

ANNUAL REPORT'21



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MESSAGE FROM THE BOARD

Our performance in 2021 reassures us of our ability to face and overcome strong constraints and continue our transformation.

Message from the Board



The year of 2020 had seen an unexpected pandemic disruption coming and going in waves, threatening to bring significant instability for a considerable period of time. This has actually happened and the year **2021 has definitely been marked by our efforts to adapt and become resilient to pave the way to a new normality.**

Like a living organism, INESC TEC reacted to the external adversity and constraints, transforming itself while pursuing its mission, and also to better pursue that mission for the benefit of society in such a difficult context. Priority was given to people – safety and work-life balance were fundamental concerns, and enhanced digitalisation brought speed and productivity to our complex networked multi-disciplinary environment.

While undergoing change, growth did not stop, reaching a **20 M€ record activity, following a 10% increase from 2020 and a 44% increase in the last five years.** The human resources structure also evolved: the number of researchers with a PhD (340+) nearly reached half of the total number of researchers, and a virtuous balance of academic staff (174), R&D employees (159) and grant holders and trainees (324) undertaking research and innovation has been achieved.

We are certainly aware that we need to continue to improve in attracting and retaining talent. We certainly need to take off from the 25% female representation in research and to go well above 10% of foreign researchers, even though we know the competition is tough in our areas.

Policy priorities also fostered work in areas of high importance for INESC TEC's social contract, in which we counted with the valuable contribution of many colleagues who have accepted to serve in committees in the areas of ethics, social responsibility, diversity and inclusion, and conflicts of interest.

The year of 2021 has also been a year of proud achievements in scientific outcomes, European competitive funding, participation in initiatives of strategic importance for Portugal, **new research infrastructures, technology licensing, spin-off launching, diffusion of science in society and effective contributions to public policies.**

With Covid-19, the impact of climate change, the excruciating invasion of Ukraine with its turmoil of still largely unforeseen impacts, and, at a national level, a new government initiating functions, the outlook for the already on-going year of 2022 threatens to become a difficult foresight exercise.

Our performance in a 2021 filled with uncertainty and adversity, the organisation's resilience, the sound project portfolio for 2022 and the emphasis on being driven by motivated people fully aligned with INESC TEC's mission and strategic options, reassures us of our ability to face and overcome strong constraints and continue our transformation, because little will stay the same.

Our final words are for our associates and partners with whom we have, very fortunately, forged strong and highly committed collaborations, and for the members of the INESC TEC community, **thanking them for their outstanding dedication that enabled our institution to achieve exceptional results in yet another disruptive year.**

/001

FOSTERING

It's all about
impact.



1.1. THIS IS INESC TEC

Ever since its establishment, INESC TEC has been promoting fundamental and applied research and engages in the transformation of new knowledge into innovation and technology, with economic and social impact. Its operating model implements a complete knowledge value chain, integrating four stages – **knowledge production, applied research, development, and technology transfer.**

Contributing to the competitiveness of Portuguese industrial networks, INESC TEC focuses on being socially relevant and internationally influential, performing in the domains of Networked Intelligent Systems (NIS), Power and Energy (PE), Industrial and Systems Engineering (ISE) and Computer Science (CS).

OUR MISSION

**EXCEL IN RESEARCH AND
SEEK SOCIAL
AND ECONOMIC IMPACT.**

OUR VISION

**BE A RELEVANT
INTERNATIONAL
PLAYER IN SCIENCE
AND TECHNOLOGY.**



PEOPLE
CENTERED

INNOVATION
EXCELLENCE

RESEARCH
FREEDOM

COLLABORATION

SOCIAL
RESPONSIBILITY

An abstract graphic featuring a white line profile of a human head facing right. The head is set against a background of large, expressive brushstrokes in blue, green, yellow, and red. The hair area is filled with a dense, colorful web of thin, fiber-optic-like strands in blue, red, green, and yellow. The word 'GOING' is written in large, bold, white capital letters with a black outline, positioned in the upper left area of the head.

GOING

**HUMAN
CENTERED**

1.2. GOING HUMAN CENTERED

To go human centered is to look ahead by taking advantage of the human-machine interactions. These are our main achievements in this area over 2021.

Activity and emotion recognition in shared vehicles based on a strategy for efficient multimodal approach and the assessment of the impact of different types of visual noise in the obtained models.

High-level harmonic descriptors of semantic value for music information retrieval and musicological analysis that can support many applications for musical analysis and retrieval (e.g., music recommendation and auto-tagging). **THEORY**

Achieving Cancelability and Non-Linkability in End-to-End Deep Biometrics, based on the Secure Triplet Loss, focused on template cancelability, which was reformulated to address the problem of template linkability on biometric verification and face images. **ALGORITHM**

Deep Signer-Invariant Representations for Sign Language Recognition, a novel end-to-end deep neural network that explicitly models highly discriminative signer-independent latent representations from the input data. **ALGORITHM**

Privacy-Preserving Generative Adversarial Network for Case-Based Explainability in Medical Image Analysis. **ALGORITHM**

Achievement of three frameworks: (i) "The Entrepreneur and the Investor Perspective on the Investment"; (ii) "Using a Research Domain Ontology as a Driver for Technology Commercialization" and (iii) "Modelling Technology Innovation Commercialization (TICO) Activity in Academia & Industry – An Ontology". **MODEL**

Presence in Active and Healthy Ageing partnerships (as result of EIP_AHA) namely in SAFE consortium (28 countries), and in international and national thematic networks for "Smart Healthy Age-Friendly Environments."

Several developments on improving the projected spatial augmented reality system, aimed to increase the maturity level of the technology and its user interfaces, increase its range of industrial applications, namely, to support human operators both in the construction of silos for the food industry, and on construction and maintenance of ships at the shipbuilding industry. **METHOD**

Development of a cognitive system aiming to increase the natural collaboration level of a robotic system with its human partner, considering a realistic engine assembly station, and a module called FollowMe, that can be used for robots follow people performing agricultural tasks, in the logistic supporting operations. **PROOF-OF-CONCEPT**

RECAP Preterm consolidated a network of 14 federated nodes, constituting a privacy-preserving health research environment, abiding by the FAIR principles, including 20 European cohorts with duly curated data of children and adults born preterm. **DATA SET**

Implemented and tested a repository-agnostic security middleware on different ADC-compliant repositories for immunogenetics. Furthermore, it evolved a proof-of-concept implementation of a block-chain based approach for the traceability of transformations used in the processing of human RNA data. **PROTOTYPE**

Development of a new method for the segmentation of retinal layers in OCT images (Retina CAD). **METHOD**

Large knowledge on the digital auscultation, also enabling the publication of an open-source dataset for the challenge, under Multiscope project. **DATA SET**

Fibre Raman endoscope was characterised and is currently being tested in terms of performance. **PROOF-OF-CONCEPT**

Method for fast classification of cells and microparticles was developed using optical tweezers systems, equipped with position sensitive quadrant photodetectors and advanced signal processing applied in the frequency domain. **METHOD**

GOING

GREEN

1.3. GOING GREEN

To go green is to live in harmony with our planet, while tackling major issues like marine litter or contributing to energy efficiency. These are our main outcomes during 2021.

Significant advances in the design and deployment of custom robotic systems for localisation and retrieval of fishing nets. **PROOF-OF-CONCEPT**

Test of the potential of using hyperspectral sensors for the remote detection of marine litter in coastal areas and shallow waters. Innovative methods in hyperspectral image processing for autonomous detection of microplastics were developed. **PROOF-OF-CONCEPT**

Prototype tested for monitoring of aquaculture tanks with visual system for estimation and characterisation of fish growth. **PROTOTYPE**

Advanced signal processing and analysis were implemented enabling to unscramble spectral interference and matrix effects in Vitis vinifera Vis-NIR spectroscopy, paving the way to the quantification of non-dominant absorbance constituents (glucose, fructose, tartaric, and malic acids) with analytical precision 'in-vivo'. **PROOF-OF-CONCEPT**

Novel two-stage Constructive Heuristic Algorithm to handle integer investment variables in transmission network expansion planning. **ALGORITHM**

Development and testing of a conceptual model to detect and mitigate extreme losses in distribution networks, namely in view of the connection of large amounts of small generation units to distribution networks. **MODEL**

Development of a functional model for the consumption elasticity of the demand response (DR) contracted consumers. The model aims to determine the load adjustment the DR consumers can provide to the retailers or utilities for different price levels. **MODEL**

Development of novel federated learning and data markets algorithms for renewable energy forecasting and low voltage control. **ALGORITHM**

Development of an approach for improving the dynamic security in islanded power systems based on the quantification of minimum synchronous inertia considering fault-induced frequency deviations.

