managed by The Navigator Company in Serra d'Ossa or in Odemira offers a picture of the efforts made to conserve biodiversity and protect threatened species. You would also find examples of the preservation of archaeological remains and of the many possibilities for sport and leisure for local people. On these properties, the income obtained from planted and sustainably managed eucalyptus forests has been the key to funding ecosystem services not restricted to production. "In conditions which may look unpromising, eucalyptus is able to produce raw material at a faster pace than other species. This provides a more frequent source of income, making it possible to channel revenues into work with other species and in other areas", explains José Vasques, Tagus Valley Regional coordinator for Navigator's Forestry Production and Operations Department. "On the Vale da Nave Estate, in Serra d'Ossa, we cultivate eucalyptus, but we also have a significant area of cork oak woodlands, which it would not be possible to maintain without the revenues from eucalyptus", he points out.

"It's these revenues that enable the company to protect conservation areas and the biodiversity in the ecosystems. The conditions in the Serra d'Ossa uplands can be replicated in other inland regions, where the population has dwindled. Eucalyptus can be grown for a profit on less productive land, securing revenues for landowners and for industry, which then use some of the funds to invest in conservation or protection areas", he concludes. In the forests managed by The Navigator Company in mainland Portugal, approximately 12% of the land is given over to biodiversity conservation.

## An Ultra Trail through the eucalyptus trees

Anyone who decides today to go on a hike in the Serra d'Ossa, in the Upper Alentejo, is likely to meet someone else with exactly the same idea. Or someone who prefers to go a little faster - running, cycling or on horseback. Many of the trails they use go through forests managed by The Navigator Company. "The Serra d'Ossa uplands are ideal for enjoying the countryside, and our planted forests are open to the community", says José Vasques.



**José Vasques**  
Tagus Valley  
Regional Coordinator  
in Navigator's  
Forestry Production  
and Operations  
Department

**Biodiversity conservation and protection of threatened species, preservation of archaeological remains and the community access to woodlands for sport and leisure are just some examples of what responsible management of planted forests means.**





“Every Sunday morning I come to the Serra to run with some friends and we always meet lots of group walking, running, cycling and also on horseback”, confirms Marco Raminhos, chairman of Rota d’Ossa, a cultural and sports association. “The uplands are alive with sports and leisure activities, and this is very positive.. I think if the land had simply fallen into disuse, without any management, there wouldn’t be the same buzz, and people wouldn’t be able to enjoy it so much”, he says. Rota d’Ossa organises the Ultra Trail Rota d’Ossa, held for the third time in October 2022, with around 400 participants. And in partnership with Sobe e Desce Team, it also organises an annual mountain bike event, Estremoz Bike, held for the tenth year running in May this year. “Around 20 km of the routes for these events go through properties managed by Navigator. The company’s cooperation and involvement have been important for their success”, explains Marcos Raminhos. “For the last trail race, we marked out the course in accordance with the safety instructions from the company’s staff. And up to the date of the event they were helpful and followed through all the planning”, he stresses. The Company’s forest management has been beneficial for the organisation of competitions of this type, and it also helps that the properties are not fended in, Marco Raminhos told us: “If the land was divided between smallholders, who tend to fence in their land, that would



Runner in last year's Ultra Trail Rota d'Ossa.



Part of a Bronze Age piece discovered in the archaeological dig in Castelo Velho.

make it more difficult to organise the events and even for smaller groups to run and cycle. So it’s great for those who want to enjoy the Serra!”. The growing number of walkers and cyclist, who enjoy getting out into the countryside, “has given a boost to the local economy, which is also beneficial for the community”, says Marco Raminhos, already busy organising the 4th Ultra Trail, scheduled for 31 October this year. “We’re expecting around 700 participants, because for the first time the event is on the calendar of the ATRP (Portuguese Trail Running Association) and will be the final race in the championship”, he told us. “This is good news for local businesses, as well as promoting the region. We have runners from all over Portugal and even Spain.”

**Protected archaeological remains**

To talk about sustainable management of planted forests is also to speak about culture, increasingly identified by different experts as the fourth pillar of sustainability. The Serra d’Ossa is home to a cultural treasure of international importance, which the eucalyptus forest helps to protect. It lies just off one of the paths followed by the athletes in the Rota d’Ossa Ultra Trail, in Castelo Velho. These are archaeological remains dating back three thousand years, extending along a woodlands path surrounded by giant eucalyptus trees, at the second highest point in the uplands, on an estate managed by Navigator. “There are finds over an area stretching 1,200 metres, making



The archaeologist, Rui Mataloto, next to the archaeological excavations in Castelo Velho, at the second highest point in the Serra d’Ossa uplands, on an estate managed by The Navigator Company.

this the largest Bronze Age site in the Iberian Peninsula”, explains Rui Mataloto, an archaeologist working for the Redondo Municipality, at the start of the route through this historical site in the middle of the forest. “We’ve preserved this area completely for more than ten years, which is why the eucalyptus trees are taller”, José Vasques tell us. “We created a protection area of seven hectares around the archaeological site, where no forestry operations are carried out. When the property was reforested in 2010, the whole area was protected. We also decided recently to block off access by motorised vehicles, in order to minimise potential risks”, he added. “Cooperation with Navigator has

**The excavations in Castelo Velho, home to the largest Bronze Age site in the Iberian Peninsula, show that preservation of archaeological heritage can go hand in hand with forestry operations.**



been really good”, says Rui Mataloto. “It’s not usual for forestry producers to be so sensitive to the need to protect archaeological heritage. But in this case, despite the area being fairly large, there’s been a lot of collaboration and dialogue”, he adds. Work has been proceeding on the site, just in the summer months, since 2018, interrupted only in 2020 and 2021, because of the pandemic. “The archaeological investigation, with excavations, takes place essentially in August, with around 20 international volunteers. Because the fire risk is significant at that time of year, safety is a central concern”, Rui Mataloto tells us. “Coordination with Navigator means we can feel perfectly safe in the forest. We have a direct line to the people in the field every day and they are informed of any fire events as soon as they start. As soon as there’s the slightest risk, we know they’ll tell us immediately what to do”, explains the archaeologist. “Without this contact, it would be completely impossible for us to guarantee safety at the time of year when we can proceed with excavations, which is when the volunteers are available.” In Rui Mataloto’s opinion, the excavations in Castelo Velho are proof that “it’s possible for the preservation of archaeological heritage to go hand in hand with forestry operations”. As well as the remains in Castelo Velho, the Serra d’Ossa is home to other finds, such as standing stones, dolmens, burial sites and a cave once inhabited by monks. “Whether classified or not, we have identified these sites and protecting them is always taken into account when we plan our forestry operations. We create buffer zones to ensure their preservation”, José Vasques assures us. “In the past there wasn’t the same sensitivity to these issues, even

The country’s largest municipality, stretching over 1,721 km2, spans a wealth of environmental and landscape treasures. The Natura Network areas combined with the South-West Alentejo and Vicentina Coast Natural Park account for close to 50% of its territory.



Archaeological dig in progress at Serra d’Ossa, an estate managed by The Navigator Company, which has established a protection area of seven hectares around the remains.

among the public, but today we can undoubtedly conciliate production with protection of all known sites that may be of historical interest”.

**Watchtower**

in the Serra de São Domingos In the **Odemira region**, the forests managed by Navigator are criss-crossed by trails used by walkers on an almost daily basis. Around 10 km of these trails are part of the Vicentine Way. “The countryside is one of the municipality’s key assets, its backbone. The promotion of this walking route has generated fresh interest in the Alentejo coast. It has brought visitors in large numbers, in the spring and autumn, outside the high season, which wasn’t the case before”, says Ricardo Cardoso, deputy mayor of the Municipality of Odemira. “It’s mostly walkers, but we also want to replicate this success with off-road cycling”, he tells us. The municipality’s plans include restoring the watchtower on the summit of São Domingos, in the Serra do Cercal, to make it a central attraction for walkers in the region - one of the paths on the Vicentine Way passes very close to the tower. This former forestry watchtower, located on Navigator’s Vale de Beja estate, commands impressive

**12.3% of the forest area managed by The Navigator Company, i.e. 12,953 hectares, are conservation interest zones, including 4,243 hectares classified as protected habitats by the Natura 2000 Network.**

panoramic views. “It could become a tourist magnet for the regions”, says Ricardo Cardoso. “There are views over most of the municipality, the sea, the whole coastline, the River Mira, and also inland. Right next to the tower we have what remains of the São Domingos Hermitage, legends about which are woven into our local folklore”, the deputy mayor tells us. “Our idea is to restore the whole site and make it somewhere people visit for the views. Make structural improvements to the tower and provide facilities and a safe experience for visitors. We’ve been in touch with Navigator about this, which responded positively to our first approach and designated the area around the tower as not for production”, he explained. “Then, in September last year, at a meeting on the site, they were open to creating

a joint strategy for the restoration project. The next step is to establish coordination, with each side pooling its resources”, he adds.

**Conserving biodiversity**

Not far from the watchtower, on the same Vale de Beja estate, some real treasures of biodiversity are hidden away. Work to restore and conserve the natural woodlands, with oaks, cork oaks, arbutus and other native species, has been under way for more than 12 years, in areas of interest for biodiversity conservation. The areas cover 150 hectares, out of the 763 hectares making up the estate. “We’ve protected several habitats, such as water courses and riverside woodlands, with oaks, cork oaks and juniper over a reasonably large area, in a good state of conservation. Our work consists of monitoring, to understand if there are any changes, or threats to the state of these habitats”, explains Nuno Rico, Navigator’s Biodiversity Conservation manager. “These habitats have been mapped and we monitor them in conjunction with specialists. We also assess the fauna and flora and classify

sites of biodiversity interest by level of importance: conservation zones, protection areas and high conservation value areas. Like these oak woodlands with **Quercus faginea**, which is in a good state of conservation and is a habitat identified in the Natura Network”, he told us. Elsewhere on the estate, the company has done even more: “Our commitments is to not just to maintain the existing areas, but also to increase them and create a number of ecological corridors through the plantations, so they are connected. Connectivity is very important here”, explains Nuno Rico. Some of the wetlands previously planted with eucalyptus have been restored. “We start by creating breaks between plantations.. Then we assess whether they are regenerating naturally or need some help - in some areas we’ve planted oaks and cork oaks. In other areas, we’ve opted for assisted natural regeneration, which consists of giving a helping hand to pre-forestry and forestry species, such as willows, arbutus, oaks, and cork oaks, controlling the other vegetation selectively. It’s going really well. We even now have



Nuno Rico, Navigator’s Biodiversity Conservation Manager, in the oak (*Quercus faginea*) woodlands, in a conservation area within the Vale de Beja estate.

View from the summit of São Domingos.







A group of partridges in a conservation area, on Navigator's Vale de Beja estate, in the São Luís area, municipality of Odemira.



The forests managed by Navigator in the Odemira area are criss-crossed by walking trails. Around 10 km of these trails are part of the Vicentine Way.

wild orchids that you can see in the spring”, says Nuno Rico. The next step is to assess the return in terms of increased biodiversity. To this end, Navigator has established an informal partnership with the Faculty of Sciences of the University of Lisbon, which envisages MSc research to gather this information. Américo Oliveira, who has been a Navigator forestry officer for 35 years in the southern region, has been involved in this ecosystem restoration work from the outset. Without wishing to pre-empt the scientific data, validated by systematic monitoring, he assures us the results of these efforts are already visible: “For example, we’ve seen growing numbers of small birds which come to nest in these areas, and which weren’t here before. The increase in the number of individuals and of species is clear to see.”

“Eucalyptus production can generate the means and resources to invest in conservation work, which makes a difference and has a significant positive impact.”

Nuno Rico, Navigator’s Biodiversity Conservation manager

**The sensitive Bonelli’s eagle**

Classified as endangered in Portugal, in the Portuguese Vertebrates Red List, the Bonelli’s eagle is very sensitive to any disruption to its habitat. It usually nests in rocky outcrops, in inaccessible and isolated places. But according to the Portuguese Society for the Study of Birds (SPEA), the Bonelli’s eagles in Portugal, especially in the south-west Alentejo, behave rather differently: most (around 70% of pairs) nest in trees, which has helped the species expand, as it is no longer limited to crags.

This is precisely what has happened on Navigator’s estates, in Serra d’Ossa and in Odemira, where nests of Bonelli’s eagles have been identified for several years, built at the top of eucalyptus trees. Like other species with endangered status, this eagle benefits from special protection measures from the company. “It all started 16 years ago, with a LIFE project we were involved in to protect the species”, Nuno Rico tells us. “When the project came to an end, we continued to take care of the species, in other words, the Company kept the protection measures in place. These include demarcating an area around the nests, where not forestry activities with any impact are carried out during the whole of the nesting season, which is from early December to the end of May”, he explains. In addition to this measure, Navigator does what it can to improve the habitat of the Bonelli’s eagle, encouraging the presence of the species it preys on (such as partridges and small mammals), and maintaining patches of tall eucalyptus trees so it has a choice of nesting sites.



A Bonelli's eagle and its nest, on a property managed by Navigator in the Odemira area.

For the past 12 years, there has been regular monitoring, to see if the birds continue to use the nests identified. The Bonelli’s eagle maintains two or three nests per territory, and in the south-west Alentejo and Monchique region, within the area of influence of the company’s estates, a total of 10 territories have been identified and the population has remained stable, with a tendency to increase. On Navigator’s properties, “we have a long-standing nest in a eucalyptus tree in Serra d’Ossa, dating back many years, and in the Odemira area there’s one on a crag and others in tall eucalyptus trees, cork oaks and Monterey pines”, we heard from Nuno Rico. The nests have been monitored in collaboration with Rogério Cangarato, an ornithologist, who has tracked these nests since the LIFE project and helps us in deciding on

measures to conserve the species. Like the Bonelli’s eagle, the goshawk and common buzzard sometimes nest in eucalyptus trees. “Whenever this happens, we establish buffer areas to protect the nests. These areas are taken out of production and become conservation zones”, explains Nuno Rico. “As an organisation certified for and promoting sustainable forestry management, we are keen to adopt best practices and to conciliate production forestry with biodiversity conservation. We’re showing that this conciliation is possible”, the biodiversity manager assures us. And he explains how: “Eucalyptus production can generate the means and resources to invest in conservation work, which makes a difference and has a significant positive impact.” ●

In forests managed by Navigator,  
**252**  
species of fauna have been identified,

and more than  
**900**  
species and sub-species of flora, including 5 species which are “critically endangered”, 13 “endangered” and 39 with “vulnerable” status.



# It's all a matter of choice

**T**here is no planet B awaiting our species, at least not for now. Nor in the foreseeable future. This is not a new situation, but it's as if we'd only now woken up to it, or very recently. We took a long time to realise this, as if we'd been too focussed on the basic business of survival and evolution to waste a moment thinking about the consequences of our decisions. Bruno Latour, philosopher, anthropologist and sociologist, whose work has shed important light on the relationship between mankind and Planet Earth, and, specifically, on how we understand the climate emergency, has said that "There is no planet suited to globalisation", explaining that the separation that exists between the outcome of human activities and nature creates a real impossibility with regard to the understanding of climate issues. Mankind has a deep-seated ecological illiteracy which is difficult to dislodge, as it results from the design of the human species. For example, let's think about culture. First of all, what do we mean when we talk about culture? We know it's the sum total of the customs, traditions, beliefs, moral standards, artistic and intellectual manifestations and other traits that distinguish a society or social group, such as when we speak of Portuguese culture or African culture. But it's also the accumulation of moral, intellectual, and artistic characteristics and the customs and traditions of a given people, nation, specific period or place, such as Hellenistic culture or Renaissance culture, or the culture of the Minho region or of London. And it's all the activities and institutions related to the production of cultural artefacts and their dissemination, such as the work of an artist, a musician, an architect or designer, or an institution like the Gulbenkian Foundation or the Museum of Modern Art in New York. In the final analysis, it's what distinguishes us from other animals and living beings. It's what can sustain the evolution of the human species, insofar as without culture there are no ethics, understanding, citizenship, respect, sense of the common good, collective thought. Without

the awareness that culture brings us, we will not succeed in being sustainable, we will be eternally irresponsible.

In 2010, the importance of culture was finally received recognition (embarrassingly overdue) from the United Cities and Local Governments organisation, which approved the policy statement that "Culture is the Fourth Pillar of Sustainable Development", putting it on an equal footing with the economy, the environment and social cohesion. Since then, the United Nations has created the Culture and Development directive, focused on its relationship with six topic areas: reducing poverty, education, gender equality, sustainable cities and urban design, environment and climate change, inclusion, and reconciliation, acknowledging the fundamental and transversal value of culture for humanity. We know that natural ecosystems have the

**Without the awareness that culture brings us, we will not succeed in being sustainable, we will be eternally irresponsible.**

ability to regenerate, that unfortunately our species does not share, something that offers a window of optimism and hope for the healing of the huge imbalances we have caused and still continue to cause. "Spaceship Earth", as it was called in 1969 by Buckminster Fuller, the father of planetary awareness, can continue without us and regenerate. We're the ones who won't go anywhere without it. In principle, we are at a moment in history when investment in culture can make us human, able to evolve in this relationship with the planet we inhabit, in a deep understanding of nature. In order to follow the path of sustainability, that has to be our choice. ●

*By Guta Moura Guedes, chair of the cultural association Experimenta*







# A forest of solutions

Natural climate solutions account for one third of the steps needed to achieve our goals in relation to global warming. Massive reforestation is an idea with a future.

In the past 50 years, the world's population has doubled, increasing the demand for food, energy, and materials, and putting added pressure on resources. Over the same period, the economy has grown almost fivefold. An extractive economy, based on fossil, which has failed to value the planet's most precious asset: nature. We have reached a point of no return, where we have to find ways to continue meeting the needs of people, while respecting the limits of the planet. We need to make the transition from a linear fossil economy to a paradigm of a circular and inclusive bioeconomy, which is climate neutral

and works hand in hand with nature. In this new economic paradigm, there is one ecosystem which, because it is the largest terrestrial carbon sink, the main host to terrestrial biodiversity and our largest source of non-food biological resources, plays a crucial role: the forest.

**Leading change**

When we realise that, in terms of greenhouse gas emissions, mankind is on a course that will lead us to exceed the limit of 1.5°C in global warming (see IPCC Report insert, on page 36), the figure that most experts regard as admissible, it is important to find viable solutions that enable

73 per cent of opportunities for natural climate solutions are found in forests.



us to change direction and respond assertively to our most pressing challenge. Recent research has pointed to the importance of “natural climate solutions” (NCS) for countering this process of ecosystem deterioration which, in addition to the environmental impacts, will lead to a reduction of 7.2% in global per capita GDP by 2100<sup>(1)</sup>. The study entitled “Natural climate solutions”<sup>(2)</sup>, by Griscom et al., argues that natural climate solutions account for 30% of the steps needed to achieve our climate goals (more than the transport sector, for example), with an effective cost of only three percent of the total<sup>(3)</sup>. Listing 20 actions consisting of

conservation, restoration and/or better land management in forests, marshlands, pasture and agricultural land, in order to increase carbon storage and/or avoid greenhouse gas emissions, this study states that 73% of the opportunities for natural climate solutions are found in forests. And around half of these have to do directly with reforestation. Mark Wishnie, Sustainability Manager at BTG Pactual Timberland Investment Group, which manages more than 1.3 million hectares of forestry plantations in the Americas, came to Portugal last November, to The Navigator Company’s Sustainability Forum, to speak precisely about “The role of nature-based solutions in the bioeconomy”. He argued that

reforestation is needed on a huge scale, giving hard numbers: we will need to plant 200 million hectares by 2030 to meet our goals of mitigating climate change. An area, according to this specialist, at least twice that currently occupied by industrial forests. As stated in the study by Griscom et al., reforestation represents 50% of all the action needed to meet climate goals. Mark Wishnie adds that planting production forests must be done in conjunction with other measures, in particular avoiding the loss of forest soils through conversion to other uses (such as for farming or pasturage, currently the main cause of forest loss worldwide), promoting sustainable forest management, investing in

improved plantations, managing some of these forests with conservation aims, safeguarding the environmental services they provide to us. **Reforestation** is vital and brings direct benefits in removing carbon dioxide from the atmosphere and storing carbon in biomass and the forest soil, but the sector’s potential goes beyond this. “There are additional benefits when we think of the forest as a whole and as a source of renewable materials”, says Wishnie. The forestry sector’s contribution also lies in wood products, which store carbon over their entire life cycle, in the effect of substituting fossil-based materials with renewable wood-based materials, and in circularity, with the reuse of wood, on a cascade basis, and its subsequent



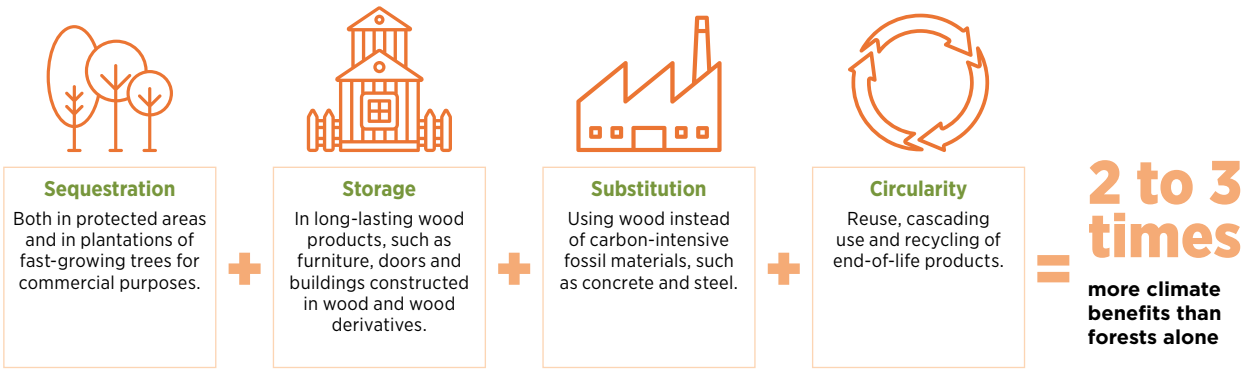
The forestry sector’s contribution is also found in wood products, which store carbon over their whole life cycle.