Advanced control strategies for improving fault ride through performance of smart power transformers feeding hybrid (AC/DC) microgrids. **METHOD**

Development of a methodology to define the best model and the best experiment design for battery energy storage parameter estimation. These models were tested as a state of charge estimator on a battery applied on an electric forklift. **METHODOLOGY**

Bid optimisation algorithms for multi-energy aggregators participation in electricity and gas markets were developed. Methodologies to increase the observability over the gas network were developed, together with algorithms to optimise the injection of green hydrogen in the public network. **ALGORITHM**

Presence in the national thematic task Force for Food-Waste.

Biolens, a citizen science tool for evaluating ecosystem health. We use artificial intelligence techniques to develop models that allow the automatic identification of biological taxa that are sensitive proxies for ecosystem health. **METHOD**

Conclusion of a gamification framework that helps companies reduce energy costs by promoting behaviour change in their collaborators. **TOOL**

GOING

DIGITAL

1.4. GOING DIGITAL

We would say that digital is our DNA. We have been contributing steadily to the digital transformation by developing several methods, systems, algorithms, or prototypes. Check out the top outcomes in 2021.

Method for modelling interface-type amorphous oxide semiconductor resistive switching by using neural networks capable of simulating dynamic systems, a key step for neuromorphic computing. **METHOD**

Method for designing an efficient 300 GHz planar antenna on III-V substrates, suitable for a true time delay microwave photonics based sub-THz transceiver with wide scanning angle. **METHOD**

Traffic-aware placement algorithms for aerial networks that enable significant performance gains (higher throughput, lower delay) when compared to state-of-the-art counterparts. **ALGORITHM**

Simulation platform for underwater communications enabling faster evaluation of underwater data mulling oriented communications solutions and offline replication of real-world experiments. **TOOL**

Significant results in the use of AUVs for data mulling. There were important scientific contributions in algorithms for close range underwater navigation with the fusion of visual information with acoustic-based range and bearing. **ALGORITHM**

Significant results in the design and control of unconventional marine platforms, such as ASVs with aerial azimuth propulsion systems and combined systems with surface and underwater components. **PROOF-OF-CONCEPT**

Important advances in the application of feature extraction algorithms in underwater acoustic images. **PROOF-OF-CONCEPT**

Results in the 3D mapping of GNSS denied of underground environments integrating LiDAR and SFM data. **PROOF-OF-CONCEPT**

Monolithic fabrication of an integrated device with femtosecond lasers for the excitation of whispery gallery modes through a suspended waveguide (all of this within a microfluidic channel). The devices produced set the world state-of-the-art on silica machining and this solves the problems associated with the robustness of whispery gallery modes excited with fibre tapers. **PROOF-OF-CONCEPT**

Development of different sensors and a microphone for large bandwidth, in terms of graphene applications. **PROTOTYPE**

Optimization of a sputtering deposition system to the development of new optical sensing structures based on different types of surface waves (eg. SPR and Bloch) to achieve high sensitivity and resolution. **PROTOTYPE**

Development and full characterisation of gold and silver nanoparticles with a wide range of sizes and shapes, with resonances at telecom wavelengths. **PROTOTYPE**

Design, simulation, fabrication and testing of metal-dielectric structures and new metamaterials for optical sensing based on nano-plasmonics and nano-structured optical material (development of Hydrogen sensors). **PROTOTYPE**

Development of control toolbox to control the spatial light modulator and light pattern acquisition. **TOOL**

Development of two data-driven functions for smart alarm processing with two main goals: (i) identify the complexity of an occurrence in the distribution grid, (ii) provide fast advice to the human operator on how to solve it. **ALGORITHM**

Developed knowledge on online commerce. By analysing online customer data we revealed that other delivery attributes matter more than how quickly an order is received. **THEORY**

Machine Learning and Monte Carlo simulation methods to approximate the objective function, and both a branch-and-bound algorithm and heuristics to reduce the number of evaluations, all to address a variant of the Probabilistic Travelling Salesman Problem. **METHOD**

Symbolic learning algorithms, based on genetic programming (GP) were studied in depth and different grammar-based variants were compared, such as context-free grammar (CFG-GP) and grammatical evolution (GE). These GP algorithms were applied to the flexible job shop scheduling. The application of online retail is also being explored, with the algorithms being used to predict the customers' willingness to pay.

ALGORITHM

Use of reinforcement learning combined with discrete-events simulation for decision support in manufacturing systems resulted in a new approach to WIP management in Assembly Manufacturing Systems. **METHOD**

Next-generation supply-chain strategies were developed and published in a book resulted from the NEX-NET H2020 project.

New insights to the development of the concept of Product Digital Twin both from the technological perspective – architecture and data/information management – and the organisational dimension – impact on the digital transformation. **THEORY**

New insights in the management of collaborative R&D projects resulting from a systematic reflection on the practice of large project management and on the adoption of digital technologies during the pandemic situation. **THEORY**

Framework for collecting and storing urban mobility data in an automated way and allowing the implementation of new mobility services and knowledge extraction in different dimensions of analysis – preliminary results. **TOOL**

Multi-robot coordination system, considering communication failures, is under development with useful outputs. **PROOF-OF-CONCEPT**

Modular and highly reconfigurable 3D Robot Perception Framework to allow robotic systems to pick up objects in complex scenarios, with the development of a software module to deal with entangled objects. Development of an inspection and quality control system tailored to support human operator during the inspection of metallic parts. Also, 3 robotic perception modules for agricultural monitoring, spraying and harvesting tasks, and more than 6 datasets relevant for deep learning training. **TOOL**

Development of an AI-based methodology for keeping digital representations of manufacturing environments updated relying on sensorial data collected by robotic systems and processed on a local, edge, and cloud level. **METHOD**

Development of a novel process for fake news detection to identify bots and creation of a model to automatically balance the need for information regarding volume and time. **ALGORITHM**

Development of an autopsy module, named MF_Detector, for the Autopsy digital forensics tool to detect manipulated photos, namely deep fakes, splicing and copy-move manipulation types. The module processes photos using a Support Vector Machines based method to evaluate the features previously extracted and to assign it a probability of the photo being manipulated. The module can be valuable to automate and speed up the detection of tampered digital photos, and to assertively search the most relevant artefacts.

ALGORITHM

Development of a prototype based on Bluetooth beacons and computer vision for indoor location of mobile devices. The goal is to create non-intrusive, energy efficient, algorithms to locate mobile devices inside a building and tackle the problem of seamless indoor location, namely dead reckoning, trilateration and computer vision. **PROTOTYPE**

Development of an authoring tool to allow easy and intuitive training activities, on Immersive Training for Industry 4.0. This authoring tool is able to integrate multisensory immersive environments that are perceptually certified for training certification. With EIT Manufacturing, a recommendation engine has been developed to assist companies in deciding the best approach to immersive training. **TOOL**


Software development, design and implementation of novel architectures using federated repositories, privacy-preserving mechanisms to support federated machine learning, and blockchain-based mechanisms for tracing data transformations. **PROTOTYPE**

Application of the OGC (Open Geospatial Consortium) standard for IoT and decision support in climate change adaptations for viticulture. **PROOF-OF-CONCEPT**

Creation of a Digital Twin engine based on the 3D Tiles OGC standard, designed for streaming and rendering massive 3D geospatial content. **PROTOTYPE**

Prototyped and tested a software ecosystem for the real-time processing of geospatial data streams, along with tools and methods for the assisted curation and exploratory analysis and publishing of large scientific datasets. **PROTOTYPE**





Development of an agile approach to Enterprise Architecture (EA) resulting in a reusable EA practice for SME's. The result of the work carried out was a transformation plan for the next two years, composed of a set of projects that will enable the migration from the current architecture to the future information systems architecture aligned with the company's business strategy. **METHOD**

Following in the direction of C-Streets European program first was **defined an architecture for a data integration point – Minho Access Point (MAP)** – and after was specified its interoperability requirements, focused on the mechanisms for data exchange between the MAP and the municipal, intercity, and national access points, concerning various mobility services identified, covering application components, interoperability, and security. **PROOF-OF-CONCEPT**