©FAO Forestry



In order to achieve the aim of mitigating climate change, large-scale reforestation is needed.

**Sustainable forest management and the manufacture of climate-positive forest products has the potential to multiply the impact of reforestation in reducing carbon emissions:**





recycling. When these advantages are combined, “they can bring two to three times more climate benefits, in terms of carbon retention, than the forest alone”, he points out.

Wood and the forestry sector

“When we realise that we don’t associate a wooden table with forests in the same way we associate a tomato with a farm, we see that society has mistaken perceptions of the forestry sector”, says Mark Wishnie. Indeed, research conducted in 2017 (see graph below) showed a dizzying gap between how society perceives the product “wood”, considered by 76% of

respondents as the most renewable material, and how it perceives the forestry sector - only 16% classed it as environmentally responsible. This perception gap is holding back the transition to a forest-based bioeconomy, preventing the creation of policies that value the sector as a real engine of change regarding climate change. Wishnie summarises the need to overcome this issue in a nutshell: “If we don’t find ways of ensuring our forests help us to face the climate problem, we will have missed a unique opportunity”. ●

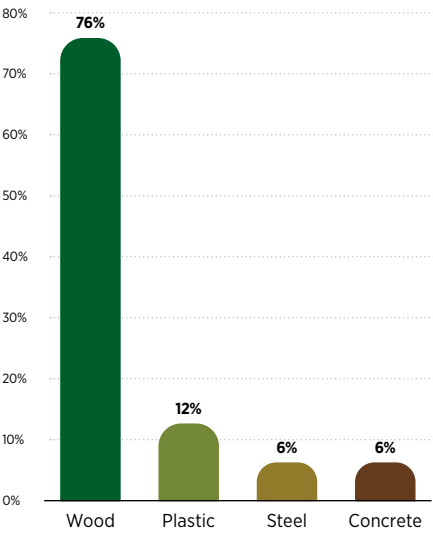
“There are additional benefits when we think of the forest as a whole and as a source of renewable materials.”

Mark Wishnie

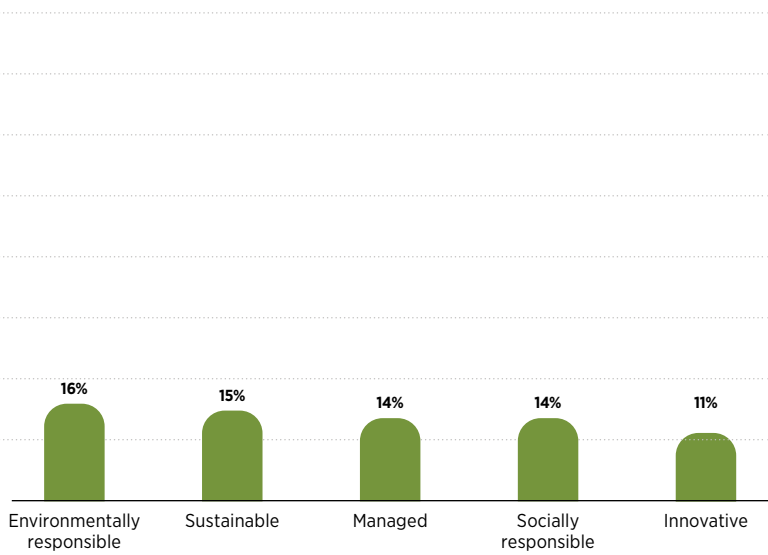
(1) Kahn et al. (2019). Long-Term Macroeconomic Effects of Climate Change: A Cross-Country Analysis.  
(2) Griscom et al. (2017). Natural climate solutions. Proceedings of the National Academy of Sciences.  
(3) Nature4Climate (www.nature4climate.org), maio 2020.

DIFFERENCES OF PERCEPTION

What is the more renewable material?



Do these terms describe the forestry sector?



(Source: 2017, “Stakeholder Perceptions Survey”, conducted by Ideas in Focus for the North American Forest Partnership. The survey respondents were 1,300 environmentally aware adults, in North America)



Society recognises the environmental value of wood, but not of the forestry sector that produces it.



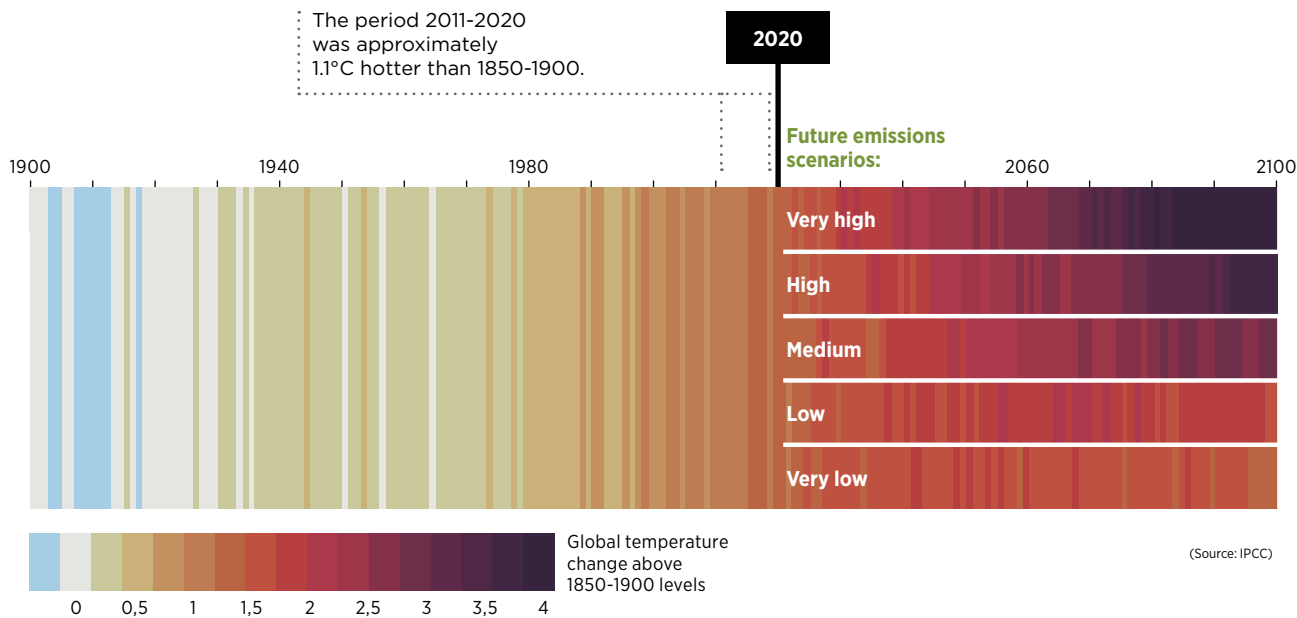
# IPCC report warns of need for urgent climate action

The current decade is critical for climate action The Synthesis Report from the UN Intergovernmental Panel on Climate Change (IPCC), released in March, concludes that, in order to limit global heating to 1.5°C, the world has to cut greenhouse gas emissions by practically half by 2030. A target we are not on course to meet: implementation of the Nationally Determined Contributions (or NDC, the commitments made by each country to reduce their greenhouse gas emissions and comply with the Paris Agreement) “make it likely that warming will exceed 1.5°C during the 21st century and make it harder to limit warming below 2°C”, we may read in the report signed by 93 scientists. Without a strengthening of policies, “global warming of 3.2°C is projected by 2100”, they write. We are at a critical moment, but if we act now, there is still hope: “There are several effective and viable options for reducing greenhouse gas emissions and for us to adapt to man-made climate change”, states the IPCC report. Capture and storage of fossil carbon, reforestation, responsible forest management, management

of water resources, ecosystem restoration or soil conservation are some of the examples cited. These are joined by sustainable urban planning, use of electrical vehicles, increased green spaces in cities, healthier and environmentally responsible diets. The great question is therefore is not “what to do”, but rather “how to do it”. This is because, in order to apply these solutions at the speed and on the scale required, more funding will necessarily have to be forthcoming. The IPCC calculations show that limiting global heating to 2.5 of two degrees means increasing the current level of public and private funding, national and international, between three and sixfold. At this moment, as the report underlines, “there is more finance flowing into fossil fuels than into climate adaptation and mitigation”. This document summarises all the reports in the 6th Assessment Cycle, published between 2018 and 2023, and will serve as the basis for evaluating global progress towards compliance with the Paris Agreement, at this year’s United Nations Climate Summit, COP28, running from 30 November to 12 December, in the United Arab Emirates. ●

The Navigator Company is responsible for planting vast tracts of forests in mainland Portugal - around 106 thousand hectares, 100% certified. In 2022, the Company set a new record for planting, at more than 3,700 hectares, the highest figure for the past 22 years.

## HOW FAR THE WORLD HEATS UP DEPENDS ON CHOICES WE MAKE NOW AND IN THE SHORT TERM



Thermoplastic compounds incorporating a large proportion of cellulose.

# The future is bio

Science and technology, which once served to distance us from nature, are now in the front line of progress towards a circular bioeconomy, which is bringing us back to the forest.

**T**he Earth is round, but our world is anything but circular. According to figures in the Circularity Gap Report for 2020, we only reuse 8.6% of a total of more than 100 billion tons of materials we extract each year. In other words, despite our growing awareness of the need for a more circular economy, the dominant economic systems appear to be based on a mentality of “extract-produce-discard” and on growing over-exploitation of resources. A scenario which applies both to non-renewable resources, such as minerals and fossil fuels, and also to renewable resources, such as wood.

We are on the verge of not being able to comply with the targets set for global heating, and so it is imperative to convert to a circular economy, where the principle is “extract/recycle-produce-reuse/recycle”. In a perfect world, resources would circulate endlessly in a closed cycle, through continuous reuse and reclamation. But the truth is that, due to inefficient processes or technological and/or physical limitations, some of the resources are lost along the way. The most effective solution is to substitute non-renewable resources with renewables - because these raw materials are able to be regenerated

**In Portugal, the bioeconomy represents turnover of 41 billion euros, and 24% of this (9.8 billion euros) is generated by the forestry sector.**



Impacts of climate mitigation by forestry sector and steps to boost this

Mitigation channel	Possible steps to increase mitigation up to 2050
Biophysical impacts	
Sequestering carbon in trees and soils (carbon sink).	Halt deforestation, increase reforestation and conserve forests. Transform global loss of forests into gains, always reforesting after final harvest.
Forest albedo.	Switch from conifer forests to deciduous or mixed forests.
Forest disruption.	Adapt forests to climate change and increase their resilience (for example, switching tree species). Reduce risks of disruption, through forest management measures.
Impacts of substitution and storage	
Substitute fossil raw materials, energy and fossil products with forest biomass.	Forest management and production of wood for forest-based products. Policies to increase demand for forest-based products, such as construction in wood.
Carbon storage in forest products.	Forest management and production of wood for forest-based products.
Emissions from forest products value chain.	
Production and logistics.	Reduce and eliminate fossil fuels in transport, heating and power generation in forest-based industries.
Socio-economic and political impacts	
Synergies or trade-offs between the mitigation channel and other social goals (such as impacts on biodiversity, impacts on incomes and employment).	Seek to maximise synergies and minimise trade-offs between mitigation measures and other social goals.
Combination of several different channels.	No single policy/action can improve all the different mitigation channels - a mix of different policies and management measures is needed.

(Source: Lauri- Hetemäki, Jyrki- Kangas, Heli- Peltola - Forest Bioeconomy and Climate Change)

The channels through which the forest-based sector can have an impact on climate mitigation are associated with a specific action to maximise the mitigating potential. So, for example, if we were only interested in maximising carbon sequestration in forests and soils, it would make sense to conserve forests, at least in the short term (over the next few decades). But if what really interested us most were the impact of substitution, then the solution would be to increase wood production. Likewise, if all the different channels and socio-economic and political responses were considered simultaneously and holistically, the course of action could differ from any one isolated option.

sustainably, increasing our ability to meet the needs of mankind, whilst staying within the limits of the planet. This is called the circular bioeconomy. The **bioeconomy** is an economic model based on consumption of biological resources for producing goods. in a **circular bioeconomy**, biological resources are renewable, managed sustainably, reclaimed and reused as much as possible. And in a **forest-based circular bioeconomy**, those renewable and sustainably managed biological resources are obtained from forests.

**An opportunity for forests**  
In this circular forest-based bioeconomy, planted forests which are managed responsibly play a crucial role. They provide us not only with goods and services valued by the market, such as wood, cork or resin, but also with a range of ecosystem services resulting from sustainable management practices - such as carbon sequestration, production of oxygen, promotion of biodiversity, soil protection, regulation of torrential hydrological regimes and creation of landscape amenities.

A bioeconomy model that includes forests enables us to act on three fronts that mutually reinforce each other; increase carbon storage in forests, improve the health and resilience of the forests themselves, through forest management, and using wood resources sustainably, to substitute non-renewable and carbon-intensive materials - the new bioproducts that may emerge here range from food additives to biocomposites, from advanced biofuels to nanocellulose, replacing fossil-based materials in sectors such as packaging, construction materials, textiles, bioenergy, pharmaceutical products and automobile parts. Forests are the best source of non-food renewable biological resources, i.e. not competing with food production. Bringing them back to the centre of our lives will enable us to rebuild the lost relationship between ecology and economics, and between technology and nature. ●

European forests 1990–2020

	1990	2000	2010	2020
European forests 1990–2020 (50 countries and territories)				
Forest area (million ha)	994	1002	1014	1017
Carbon stock in biomass (Gt)	45	48	51	55
Total carbon stock (Gt)	159	162	168	172

(Source: FAO)

From paper and packaging to biofuels and innovative biomaterials for the construction, chemicals or textile sectors, forestry products and the forests from which they come capture and store carbon. This is a unique capability, which positions the forestry sector at the heart of the transition to a circular, sustainable and low carbon future, based on renewable natural resources.



Micro- and nanofibrillated celluloses are an example of the forest-based bioeconomy and have been tested in paper production, to improve mechanical strength properties.





Viscose is made from cellulose, with environmental advantages that have been boosted by new technologies.

# How the bioeconomy is already changing our lives

It's the much-heralded solution for a sustainable future. But we don't need to wait to enjoy this new development model. Discover some examples of how the forest-based bioeconomy is already filling your shopping trolley.

It's nature that provides them, but technology that has made it possible to bring innovative solutions on to the market, offering an alternative to a linear economy dependent on fossil sources. When consumers opt for these new naturally sourced and renewable bioproducts, production can be scaled up, prices lowered, and supply expanded.

### Paper on the front line

Forest-based products have established themselves as an alternative to plastics, especially single use plastics, in packaging and utensils. For the sake of decarbonisation, the circular economy and a commitment to non-fossil, renewable raw materials, legislation requires them to be replaced and paper has been in the front line of the most sustainable alternatives. In 2021, The Navigator Company launched in Portugal a new packaging paper range, under the gKRAFT brand – the first solution of its kind in the world, using virgin Eucalyptus

globulus fibre to replace the single use plastics dominating the packaging market. This product grew out of technological research conducted by RAIZ – Forest and Paper Research Institute, the R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture, and the range includes paper for bags, for flexible packaging suitable for the food and other industries, and for corrugated cardboard boxes. As well as its environmental advantages, an important argument in favour of gKRAFT is food safety and hygiene: it is produced exclusively from virgin Eucalyptus globulus fibre which, unlike recycled fibre, avoids any danger of contamination. At present, several high-profile global brands already include the gKRAFT logo on their paper bags, as a symbol of the move from fossil to sustainable forest-based materials. In addition to Navigator, many large corporations have got involved. For example, Coca-Cola has announced it

is working to develop a 100% paper bottle. And Nestlé has been replacing plastic packaging with cardboard – haven't you noticed that the iconic Smarties tube is now a hexagon made from 100% recyclable paper?

### Textiles from the bioeconomy

Did you know that viscose is made from cellulose and can be based on wood pulp? This gives it advantages over polyester (which is synthesised from petrochemicals), requires less land use than wool production and, in comparison with cotton, consumes less water and less fertilisers and pesticides. Lyocell, a fabric made from wood pulp sourced from sustainable forests, without using chemicals, has established itself as a leader and already features in the catalogues of several brands, from bed linen to ready-to-wear. According to the European Forest Institute, cellulose-based fabrics account for 7% of the textile sector, and in Portugal the industry is supplied with

**Cellulose-based fabrics account for 7% of the textile sector, and in Portugal the industry is supplied with dissolved eucalyptus pulp.**



eucalyptus pulp. Tintex is a company in Vila Nova de Cerveira that incorporates at least 60% sustainable materials, including regenerated cellulose fibres and fibre. And Filasa, in Guimarães, produces wood-based viscose with savings in water consumption and greenhouse gas emissions in the order of 50%, in relation to conventional viscose.

A Finnish company, Spinnova, has recently patented a technology that promises even less environmental impacts in producing cellulose-based fibres, as it involves no chemicals, but instead a pressure and spinning process similar to that used by candy-floss machines. Spinnova made it on to Time Magazine's list of the Best Inventions of 2022, and the fibre is already being used by brands like Adidas.

**The true carbon footprint**

The footwear sector has embraced a number of options that incorporate forest-based raw materials. Timberland's Earthkeepers range includes models where the uppers are made from a Lyocell fabric, made from 70% eucalyptus and 30% recycled cotton. The sole of the Plant Shoe (manufactured in Portugal), from the Canadian company Native Shoes, is created from the sap of the rubber tree and has an inner liner in eucalyptus viscose. Eucalyptus and natural rubber (instead of petroleum-based rubber) are also used in Reebok's Forever Floatride Grow trainers.

**Change is accelerating in the motor industry**

In Europe, the automobile industry used around 80 thousand tons of wood and plant fibres each year, instead of synthetic glass and carbon fibres, according to figures from the European Commission. Biocomposites are increasingly popular, because they make for lighter cars, which improves their performance and

reduces CO2 emissions. The Porsche 718 Cayman GT4 Clubsport MR, which competed in 2020 in the Nürburgring 24-hours, used for the first time a full bodywork kit built from composites of natural fibres, including balsa wood. And for the new BMW M4 GT4, the car maker has announced that new natural fibre components have brought down plastic content in interiors to 70% and brought down CO2 emissions by 60%. Outside the racing world, other models are striving to make a difference on the roads. An example of this is the Hyundai IONIQ, where the manufacturer has increased the use of bioplastics with a larger proportion of wood fibre in doors and interiors, as well as using Tencel fabric made from eucalyptus to upholster the seats. Land Rover has also created an exclusive fabric, called "Eucalyptus Melange", as one of the options for the seats in its new Range Rover Evoque.

**Biochemicals and bioplastics**

A significant proportion of the chemicals currently used in medicine and pharmaceuticals, in detergents and perfumes, and in plastics, can be obtained by processing biomass. Braskem, in Brazil, has a polyethylene factory, where it produces plastics from biomass sugars. And the Finnish UPM groups is pressing ahead with a capital project worth 500 million euros in Germany, to produce biochemicals from wood. Since 2019, production capacity for bioplastics - polymers based on renewable and/or biodegradable biological raw materials - grew by 1.79 million tons to an estimated 2.42 million tons this year, according to European Bioplastics. This type of material is already used in countless products, from electronic devices, toys or receptacles for food, such as the Heinz ketchup bottle, which incorporates up to 30% cellulose fibres and is 100% recyclable.



Coca-Cola has announced it is developing a 100% paper bottle.

**Forest-based products have established themselves as an alternative to plastics, especially single use plastics, and paper has been in the front line of the most sustainable alternatives.**

In the iONIQ, Hyundai uses wood fibre in the doors and interiors, and a fabric made from eucalyptus to upholster the seats.



Cellulose-based fibre, produced with a technology that uses no chemicals, is already being used by brands such as Adidas.

Timberland's Earthkeeper footwear range uses a Lyocell fabric made from 70% eucalyptus.



Bioplastics, based on biological raw materials, such as forestry cellulose, are already found in products ranging from food packaging to toys and single use utensils.

**High-flying cork**

From sound insulation in trains to floating floorboards without PVX, from a combination with concrete in the outer walls of the Lisbon Cruise Ship Terminal, to CorkSorb, a high absorption product used to mitigate hydrocarbons spills at sea, caused by oil tankers, cork has found its way into hi-tech markets. As well as winning over NASA and SpaceX, cork was used in the mission XIV of the European Space Agency as part of the thermal ablative protection system, for which the Portuguese company, Amorim Cork Composites developed a composite able to protect the structure of the spacecraft from the effects of the thermal environment.

**Vanilla flavour**

with the aroma of sustainability Only 1 to 2% of the world market in vanilla flavouring is derived from vanilla pods, the rest is synthesised. The alternative to producing this from petroleum products is to use the black liquor resulting from the cooking of biomass, which is a by-product of the paper industry. Borregaard, in Norway, is the world's leading producer of this vanilla flavouring and the only one to manufacture it from wood, sourced from certified forests. According to the company, its bio-vanillin offers a 90% reduction in CO2 emissions, when compared with that synthesised from petroleum. ●



# The world of advanced biofuels



Whilst electrification may have a significant role for cars, liquid fuels remain essential for the future of aviation, maritime and road transport, and in industrial boilers and furnaces. Hence the importance of second-generation biofuels.

Consumption of primary energy from biofuels grew worldwide by more than 12.5 thousand per cent from 1965 to 2021. At present, most of these are obtained from agriculture or farmland: these are first generation biofuels. “Second generation, or advanced biofuels use materials not in competition with the food chain, such as forests or agricultural waste and used food oil”, explains Alexandre Gaspar, Industrial Scale-up & New Business Development manager at RAIZ – Forest and Paper Research Institute, R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture. Several plants have been set up in Europe to process forestry biomass with a view to converting it to biopetrol, which can replace either petrol or diesel from fossil sources. It is also possible to

transform forestry waste into biogas for generating thermal energy and power. And roasting forestry biomass can create, in seconds, a substitute for coal, which nature took millions of years to form. This product is presented in high energy density pellets. With the current market in ethanol for biofuels representing more than 100 billion euros a year, there is also great potential for the more advanced version. Clariant started to produce this biofuel in 2021, in Romania, using biomass, and Shell immediately acquired the entire annual output of 50 thousand tons, to blend in its petrol for Europe, complying with European directive that require incorporation of advanced biofuels in road vehicle fuels. According to Clariant, its technology for producing their advanced cellulose bioethanol “helps to decarbonise the transport sector by offering a CO<sub>2</sub> saving of up to 96% in comparison with a fossil fuel”. ●

# “Pulp and paper are bioproducts par excellence”

Cellulose pulp is the basis for many new and innovative bioproducts, but we shouldn’t forget the most traditional of all: paper.

Its main source of raw material is the forest, and natural fibres. For this reason, “cellulose pulp and paper are bioproducts par excellence”, says Ricardo Jorge, head of the Research and Technology Consultancy Department at RAIZ – Forest and Paper Research Institute, R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture. However, although paper products have a long history, their eco-friendly character has only been properly valued since the circular bioeconomy became an important concept in the

context of sustainable development, and forestry raw materials asserted themselves as a fundamental and greener alternative to materials from fossil sources. Forests are natural and renewable sources and, through their life cycle, contribute to what are regarded as best practices in the circular economy. The bioproduct paper is one of the most heavily recycled materials in Europe and has the advantage of being biodegradable and compostable, when not recycled, without negative impacts on the environment or human health. The sustainability of this product has been boosted by progress in forest management and good forestry

practices promoted by certification, as well as by stricter environmental requirements in industrial regulations. In Portugal, we can also point to the work done by RAIZ, to increase the yields and resilience of the forests supplying the paper industry, to optimising manufacturing processes and to developing new innovative and increasing ecological papers. The Navigator Company’s paper is a good example of this. It comes from managed and 100% certified forests. It uses fibre from Eucalyptus globulus, with which more paper can be produced from less wood and consuming less chemicals. And it withstands being recycled over and over again. ●





Inpactus - Innovative Eucalyptus-based Products and Technologies

# Looking for sustainable solutions

The largest Portuguese R&D programme in the forest-based bioeconomy was set up to develop bioproducts with the potential to replace materials from fossil sources, and to create new businesses for a circular and competitive economy. Inpactus brought together academics and industry, and pooled expertise on an unprecedented scale.

**F**rom new bioproducts to cutting edge technologies that promote circularity, Inpactus demonstrated, without any room for doubt and with convincing evidence, that eucalyptus forests can be the basis for creating alternative to products from fossil sources. The project was conceived in the first place to support The Navigator Company's core business, by improving and diversifying pulp, paper, tissue, and packaging products and by optimising industrial processes. At the same time, it set out to promote a new biorefinery and bioproducts area, focused on the urgent transition to a circular economy based on natural raw materials. In short: over nearly five years, investment of 14.6 million euros served to research and develop new solutions to replace materials from fossil sources with forest-based alternatives. "Five years ago, the idea of biorefinery and bioproducts in the eucalyptus

sector was still relatively unexplored", points out Carlos Pascoal Neto, director-general of RAIZ - Forest and Paper Research Institute, R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture. "In this regard, Inpactus was pioneering." It was also a collective effort. The project was co-promoted by RAIZ, The Navigator Company, the University of Coimbra and the University of Aveiro, with the involvement of partner institutions, such as the universities of Beira Interior and the Minho, the Higher Technical Institute, Universidade Nova de Lisboa, the Iberian Nanotechnology Institute, the RISE Bioeconomy R&D Centre (in Sweden) and the Fraunhofer Institute (Germany), and a spin-off, Satisfibre. The collaborative model won praised as an example of good practice by the OECD (Organisation for Economic Cooperation and

€14,6  
million invested

8 projects  
in the area of pulp

7 projects  
in the area of uncoated  
printing and writing  
papers

7 projects  
in the area of tissue

19 projects  
in the area of biorefinery

**“The training of highly skilled human resources was one of Inpactus’ main contributions.”**

Paula Pinto, coordinator of Technological R&D at RAIZ



**Over nearly five years, Inpactus involved 218 researchers in the Portuguese technology and science system and Navigator’s technicians.**



4 new products  
(3 in tissue and 1 in packaging paper)

37 patents

66 prototypes

218 researchers and technicians from universities, RAIZ and The Navigator Company

2 international guest professorships

147 publications

224 lectures

24 PhDs

45 master's degrees

Development), and Inpactus also helped RAIZ to gain European certification as a Business Innovation Centre. UNESCO Portugal also applauded RAIZ and the way it promoted and disseminated the expertise developed in this project to civil society, and especially to younger people.

**New generation of researchers creates a new generation of bioproducts**

The work started on the basis of 41 research sub-projects, after securing funding from FEDER, under the Operational Programme for Competitiveness and Internationalisation, in the Business Incentives System. On the table were eight projects in the field of cellulose pulp, seven related to uncoated printing and writing papers, another seven in the tissue segment and 19 in the area of biorefinery, i.e. an industry that makes integrated use of wood and biomass to produce bioproducts, biochemicals, biomaterials and biofuels. All “greener” alternatives. Over nearly five years, Inpactus involved 218 researchers in the Portuguese technology and science system and Navigator’s technicians. “The training of highly skilled human resources was one of Inpactus’ main contributions,

having established a joint university-industry platform focused on excellence, to support the competitiveness of the forest-based bioeconomy centred on eucalyptus and the pulp and paper industry”, confirms Paula Pinto, Technological R&D coordinator for RAIZ and also for the project.

The numbers speak for themselves: 24 PhDs and 45 Master’s degrees completed as part of Inpactus. But the expertise developed found applications well beyond the laboratories. Navigator has also launched four new products on the market, developed eight potential new bioproducts or businesses still at the technical-economic assessment stage, and filed 27 patent applications. When the project’s main results were made public, at the closing session for Inpactus in October last year, the sustainability solutions discovered won “recognition from the public authorities, expressed by the presence of the Minister for Science and Technology and the vice-chancellors of the co-promotor universities”, Carlos Pascoal Neto tells us.

The project started in 2018 and ended in October 2022, but its effects will be felt for a long time, with a continuing influence on the sustainability of the planet and the quality of life of future generations. Learn about some of the researchers involved. ●



Patrícia Moreira  
Natural alternative without side-effects



As a child, she wanted to be a florist, because of the contact with the natural world. Later, she discovered that laboratory work was her real passion. Her first great area of interest was toxicology and forensic science, resulting in a master’s degree in Forensic Medicine. Looking more widely, Patrícia Moreira discovered an affinity with neuroscience, and the research grant that took her to Coimbra was related to Alzheimer’s disease. She put this on hold to join the Inpactus project, with a PhD subject that involves extracting bioactive compounds from eucalyptus plantations and the felling of acacias, to test them in combating Alzheimer’s, and later also for dermo-cosmetic applications. “We demonstrated that eucalyptus extracts had many beneficial effects on memory and anxiety”, she says. In skin care, the extracts revealed anti-ageing, anti-inflammatory

and lightening effects. In addition to the advantage of their natural and sustainable origin (they are reclaimed from forestry waste), these are also alternatives without any toxicity, causing no allergies or irritation. In Alzheimer’s disease, they also have the potential to replace synthetic compounds and their side-effects. One of her reasons for choosing this subject was that it fits within a sustainable circular bioeconomy, based on natural products. “People often take a negative view of eucalyptus, but it’s a plant with great potential, not just in this area, but also for carbon sequestration”, she explains. “My generation is rather more concerned with environmental issues and businesses themselves are seeking to promote a greener economy. What I would like most is for a pharmaceutical company to take an interest in this area.” ●

**Patrícia Moreira**  
**Age 30**  
Degree in Biology, University of Porto  
Doctoral thesis at the University of Coimbra, sponsored by Inpactus, on: “Characterisation of the phytochemicals of Eucalyptus globulus leaves and their pharmacological potential: a functional perspective”  
Patent applications filed through Inpactus: 2



Bruno Valente

The forest as a plentiful and renewable raw material

The topic of biocomposites that he explored in his PhD was “a mixture of chance and my motivation, as citizen and scientist, to contribute to a better and more sustainable society, increasingly concerned about climate change and the need for a transition to a circular, biologically based economy. In addition, I was born in an area with vast and valuable forests, so I identified with developing products and technologies from forests”, says Bruno Valente. Having completed his Inpactus research project, his dream is to reduce the current percentage of polymers from fossil sources and to see biodegradable composites, wholly based on renewable sources, reach the market at competitive prices. These could constitute, for example, PLA or PHB, reinforced with cellulose fibres. If they are to be widely used, he believes they have to use a plentiful raw material. Forests, and eucalyptus forests in particular, answer to this description.

The materials he developed have been extensively characterised with regard to their mechanical and thermal properties, their capacity to absorb water, fluidity and biodegradability in the environment, in order to assess different blends of fibres from bleached cellulose pulps with a range of thermoplastic matrices from renewable sources. He then also tested biological alternatives to existing additives, from fossil sources and harmful to the environment and human health, used to improve the specific properties of composites, such as impact resistance and the fluidity index. As a result, he won a prize from the Blue Sky Young Researchers and Innovation Award Europe 2022, organised by CEPI (Confederation of European Paper Industries), for his biocomposites made entirely from renewably sourced products: up to 40 per cent cellulose fibre, cellulose butyrate acetate and a derivative of linseed oil (plasticiser). ●



Bruno Valente  
Age 31

Degree in Biochemistry and master's degree in Clinical Biochemistry, University of Aveiro

Doctoral thesis, sponsored by Inpactus, on: “Development and characterisation of composites with a high level of cellulose incorporation”

Patent applications filed through Inpactus: 2

Mariana Amândio

New links in the chain of the circular bioeconomy

Mariana Amândio is serious about her concern for the future of the planet (her involvement in the scouting movement made her feel a connection to nature), and she does her bit by researching bioethanol, a renewable fuel. She first embraced this topic in her master's degree, and brought it with her to Inpactus, motivated also by the synergies between universities and business.

Starting out with pre-treated eucalyptus bark, she produced a hydrolysate rich in cellulose sugars, which can be used in several applications, in particular for producing biofuels and bioplastics, among other things. She converted these cellulose sugars into bioethanol, one of the applications specified in the project goals. As well as proving it is possible to produce bioethanol from bark, which is currently used only to generate thermal energy in industrial biomass boilers, her research led to two patentable innovations. First, simultaneous execution of the two stages in the process (hydrolysis and fermentation), in order to save time and operational costs. And then, reclamation of the yeasts in the fermentation broth - a biological waste product which is reused, thereby creating an important link in the chain of a circular bioeconomy. In Europe, where the trend is for electrification, she does not believe that bioethanol will make much headway in passenger transport. However, she thinks it is important to have more sustainable, forest-based alternatives for the bioethanol used in other countries from crops directly competing with the food chain, such as maize. “Considering the goals established in the European Green Deal for sustainable development, we need to have an array of options for achieving carbon neutrality, and not focus on just one. Bioethanol could be an alternative for long-haul transport”, the researcher believes. ●



Mariana Amândio  
Age 27

Master's degree in Chemical Engineering

Doctoral thesis at the University of Coimbra, sponsored by Inpactus, on: “Production of cellulosic sugars and bioethanol”

Patent applications filed through Inpactus: 1 provisional application filed and 1 in preparation



Helena Gil Gomes

Energy recovery as an incentive for forest management

When she saw the Inpactus announcement she was on a bursary to research natural gas combustion, but she had previously worked on biomass. She felt it was a challenge for her: “Portugal has a lot of forest to manage. If the forest waste collected were used in thermochemical systems of this type for energy recovery, it would be a plus for Portugal and for the planet, both on economic and social grounds, and environmentally”, says Helena Gil Gomes. “Navigator is also concerned with this, and with being as green as possible, and that’s why I applied.”

What she was looking for was sustainability. She already had the “environmental bug” – influenced by her family – and her training helped her to look at things from a perspective that was not merely economic. During Inpactus, she focused on optimising production of gas from the gasification of waste eucalyptus and pine biomass. She is now continuing her work, with a scholarship from FCT (Foundation for Science and Technology), with the processing and combustion of biomass gas. “This gas has different environmental advantages when compared to natural gas (fossil), because it’s renewable. In addition, the gas produced in this type of process does not compete in any way with the food industry, as the raw material used to make it is waste forestry biomass. Now I want to understand the environmental impact of burning this gas”, she explains.

What is more, in the long term, the refining of this forest-based gas has “potential for conversion into hydrogen and synthetic natural gas (biomethane), two rather promising applications: the first promotes decarbonisation of the planet and the second allows us to use exiting natural gas piping and injectors, without depending on fossil fuels”. The gas can also be a raw material for producing liquid fuels, and for thermal energy through direct burning and power through co-generation. “This work is relevant to us today, which is why I wanted to do it. This part of the circular economy, the bioeconomy and decarbonisation will definitively have a very great impact on the health of the planet and our own”, she concludes. ●



**Helena Gil Gomes**  
**Age 28**

Master’s degree in Environmental Engineering  
University of Aveiro

Doctoral thesis, sponsored by Inpactus, on: “Improving the quality of combustible gas produced through biomass gasification”

Anabela Santos

Surprising advantages of eucalyptus



It all happened very naturally. A research bursary at RAIZ led Anabela Santos to Inpactus and to the paper sector. In her case, to a new product, a high absorption non-woven fabric. She was delighted to work with Navigator’s eucalyptus fibres, to explore a new segment and think about a bio-based, sustainable future, one step ahead of the current market. Navigator’s pulp had to be adjusted. It had to be dried, but with individualised fibres, and the expertise to do this had to be developed. New laboratory equipment then had to be designed to produce the non-woven fabric sheets aerodynamically, i.e. without using water. Lastly, thermal, and chemical binders were tested. Conclusions: “Eucalyptus fibres can perfectly well be used to produce this new generation of more sustainable non-woven fabrics. All the approaches were made using ingredients of biological origin and/or

biodegradable ingredients, or with moisture”, she explains. They obtained functional structures with high absorption levels or mechanical properties equivalent to articles on the market, such as absorbent articles made from less ecological materials, including fossil-based products. At present, even those which incorporate cellulose fibres had synthetic additives and it’s difficult to find any which are wholly biodegradable. The new solution developed has no components from fossil sources and only uses paper fibres, without the dissolving or regeneration of cellulose that gives rise to continuous filaments of fibre. Just environmental advantages and, thanks to E. globulus fibre, “improved absorption and softness, or equivalent mechanical properties. Eucalyptus always comes up with surprises”, the researcher told us. ●

**Anabela Santos**  
**Age 28**

First degree and master’s in Biochemistry at the University of Beira Interior

Doctoral thesis at the University of Coimbra, sponsored by Inpactus, on: “Unwoven fabric structures with eucalyptus fibre”

Patent applications filed through Inpactus: 2



Patrícia Henriques

A new business segment based on cellulose pulp



After studying the stabilisation of wines for her master’s degree, Patrícia Henriques was offered a research bursary with Inpactus, in the field of xylo-oligosaccharide production. She was immediately interested in joining forces with a large company like Navigator, enjoyed the experience and then decided to embark on a PhD. “What attracted me most was seeing a practical purpose for the work. Xylo-oligosaccharides are prebiotics, and everyone’s heard of those, if only in yoghurt ads”, she says. Her research showed it is possible to produce prebiotics from paper pulp. She also studies several methods for producing these compounds and found they have the desired activity: they feed our good intestinal flora, which regulates several functions in the body. The most immediate applications for these fibres could be in animal feeds and then,

once approved for human consumption, they can also be introduced in foods or sold as supplements. The prebiotics studies present several advantages. They are able to generate the same effect with smaller doses, and also represent another potential business segment based on cellulose pulp. “I’m very aware of environmental issues and, in this research, we always took this into account: by using less harmful reagents and reducing water consumption to a minimum”, the researcher explains. “But, when it comes to sustainability, people are prejudiced against eucalyptus. I’m from Tomar, where we have large areas of forest and a lot of fires, and I myself share this prejudice. This work helped me to a better understanding that paper production does not mean deforestation.” ●

**Patrícia Henriques**  
**Age 29**  
Master’s degree in Chemical Engineering  
  
Doctoral thesis at the Higher Technical Institute, sponsored by Inpactus, on: “Production of prebiotics from bleached *Eucalyptus* kraft pulp”  
  
Patent applications filed through Inpactus: 2

Vítor Rodrigues

The advantage of natural extracts

An interest in learning how things work and how to influence processes, combined with a desire to work on something with a concrete application and a connection to the business world, led Vítor Rodrigues to the uses of eucalyptus leaf biomass in his MSc thesis. When Inpactus was launched in 2018, this was an opportunity to continue his research, extending it to other waste forest biomass, such as from acacia leaves and barks, which was then practically unexplored. The technology used is called “supercritical” and the explanation for lay people involves the example of a pressure cooker at such high temperatures that it reached the critical point and extracts from the biomass a fluid somewhere between a liquid and a gas, with the advantages of having the solvent power of water and a viscosity similar to gas, making able to penetrate materials which

are practically solid. Supercritical extraction - which he insists fulfils the objectives of green chemistry, i.e. replacing toxic solvents - enabled Vítor Rodrigues to obtain the natural extracts without wetting the biomass, and without destroying or contaminating it, which means it can continue to be used for producing renewable thermal energy. The bark results in a powdered product and the leaf in a viscous product. These are bioactive compounds, derived from luteol, in concentrations higher than with conventional extraction techniques. The potential applications are in pharmaceuticals, when purified, for food supplements and animal feeds, in order to substitute the use of medicinal products. Why? “Some of these compounds have a potential anti-inflammatory, anti-tumoural, antiviral and in some cases anti-carcinogenic activity”, says Vítor Rodrigues. ●

**Vitor Rodrigues**  
**Age 31**  
Master’s degree in Chemical Engineering University of Aveiro  
  
Doctoral thesis, sponsored by Inpactus, on: “Supercritical technology for producing natural extracts from forest biomass”







Inpactus project: the principal results

# Innovative bioproducts derived from eucalyptus

When you take a eucalyptus tree, add cutting edge technology and are able to extract all the value the species offers, the result is a huge leap towards a sustainable planet. All new businesses that grow out of this tree and paper industry by-products are good examples of the forest-based circular economy. Now that Inpactus is over, there are solutions which are being marketed and partnerships for exploring opportunities for placing more innovative materials on the market.

“**A** step forwards to a greener, global and sustainable bioeconomy in Portugal, based on eucalyptus and the pulp and paper industry.” This was how, five years ago, researchers from RAIZ – Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture) defined Inpactus, recalls Sara Monteiro, the Science and Technology manager for the project. “Prompted by this urgent need, it exceeded all expectations and was a thorough success. It’s actually been cited as

an example of good practice by the COMPETE 2020, the Operational Programme for Competitiveness and Internationalisation”, she adds. What it planned to do, and achieved, was to realise the full value of eucalyptus. Even the bark, branches and leaves can be used for much more than just energy, as they are today. And the research demonstrates that it’s possible to obtain the desired essential oils from the biomass and then still send it for energy production - the process entails losses of less than 1%. The new technologies developed also make it possible to optimise the industrial process and reuse the by-products, either for new articles in the current business sector (four

new paper products have already been launched on the market), or to improve the environmental management of the mills, or else as the basis for new businesses. The summary of the findings of the 41 sub-projects undertaken fills 108 pages of the “White Paper Inpactus 2018-2022”. Here we highlight some of the most important results in the four major areas of R&D: pulp, paper and tissue, in Navigator’s business, and biorefinery, a new area of the forest-based circular economy.

**Pulp for multiple uses**  
Despite being a traditional product of the paper industry, pulp can potentially be optimised and used as a raw material

Navigator is developing packaging in moulded cellulose, for use in the food sector. The new factory that is being built for this purpose is expected to start production in the first quarter of 2024.