Prototyped and tested a platform that incorporates libraries for efficient spatiotemporal data-access for handling data input to visualisation pipelines. the automatic representation and quantification of change on spatiotemporal phenomena, and its summarisation through static visual narratives. **PROTOTYPE**

Development of extensions to the EasyCrypt framework to deal with post-quantum cryptography, including the capability to express computational complexity restrictions, and their application to the formal verification of advanced cryptographic protocols. **TOOL**

Release of Alloy 6, a new version of the Alloy formal specification language (first developed at MIT) that incorporates major contributions developed in collaboration with ONERA, the French aerospace lab. **TOOL**

Research and development of new storage solutions for HPC data centres, which optimise the access to large amounts of information from Big Data applications, such as AI Frameworks. **METHOD**

Development of a proof of concept for the Mobile Driver's License (mDL). **PROOF-OF-CONCEPT**

Collaboration to establish/improve the teaching of Computer Science in Portuguese schools, namely by supporting the creation of innovative practices in the digital age, through new teaching tools, materials, and learning software. **COURSE PROPOSAL**

Prospect the use of data science in port management, under the project Port XXI, funded by ESA - the European Space Agency. **PROOF-OF-CONCEPT**

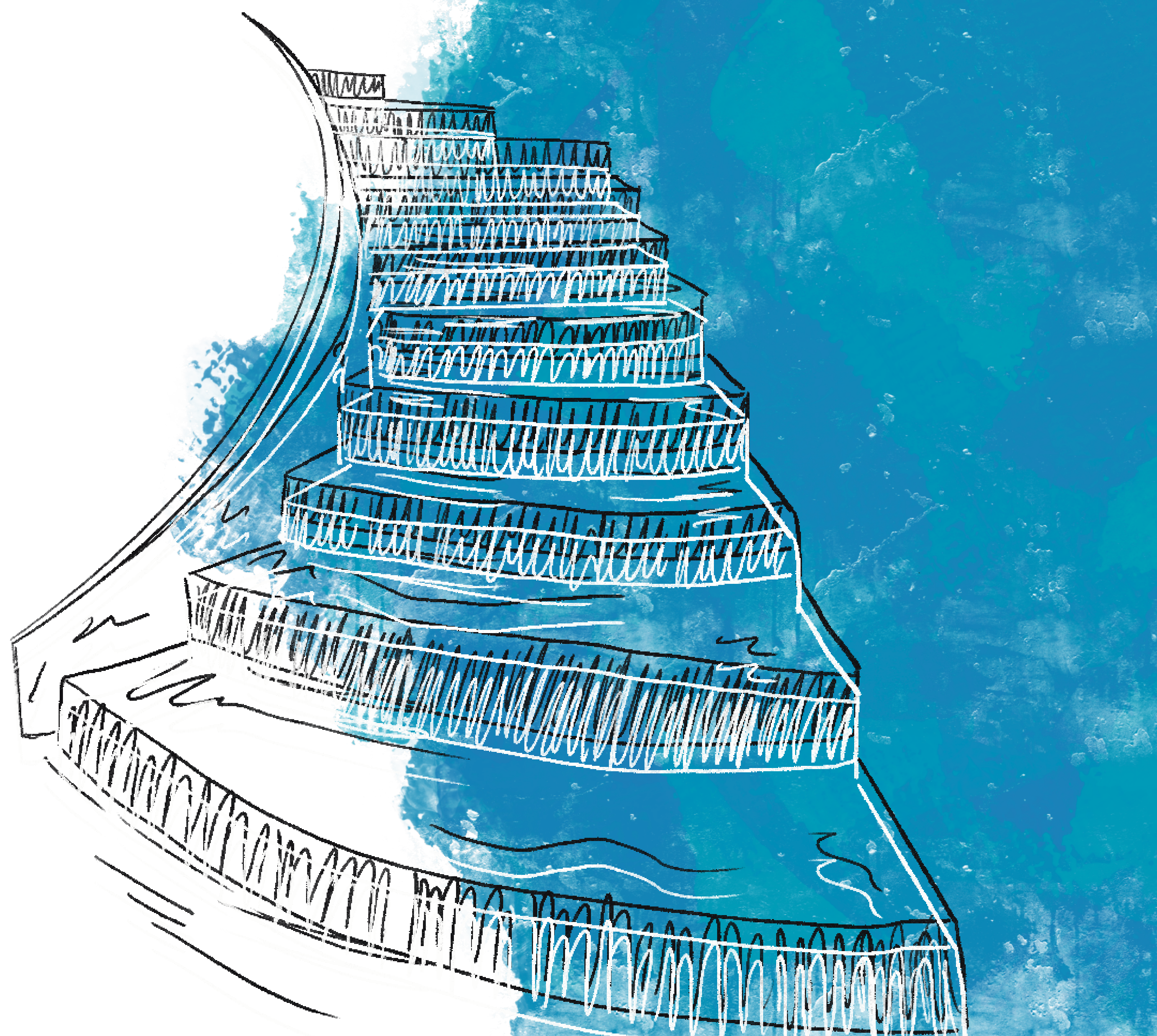
Information extraction and summarisation, using Natural Language Processing, under the project Gentil – Text Mining, in collaboration with IPO Porto. **ALGORITHM**

Development of new methodologies to measure optical properties of liquids and solids including the polymers curing process monitoring in real-time. **METHODOLOGY**

/002

ACHIEVING

It's all about
the journey.



+800

INTEGRATED
RESEARCHERS

+25

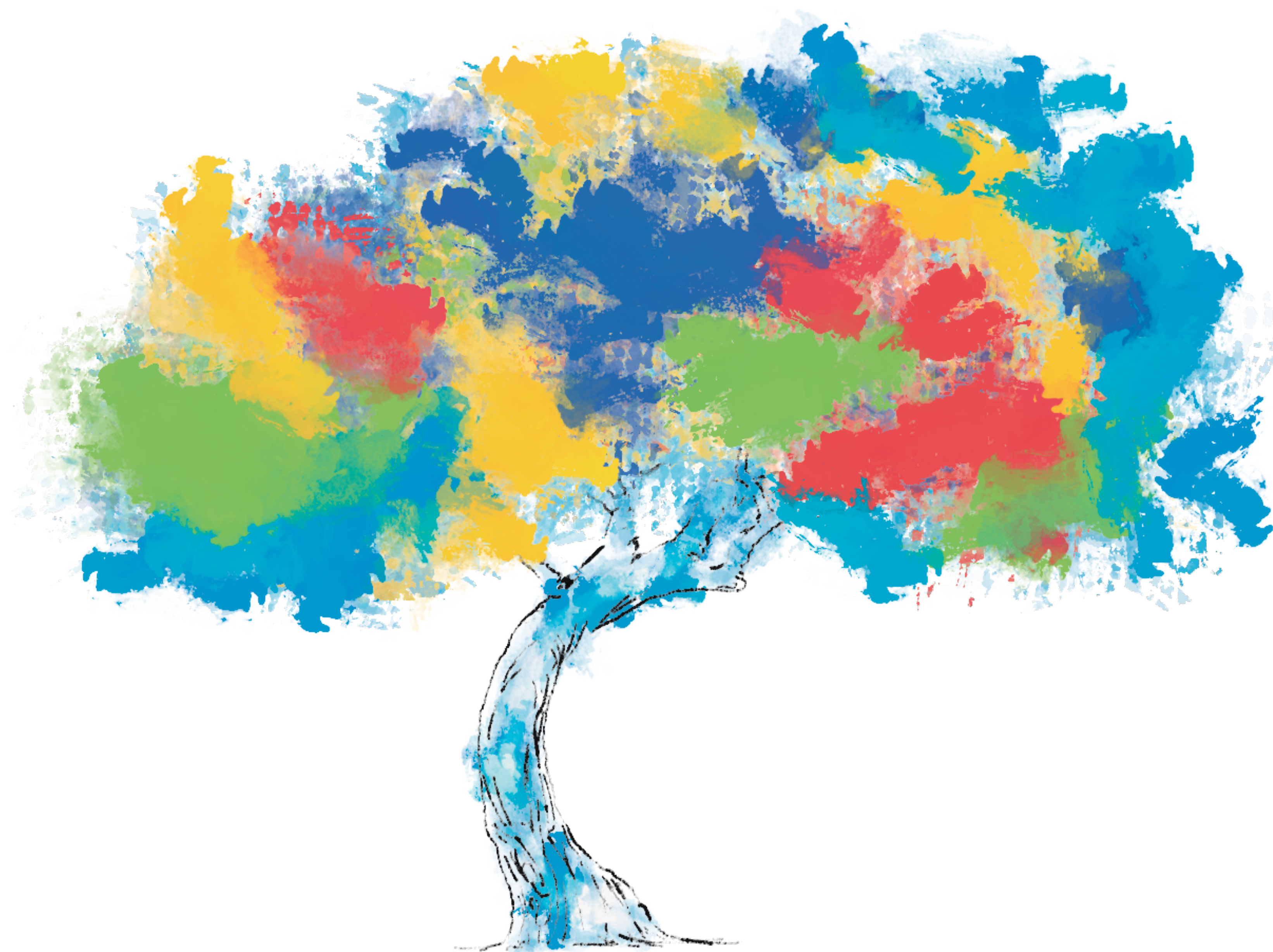
NATIONALITIES

+340

INTEGRATED
PHDs

+300

PEOPLE GOING TO
THE MARKET PER
YEAR



20M€

ACTIVITY

+360

ONGOING R&D
PROJECTS

30

PATENT
APPLICATIONS
(11 GRANTED)