Pulp can potentially be optimised and used as a raw material for other bioproducts.

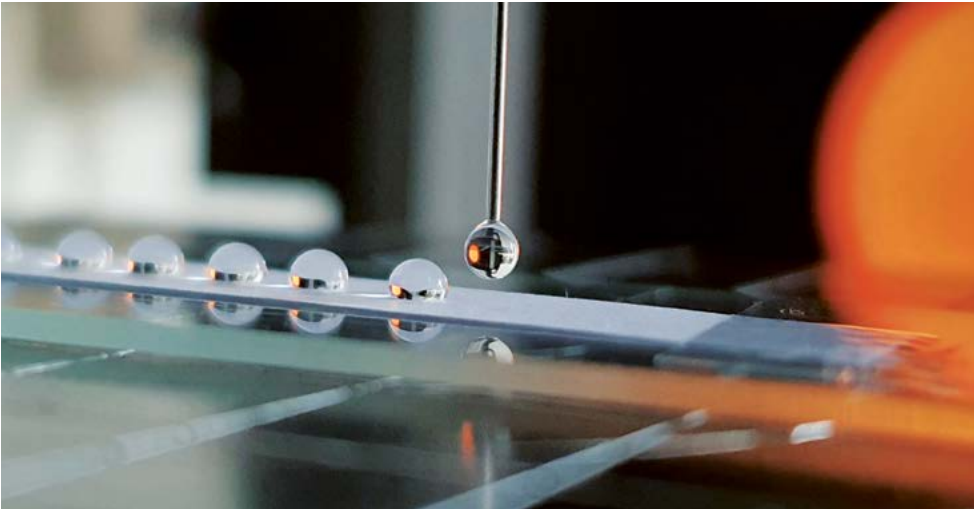
for other bioproducts. In the industrial field, Inpactus succeeded in creating processes and technologies that can reduce consumption of chemicals and water in bleaching, remove phosphorus from process circuits, reduce chemicals in effluents, with ecological benefits, and even secure a new life for fly-ash from the pulp mill's biomass boilers in the production of cement and mortars, which could lead to the development of new products. By testing cooking conditions, Inpactus was able to produce a high yield pulp called HYKEP, for a new packaging paper business line, under the gKRAFT brand, launched commercially by Navigator in late 2021. Non-woven fabrics have also been produced from eucalyptus pulp, to replace disposable materials derived from petrochemicals, with the potential for creating new renewably sourced bioproducts.

Increasingly versatile paper

Application of the technologies developed by Inpactus has also led to trials that point to possible new paper products, such as papers with hydrophobic (water repellent) properties, for use in packaging, and with colour-changing properties, to produce moisture sensors, for example. The portfolio of new solutions for this bioproduct par excellence also included the design of security papers (such as for paper money), piezoelectric paper (producing an electrical charge) and papers for clinical diagnosis or electronics.



Biocomposites: cellulose fibres are mixed with thermoplastic materials, preferentially bioplastics.



Tests are under way of papers with hydrophobic (water repellent) functions.

The production and application of micro- and nanofibrillated celluloses (materials with very small fibres) in paper has confirmed the potential for increasing their strength, and many other projects had successfully demonstrated new processes and compounds for differentiating paper and for developing advanced tools for

environmental management of their manufacturing process.

Innovative tissue

Research showed that it was possible, in the mill, to produce this type of paper with 100% eucalyptus pulp, and resulted in the launch of three new innovative products in 2021 and 2022. After identifying the raw materials and additives with the most potential for developing softness and absorption, Navigator was able to create Amoos Naturally Soft™ toilet paper. The incorporation in paper of micro- and nanocapsules containing fragrance led to the launch of Amoos Air Sense™, after confirming the controlled and prolonged release of a floral aroma, activate by contact with the skin. Lastly, new formulations based on incorporating substances in paper gave rise to a new Navigator product, Amoos Aquactive™, which includes soap and foams when dampened, making for more efficient cleaning.

Biorefinery on the right side of the future

“We’re going to help reduce our dependence on fossil resources. We’re going to help establish the forestry



Find out more about innovation in tissue on pages 64-69.

What now?

We asked Carlos Pascoal Neto, director-general of RAIZ, what happens now that Inpactus has ended.



“The research hasn’t ended, it never ends”, he assures us. In addition to products reaching the market and the industrialisation stage, for those where the technology has not yet matured, RAIZ will continue to invest in the most strategic, such as the whole area of packaging and papers with barrier properties against fats and water. “We’re already installing pilot equipment to scale up the application of products to the paper surface, with a view to replacing single use plastics”, says Carlos Pascoal Neto.

**What are the new bioproducts with the most potential?** “In terms of new businesses, what’s emerging now is the area of packaging from moulded cellulose, for use in the food sector. Next year, in the first quarter, we hope that will go into production, with an industrial unit at Navigator’s Industrial Complex in Aveiro. I would also point to two other topics with the potential to evolve into business: biocomposites and bioactive extracts. In the first of these, we mix cellulosic fibres with thermoplastic materials, preferentially bioplastics, which can supply the plastic injection

industry for uses in the automobile sector, packaging and filaments for 3D printing, or textile filaments. In bioactive compounds, where essential oils are the clearest option, we are also assessing production of these from waste biomass, such as eucalyptus bark and foliage, for use in cosmetics, nutraceuticals and the health sector in general. With the expertise generated in recent years, also in the context of Inpactus, we’ve equipped the RAIZ Pilot Laboratory with an almost pre-industrial unit to develop products and test markets.”

**What’s the future of the forest-based bioeconomy?** “Two things make it a winner: it contributes to decarbonisation and reducing our dependence on fossil resources, and it addresses the scarcity of resources in the future. Forests have a decisive role here. With CO2 sequestration, they provide carbon neutral products, and the more we use and recycle renewably sourced products, the more we mitigate the problem of finite fossil resources. And Portugal has a unique opportunity to establish itself in this field.” ●



sector, and the eucalyptus sector in particular, as a vital pillar of the Portuguese economy, and as offering a paradigm shift for the whole world”, says Pedro Costa Branco, a researcher at RAIZ who worked on several Inpactus projects in the biorefinery field. This research has made it possible to add value to the forestry biomass reaching the mills, by obtaining bioactive extracts from eucalyptus leaves and bark, producing cellulosic sugars and bioethanol, bio-oil for producing biofuels, biomaterials and platform chemicals (forerunners of high value added bioproducts), biochar with potential as a soil corrective, or renewably sourced biogas. Because project is underpinned by a closed-loop conception of how to reduce resource consumption, in which the cycle does not end at the end of the product’s life, which can be the start of the life cycle of new products, the research also looked at by-products from the industrial process. Potential new uses were found for black liquor (from cooking wood) and the lignin it contains, for example with findings that involve the production of new polymer materials, such as insulation foams, bio-adhesives, and even the possibility

of replacing the commercial plasticiser used in producing cement. Bleached eucalyptus kraft pulp has also been used to produce sustainable micro- and nanocelluloses with innovative characteristics, and the production of low-cost anti-fog coatings. The same pulp has been used to develop a new prebiotic with benefits for human health. And it has been shown to be a viable raw material for manufacturing sustainable carbon fibres and thermoplastic composites incorporating high levels of cellulose. “With all this, Inpactus generated new expertise to support the competitiveness of the forest-based bioeconomy centred on eucalyptus and the pulp and paper industry, with a large number of intellectual property rights filings and widespread dissemination of scientific knowledge,

as well as awards at conferences and initiatives in the sector”, says Paula Pinto, who was Technical and Scientific Coordinator for the project. Now that it’s over, the research continues at RAIZ, with a view to developing new businesses. “There’s a lot of work that still continuing under the agendas of the Resilience and Recovery Plan and that will be continued under the Portugal 2030 programme, with applications in the field of new bioproducts. The aim is to create new products and open the door to new businesses”, says Sara Monteiro. She added: “There’s huge potential for the forest-based bioeconomy. Navigator can play a fundamental role here, leveraging a new area of industrial biotechnology, which is relatively underdeveloped in Portugal, setting a global standard.” ●

“Navigator can play a fundamental role here, leveraging a new area of industrial biotechnology, which is relatively underdeveloped in Portugal, setting a global standard.”

Sara Monteiro



Thermoplastic compounds incorporating a large proportion of cellulose.

# Partnerships to speed up results

The first Co-creation Programme launched by RAIZ brought together eight partners to work intensively on projects outside Navigator’s core business, seeking to bring the technology to maturity, reduce the time needed to launch new products or to create new ventures.



RAIZ Team involved in Co-creation Programme.

“From the outset, we’ve anticipated that the Inpactus findings could be very promising and those in the bioeconomy area were so interesting that we couldn’t keep this expertise in a drawer”, says Sara Monteiro, coordinator of the National Co-creation Programme for Promoting Scientific and Technological Knowledge in the Circular and Digital Forest-based Bioeconomy. According to Carlos Pascoal Neto, director-general of RAIZ – Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and

University of Lisbon, through the School of Agriculture), this initiative arose because “we have a lot to gain from bringing in external actors for things outside of Navigator’s core business. We’re talking about start-ups and SME with expertise and skills that complement our own, helping us to respond faster in assessing the possibility of generating new intellectual property, or creating new products, or even new companies”. The main purpose of the synergies from working together was to quickly advance the technological maturity of certain products and to get them on to the market faster. The idea was launched before the end of Inpactus

and required a process of selection. Applications more closely related to Navigator’s industrial sector and core business were pointed to the RRP (Resilience and Recovery Plan) projects. But others, where RAIZ felt it could work more directly and that had the potential to bear fruit within nine months (with a proof of concept that would be taken up industrially and marketed, or something so promising that it gives rise to a new start-up), were brought into the Programme, which kicked off in September 2022 and ends in June this year. In total, there are eight ventures and eight projects, which you can read about on the following pages.





Raphael Canadas, co-founder of Tech4Med.

**Tech4Med**  
**Lignin to protect your skin**  
Tech4Med, a start-up based in Guimarães, is working on new textile and cosmetics functions. They are conducting tests with lignin nanoparticles, a by-product from the paper industry, to assess the microbial properties of the product, which can be blended with another the company has already developed and validated, and which is of interest for cosmetics and biomedicine, in particular for treating burns, healing wounds and antibacterial paper. The company starts with industrial waste which, after a biorefinery process, are incorporated in cutting edge ecological technologies, for uses essentially in cosmetics and technical textiles. Under the Co-creation Programme, they propose validating bioactive extracts and lignin-based nanotechnologies. Applications range from UV filters (current sun blocks contain toxins that are one of the main contaminants in waters), to rejuvenating the skin and combating acne.

**Pharmaplant**  
**Toilet paper that is good for your health**  
This brand which belongs to the company Dandlen Bioscience, a spin-off from the University of the Algarve based in Alcoutim, is working with RAIZ on an innovative process for encapsulating essential eucalyptus oils for incorporation in tissue paper with new health-related features. The Co-creation Programme “provides an opportunity to create a product that responds to market requirements and tendencies”, says Jorge Fabian Crespi, manager of the company.

**The National Co-creation Programme for Promoting Scientific and Technological Knowledge in the Circular and Digital Forest-based Bioeconomy involves participation by eight companies.**



Pedro Mendes, co-founder and CEO of Spawnfoam.

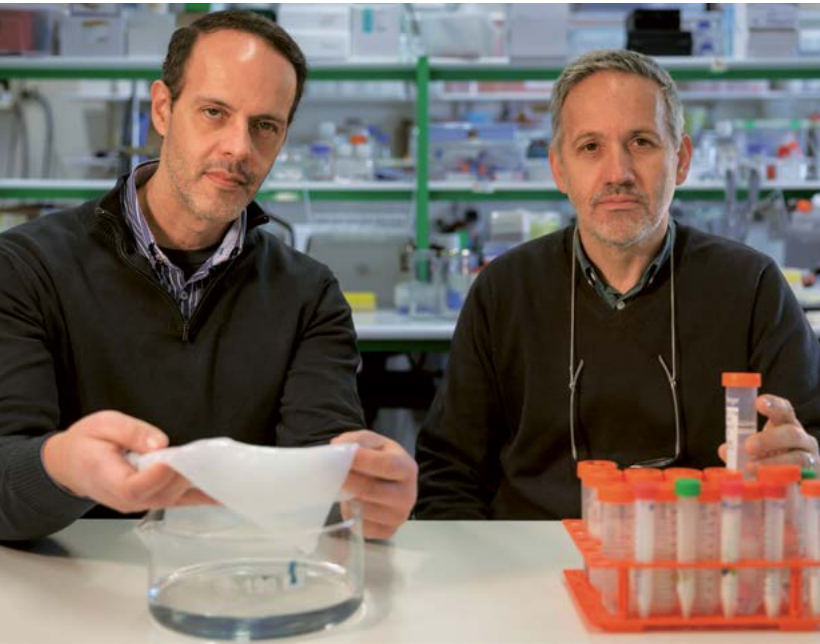
**Bio4Plas**  
**Thermoplastics for cars and furniture**  
The biocomposites that Bio4plas are developing under the Programme are based on a by-product from the pulp and paper industry, cellulose powder, from industrial tissue production units. “With this project, we will develop a new masterbatch (concentrate of pigments and additives, designed to confer characteristics on polymers) of polypropylene with cellulose fibre incorporated”, explains Elisa Sá, Quality, Environment and Safety manager for this company in Cantanhede. The

resulting materials have applications in thermoplastics for the car and furniture industries, for example.

**Spawnfoam**  
**Biodegradable tray for nurseries**  
This company in Vila Real has been making and marketing biodegradable vases since 2017, using waste biomass, winning it recognition at home and abroad. The proposal they submitted to RAIZ was for the development of a tray with biodegradable tubes, which disappear in two or three weeks in the earth, for use at Navigator’s Aliança Nurseries and to be offered to the wider market, because nothing similar exists using 100% organic material. With the Co-creation Programme, this spin-off from the University of Trás-os-Montes and the Upper Douro had the opportunity to test in their manufacturing process the incorporation of by-products from the paper industry, such as primary sludges and dirty sawdust, which cannot be used for making pulp.

**Sertec20**  
**Essential oils and packaging**  
With Sertect20, a Spanish company, RAIZ is developing new bioproducts on two fronts. On the one hand, they are sharing knowledge with a view to encapsulating essential oils, but with a technique different from that being promoted with Pharmaplant, and which will lead to different results, such as applications not only in tissue paper but also, for instance, in detergents. On the other hand, they are testing barrier properties in absorbent paper so that, even when wet, it can maintain its resistance, for uses in packaging.

**Sebol**  
**Cellulose as supplement in animal feeds**  
This company in Coruche, which belongs to the ETSA Group and formulates fertilisers, animal feeds and biodiesel, applied to the Programme



Miguel Gama and Fernando Dourado, researchers at the Biological Engineering Centre of the University of the Minho and co-founders of Satisfibre.

with a view to enriching its animal feeds sector. The research is based on extracts from eucalyptus biomass, which can be used in formulating stabilised animal meals. “The aim is to identify and study the possibility of integrating extracts with bioactive compounds from sustainable sources, assessing their antioxidant capacity”, explains Ana Rosa, from the R&D and New Business Department.

**Satisfibre/Biotrend**  
**Bacterial cellulose**  
produced on a large scale  
The start-up Satisfibre develops technologies for manufacturing bacterial cellulose, produced through microbial fermentation of biomass sugars, and for putting this to industrial and commercial use. It already has intellectual property for cosmetic applications, with this cellulose demonstrating superior capabilities as stabiliser and

thickener, and potentially for food applications, having applied to EFSA (European Food Safety Authority) for authorisation to use this material. Satisfibre took part in Inpactus with the aim of using biomass syrups as the basis for the fermentation carried out by the bacteria that produce this type of cellulose. In the Co-creation Programme, it will be working with Biotrend to assess different configurations of bioreactors to produce bacterial cellulose with a distinct morphology, using the same raw materials as in Inpactus, and also to reduce production costs. “It will be the most difficult project to carry through to the market, but if it works out, it could be very promising”, says Sara Monteiro. The goal is to develop technology to scale up production, with a view to serving countless potential markets, looking especially to the paper and packaging industry. ●



# Hi-tech tissue

Kitchen roll with soap incorporated? Or that quickly absorbs fat and reduces calories in fried food by 25%? Napkins free of chemical bleaching agents? Toilet paper with touch-activated perfume? When the best raw material is combined with scientific research, advanced technology and awareness of what consumers want, tissue can be reinvented.

**D**id you know that behind a roll of tissue paper may lie months of laboratory research, multidisciplinary teams of dozens of people and a long sequence of industrial testing? When The Navigator Company moved into this business area in 2015, it played some of its trump cards to enable it to go beyond what was already on the market. Which should come as no surprise. Innovation and a willingness to explore new paths are a strategy which has always been part of the company's identity. Hermano Mendonça, Navigator's commercial director for tissue, recalls how, in a mature sector, where

everything appeared to have been discovered already, it was possible to develop new products, with surprising features: "It's in our DNA, there's no getting away from it. Just as happens with printing and writing paper, where for decades we have looked for innovative and distinctive features, in tissue we followed the same strategy. We have prime quality raw material, Eucalyptus globulus, and so it would be odd if we didn't make the most of that, with help from RAIZ - Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture),

**In a mature sector, where everything seemed to have been discovered already, Navigator has developed new products with surprising features.**





“It was fundamental to do something different in order to gain a foothold, with a distinctive value proposition, that responded to what consumers want”.

**Hermano Mendonça,**  
commercial director for Tissue

which is on top of all the latest advances in Research and Development in forestry, pulp and paper.”

The company itself was ideally placed for the challenge, and there were also external factors that helped, explained Hermano Mendonça. “This is a mature market segment, dominated in the retail sector by supermarket own brands and a number of well-established brands. So we were moving into a very well-established market. That meant it was fundamental to do something different in order to gain a foothold, with a distinctive value proposition, that responded to what consumers want”. Investment in innovation, with disruptive and technologically advanced solutions, was the path we chose. By adding value to products, differentiating them from the competition, we give retail channels a good reason to give our products shelf room. “As soon as we launched products such as Amoos Acolchoado or Amoos Aquactive, for example, the big supermarkets immediately sat up and noticed us”, Hermano Mendonça told us. Once that foothold has been secured, you’re on the end consumer’s radar. “And we want consumers to see us with the distinctive features in which we have invested, and not just as another kitchen roll like all the others”, he concludes. So the consumer is at the end of the chain, but what consumers want also decides the start of the process. In other

words, the innovative products that Navigator has been developing are often a response to needs we have identified, with the research oriented to something that the market values. The Company has invested in consumer surveys, which have yielded useful information, and then we had to see if the way ahead was technologically feasible.

All this effort has brought rewards. Between 2015 and 2020, the value of Tissue sales increased almost fourfold, and today accounts for approximately 8% of all Navigator’s sales.

#### **To innovate, you have to cooperate.**

All the success in innovation over these years has been based on wide-ranging teamwork. in very close collaboration with RAIZ: “It’s our R&D arm, jointly with its partner universities. We work regularly together and that’s what enables us to develop differentiated products, setting us apart from the competition”, says José Pinheiro, Navigator’s head of marketing for Tissue business. “We have regular meetings to establish ideas and shape projects that show promise for helping to differentiate our products. The meetings are attended by everyone from RAIZ researchers to people working in production, the supply chain, product development, marketing... We go through all the topics with potential in the medium term”, he tells us. Hermano Mendonça also underlines

**The innovative products that Navigator develops are often a response to needs we have identified, with the research oriented to something that the market values.**

the importance of teamwork, which can sometimes be challenging: “A multidisciplinary approach is the key to all this innovation. The connection with RAIZ functions on the basis of cooperation. Each project brings together researchers, sales staff, industrial and production personnel and suppliers (of raw materials and equipment), and we have to conciliate different sensibilities. The process is only a success when we have excellent cooperation between all of them.”

#### **Outstanding raw material**

Eucalyptus globulus, which Navigator grows in Portugal, is also an outstanding raw material for producing tissue paper. “It enables us to offer product characteristics as important as softness, and having this advantage is crucial”, explains Hermano Mendonça. Aside from the question of competitiveness, it is important to note that the raw material from which The Navigator Company produces

its tissue products is sourced from responsibly managed forests, which also differentiates them in terms of sustainability. In addition, the company’s production processes use resources on an efficient and circular basis: 90% of the materials used are renewable and 90% of the waste generated is reused. Certification from the FSC (FSC® COO8924) and the EU Ecolabel gives consumers an assurance of a high standard of environmental performance. The fact that Navigator’s operations are integrated, from production of raw material to the research centre and industrial production, is another advantage for the company, in this and other business areas. “I believe it’s fundamental for us to benefit from this vertically integration: from the tree that comes from the nurseries, grows in the forest and is then processed into the finished product”, says Hermano Mendonça. He concludes: “It’s a huge advantage, with environmental, economic and quality benefits”. ●

## Tissue business is growing

The Navigator Company has recently acquired Gomà-Camps Consumer, in Zaragoza, now known as Navigator Tissue Ejea, boosting its strategy of growth in the tissue sector and positioning it as the second largest Iberian manufacturer in the segment. The production unit at Ejea de los Caballeros has therefore joined those in Aveiro and Vila Velha de Ródão, increasing annual production capacity to 165 thousand tons. Integration of the new mill will enable the Company to optimise the management of its Iberian customer portfolio, while positioning it better for new business in Spain and France and bringing operational synergies. This has further diversified Navigator’s markets and customers, who will now also enjoy a fuller and more rounded portfolio of products. With this acquisition, tissue is now Navigator’s second largest sector in terms of turnover, ahead of renewable energy, pulp and packaging. ●





# The brands of innovation

The innovative tissue products launched by The Navigator Company from 2020 to 2022 grew out of wide-ranging scientific and technological research, lengthy trials in the laboratory and in mills, and several series of prototypes. Three of these products owe their beginnings to **Inpactus**: Amoos Naturally Soft, Amoos Air Sense and Amoos Aquactive. But this was an endeavour which had already started and is planned to continue into the future. “There’s a series of ideas in the pipeline, that are being developed through ongoing work with RAIZ”, we heard from

José Pinheiro, Navigator’s marketing manager for Tissue. Navigator’s proprietary technology has resulted in several trademarks, representing the added value offered by the company’s products. “These end up being a form of Navigator branding, identifying us in consumers’ minds when we talk about our Amoos brand, and which also give us visibility on private label brands using our technology”, explains Hermano Mendonça, commercial director for Tissue. Learn about the trademarks identifying these innovative products.



**Air Comfort™ Technology**  
This is the main feature of Amoos Acolchoado toilet paper. It’s an embossing technology, making for improved volume and cushioning, ensuring user comfort.



**Natural Soft Fibre™ Technology**  
This lies behind the Amoos Naturally Soft range, which combines care for nature with softness to the skin. Free of bleaching agents, it is produced using an optimised manufacturing process which is ecologically efficient in its use of raw materials, wood, water and energy.

A project jointly promoted by Navigator, RAIZ, the University of Coimbra and the University of Aveiro represented the largest ever investment in Portugal in an R&D project in the field of the forest-based bioeconomy, totalling 14.6 million euros. Find out more on pages 46 to 63 of this edition.



**Aquactive™ Technology**  
The basis for Amoos Aquactive, a multipurpose kitchen roll with incorporated soap, produced only by Navigator and pioneering a new market segment. The soap is activated through contact with water, immediately foaming and resulting in fast and safe cleaning. The innovation won it the “2022 Five Stars” award from consumers, in the “Kitchen Roll category”.



**Air Sense™ Technology**  
The key feature of Amoos Air Sense toilet paper, releasing a long-lasting fragrance. This is contained in micro-pearls incorporated in the paper, and the perfume is only activated when used, guaranteeing an aroma lasting a minimum of 24 days. Amoos Air Sense was the winner in the “Toilet Paper” category of the “2023 Five Stars” awards.



**Absorb Tech™ Technology and Textured Technology™**  
Used in multipurpose rolls, for home or professional use, such as Amoos Super Absorvente. It uses an alternative embossing technology, expanding the structure of internal layers, ensuring there is more volume available to maximise the effectiveness and speed of absorption. as well as saving paper each time it is used.



**Calorie Control™ Technology**  
This is the basis of Amoos Calorie Control kitchen roll, where the internal structure features tiny air pockets, boosting absorption capacity and speed. It reduces the calories of freshly fried foods by up to 25%, by absorbing the frying fat, thereby contributing to a healthier lifestyle. ●

Between 2015 and 2022, the value of Navigator’s Tissue sales increased almost fourfold.



# Smart paper is now a reality

What if paper could become sensitive to touch? What if it could communicate electronically? And what if, on top of this, it could offer the characteristics of other materials, such as impermeability or the capacity for thermal insulation? The fact is that paper can already do all this and has the potential for much more. Together with cellulose, on which it is based, this ancestral bioproduct has more and more applications, making it a key element in the bioeconomy of the future.

**T**ouch-sensitive paper surfaces or paper with biosensors that detect the presence of certain substances. Packages that can be traced at any moment and tells us whether the food they contain is in a good state of conservation. An “accelerator” for cooling drinks. Or an innovative culture medium based on cellulose, in a laboratory Petri dish made of paper. All using renewable raw materials and cheap to make. It sounds like science fiction, but it's just science. Without the fiction - it's the future here today and ever more necessary, as many of these new solutions enable us to substitute materials from fossil sources, essential for combating climate change. The AlmaScience Beyond Paper CoLab works daily to find new ways of substituting fossil materials. “Sustainable innovation for a smart future” is the motto guiding 20 researchers who work on disruptive projects in the field of paper electronics

and sustainable cellulose-based technologies.

“Our mission is to build the bridge between knowledge, which is being developed by academics, and the people who can produce it, in other words, to make it viable and achievable on a large scale. This point is very important for the economy, especially at this moment of transition we're experiencing now”, says Yoni Engel, head of Business Development at AlmaScience.

The CoLab's scientific partners are Universidade Nova de Lisboa, the Association for Innovation and Development of the Faculty of Science and Technology, Universidade Nova de Lisboa (NOVA.ID.FCT), RAIZ - Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture) and Fraunhofer Portugal Research. But it also has five industrial



A paper surface covered with a cellulose-based gel which, when wet, allows the products it contains to cool down faster.

**Paper is renewable and biodegradable, making it the ideal vehicle for certain applications in electronics, in the context of the transition to a circular and sustainable bioeconomy.**

partners, one of which is The Navigator Company. The laboratory accordingly acts as the bridge, described by Yoni Engle, between academe, with its disruptive ideas, and industry, which will put those ideas into circulation, as products.

“A centre like AlmaScience is what Portugal has needed, because there's the interest at several levels - commercial, economic, environmental - and we've long had the know-how”, says Luís Pereira, teacher, researcher and technical and scientific director of AlmaScience, who has been working on paper electronics for more than 10 years. “We have an ideal ecosystem, with a pulp and paper director on the scale of Navigator, which is diversifying its business. We have skilled human capital. We were just missing this link in the chain, highly focused on the end product and the market”, he explains.

Having started up in early 2020, and with the restrictions imposed by the pandemic, AlmaScience is at an early stage of its work, but it's about to see its first products on the market.

## A fast-cooling wrapper

Almost ready to start real-life pilot tests with an industrial partner, GELA is one of the first products with commercial potential to come out of AlmaScience. It's a paper surface covered with a cellulose-based gel which, when wet, allow the products it contains to cool down faster. It has the potential to be marketed as a product in itself, but the first shape in which it will reach the end consumer is as a wrapping, replacing the labels on drinks bottles.

“GELA enables you to cool a bottle to



**Luís Pereira**  
Technical and Scientific Director of AlmaScience



**Yoni Engel**  
Business Development Manager at AlmaScience



the desire temperature in half the time, which will make it especially useful in cafés and bars, where the cool storage space is limited”, explains Yoni Engel. In the freezer, it will be possible to have a drink at four or five degrees in just 15 minutes, instead of the 30 minutes normally needed.

**A plastic-free Petri dish**

Saves time. Saves money. Saves the environment. Three strong arguments in favour of the new PetriCell Dry™, a product developed by AlmaScience for the health sector and which is awaiting a partner for large scale industrial production. “It’s a solid and dry culture medium, for use in laboratory analyses, made from cellulose. It can last for months before it is used, without being refrigerated, unlike similar products available today. To use it, just hydrate with water and then use it like you would the other commercial products on the market”, explains Yoni Engel. “There’s no plastic involved, as the Petri dish itself is made of paper. Normally, these dishes are plastic, and the material is burned after use, with a huge environmental impact. Single use plastics in biomedical research are a big problem. PetriCell Dry™ has the potential to offer an alternative on a large scale. Not least because it’s fairly simple to produce and uses only natural and renewable raw materials”, the expert tells us.

**Paper electronics can be produced in Portugal. It’s sustainable and its environmental footprint is minimal or non-existent.**



Team of researchers at AlmaScience.

**Smart paper and “live” packages**

Other projects at the AlmaScience CoLab involve what is called paper electronics. Yoni Engel explains the concept: “Paper surfaces which can be electronically activated and that can have pressure sensors. We’re creating this interactive paper, what’s called ‘large area electronics’. At the end of its life, this paper, which can last one or two years, is placed in a compostor and there will be no waste. In short, it will be compostable electronics.” Another fundamental feature of this solution, in addition to being biodegradable, is that it is cheap and easy to produce. “The process involves covering the paper surface with a cellulose-based gel and printing the electronic part. We don’t need to move production or be dependent on expensive electronic components for which the production process - and their end of life -- creates a lot of pollution”, explains Yoni Engel. “Paper

Navigator,  
key partner

“We’ve had a fruitful and very open partnership with The Navigator Company. It’s without doubt one of the key partners for developing this type of technology in the area of smart paper”, affirms Luís Pereira. “They’re the first people we talk to when we think of new solutions involving paper. We’ve relied on their technical advice, because we need to assess the feasibility of production. We’re always thinking of mass consumption for the solutions we create”, says the Technical and Scientific Director of AlmaScience. ●



electronics can be produced here in Portugal and produces very little or no waste. It’s sustainable and its environmental footprint is minimal or non-existent”, he concludes. Where can it be used? “Today, with the Internet of Things, there’s a vast range of devices which could use paper electronics, as they don’t need to be very sophisticated or durable”, replies Yoni Engel. The packaging area is one of them. “We’re bringing packaging to life”, he tells us. “We want it to ‘speak’ to its recipients, to the carriers, the retail chains, to the logistical operators or the end consumers, at different points in its progress. In addition to being traceable at any time, it can tell us, for instance, about its condition, which in the case of food is especially relevant”, he adds. All this through labels printed on paper. “It’s very simple in terms of the materials it uses. It does away with silicon chips, which are conventionally sued in labels with this type of function. It will all be made in paper and with printing technologies,

produced at low cost, on a large scale, and compostable at the packaging’s end of life”, explains Luís Pereira. Paper electronics can also be used by companies to engage with consumers. “It’s what we’re looking into for a vitamins brand, in its children’s range. We proposed that the paper packaging should have an area that can be used as a controller or ‘game pad’, interacting with a video game played on a tablet or smartphone. We already have the technology to do it, converting the mechanical energy from touching the paper into electrical impulses”, Yoni Engel tells us. “The concept is simple, so is the integration, and we obtain a sustainable product. In addition, on a large scale, the production cost will be small”, promises Luís Pereira. Paper electronics and cellulose-based sustainable technologies are a world about to enter our lives. As well as protecting the planet, they offer practical and useful everyday solutions. ●

Left: smart labels printed on paper dispense with silicon chips and promise to bring packaging to life; below: plastic-free Petri dish, made from cellulose.



Science  
with Soul

The AlmaScience CoLab chose its name to evoke the idea of soul (alma in Portuguese), of “Science with Soul” and “Science in the Soul”. In other words, “we believe in the mission of creating technologies that can contribute to a more sustainable future for mankind”, explained Luís Pereira. But “Alma” has a double meaning, because it is also the first four letters of Almada, the city that is home to FCT-NOVA and CENIMAT/I3N, where the idea of this collaborative laboratory came into being, with the support and encouragement of Prof. Rodrigo Martins and Prof. Elvira Fortunato. ●



# The packaging of the future is on the Agenda

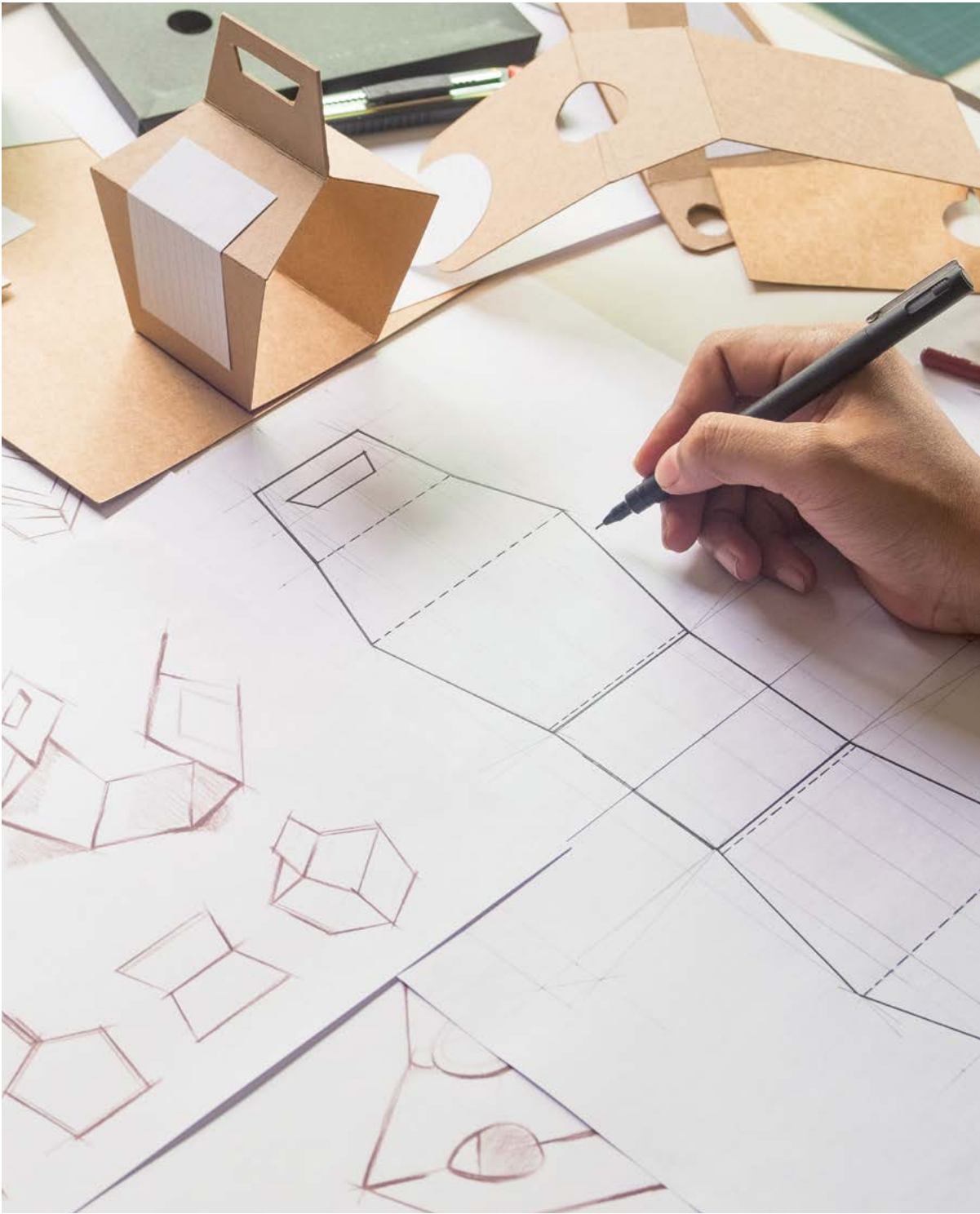
“From fossil to forest” encapsulates the shift that is transforming the packaging world. The From Fossil to Forest Agenda, approved under the RRP, will speed up the transition from the mass use of plastic in the sector to the use of a natural, renewable, recyclable and biodegradable raw material.

**A** Substitution of fossil-based materials is an essential step in combating climate change and switching to a sustainable circular bioeconomy. So there's an urgent need to find alternatives for the packaging sector and its single use plastics. In this context, it's easy to understand the importance of the From Fossil to Forest Agenda, one of the Mobilising Agendas for Business Innovation, approved under the Recovery and Resilience Plan (RRP), which brings Portuguese industry together with cutting edge research in the quest for packaging solutions based on a natural and renewable raw material - eucalyptus wood obtained from certified planted forests.

This Agenda is led by The Navigator Company and involves 27 companies, universities and research centres organised into a consortium. With investment of 103 million euros, the aim is to research and develop innovative products in the field of packaging and put them into industrial production. The project is divided into six work packages. “The combined efforts of these six groups will bring real progress in replacing single use fossil-based plastics with innovative and sustainable packaging, based on cellulose, produced using Portuguese raw materials, know-how and technology, under Navigator's leadership”, enthuses Carlos Pascoal Neto, director-general of RAIZ - Forest and Paper Research Institute (R&D

“Considering pressing issues such as the circular economy and sustainability, the impact of this Agenda can be truly transformational.”

Luís Pereira, Chairman of the Advisory Board for the From Fossil to Forest Agenda



## Figures for the From Fossil to Forest Agenda

- 103 M€  
Total investment
- 80 M€  
Investment in Production
- 23 M€  
Investment in Research and Development
- 27  
partners
- 16  
companies
- 11  
Universities and Research Centres
- 100  
direct jobs
- 120 M€  
annual turnover to be generated

laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture) and R&D coordinator of the From Fossil to Forest Agenda.

**Positive impact**  
The From Fossil to Forest Agenda will help to decarbonise the economy, by reducing greenhouse gas emissions, achievable by replacing fossil-based plastics with carbon neutral cellulose materials. And because packaging sourced from forests is highly recyclable and biodegradable at the end of its life. But its value lies not just in its environmental credentials: “It will also bring economic benefits, with new businesses and the resulting multiplier effect, and a positive social impact, because of the new jobs it will create”, says Pedro Sarmento, from Navigator's Business Development sector and coordinator of two of the work packages. “Considering the importance of issues such as the circular economy and sustainability, the impact of this Agenda can be truly transformational, especially when we consider products with a short life time, where plastics are used on a massive scale, such as in packaging”, explains Luís Pereira, Chairman of the Academic Board for the From Fossil to Forest Agenda and Technical and Scientific Director of the AlmaScience CoLab, one of the consortium partners. The work packages are at the kick-off stage, and will proceed until 2025. On the following pages we explore each one of them. ●



Work Package 1

High yield pulps and brown pulps

“In this group, we’re going to start from a range of recent Navigator products: papers for various packaging solutions, under the gKRAFT brand”, explains Pedro Sarmento, coordinator of Work Package 1. “In the first place, we want to improve the yields and add certain properties to the pulp from which the paper is made. In other words, for the same quantity of pulp, using less wood than we need at present. That’s the first aim”, he tells us. “Once we have this improved pulp, we also want to improve and extend the range of products already

existing under the three gKRAFT sub-brands: BAG, FLEX and BOX”, he adds. This involves taking a thorough look at issues of recyclability, biodegradability and compostability of the papers, including the main products of the competition. Questions related to food safety will also be studied in depth. “Three companies from the processing sector are also involved: they’re the ones who are going to process our reels of paper into different packaging solutions”, concludes Pedro Sarmento. ●

Work Package 2

Papers with improved mechanical strength

“Stronger papers will be better at doing their primary job, which is protecting the content of packaging, making them better suited to replace plastic packaging from fossil sources”, we heard from Ricardo Jorge, Research and Technological Consultancy Manager at RAIZ and coordinator of Work Package 2. “So we’re going to study ways of improving the mechanical strength of paper. One of these is with microfibrillated cellulose, produced from paper pulp, an innovative material

that RAIZ has researched in recent years. It’s not a coating, it’s incorporated into the composition of the paper product, resulting in stronger paper”, he explains. This group will also look for other ways of increasing paper strength, through research conducted up to 2025. “Our partners are universities which will study and test other solutions, which may involve new additives, and at the end we’ll make an assessment of the different responses found”, concludes Ricardo Jorge. ●

Work Package 3

Papers with barrier properties

Another characteristic that the paper needs to have in order to replace fossil-based plastics as a raw material for packaging is the ability to act as a barrier: not absorbing liquids, oils of fat from food, and not letting in oxygen or moisture. Work Package 3 will look at the best ways of achieving paper with good barrier properties. “It’s a matter of making it resistant to steam, oxygen and oils and fats, which will

be possible using water-based or bioplastic solutions”, explains Ricardo Jorge, who is also coordinating this Work Package in the From Fossil to Forest Agenda. Paper with barrier properties will be able to substitute fossil plastics in food packaging that uses flexible film to contain various types of food products - both for sale in the retail sector, and for use in the takeaway business. ●



Work Package 4

Developing biocomposites that use cellulose to replace plastic parts

Incorporating cellulose into plastics and bioplastics will result in composites and biocomposites. “In the former, this addition will make them more ecological, because we’ll reduce the use of raw materials derived from petrochemicals”, explains Alexandre Gaspar, Scale-up & New Business manager at RAIZ and coordinator of Work Package 4. “When incorporated in bioplastics, cellulose fibres enable us to obtain a 100% biologically sourced product and also to lower costs, in relation to just using bioplastic”, he adds. The aim is for Navigator to be able to develop these biocomposites, which manufacturers will then use in a series of end products, to replace fossil-based plastics”, concludes Alexandre Gaspar. ●

Work Package 5

Sensors in paper for smart packaging

This Work Package 5 “sets out to develop what is called ‘smart packaging’, which involves above all controlling and monitoring the temperature of the food they contain”, explains Ricardo Jorge, coordinator of this research group. “We’re looking at solutions based on cellulose hydrogels and aerogels for thermal control of packaging”, we were told by Luís Pereira, Chairman of the Academic Board for the From Fossil to Forest Agenda and Technical and Scientific Director of AlmaScience. “In the case of hydrogels, these are used to achieve accelerated cooling, much faster than normal, and they can be directly incorporated in the packaging paper or act as a ‘wrapper’ around any type of packaging”, the researcher went on. “As for aerogels, the aim is to create laminates with the packaging paper, with a view to thermal insulation”, he explains. Another solution being developed in this work package of the From Fossil to Forest Agenda is the creation of RFID (Radio Frequency Identification) labels printed on paper. “One type of labels designed to monitor the temperature and moisture level in the packaging, another to monitor the condition of the packaged food and its possible deterioration”, Luís Pereira tells us. ●

Work Package 6

Moulded cellulose for hard packaging

Moulded cellulose will very soon be a new business area for Navigator, and this work package was designed to develop the packaging that will be produced, from this material, at the new factory to be set up on the Aveiro industrial complex. Takeaway containers, for instance, are one of the target applications. “They’ll replace those made from fossil-based plastic, and in this case, single use plastic, which makes the impact of the new packaging even more positive”, considers Pedro Sarmento, coordinator of this Work Package. “They can also replace aluminium packaging, as well as expanded polystyrene trays used in supermarkets, a product from fossil sources, used

normally to package products such as meat, ham and cheese”, the coordinator tells us. The R&D partners will work on the barrier properties, a fundamental feature, in view of the market segment at which these moulded cellulose products are targeted. “We have to find alternatives to the use of plastic, in line with the underlying concern of this Agenda: developing products and processes that are environmentally sustainable”, adds Pedro Sarmento. Equally important will be the work done to support the start-up of the new industrial unit: “We need to study the fibrous composition, the treatment of fibres, the additives and respective doses, in order to obtain a better end product”, he explains. ●

**The From Fossil to Forest Agenda will help to decarbonise the economy, by reducing greenhouse gas emissions.**



# “An efficient biological machine”

Managed eucalyptus forests produce more and better raw material for the circular bioeconomy, with environmental advantages. They provide more resources, thanks to the large yields. They are more efficient in using water. They sequester more carbon per hectare than other planted forests in Portugal. And the unique properties of *Eucalyptus globulus* fibres optimise consumption levels in industrial processes and the quality of the pulps and papers produced, resulting in distinctive products which are highly competitive on international markets.