7

ACTIVE SPINOFFS
(TRACK-RECORD:
+20)

2.1. A HUB OF TALENT

Bringing together more than 800 professionals, among **Grant Holders and Trainees** (39%), **Academic Staff** (22%), **R&D Employees** (19%), **Management, Administrative and Technical Staff** (12%) and **Affiliated Researchers** (8%), INESC TEC is one of the leading Portuguese organisations in scientific employment. Multifaceted, versatile, and purpose-driven teams are the core of INESC TEC's mission. Also, INESC TEC acts as a hub of talent, training and transferring thousands of professionals to market every year.

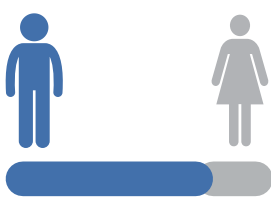
Types of Human Resources		2021
Core Research Team	Employees	159
	Academic Staff	174
	Grant Holders and Trainees	324
	Total Core Researchers	657
	Total Core PhD	255
Affiliated Researchers		67
Management, Administrative and Technical Employees	Employees	102
	Academic Staff	11
	Grant Holders and Trainees	6
	Management, Administrative and Technical Employees	119
Total Integrated HR		843
Total Integrated PhD		342



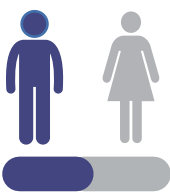
39%
Grant Holders and Trainees
MALE 75% | FEMALE 25%



22%
Academic Staff
MALE 84% | FEMALE 16%



19%
R&D Employees
MALE 78% | FEMALE 22%



12%
Management, Administrative and Technical Employees
MALE 46% | FEMALE 54%



8%
Affiliated Researchers
MALE 88% | FEMALE 12%

Grant Holders and Trainees are still the largest group of human resources because INESC TEC plays a relevant role as a starting point for junior researchers, providing training and being the perfect place to carry out their research. We attract talent from more than 25 nationalities, crossing different mindsets and boosting multidisciplinary research.

2.2. PUBLICATIONS

The number of publications is obtained from different indexing sources (**ISI** and **SCOPUS**) gathered by the **Authenticus** platform, a software platform that automatically associates publication authors to known researchers and corresponding **publication records to Portuguese institutions, and from CORE (Computing Research and Education Association of Australasia)**.

Publication Type	NIS	PE	ISE	CS
Indexed Journals	121	98	122	136
Indexed Conferences	90	40	90	170
Books	1	0	2	0
Book Chapters	4	3	19	12
Concluded PhD theses - members	8	4	7	11
Concluded PhD theses - supervised	13	6	10	30

24%

16%

25%

35%

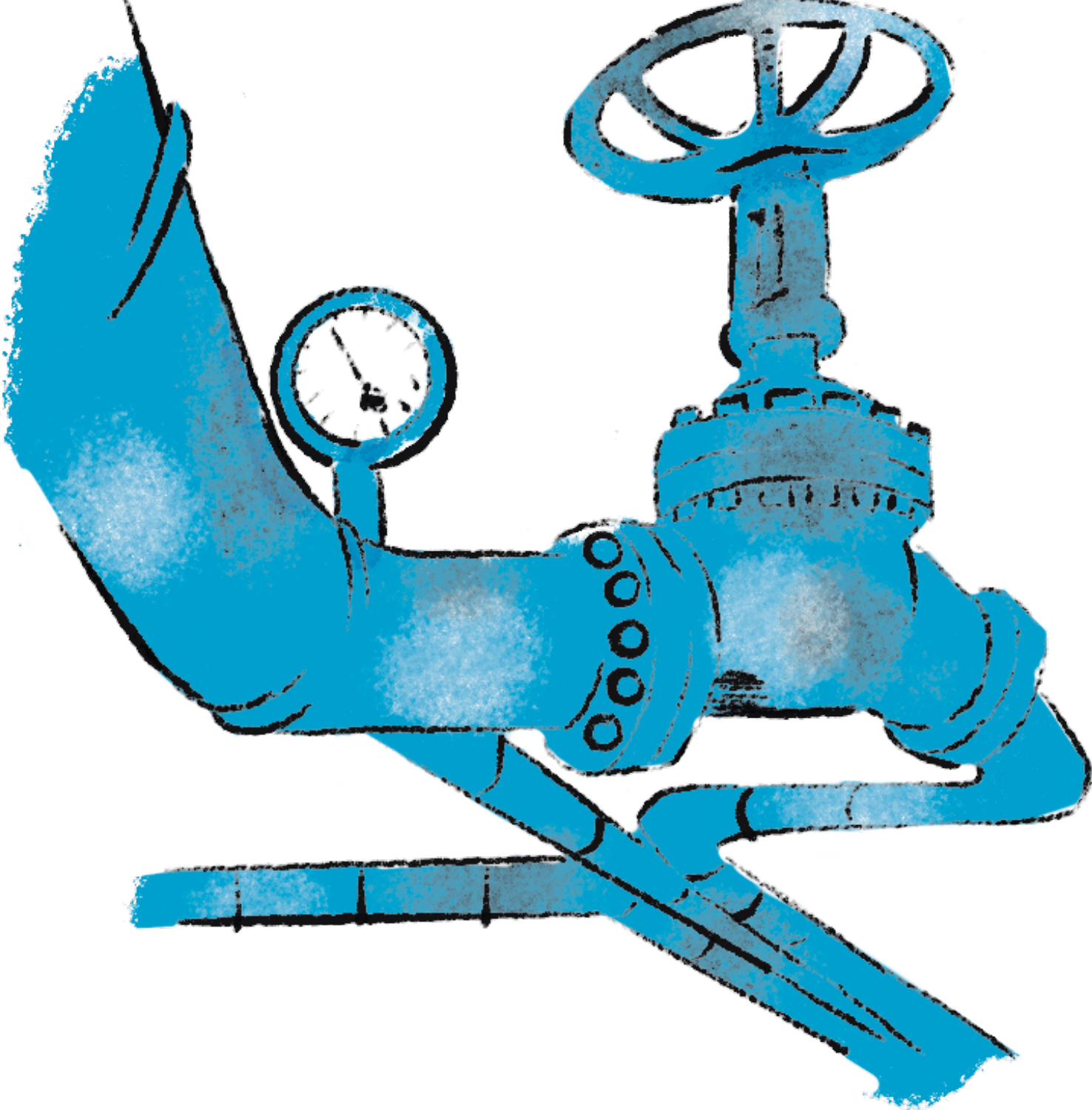
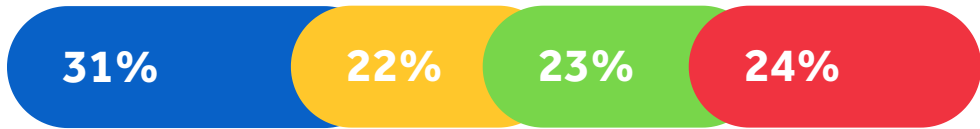


INESC TEC's purpose has always been to keep its scientific production stable in terms of articles in indexed journals, with a clear focus on publications classified by SCOPUS. Moreover, despite some restrictions caused by the pandemic during 2021 - and considering how we successfully adapted events to formats other than online initiatives -, INESC TEC R&D Centres firmly increased their activity in indexed conferences proceedings.