**F**aced with a future of growing demographic pressures on resources and increasing demand for forest-based materials to replace products and energy from fossil sources, it is natural to ask: how can we create more sustainable forests, to increase wood production and meet the needs of the bioeconomy? The answer makes Portugal a key player in Europe's effort to shift to a greener economic model, thanks to the climate and soil conditions in the country for producing a high-yield and highly sustainable tree: *Eucalyptus globulus*. “The key thing is that this

species is able, in the same space and time, to produce more biomass, with similar impacts on water consumption and soil conservation”, explains Nuno Borralho, Research and Forestry Consultancy manager at RAIZ – Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture). It was around 200 years ago that eucalyptus trees arrived in Portugal and quickly adapted to the climate and soil conditions in the country, especially in the case of *Eucalyptus globulus*, today

regarded as naturalised. After initially being appreciated for its beauty as an ornamental tree, interest in its economic possibilities started to develop in the late nineteenth century. It was first used for fuel and to produce posts, stakes and railway sleepers. Then, in the mid-twentieth century, it was used to manufacture pulp using the kraft process and premium quality paper, making an important contribution to Portugal's economy. *Eucalyptus* trees are found today in more than 90 countries around the world, and 15 of the approximately 700 species in existence are used commercially. Despite accounting for





only 0.5% of the world's forested area, it accounts for around 12% of planted forests. Its potential for growth and the unique properties of its wood have made

**E. globulus** “the most widely studied eucalyptus species”, as we may read in the 2020 report entitled “Opportunities and challenges for eucalyptus plantations in Europe: the experience of the Iberian Peninsula”, by the researcher Margarida Tomé and others, published in the European Journal of Forest Research. Science has shown that planted eucalyptus forests present better yields, greater efficiency in water use and more carbon sequestration than other planted forests in Portugal. And the differences are even greater when we make the comparison with non-forestry soil uses, such as brushland and pasture, which account for 31% of Portuguese territory. The eucalyptus is present in less than 10% of Portuguese territory, an area smaller than that occupied by cork oak and holm oak savannas, and similar to that of maritime pine woodlands.

**Better yields**

What makes eucalyptus so productive is its ability to withstand adverse environmental conditions and to recover when the situation improves. For example, it has fire-resistant bark and mechanisms that enable it to withstand periods of drought. In addition to being highly efficient in assimilating carbohydrates, permitting continuous growth and rapid crown development, it is extremely effective at absorbing nutrients from the soil

and reusing them from the biomass created by foliage, bark and branches that fall to the ground. Depending on the environmental conditions and the forest management approach, annual yields in the best locations vary, according to the study by Margarida Tomé et al., between 24 and 30 cubic metres per hectare. However, most stands produce between 7 and 18 cubic metres a year, when the plants are 12 years old. This means that the wood production is on average more than 50% greater than for maritime pine, or almost double that of umbrella pines. The fast growth of eucalyptus, allowing for short planting and felling cycles of just 12 years - followed in the case of professional and sustainable management, by replanting after two or three rotations - also increases its capacity to generate jobs and wealth, above all in underprivileged rural areas. For example, in 2022, The Navigator Company paid out more than 7.3 million euros to landowners under leases and more than 25.5 million euros to suppliers up and down the country.

**Less water**

Forests play an active part in regulating the hydrological cycle: of the water they use, only 0.3% stays in the wood, and the rest is released into the atmosphere. On a local scale, they help promote water infiltration in the soil and regulate flows, minimising the risk of floods. Water use by eucalyptus has accordingly been the topic of countless studies. “Eucalyptus is a fast growing tree,



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which in general does not require more water per quantity of biomass produced than other species, which makes it more efficient in using this resource”, we may read in the publication “Eucalyptus plantations and natural resources in Portugal: recent advances and challenges for the future”, recently published in a special edition of the scientific journal Silva Lusitana. The factors contributing to this efficiency, i.e. to lower water consumption per cubic metre of wood produced, include its capacity to form a crown in a short space of time and to control efficiently the loss of water through transpiration, due to the gradual closing of stomas in periods when water is less abundant. Thanks to its elongated leaves and

relatively open crowns, eucalyptus also intercepts less rainwater than other species, allowing it to reach the ground, contributing to greater infiltration and increased supply to aquifers. The hanging position of the leaves means they sway in the breeze, which enables the tree to control its temperature, without expending a lot of water. In 2021, a study entitled “Hydrological processes in hydrographical basins forested with eucalyptus and pine in the Mediterranean region”, involving contributions from European researchers, including some from Portugal, concluded that the “average annual **evapotranspiration** of pine (907 mm) was higher than for eucalyptus (739 mm), demonstrating that mature pine plantations lead to higher water consumption than eucalyptus stands”.

**Better soil**

Vegetation protects the soil from erosion due to wind and rain, and eucalyptus roots do this especially well. Because root systems develop mostly (80%) in the top 40 to 80 centimetres from the surface, they help to secure the soil, improve its structure, drainage, and airing, and carry nutrients to the surface. When the bark, leaves, and branches of eucalyptus (concentrating up to 70% of the tree's nutrients) fall and decompose, they increase the quantity of organic matter in the ground. When good forestry practices are used, there is scientific evidence that eucalyptus cultivation can improve the properties of soils. In research conducted in Spain, for example, it was proven that the nutrients returned to the soil by eucalyptus help to reduce its acidity, which is crucial for fertility, in comparison with the soils of stands of species such as cork oak, oak and pine.

“In the same space and time, this species is able to produce more biomass, with similar impacts on water consumption and soil conservation.”

Nuno Borralho, Forestry Research and Consultancy manager at RAIZ

Eucalyptus globulus produces better raw material, and more of it, for the circular bioeconomy.

Loss of water from soil through evaporation and loss of water from the plant through transpiration



“It has been established that, in the same area, globulus sequesters three times more carbon than pine and seven times more than cork oaks.”

Carlos Pascoal Neto, director-general of RAIZ

**Carbon sequestration**

These same high yields and levels of efficiency that contribute most to the tree’s excellent performance in carbon sequestration, helping significantly to mitigate climate change. The plants take CO2 from the atmosphere, through photosynthesis, in order to obtain water and glucose, the sugar on which they feed. So the faster they grow, the more carbon dioxide they consume and accumulate in their leaves, bark and wood - the wood is approximately 50% carbon, and 60 to 70% of an adult eucalyptus is wood. “It has been established that, in the same area, globulus sequesters three times more carbon than pine and seven times more than cork oaks. It’s an efficiency biological machine for sequestering CO2 and producing woody matter”, says Carlos Pascoal Neto, director general of RAIZ. At the same time as helping to decarbonise the planet, eucalyptus performs yet another essential function for mankind: the more carbon it sequesters, the more oxygen is released by the tree. For each kilogram of carbon sequestered, approximately 2.67 kilograms of oxygen are released. As eucalyptus sequester between 4 and 9 tons of carbon hectare, each year, it can release annually between 11 and 24 tons of O2 per hectare, enough for the survival of 37 to 80 people over that period. But it’s not just the trees that sequester carbon. Forest soils are reservoirs with stock values higher than those existing in the vegetation, thanks to the plant matter that falls and is incorporated, and, in the case of commercially operated

plantations, from felling waste, as well as the biomass in the roots. The calculations of carbon flows in three Mediterranean ecosystems - eucalyptus woodlands, pasture and cork oak savannas - show that forests have the edge, and eucalyptus forests most of all. A benchmark study conducted in southern Portugal and published in 2007 by J. S. Pereira et al., concluded that eucalyptus forests (in the case under study, managed by The Navigator Company at the Espirra Estate, with yields of approximately 10 cubic metres per hectare per year) were able to sequester 10 to 13 times more carbon in dry years and four to six times more in raining years than cork oak woodlands and pasture. “The increase in carbon sequestered is achieved with more and better woodlands. If the conditions are not right for a significant increase in the area of planted forests, it’s essential to be able to improve yields and reduce the risks that can affect them, through proper management of resources, use of genetic improvement in reforestation and tight control of pests, diseases and fires”, explains Nuno Borralho. “Only very rarely are forests planted at the cost of pre-existing forest. As a rule, industrial plantations occupy areas that have been deforested for pasture or intensive farming and are left in a degraded stated”, says the researcher from RAIZ. In Portugal, the forested area has been increasing since the late nineteenth century, reducing the area of uncultivated land, thanks to forestation efforts that started above all with maritime pine and the



expansion of cork oak woodlands in the Alentejo, and then later included eucalyptus.

**Highly sustainable**

Planted forests - accounting for 7% of the world’s forested area (290 million hectares) - are an efficiently solution in the fight against deforestation. By meeting one third of the demand for wood used in industry, this supply relieves pressure on primary forests and on the food chain. In replacing the cellulose from farm crops for

the manufacture of bioproducts, forestry biomass is even more sustainable, because, in relation to farming, forestry requires less energy consumption, has lower rates of soil erosion, involves less intensive management, promotes greater biodiversity, and improves the balance of the water cycle. There are also countless benefits from using Eucalyptus globulus in the industrial process for manufacturing bioproducts. On the one hand, it has cellulose fibres with a structure

and morphology uniquely suited to producing top quality paper pulp. And then, because of its composition, it is “an easier material to process, with less environmental impact than competing species of wood. In the bleaching process, for example, it can consume up to around 20% less chemicals, compared to similar species”, says Carlos Pascoal Neto. It also takes less wood to produce the same quantity of pulp, with difference of up to 30%. Globulus has an average yield of three cubic metres per ton of pulp. Other

species, and even other eucalyptus varieties, require 3.8 to 4 cubic metres. “At RAIZ we have made a comparative study with other cellulose fibres, in terms of recyclability for bleached fibre, and globulus withstands another two to six cycles. In brown papers for packaging, globulus surprised us even more - it can be recycled ten times, whilst Scandinavian long fibres withstood only two cycles, whilst ensuring the quality standard for kraftliner packaging paper”, he concludes. ●

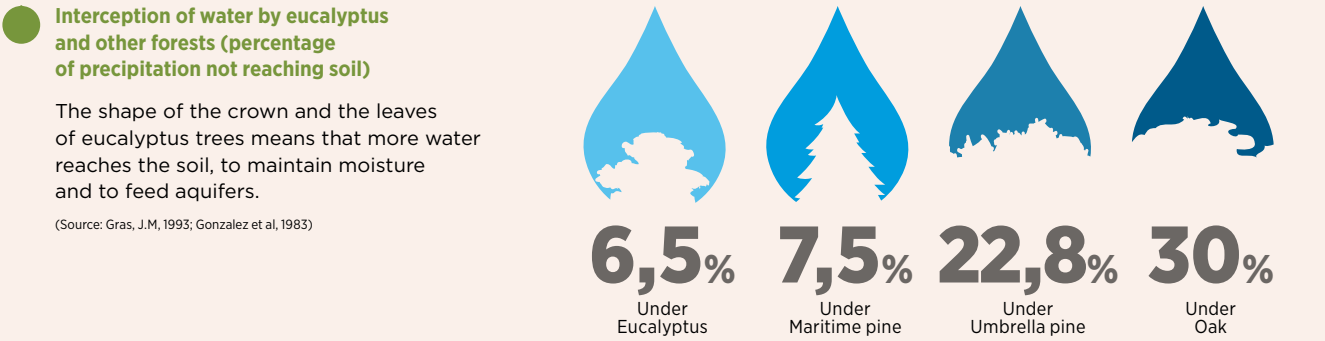
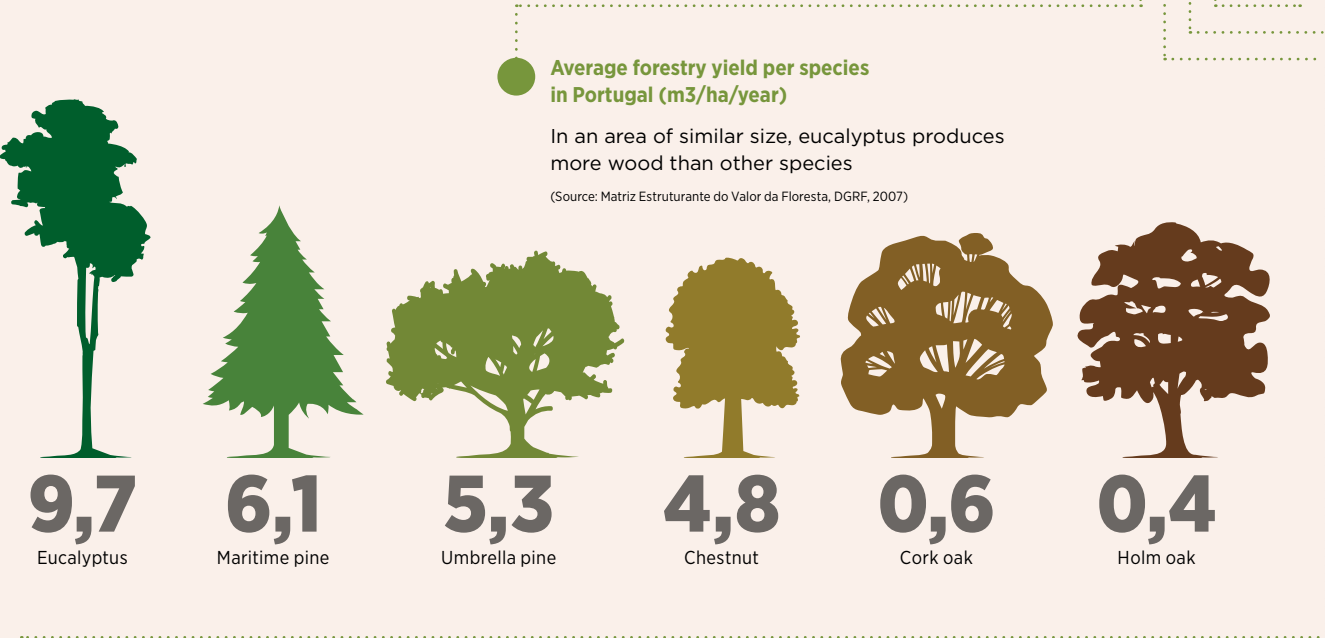


# Eucalyptus: the perfect ally for the forest-based bioeconomy

Eucalyptus is a species uniquely suited to lead this new development model, putting forests back in the centre of our lives. **Advantages:** higher wood yields than other planted forests, occupying the same area; highly efficient water use, consuming less per cubic metre of wood produced; highly efficient in using water, consuming less per cubic metre of wood produced; carbon sequestration superior to other planted forests in Portugal and

brushland; forest source of cellulose used to produce bioproducts, as alternative to agricultural sources, relieving pressure on land use for growing food; less wood is needed to produce the same amount of pulp used to manufacture bioproducts; easier material to process, with less environmental impact, due to less consumption of chemicals; globulus fibre withstands being recycled more times than competing woods.

## ADVANTAGES FOR FORESTRY



**Acidification of soil by organic waste**

The nutrients and organic matter that eucalyptus returns to the soil result in a better acidity balance, boosting fertility.

(Source: "Influencias de nutrientes y polifenoles vegetales en la humidificación de la hojarasca de especies autóctonas e introducidas en la provincia de Huelva", Domínguez de Juan et al)



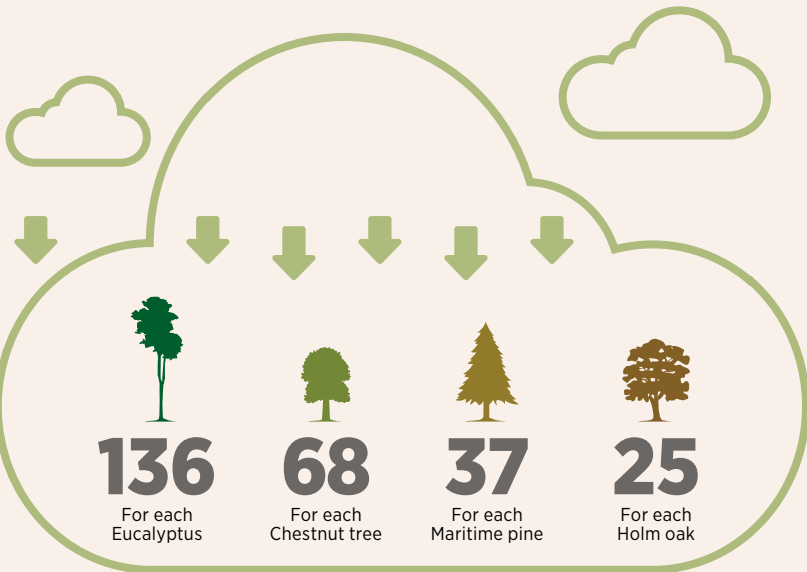
**CO2 sequestration by eucalyptus and other species (kg CO2/year sequestered by each tree)**

Due to its shorter cultivation cycle, eucalyptus sequesters more carbon than other trees.

**3x** more CO<sub>2</sub> sequestration by E. globulus than pine, per hectare

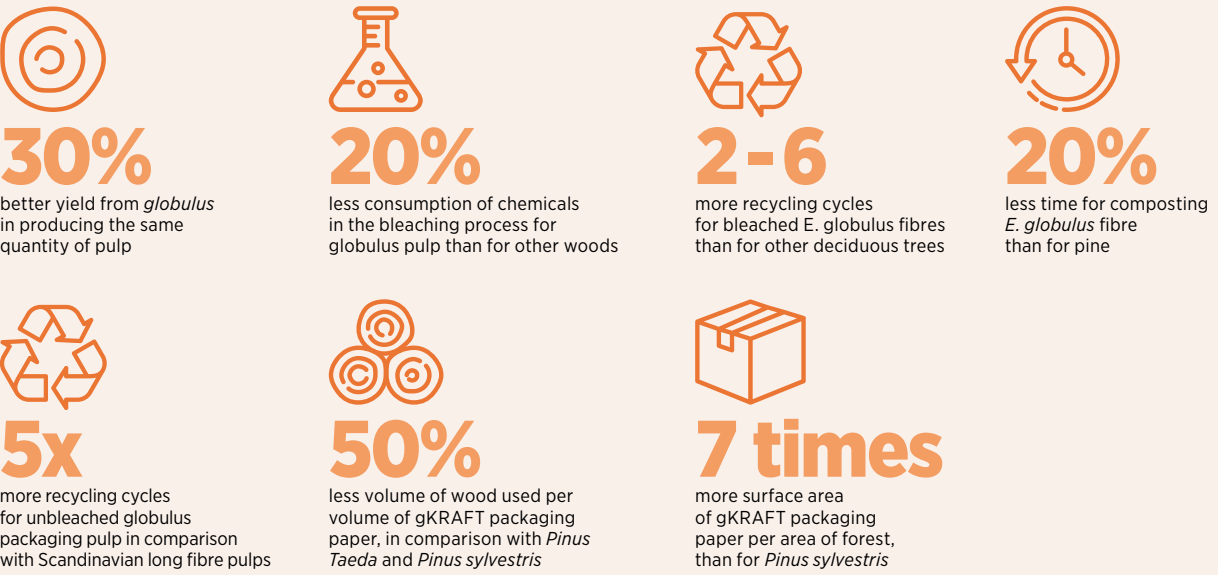
**7x** more CO<sub>2</sub> sequestration by E. globulus than cork oak, per hectare

(Source: Monografías INIA, serie forestal 13, Ministerio de Medio Ambiente)



## INDUSTRIAL ADVANTAGES

(Sources: RAIZ; Navigator)





# Educating for change

The professionals and decision makers of the future are the students of today. In a rapidly changing world, witnessing the bioeconomy revolution, how are universities preparing our young people? Six university lecturers reply and reflect on the decisive role of education in this context.

**T**ransition, innovation, change, conversion, disruption and revolution are all words used to describe the historic period in which the world economy finds itself. The linear and extractive model is giving way to a circular model that seeks to restore the lost balance between the needs of mankind and respect for nature. In this context, we also repeatedly hear the words policy, industry, business, legislation, society and consumers. Much less often do we hear about education. Is it perhaps less important? Not at all, “it’s the most powerful means we have for changing the world”, as Nelson Mandela called it. And so it is also central to this process of change.

“There’s complete and absolute consensus about the fundamental role of formal education in this context of transition, of establishing new practices, strategies and approaches, that businesses have already defined or are currently defining”, says Fátima Poças, teacher and lecturer at the Higher School of Biotechnology at the Universidade Católica in Porto. “It’s always hard to assess whether it’s academe leading change or whether it responds to needs and pressures from industry, companies and society”, she tells us. But what is clear is that although the

revolution is more visible to the public in the business or industrial sectors, it started to happen a long time ago in the academic world, as pointed out by Armando Silvestre, teacher, researcher and head of the Chemistry Department at the University of Aveiro: “These are issues written into the United Nations Sustainable Development Goals, and so they’ve permeated all our efforts to adapt both university education, and our research. It’s not just now. We might say it’s a path we’ve been following since the turn of the century, including in our syllabuses programmes that seek to respond to these needs which have to do with increased circularity, the demand for renewably sourced materials and sustainable modes of production”.

A concern that is felt across multiple areas: “It’s not just in the Chemistry Department that we’ve been pursuing this. It’s true of all the courses offered at the University of Aveiro, from engineering to the fundamental sciences, and even design. It’s embedded in all our study programmes”, Armando Silvestre assures us.

The same is true at the Department of Chemical Engineering of the Faculty of Science and Technology at the University of Coimbra. “The





paradigm has shifted and so what we teach has changed too”, confirms Jorge Pereira, lecturer and deputy head of department. “We can’t continue to extract, use and discard, as happened in the linear model. What was discarded must be reincorporated. The focus was on production with maximum efficiency. Not it’s on producing so that, in the end, everything can be regenerated or recycled. Everything must be converted into something, including energy. We’ve long talked about sustainability, but now we’re also talking about circularity and biostrategies, which include all the potential of plants like eucalyptus. We’re also talking about soil regeneration, which wasn’t addressed in the past. We’re teaching that at the end, everything has to return to the beginning”, he concludes.

**The professionals of the future** and the urgent need for answers In the opinion of José Teixeira, lecturer in the Department of Biological Engineering of the School of Engineering at the University of the Minho, the circular bioeconomy is not a new concept: “What’s new is the need to apply it systematically on a global scale. That’s why biotechnology has grown so impressively in the past two decades. When I was an undergraduate, more than 40 years ago, there was only one optional curriculum unit on Bioengineering. Today we have units with huge expertise in Biotechnology, in all its different areas.” Paulo Ferreira, teacher and researcher at the Department of Chemical Engineering of the University of Coimbra, corroborating the idea that the topic is not new, but has evolved: “In Chemistry, the environmental component has always been there. Our curricula have never left out the issues arising from circularity, waste reclamation.... even when I was a student, almost forty years ago, we talked about effluents and how to treat them. But of course, things have moved on”, he tells us. For example: “Since 1988 we’ve had

“There’s a consensus about the fundamental role of formal education in this context of transition, of establishing new practices, strategies and approaches, that businesses have already defined or are currently defining.”

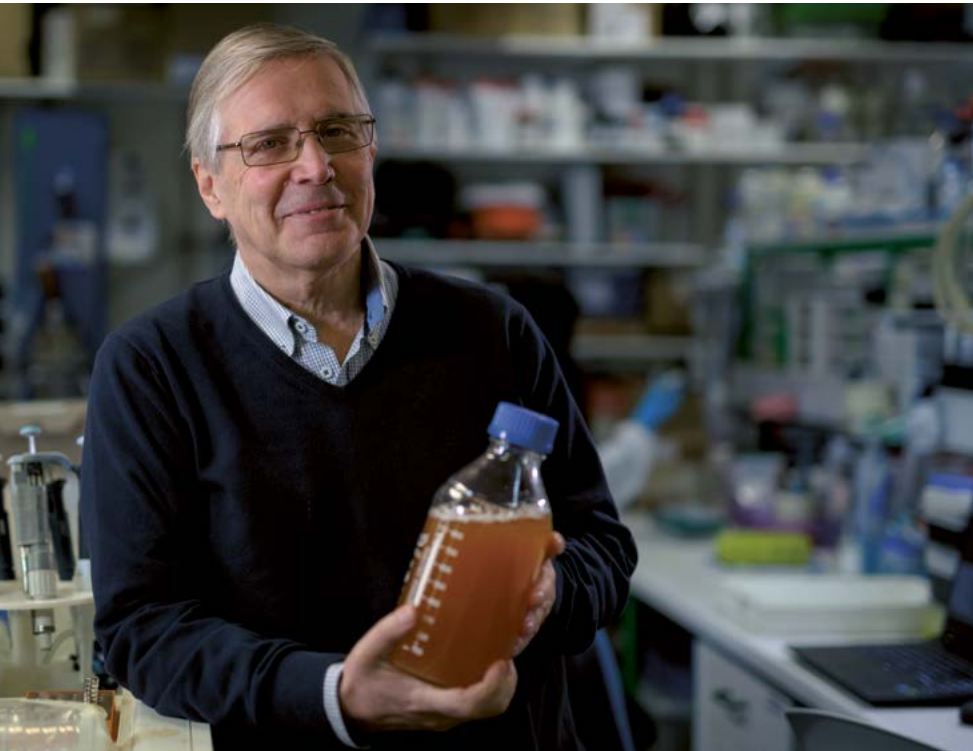
Fátima Poças

master’s subjects in the field of pulp and paper, centred on a process which is an example of the circular bioeconomy. Even if we haven’t always called it that, we’ve been talking about it for a long time. But things have changed in the meantime. The teaching was originally very centred on the process, whereas today it’s more focussed on the product and its degradability. So what will happen is that the end product has become a central issue. For instance, we talk about totally compostable or recyclable packaging.” In addition to changes in existing

subjects, the master’s programme now includes new ones, such as the Circular Economy and Carbon, Energy and Biofuels Management, Control of Atmospheric Pollution, and also Biorefineries. “Environmental Protection is now compulsory and not just optional, because the curriculum is in fact highly focused on the environmental component and the circular economy”, explains Paulo Ferreira. “We’ve invested a lot in this area, because without doubt it’s extremely important in the training of future engineers”, he concludes. Luísa Durães, head of the Department of Chemical Engineering at the



Fátima Poças, teacher and researcher at the Higher School of Biotechnology of the Universidade Católica, in Porto.



José Teixeira, lecturer in the Department of Biological Engineering of the School of Engineering at the University of the Minho.

more, in order to have a response ready for the problem before it becomes urgent”, he concludes. In Armando Silvestre’s opinion, “the greater the investment needed to implement them, the slower the changes are. In sectors like the pulp and paper industry, what can sometimes look like conservatism has to do with this issue. But even so, we should note that, both in terms of reduction of the environmental footprint, and of the search for new solutions and products, it’s a sector that has evolved enormously in recent decades. And what it has achieved is very significant”.

University of Coimbra, points to the urgency of these changes: “We’re training people who are going to be the business leaders of the future. And these people have to be educated with this new paradigm. Nature can’t wait 20 years.” Fátima Poças agrees: “I’ve been teaching for more than three decades and in recent years the changes are happening faster. This requires a constant effort on the part of academics to keep up, to integrate the new concerns. There’s no doubt the curricula are changing greatly. The important topics here, like sustainability and circularity, are presented within the existing curriculum units, but new programmes and units are also being designed”, she explains. For his part, looking at the outside world, José Teixeira believes the pace of change could be faster: “We have to be quicker on our feet. The processes take a long time, when we have to offer an urgent response.

If we want to be in the front line of resolving problems, we need to have well-designed systems. This is an area where we can’t continue to put things off”, he warns. “A project can’t be at a standstill for three or four years. I think that’s the great challenge, continuing to strengthen the relationship between the scientific system and industry, because in this matter industry may have a much more important role: anticipating challenges and referring them to academe in advance. We can’t just react to events, we have to plan

“Today we have units with huge expertise in Biotechnology, in all its different areas.”

José Teixeira

**Academe and Industry united in the transition** “The relationship between universities and business is absolutely crucial for the success of the country’s economic development. All the parties stand to gain from this engagement”, believes Armando Silvestre. “We respond to the development needs in the business fabric. There are countless sectors where these issues of sustainability, circularity and renewably sourced materials are absolutely central and universities are seeking to respond. Our PhD programme in biorefineries, for instance, grew out of just such collaboration. It was designed on the basis of one of the main players in Portugal’s pulp and paper industry, The Navigator Company, and its needs for skilled human resources in this area”, he tells us. “Another indisputable example, in the field of the circular bioeconomy, is the **Inpactus project**. From the

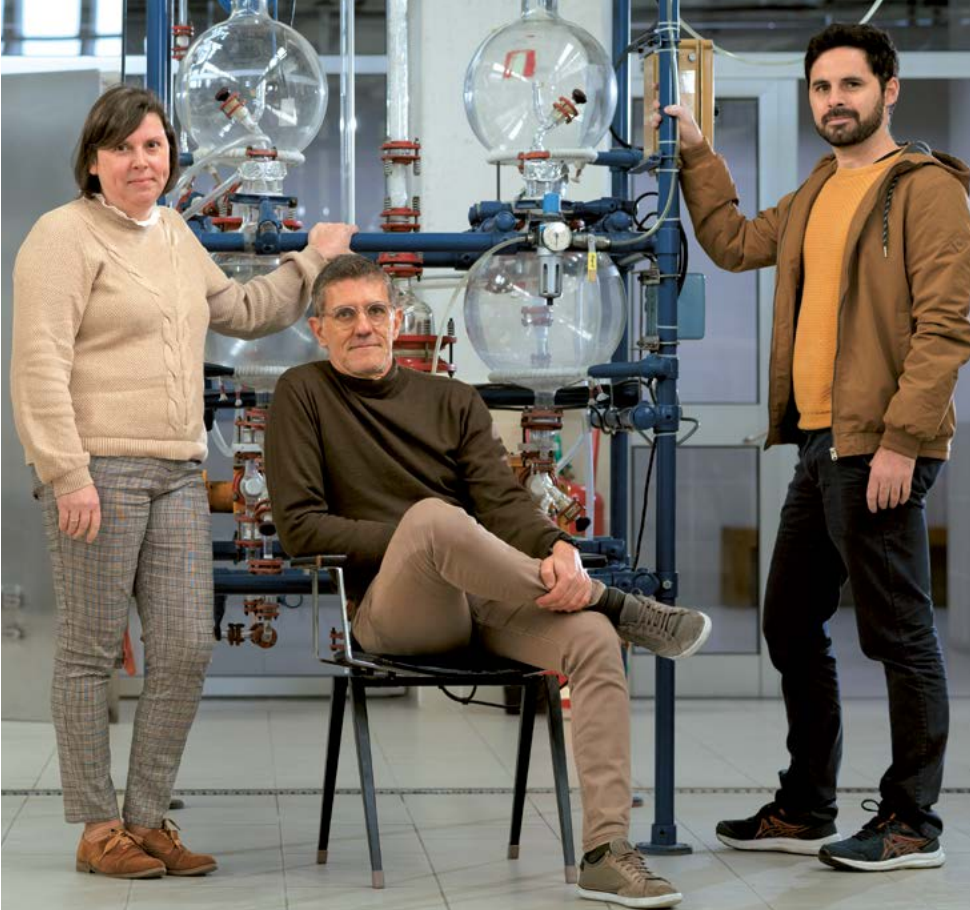
Find out more about the Inpactus project on pages 46 to 63 of this magazine.



point of view of generating scientific knowledge, training PhD students to specialise in these areas and creating new products, Inpactus was undoubtedly a success story, and has been recognised as such by the public authorities”, says Armando Silvestre. And he pointed out a further merit of this project: “In addition to the expertise and intellectual property generated, reflected in patents, it opened up vast prospects for future developments which will reach the market.” But this close and fruitful relationship between the academic world and the business community has not always existed everywhere: “When I started teaching, more than 40 years ago”, recalls José Teixeira, “there wasn’t the same contact, nor did the question arise. Then there was a stage when some links started to be established, to respond to teaching or research needs. Today there is clear collaboration between the two worlds. It might not be very obvious to the general public, but collaboration has in fact been firmly established”, he tells us. He adds: “We have to get the message to young people that an academic and scientific career will also involve this relationship with industry.” At the University of Coimbra, the relationship with industry has deep roots going back decades. “Training engineers to work in Portuguese industry has always been the guiding aim of the courses we offer and the syllabus content”, says Paulo Ferreira. “The Department of Chemical Engineering has always had strong links with the pulp and paper industry. In our master’s courses, we have a lot of classes given by highly qualified industrial technicians, most of them from Navigator”, he points out.

“The economy will be the engine of change and education will be a key component in that change.”

Jorge Pereira



Faculty of Science and Technology, University of Coimbra: Luísa Durães, head of the Chemical Engineering Department; Paulo Ferreira, teacher and researcher in the Chemical Engineering Department; Jorge Pereira, teacher and deputy head of the Chemical Engineering Department.

In terms of research, the links with the paper industry have long been a feature of life at the Department of Chemical Engineering of the University of Coimbra. “We have a Research Centre with very strong links to the cellulose and paper sector: the Centre for Research in Chemical Processes and Forest Products Engineering (CIEPQPF). A lot of lecturers are exploring green chemistry, which is then reflected in study plans”, explains Paulo Ferreira. The business perspective is taken very seriously in the department, as Jorge Pereira confirms: “In our new module on ‘Circular Economy and Carbon Management’, for example, we want to explore the

question of business models centred on circularity. Great importance is attached here to links with companies, to creating value, new business ideas, bioenterprise. We have a lot of initiatives in this area, outside the syllabus, with competitions for students.” In the case of Universidade Católica, “all our work, not just teaching, but also research, is based on a very close partnership with the industrial and business community. We have several examples of joint endeavours that illustrate this approach in the institution, in its role in educating and training our students”, Fátima Poças tells us. “In particular, we have post-graduate options in areas highly relevant to Portuguese industry, such as wine and cork, where the programmes were designed in partnership with industry”, she adds. In addition, the Higher School of Biotechnology has a unit devoted to links with industry, from the perspective of laboratory techniques; “It’s called CINATE and it’s a

laboratory that undertakes specific projects with companies. They might not be huge projects, but the organisation is very active in responding to business needs on a daily basis”, says Fátima Poças, who, in addition to her teaching and research responsibilities, is in charge of this centre. “It’s a very good place for understanding what companies currently need. It may result in more structured projects, in multi-company partnerships, for example, or in more focused and localised studies”, she explains. Fátima Poças is also keen to point to an important collaboration project which is now getting under way, through the participation by the Higher School of Biotechnology in the **From Fossil to Forest Agenda**, approved under the Recovery and Resilience Plan: “To work alongside a company like Navigator in its strategy of producing paper and products based on cellulose fibre for

packaging will be a very beneficial partnership. We’ll be contributing our wide experience in different aspects of packaging for food products, and we’ll learn from the whole side of raw material selection and production, all the innovation that will be made to the process. We will all surely learn a great deal from each other.” In Jorge Pereira’s opinion, “education is the path that will enable businesses to take the right decisions, properly supported by science. Whilst once we came to university to receive information and knowledge, we now come to look for solutions and find out how to take the best decisions. The economy will be the engine of change and education will be a key component in that change.” ●

Read more about the work of the From Fossil to Forest Agenda on pages 74 to 77 of this magazine.

“The relationship between universities and business is absolutely crucial for the success of the country’s economic development.”

Armando Silvestre



Armando Silvestre, teacher, researcher and head of the Chemistry Department, University of Aveiro.

Education shouldn’t end when we leave education

Whilst the syllabus content for first degrees, master’s degrees and PhDs are fundamental for the changes that are happening in business, in industry and throughout society, that is not to say that, on leaving education, young professionals have finished their training. “Everything is changing very quickly, and so training cannot stop when people leave university. With this in mind, at the University of Coimbra, we also offer courses for people already working. Companies have asked us to provide training in the circular bioeconomy and we’ve responded”, says Luísa Durães. Jorge Pereira adds: “Training and education continue to be crucial for developing solutions in this transition.” Fátima Poças thinks likewise: “We’ve succeeded in finding channels, in conjunction with companies, for providing a rapid response to their training needs.” She cites an example: “When the new recycling regulations were published in November 2022, we had an avalanche of enquiries and formal requests to the university. And the university went into action. There was a need to respond with tailor-made training, which can happen in companies or serve multiple clients here in our own facilities. These are less formal training models, but implemented very quickly”, she tells us. “Companies need immediate responses to external constraints, due to either economic issues or to legislative issues. And the academic world must be ready to respond”, she adds. ●



# The circular bioeconomy made simple

The fact that forests are the main form of land use in Portugal, occupying more than a third of the country, does not mean that the public opinion is familiar with them or that young people learn about them at school. The Forest of Learning project was designed precisely promote forest literacy and the related concept of the circular bioeconomy.

**T**he key role of education in the transition from a linear, fossil-based economy to a circular economy based on renewable resources is not limited to higher education. Whilst issues of circularity and sustainability are already being incorporated in syllabus content and taught to students, in pre-school and primary education, these subjects seem far from being included. It was to bridge this gap that the Forest of Learning project was designed and promoted by RAIZ – Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture), with support from the Calouste Gulbenkian Foundation. “The project combined the component that already existed of allowing children to make contact with the natural, historical and cultural heritage of the Quinta de São Francisco, where RAIZ is based, with the sharing of recent research and scientific knowledge relating to the circular bioeconomy”, explains Sara Monteiro, general coordinator for the Forest of Learning. “We design programmes of activities adapted to different age ranges and educational levels. In all of them we seek to involve the children, because we want them to feel that it’s their project”, she adds. In just its first year, the project welcomed more than 6,500 on-site


visitors, most of them primary school students, but also pre-school groups.

**From the tree to the laboratory**

João Ezequiel, scientific coordinator of the project, explained that the Forest of Learning is based around three main areas - forests, the bioeconomy and sustainability: “We take advantage of the wealth of natural features at the Quinta de São Francisco, at the same time as drawing on the research that RAIZ has conducted down the years, especially as concerns the bioeconomy and sustainability.” This educational work, and above all the contact with the school community, is something RAIZ was already doing, but the project has made it better structured and more meaningful. And it also enables the team to help teachers address these issues: “There’s a widely held idea, both in schools, and among the public, that forests are above all natural forests. Which is not true. Most of the forests in Portugal, around 98%, were planted for economic reasons. And this is absolutely necessary. We depend on the forest economy. We have to look at forests as a natural resource of treat value for the country. We need schools to work on this idea”, believes João Ezequiel. “Our activities contribute to this. They set out to show what Portugal’s forests are really like and how we arrive at bioproducts. We use simple activities, because our audience is very varied, but they show the basic things that wood is made



**The relevance of the Forest of Learning to the field of education has won RAIZ recognition from UNESCO Portugal and from the UNESCO Club.**



Find out more about the Forest of Wisdom project by reading the QR Code.

of, substances that can be used in medicine, cosmetics or nutraceuticals. In the last instance, the project shows people why we should value our forests, for natural and environmental reasons, but also for environmental and social ones. All these aspects are important”, concludes João Ezequiel. Another misconception that is taken apart in Forest of Learning activities is that planted forests only produce raw material for companies. “It’s not true”, says the project’s scientific coordinator. “They provide a series of services and benefits for society as a whole. Starting with the oxygen they produce, which is obvious, but there’s more. Such as structuring and conserving soils and maintaining water regimes, with a series of biogeochemical cycles involved. These forests are also a refuge for many species. This isn’t talked about - the ecosystem services



of planted forests are completely overlooked”, points out João Ezequiel. Forest of Learning activities are varied: from guided tours of the Quinta de São Francisco, where the youngsters use all their senses, which is especially important for pre-school children, to activities in the laboratories, where students can discover how researchers study the potential of eucalyptus for developing new bioproducts. The project also offers visits to the Espirra Nurseries, in Pegões, where children can see how the forest is born. In addition to contact with different sectors of the educational community, the Forest of Learning also organises think tanks with several bodies in different areas. “The idea is to complement what is on the school curriculum and to respond to the needs that teachers feel in the classroom. The think tanks have responded to questions asked by teachers themselves. We bring in our experts and also university researchers or other specialists able to address the difficulties and issues that primary school teachers face”, explains Sara Monteiro. And she adds: “We always seek to engage with civil society to promote forest literacy.” ●



# Boeing engineers in the US beat the Guinness world record with an aeroplane made from Navigator paper

Three engineers from the aeronautical industry, two of them from Boeing, launched a paper aeroplane that beat the world record for distance flown. The “fuselage” was built from 100 g/m2 Navigator paper, which was the “most cost-effective” and because of its “firm structure”, My Planet heard from Dillon Ruble, an engineer with a passion for origami.