2.3. INVESTMENT AND VALUE

INESC TEC's Research, Development and Innovation activities are supported by relevant funding opportunities, originated from both national and international sources. **The comprehensive development and submission of proposals to different funding programmes, always in collaboration with the R&D Centres and other structural services, is crucial to the institution's success.**

Funding Source	NIS	PE	ISE	CS
National R&D Programmes - FCT	1037	179	408	670
National R&D Programmes - S&T Integrated Projects	5	44	0	0
National Cooperation Programmes with Industry	622	367	755	446
EU Framework Programmes	1415	1648	1468	998
EU Cooperation Programmes - Other	309	8	11	121
R&D Services and Consulting - National	759	850	773	1132
R&D Services and Consulting - International	366	123	70	119
Other Funding Programmes	72	11	7	66
Total Projects/Funding (in k€)	4585	3230	3492	3552



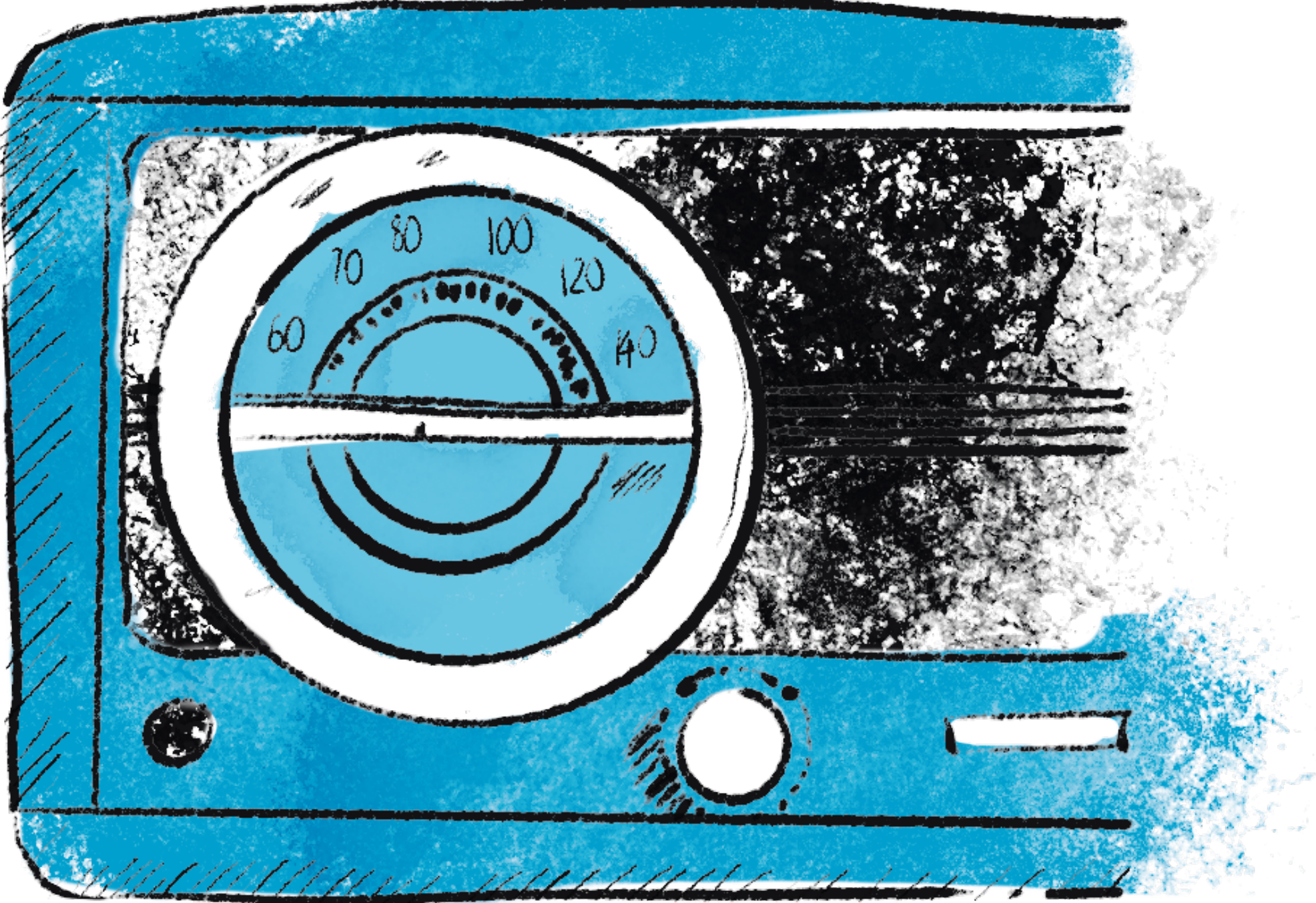
Secure funding opportunities are vital to support researchers in submitting successful proposals and developing their planned activities. The projected evolution in 2021 showed an increase in European programmes and an overall growth in all funding sources, emphasising the importance of international investment to the Institute's outputs.

2.4. BROADCAST

Dissemination activities allow INESC TEC to build bridges with academia, industry, public administration, and society, as those are relevant sectors to share the knowledge and results generated from the Institute's research and innovation activities. **The dissemination of research results, projects' development and other scientific activities helps INESC TEC to create opportunities, towards value creation and social impact**

Along 2021 our researchers participated and attended more than 7000 conferences, workshops and scientific sessions.

Participation as principal editor, editor or associated editor in journals	118
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	77
International events in which INESC TEC members participate in the programme committees	259
Participation in events such as fairs, exhibitions or similar	82
Conferences, workshops and scientific sessions organised by the R&D Centres	75
Participants in the conferences, workshops and scientific sessions organised by the R&D Centres	7 239
Advanced training courses organised by the R&D Centres	15
Magazine issues edited and published by INESC TEC (INESC TEC Science&Society)	2
Science Communication features on INESC TEC's Newsletter BIP (Spotlight)	2
Podcasts produced by INESC TEC (Science Bits)	11



In 2021, and in order to reinforce the commitment to take science and technology to the people, INESC TEC launched a brand-new section in its newsletter, BIP. Spotlight is a science communication section dedicated to the research carried out at INESC TEC, delving deeply into topics and issues which our researchers are solving, aligned with the major trends in science communication. Also, INESC TEC edited two issues of INESC TEC Science & Society Magazine and continued recording its Podcast, Science Bits.



INESC TEC Science&Society Magazine

As an Associated Laboratory, INESC TEC plays an active role in advising public entities dedicated to science and innovation. INESC TEC Science&Society Magazine aims at disseminating science among society and contributing to the discussion of public policies.

Two issues of INESC TEC Science & Society Magazine were launched in June and December 2021, addressing the topics "High Value Added, Resilient and Sustainable Industry" and "Beyond 5G Communications", respectively. The magazine is also available in digital format (in Portuguese and English). Its digital versions had a total of 2600 views in 2021.

Spotlight

Spotlight is a new section, introduced in 2021 in BIP, INESC TEC monthly newsletter. Spotlight is a **science communication** section dedicated to research carried out at INESC TEC, delving deeply into topics and issues researchers from our institution are solving, according to the major trends in science communication. Two issues for each new section were published.

Science Bits

INESC TEC Science Bits is a podcast, produced by INESC TEC and Engenharia Rádio, that aims to shed a light on the latest trends in science and technology, trying to dive deeper in each subject with the help of INESC TEC researchers. In 2021, 11 episodes were recorded, counting on with 3140 streams.