In his professional life, he deals with real aeroplanes. Dillon Ruble and Garrett Jensen work at Boeing, the global aeronautics giant which gave the world the iconic Boeing 737 and 747 airliners, and the disruptive 787 “Dreamliner”. Nathan Erickson works for Garmin, the famous manufacturer of navigation and flight systems. Recent graduates in Aerospace and Mechanical Engineering, they met at the Missouri University of Science and Technology and all share an interest in origami. Their engineering expertise has shaped this personal passion and was the driving force behind the paper aeroplane with which they broke the world record for distance: a flight of 88 metres - almost the length of a football pitch. For those who might ask what leads aerospace engineers, who design and work on real aircraft, to put their heart and soul into designing paper prototypes and getting them to fly as far as possible, Dillon explains that the two worlds are not so distant: “Paper aeroplanes and real-life aircraft differ greatly in their complexity, but they both operate according to the same principles. The basic forces of impulse, lift, drag and weight can be used to theorise how to fold the paper.”

“The malleability of the paper for achieving these complex forms is what gives this hobby its creative side.”

Dillon Ruble

The prototype that managed to beat the world distance record was in fact inspired by hypersonic aircraft, which can travel as speeds five times the speed of sound. Which is why the paper aeroplane was given the name Mach 5. “We spent close to 500 hours creating different prototypes, designing a plane that could fly further”, Dillon tell us. “The repeated development of prototypes was the main factor behind our success. We theorised about the changes we could make to the structure, we folded and compared the results with previous

projects. Using this method, we gradually succeeded in improving the design, one fold at a time. Gaining two or three metres after each rethink might not seem much, but for a world record, every centimetre counts”, explains the Boeing engineer. Boeing was fully supportive of Dillon’s initiative, taking the view that “breaking records is more than just a number, it challenges us to go a little further and work a little more”. “We value the desire to improve ourselves constantly, as well as our designs and the world around us. With this achievement, we hope to encourage creativity, inspire people to follow their dreams and promote the engineering talents of the next generation”, the company concludes.

## The discovery of Navigator’s paper

In order to beat the world record for the distance flown by a paper aeroplane, Dillon and the team started to create prototypes using letter size sheets, the most common format in the United States. “However, as we gradually improved the design, we decided to switch to A4”, he recounts. “We realised that this format made the various



Left to right: Dillon Ruble, Garrett Jensen and Nathan Erickson.

critical folds easier, and led to better performance. In addition, we opted for using the densest paper permitted by the Guinness World Record, 100 grammes (g/m2)”, he adds. It was then that the team discovered Navigator, which ended up forming the fuselage of the record-breaking plane. Dillon explains the reasons that led to this choice: “It’s the most cost-effective of 100 g papers and its firm structure was ideal for a

high-performance paper aeroplane. On the one hand, the drag exerted on an heavy aeroplane decelerates it less than with a lighter craft, and on the other, the firmness of this paper enabled the plan to maintain its shape more effectively during the flight.” “We weren’t familiar with the brand before this project, but after trying out other types of paper, Navigator A4 100 g/m2 is now our paper of choice for achieving the best

performance in our aeroplanes”, he concludes.

## The fascination of paper

The fascination of paper lies in the ease and simplicity of testing out designs and launch techniques. “Paper offers unique advantages”, Dillon enthuses. “The first is the ratio between surface area and weight, which enables us to create certain models, such as gliders and hybrids, which depend on large wings and low weight to travel long distances”, he explains. But that’s not all. “The second great advantage of paper is its +potential for creating complex forms from a simple sheet. By changing some of the folds in a paper aeroplane, the final shape and performance can be adapted for any desired outcome. The malleability of the paper for achieving these complex forms is what gives this hobby its creative side.” And there’s the other side of the question: “Paper is still important in our lives because it confers a sense of authenticity on anything you print on it. Its tangible nature lends itself to a more enjoyable viewing experience. Our whole team prefers real books to ebooks. There’s a physical sensation when we hold a real book that other media can’t replace without losing something on the way”. ●



# Paper and the cat

**M**y cat, as it is supposed to do while I write, arranges itself in that Egyptian pose, seated, with its tail wrapped around the base, and remains static in that position whilst I tap away at the keyboard. Dozing, but watchful. There is supposedly a close relationship between cats and writers, as Hemingway, T. S. Elliot and Mark Twain, to cite just three names taken from a male-dominated era and culture, turned into a style. It turns out that the writer, in the gloom of his lonely study, had a cat, either because they were both free spirits, or else because the cat was no trouble and very low maintenance, or else because sometimes both felt the need to cuddle up. There was a symbiotic relationship between intellects. But that's what comes of reading. It spoils good stories. The cat as a species has never been the friend of writers. Cats exist as a lineage to be the guardians of books. Without books, cats would not have spread all over Europe, and then through the world. In the Middle Ages, cats were adopted as domestic animals by monks to stop the mice destroying the precious manuscripts they produced. Of all the community's possessions, the manuscript was one of the most precious that a mouse could destroy - especially, when we speak of the Bible or other texts that served to store divine teachings. And the expansion of Christianity as the written word was the expansion of the cat. So much so that cats were fed on leftovers from the monks' food - essentially fish, as their fasts rarely permitted meat (and yes, cats like meat). I read somewhere that it was wrong that the route connecting Southern Asia to Europe, and which led to flourishing trade and the exchange of ideas, and so to the world we live in today, is known as the Silk Road. It should be known as the Paper Road. Of all the goods traded along the way, it was paper which beyond doubt led to an unstoppable transformation at this end, coming from China and arriving in Europe via Al-Andaluz and the Iberian Peninsula. The explosion in thought triggered by the Gutenberg press, releasing ideas into books, some of them dangerous and prohibited, changed Europe, and later the world, transforming religion and spreading ideas of liberty and equality. With the help of cats, to protect those books, leaflets, and journals from being eaten by the status quo. We should note that one of the great plagues in

Europe coincides with a witch hunt in which the instigators resolved to implicate cats and sought to decimate them. Without cats, the rat population increased, bringing the plague.

All this to say that my cat is watching me as I write, but somewhere in its DNA it expects what I produce to come out on paper. One of its primeval reasons for existing: to save books, magazines, and journals from being destroyed. And many of those who write and have cats watching them are convinced that their domesticated felines are looking out for them and their writings and not for the medium itself, the paper.

My cat doesn't bother me. Instead, it's actually a relief that it has no expectations about the quality of my work, and I imagine it feels that somewhere else along the production line there's another cat looking out to make sure this text isn't destroyed by an ignorant mouse.

**Cats exist as a lineage to be the guardians of books. Without books, cats would not have spread all over Europe, and then through the world.**

What I'd like it to know is that there's a difference when you write, when you imagine the letters spreading over a sheet of paper or the result of a code on a screen. When we write a book, we know we can lose it to editorial oblivion if it's the wrong paper. If we write for a good magazine, we know the text will always be good, because there's something erotic when the glossy pages separate for the first time and the light is reflected on the white, tangible page. My writings that I've kept on paper, from magazines and books, have stood the test of time. Those I've delivered to a cloud to a newspaper "to save" vanish as if a horde of mice had obliterated a medieval library without cats, at the orders of a nameless Torquemada, behind a self-important hacker. I've learned my lesson. If it's precious to me, I keep it on paper. Not least because I have a cat in the house. ●

*By Luís Pedro Nunes, journalist and writer*





# Navigator mills cut water use by 10%



Cutting water use is a key concern in Navigator’s operations, an intrinsic part of its values and purpose. In 2022, water intake at Navigator’s sites was down by 10% from 2019, the baseline year for the Water Use Reduction Programme (WURP), implemented by the Company in 2017 as part of its policy of environmental sustainability and operational efficiency. In practice, this reduction represents more than one month’s industrial operations. “Water is an essential resource for our business, and although we are relatively modest users of this resource, there has been a great concern to reduce our use”, explains José Nordeste, Environment and Energy director at The Navigator Company. “This 10% reduction reflects that concern, which was translated into internal changes to processes and optimised water management, and into measures that require investment but enable us to make larger reductions”, he adds. Although the care taken with this issue has a long history, it was instituted more systematically in 2017 with the start of WURP, which is coordinated by Luís Machado, working from RAIZ – Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of

Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture). “WURP was established as a structured programme across the organisation. We have adopted new technologies measures and changes to processes, leading to an effective reduction in water use, as can be seen in the results for 2022”, he explains. As part of its 2030 Agenda, the responsible business strategy designed by The Navigator Company to address the challenges of the decade and increase its creation of sustainable value, the company has committed itself to “promoting efficient use of resources, minimising our ecological footprint”. The commitments under the 2030 Agenda include those to “cut specific use of water (m3/t product) by at least 33% by 2030 (baseline: 2019)” and to propose solutions that enable us to improve efficiency in water use. The Navigator Company, mentor of the My Planet project, is an integrated forestry operator, producing pulp, paper, tissue, sustainable packaging solutions and bioenergy. Its operations are based at state-of-the-art plants featuring world-beating technology. It is recognised as setting global standards for quality sustainability in its sector.

# Ecological restoration

*Zambujo reCover* is a woodlands restoration and soil protection project undertaken by The Navigator Company, in partnership with RAIZ – Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture), and will restore the ecology in 110 hectares in Idanha-a-Nova. The project sets out to increase the environmental value of natural and semi-natural forest habitats in Zambujo, an estate owned by Navigator in the International Tagus Natural Park and in the International Tagus, Erges and Pônsul Special Protection Zone, classified as part of the Natura 2000 Network. In addition to work to help conserve soils, the project involves reforestation and woodlands densification with holm oaks, and especially *Quercus rotundifolia*.

# Eucalyptus in Contige wins fifth place in European Tree of the Year 2023



This imposing eucalyptus measuring 11 metres in circumference and 43 metres high is a local landmark in Contige (Sátão) and won the title of Portuguese Tear of the Year 2023, finishing the European competition in fifth place. And oak in Poland won European Tree of the Year 2023, followed by another in Slovakia and an apple tree colony in Ukraine. Classified as a tree of public interest since August 1964, the eucalyptus in Contige is one of several monumental eucalyptus trees in Portugal. With 10,281 votes, the excellent result achieved by the Contige eucalyptus in the European poll serves to underline the diversity of Portugal’s forests.



António Redondo, CEO of The Navigator Company.

# “The old fossil-based economy is on the way out”

The Navigator Company and the Portuguese weekly newspaper Expresso organised a conference on the “Forest-Based Bioeconomy”, which brought together representatives of academia and companies in the sector, as well as political decision-makers, to discuss a topic that the Minister for Science, Technology and Higher Education, Elvira Fortunato, described, in her opening address by video, as an essential path towards the goals of carbon neutrality. Jori Ringman, director-general of the Confederation of European Paper Industries (CEPI), reminded the participants that wood, together with other forms of cellulose, is the most plentiful material in nature: “We know, perhaps better than anyone else, that even plentiful resources have to be managed sustainably. We know it because our industry, our investments in our future, depend completely on this. It is not by chance that the

countries with a strong paper industry also have the best forests in Europe”, he said. “For us, the future is clear: a circular, renewable and carbon neutral bioeconomy. Which has the potential not just to be less polluting, but to be truly regenerative. The old fossil-based economy is on the way out”, the director-general CEPI assured his audience. For his part, António Redondo, CEO of The Navigator Company, highlighted the company’s achievements in the area of new bioproducts obtained from Eucalyptus globulus fibre, able to substitute those derived from fossil raw materials: “All this research that we have been doing shows that the traditional process of producing cellulose pulp generates valuable flows that can be used for new products with every greater added value”. “This traditional production process”,

he added, “forms the basis for the gradual transformation of our current cellulose pulp mills into biorefineries. Where today wood and biomass are transformed into cellulose fibre, paper products and energy, we will also start to produce biomaterials, biofuels and biochemicals, alternatives to those derived from petroleum; renewable, recyclable, biodegradable or compostable”. However, the Navigator CEO warned that, for this transformation to happen, more raw materials is needed in Portugal: “Without this, the future of the existing pulp and paper industry cluster fill be seriously compromised and new industrial clusters bringing even greater value added will not be developed in Portugal”.

## The view from academe

The first panel discussion, on “Research and Development as the Engine of the Forest-Based Bioeconomy: progress and



challenges”, brought together representatives of academe. Emídio Gomes, vice-chancellor of the University of Trás-os-Montes and the Upper Douro, highlighted the fundamental role of forestry sector companies in this area: “We’re seeing a profound revolution in the forestry sector. This is one of the areas where research is most advanced and the way that knowledge has been transferred to companies is a lesson for other sectors.” Francisco Gomes da Silva, lecturer at the Higher Institute of Agronomy, pointed to the need for a new way of looking at forests: “They are need from the single perspective of direct decarbonisation, and their role in retaining carbon. But we’re missing an opportunity to shape our forests so that it can supply this sector with raw material in the quantity and quality needed, maintaining and increasing its capacity to sequester carbon and also generating other forms of value for society, or what we call ecosystem services”.

Júlia Seixas, dean of Universidade Nova de Lisboa, told the audience that “the value of sequestration is very important, but we also have to look at the value of the products coming out of this sector, insofar as they can substitute fossil-based products.” The need to take a fresh look at planted forests was also underlined by Luís Mira, secretary general of the Confederation of Portuguese Farmers (CAP), who warned that forestry producers continue to battle with a huge prejudice against a specific species: eucalyptus.. “The bioeconomy is not hindered by an ownership structure in which smallholdings predominate. But it is constrained by misinformed public policies and ideological preconceptions”, he said.

**The role of companies**

“Almost everything we obtain from the petroleum industry can be obtained from the forestry in”. Paula Pinto, Technological R&D coordinator at RAIZ – Forest and Paper Research Institute (R&D laboratory co-owned by The Navigator Company, University of Aveiro, University of Coimbra and University of Lisbon, through the School of Agriculture), summed up the issue in the second panel discussion of the event “Implementing the forest-based bioeconomy; from the laboratory



Panel discussion on “Research and Development as the Engine of the Forest-Based Bioeconomy: progress and challenges”.



Panel discussion on “Implementing the forest-based bioeconomy; from the laboratory to the market”.

to the market”, which brought together spokespersons from companies in the forestry sector. Arguing that “access to research, development and innovation is crucial for the industry’s competitiveness”, she highlighted the Inpactus project and the results obtained from it, including four new products already on the market (three in tissue paper and one in packaging) and the training of highly skilled human resources. Adelaide Alves, R&D manager for Sonae Arauco, said that circularity is a rationale which has been built into the company’s business model and that “people’s lifestyles are changing, and so the products we offer them have to change too”. A view corroborated by Eduardo

Soares, executive director and head of Innovation and Project Management at Amorim Cork Composites: “We pay attention to consumer trends, which point to a change and could be an opportunity for us”, he said. “Our production process is itself a classic example of circularity”, said Gabriel Sousa, head of Innovation and Technological Development at Altri, pointing also to the sector’s contribution to fossil decarbonisation. José Oliveira, head of Sales, Marketing and Innovation at DS Smith Packaging, alluded to the company’s vision for rethinking packaging, with a focus on substituting plastics, “using a recyclable and sustainable raw material, which is why we use wood fibre”.



**Vítor Gonçalves**  
Member of the Board  
of Directors of  
The Navigator Company <sup>(1)</sup>

# Navigator’s contribution to a new paradigm

**B**ecause The Navigator Company’s business is intrinsically linked to forests, the preservation, sustainability and improvement of those forests is of central importance to the company’s operations. This natural concern is joined by The Navigator Company’s conviction that business should make a decisive contribution to building a better world and developing a sustainable operational model. This vision is shared, and actually demanded, by a society which is increasingly aware of global and local challenges, that we all need to overcome. In a context where companies face ongoing challenges of productivity, growth and profitability, operating on open and highly competitive markets, the allocation of resources to sustainability commitments cannot be seen as altruism or corporate philanthropy, but rather as an absolutely essential condition for achieving good results. The inevitable link between profits and value remains, but the meaning of value has become much broader and involves environmental and social dimensions, as well as transparency, and value is no longer assessed by clients alone, because the assessment made by a range of participants in the business ecosystem, the people we call stakeholders, is also crucially important. At The Navigator Company, we have a clear sense of this reality and our positive results achieved through attainment of ambitious targets for productivity, growth and profitability are also supported by concrete and equally ambitious targets for sustainability issues relating to environmental impact, social policy and practices, and, lastly, corporate governance that is ethical, professional, transparent and responsible. These were the broad considerations which in 2020 prompted The Navigator Company, in line with the United Nations 2030 Agenda and the related Sustainable Development Goals, to design its own 2030 Responsible Management Agenda, supported by a corporate management tool, the 2030 Roadmap, setting out ambitious and concrete goals, with results

to be measured, audited and published annually, enabling the Company to steer its way through the next decade, contributing to the creation of sustainable value. Forests, and eucalyptus in particular, one of the cornerstones of the company’s operations, were inevitably central to the strategy in the 2020 Agenda and Roadmap, which includes developing bioproducts. We all know that our planet’s natural resources are finite and cannot be used as if they will last for ever. The current economic development model has had a significant impact on the health of our planet, and we need to move from the extractive rationale of extracting natural resources to alternatives based on the principles of the renewably based circular bioeconomy. Embracing its role in this process, Navigator has invested in research, investment and innovation in order to find viable solutions, taking advantage of the potential offered by forests, the main source of its raw material. Bioproducts accordingly offer a way of minimising the impacts of an unbalanced economic model, by providing alternatives, for example, to fossil-based resources or by substituting products with renewable solutions found in nature. Among The Navigator Company’s multiple goals for 2030, I would draw attention to the development of new cellulose materials and composites, which are recyclable and biodegradable, and the development of biofuels, bioplastics and biochemicals from waste forestry biomass, through stronger partnerships with universities and technology centres in Portugal and abroad. These developments will undoubtedly play a strategic role in building new sustainable business models that will contribute to mitigating the impact of the non-circular and fossil-based paradigm of our current society, and at the same time to making The Navigator Company stronger, more relevant and a force for creating growing and sustainable value. ●

<sup>(1)</sup> Elected for 2019-2022, in office until the Company’s General Meeting in May 2023





**João Paulo Oliveira**  
Member of the Executive  
Board of The Navigator  
Company

# The game changers in the Bioeconomy

**T**he Navigator Company's origins are closely connected to a concept that is increasing central to our times: technology transfer. The ability to apply expertise and innovative processes to industry has been a feature of the company since 1957, when the then Companhia Portuguesa de Celulose became the first in the world to produce bleached Eucalyptus globulus pulp using the kraft method, on an industrial scale, creating a brand new and successful global market in eucalyptus fibres - which today accounts for more than 70% of short fibre, more than 40% of all cellulose fibres and more than 25 billion dollars in annual turnover. This historical fact is all the more relevant at a time when the forest-based bioeconomy, and in particular that centred on Eucalyptus globulus, presents itself as a robust alternative for obtaining goods which are today produced from fossil raw materials. Just as happened 66 years ago in Cacia, it is investment in R&D&I processes that is paving the way for new cellulose applications, taking the bioeconomy to an entirely new level of achievement. Science and technology are again the game changers in the equation. The Inpactus project, co-promoted by Navigator, RAIZ and the universities of Coimbra and Aveiro, the results of which we announced in the final quarter of 2022, is paradigmatic of this work leading to decarbonisation and a more sustainable, circular and competitive economy. This initiative, the largest ever undertaken in Portugal, generated cutting-edge expertise with economic impact (innovative and distinctive products, some already on the market), trained and empowered professionals, but also demonstrated that the traditional process for producing cellulose pulp generates flows that lie behind a new generation of bioproducts with a high level of added value. This traditional industrial base is the foundation for the gradual transformation of our current cellulose pulp mills into biorefineries: full use is made today of the wood and biomass for producing cellulose fibre, paper

products and energy, but in the very near future we will see these activities joined by the production of biomaterials, biofuels and biochemicals, alternatives to petroleum derivatives which are renewable, recyclable, biodegradable or compostable. In addition to this industrial base, scientific expertise, efforts to promote talent, high standards and skills, wedded to innovation and technology, are the key factors for the future development of biobusinesses, like that of Navigator, and also for other Portuguese industries which seek to create economic value in harmony with the climate and nature. Navigator is especially well placed in this area: in addition to the outputs from Inpactus, it is working on new research fronts in the cellulose-based sustainable packaging segments, helping to reduce the quantity of plastic used in this area, and in 2022 has laid the foundation for the production of eSAFs (e-Sustainable Aviation Fuels), carbon neutral synthetic jet-fuel produced from green hydrogen and biogenic CO<sub>2</sub> obtained by exploiting forest waste for energy, in the operation of the Company's integrated pulp and paper mills. As hubs for people, talent and resources, companies play a crucial role in the response to the challenges facing humanity, which are moving the world to urgent action on issues such as climate changes and dependence on fossil fuels. The development of solutions for the forest-based bioeconomy therefore has a great sense of purpose for The Navigator Company, involving the creation of responsible value through natural products that are sustainable, recyclable, and biodegradable, that help to sequester carbon and produce oxygen, that protect biodiversity, improve the soil and combat climate change. This purpose, focused on people and the planet, is what guides our efforts towards the areas where we believe the company can create the greatest positive impact. This is perhaps the greatest game changer of the times we live in: the social responsibility of companies. ●

How many animals and plants can  
you see from your window?  
From ours, we can count 245  
species of fauna and more than 800  
species and subspecies of flora.



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