MAIN HIGHLIGHTS

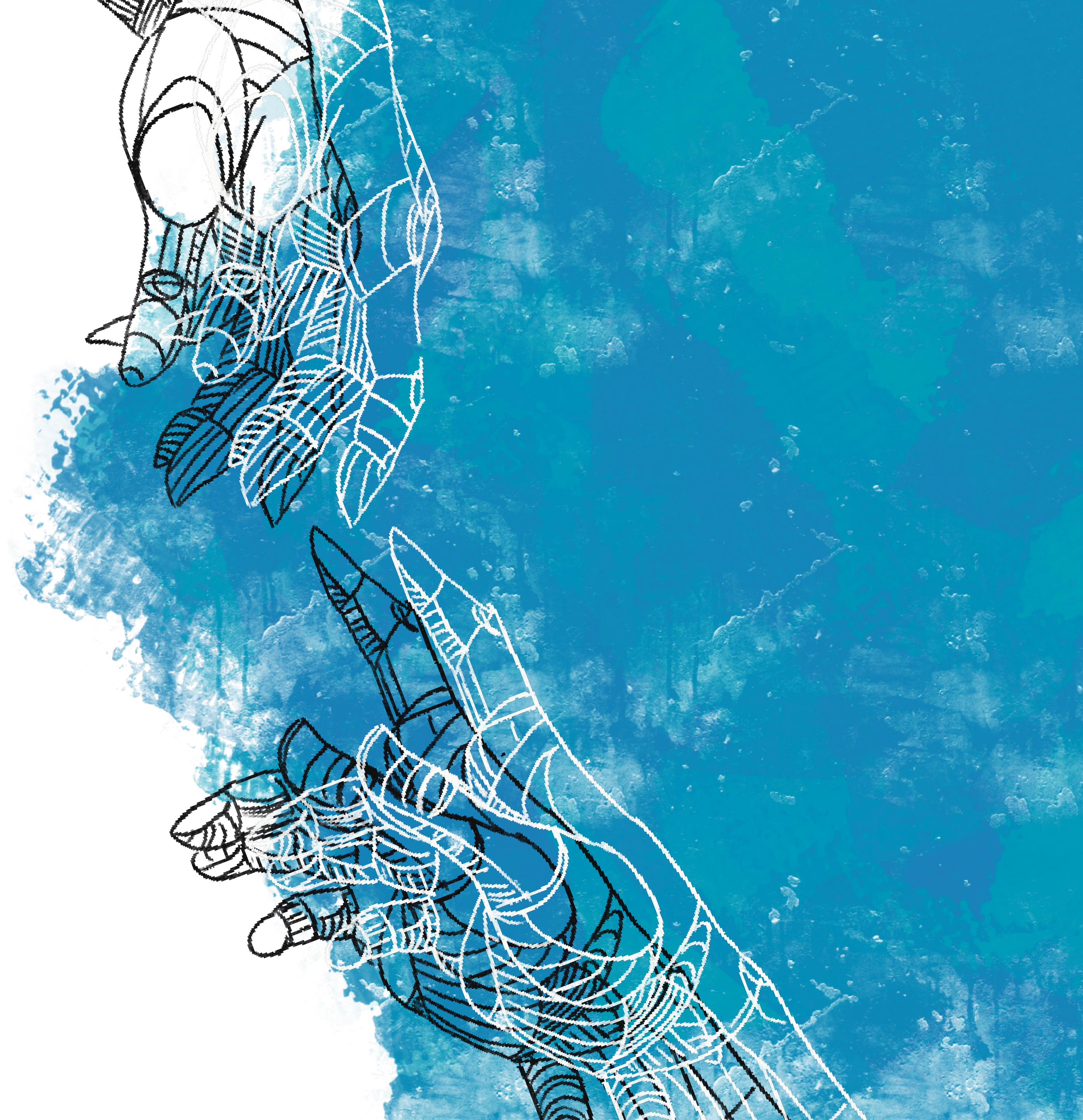
At national level, the highlight goes to the **Autumn Forum**, which did not take place in 2020, but rather in 2021. The sixth edition of the Autumn Forum took place on November 23, under the motto "**Artificial Intelligence and Health: Challenges and Opportunities**", gathering **130 attendees**. In 2021, the Forum was organised in partnership with the Institute of Public Health of the University of Porto (ISPUP).

Internationally, the **EUCNC (European Conference on Networks and Communications) & 6G Summit** was the event with the highest influence, thanks to the online presence of more than **2300 participants** over four days. Organised between June 8 and 11, the conference discussed the requirements and the **6G research programmes**.

Honouring the commitment to support science communication initiatives, INESC TEC was involved in a series of activities that took place in different formats, namely the Science Summit (promoted by the Ministry of Science, Technology and Higher Education and the National Agency Ciência Viva), the Mostra UP, the European Researchers' Night and FICA – International Science Festival.

/003 **BEING**

It's all about
people.



3.1. OUR ORGANISATION

ASSOCIATES

University of Porto
Polytechnic of Porto
INESC
University of Minho
University of Trás-os-Montes and Alto Douro

NUCLEI

Universidade Aberta
Polytechnic Institute of Bragança

WE **COVER THE KNOWLEDGE-TO-VALUE PRODUCTION CHAIN.**
WE **TRANSFER KNOWLEDGE, TECHNOLOGIES AND PEOPLE.**
WE **ENABLE SCIENCE-BASED INNOVATION.**
WE **OFFER ADVANCED CONSULTING AND TRAINING.**
WE **CREATE SPIN-OFFS.**

WE ARE **COMPUTER SCIENCE.**
WE ARE **INDUSTRIAL AND SYSTEMS ENGINEERING.**
WE ARE **NETWORKED INTELLIGENT SYSTEMS.**
WE ARE **POWER AND ENERGY.**
WE ARE **INESC TEC.**

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José Manuel Mendonça



VICE CHAIRMAN/CEO
João Claro



MEMBER OF THE EXECUTIVE BOARD
Gabriel David



MEMBER OF THE EXECUTIVE BOARD
Luís Carneiro



MEMBER OF THE EXECUTIVE BOARD
Luís Seca



MEMBER OF THE EXECUTIVE BOARD
Maria da Graça Barbosa



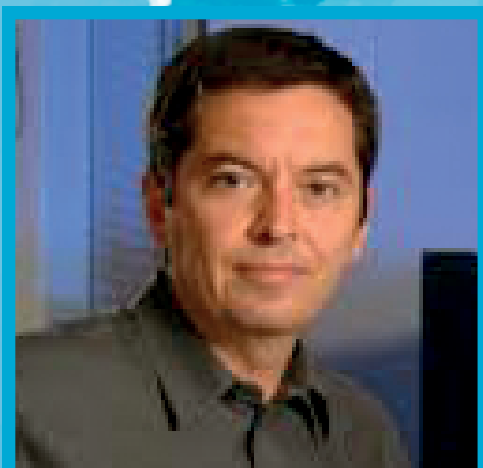
Aníbal Matos



José Carlos Caldeira



Rui Oliveira



JOSÉ FORTES
CHAIRMAN
 UNIVERSITY OF FLORIDA (USA)



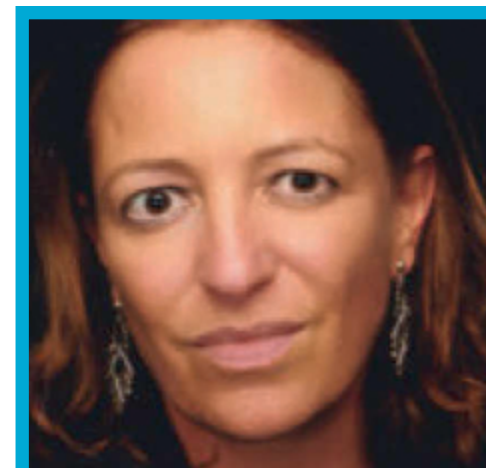
ANNE-MARIE
KERMARREC
 INRIA – RENNES (FRANCE)



BRUNO SICILIANO
 UNIVERSITÀ DEGLI STUDI DI
 NAPOLI FEDERICO II, PRISM LAB
 (ITALY)



EDWARD KNIGHTLY
 RICE UNIVERSITY (USA)



ELSA ANGELINI
 IMPERIAL COLLEGE
 LONDON (UK)



MARIO PAOLONE, EPFL
 L'ECOLE POLYTECHNIQUE
 FÉDÉRALE DE LAUSANNE
 (SWITZERLAND)



MASARU KITSUREGAWA
 INSTITUTE OF INDUSTRIAL
 SCIENCE, THE UNIVERSITY OF
 TOKYO (JAPAN)



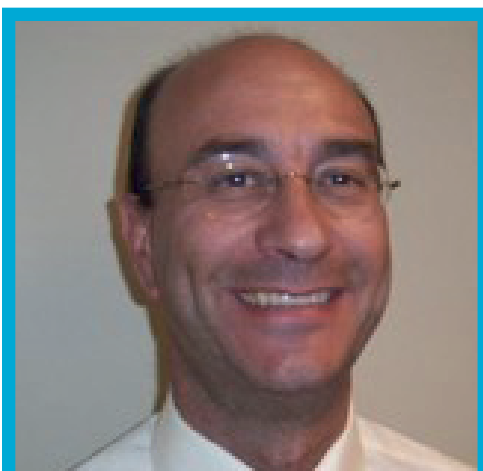
M. GRAZIA SPERANZA
 UNIVERSITÀ DEGLI STUDI
 DI BRESCIA (ITALY)



PERE RIDAO
 INSTITUT DE RECERCA EN VISIÓ PER
 COMPUTADOR I ROBÒTICA (SPAIN)



ROBERT LIEBERMAN
 FORMER PRESIDENT OF SPIE,
 PRESIDENT OF LUMOPTIX LLC (USA)



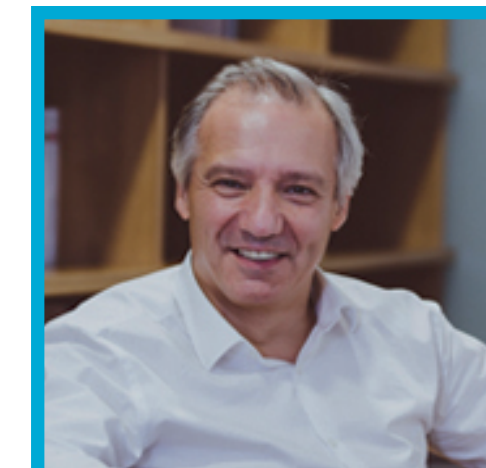
TOMÁS GÓMEZ SAN
ROMÁN
 UNIVERSIDAD PONTIFICIA
 COMILLAS (SPAIN)



VOLKER STICH
 AACHEN UNIVERSITY OF
 TECHNOLOGY (GERMANY)



ALBERTO BARBOSA
 EDP
 MEMBER OF THE GENERAL
 AND ADVISORY BOARD



ANTÓNIO MURTA
 PATHENA SGPS S.A.
 MANAGING PARTNER



JOÃO PAULO OLIVEIRA
 THE NAVIGATOR COMPANY
 MEMBER OF THE
 ADMINISTRATIVE BOARD



JORGE VASCONCELOS
 NEW ENERGY SOLUTIONS
 CHAIRMAN



LUÍS FILIPE REIS
 SONAE FINANCIAL SERVICES
 CEO

SCIENTIFIC ADVISORY BOARD

BUSINESS ADVISORY BOARD

SCIENTIFIC COUNCIL



**MANUEL ANTÓNIO
MATOS (CHAIR)**
FEUP



ANA MARIA VIANA
CEGI (ISEP)



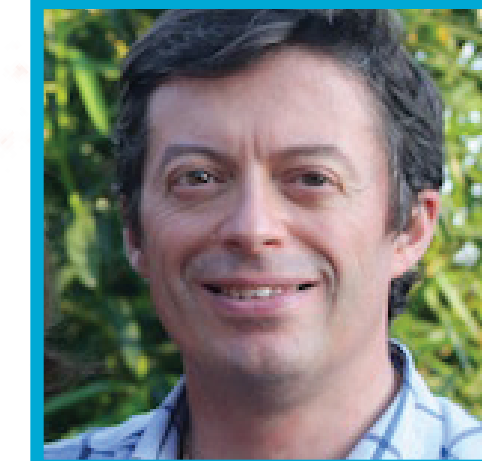
**AURÉLIO JOAQUIM
CAMPILHO**
C-BER (FEUP)



EDUARDO SILVA
CRAS (ISEP)



**HENRIQUE FARIA
SALGADO**
CTM (FEUP)



JOÃO JOSÉ PINTO FERREIRA
CITE (FEUP)



JOÃO PAULO SARAIVA
CPES (FEUP)



JORGE PINHO DE SOUSA
CESE (FEUP)



MANUEL SANTOS SILVA
CRIIS (ISEP)



**MARIA ANTÓNIA
CARRAVILLA**
FEUP



MARIA CRISTINA RIBEIRO
CSIG (FEUP)



**PAULO VICENTE
MARQUES**
CAP (FCUP)



PAVEL BRAZDIL
LIAAD



SANDRA ALVES
CRAC^S (FCUP)



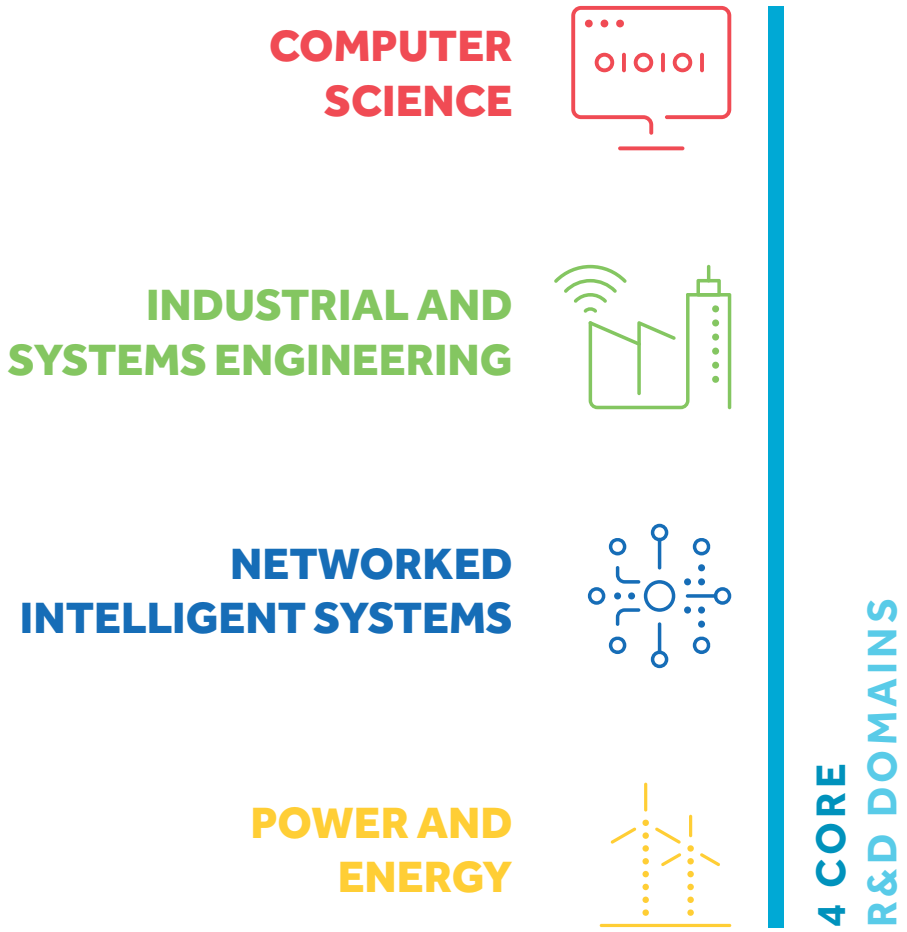
**SUSANA ALEXANDRA
BARBOSA**
CSIG

3.2. OUR SCIENCE AND TECHNOLOGY

Research at INESC TEC is undertaken by 13 research centres, brought together in specific domains for strategy development and long-term planning of the Institute’s four scientific areas: **Computer Science (CS)**, **Industrial and Systems Engineering (ISE)**, **Networked Intelligent Systems (NIS)** and **Power and Energy (PE)**.

The domains bring together Centres in core scientific domains for R&D strategy development and long-term planning, and the TEC4 initiatives articulate the activities of the institution towards a set of main markets matching major societal challenges.

As a whole, this model implements a complete knowledge value chain, integrating four stages – **knowledge production, applied research, development, and technology transfer** – whose **outcomes fall in different Technology Readiness Levels and whose activities are supported by different funding sources**.

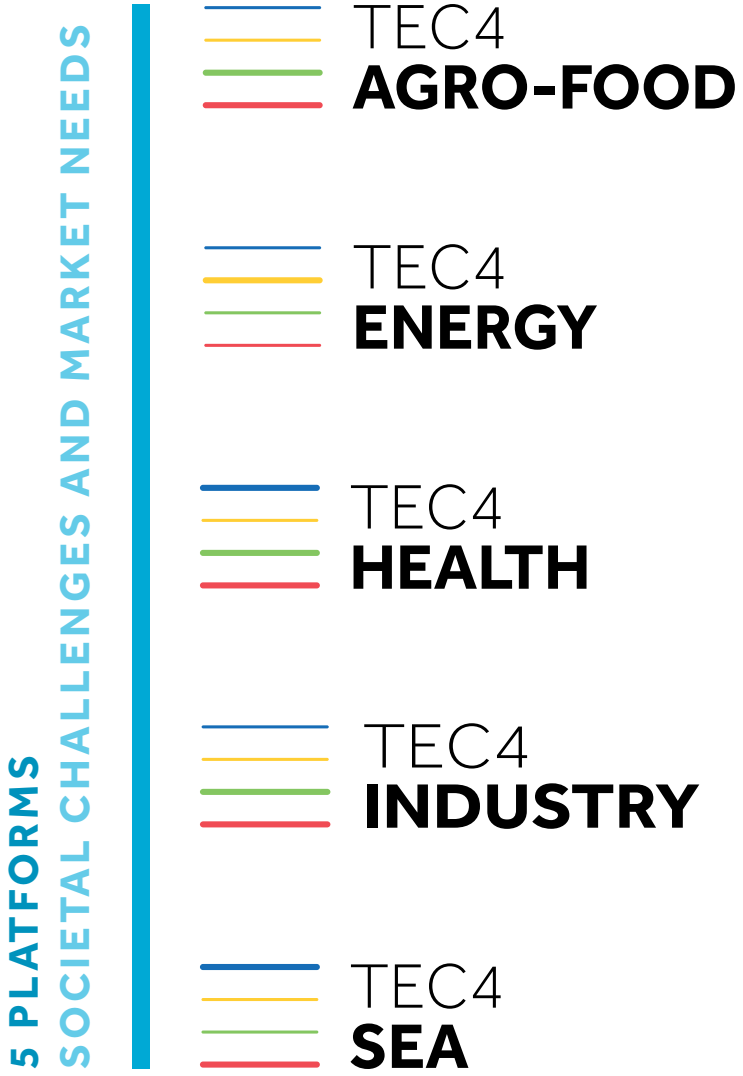


RESEARCH DOMAINS BEHIND SCIENCE PUSH

Domains of research centres build a multidisciplinary environment to optimise resources and maximise synergies.

INNOVATION TEC4 BEHIND MARKET PULL

Strategy driven platforms addressing and impacting great societal challenges and market needs.





COMPUTER SCIENCE

As computing becomes fully decentralised, mobile, increasingly autonomous, and ubiquitous, there is an increasing need to address many of these technological as well as societal challenges with competences on Artificial Intelligence, Computer Graphics and Virtual Environments, Cryptography and Information Security, Information Management and Systems, Parallel and Distributed Computing, and Software Theory and Engineering.

RESEARCH CHALLENGES

**COMPUTING SYSTEMS
TO EMPOWER HUMAN
CAPABILITIES**

**METHODS AND TOOLS TO BOOST
QUALITY AND ENERGY-EFFICIENCY
OF FUTURE SOFTWARE SYSTEMS**

**PERFORMANCE, INTEROPERABILITY,
AND DEPENDABILITY OF CRITICAL
INFORMATION SYSTEMS**

**TRUSTWORTHY CONTROL OF DATA
CONFIDENTIALITY AND PROVENANCE**



INDUSTRIAL AND SYSTEMS ENGINEERING

Research and innovation in systems and services applied to the management of value streams in different industries (e.g., manufacturing, process industries, retail, health and mobility). Technologies such as collaborative robots, optimisation, machine learning and blockchain are being thoroughly studied from the lens of operations management and decision support.

RESEARCH CHALLENGES

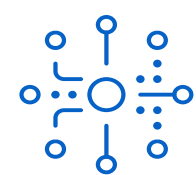
**OPERATIONS MANAGEMENT FOR
RESPONSIVE, RESILIENT AND
SUSTAINABLE SYSTEMS**

**OPERATIONS RESEARCH FOR DECISION
SUPPORT IN A DIGITALISED WORLD**

**COGNITIVE, AWARE AND COLLABORATIVE
ROBOTIC AND AUTONOMOUS SYSTEMS**

**RESPONSIBLE AND SUSTAINABLE
TECHNOLOGY DRIVEN INNOVATION**

**INDUSTRIAL INFORMATION SYSTEMS
SUPPORTING CIRCULARITY AND
SUSTAINABILITY**



NETWORKED INTELLIGENT SYSTEMS

Development of systems that can aggregate sensing, computer vision, communications, and navigation components, using low power devices, and implementing edge intelligence (including cyber-physical systems and autonomous systems), bearing in mind the capacity to adapt and learn from past experience.

RESEARCH CHALLENGES

- NOVEL PERCEPTION APPROACHES
- CONTEXT-AWARE COMMUNICATIONS SYSTEMS
- BEYOND HUMAN VISION
- AUTONOMY OF ROBOTIC SYSTEMS



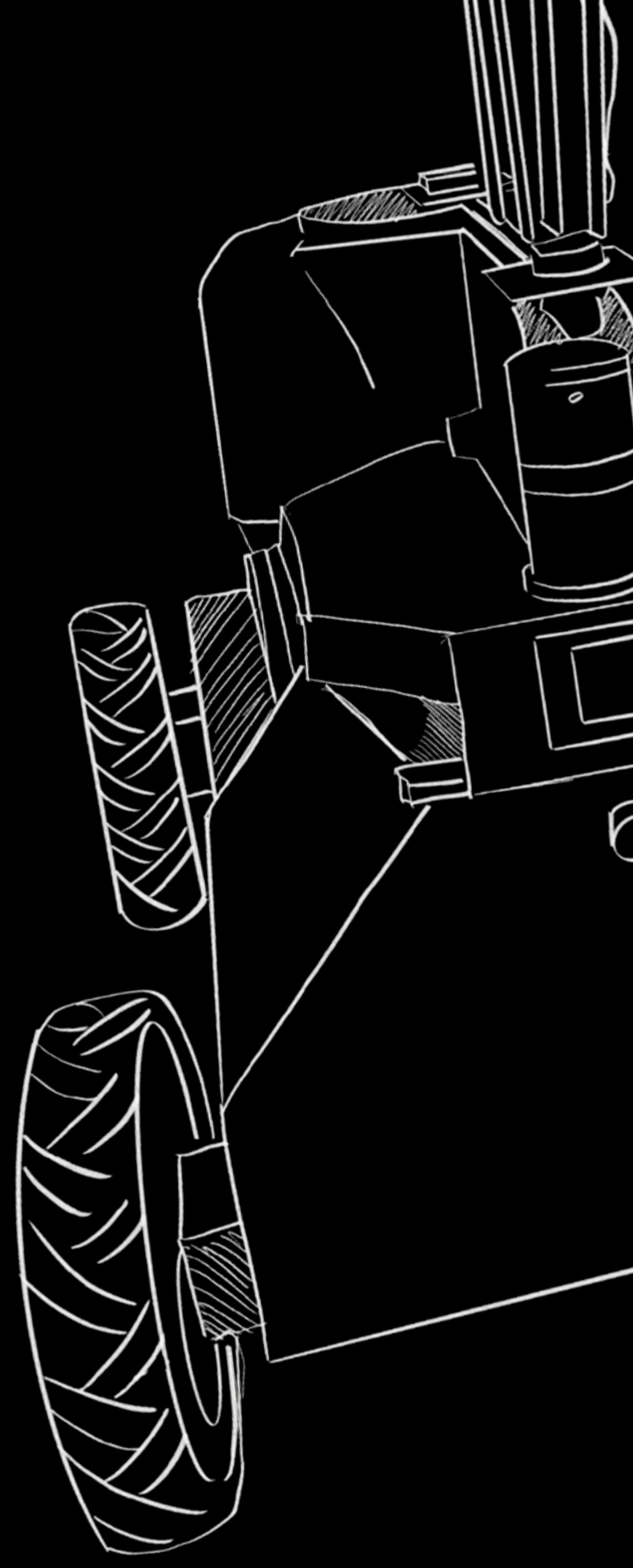
POWER AND ENERGY

Aligning with the EU policies for digitalisation, energy efficiency and increase in Renewable based Energy Sources (RES) integration, the domain addresses the main challenges of the energy sector transformation, exploiting synergies between advanced mathematical modelling and digital technologies to support a reliable decarbonisation of the energy system.

RESEARCH CHALLENGES

- MASSIVE RES INTEGRATION THROUGH POWER ELECTRONIC-BASED INTERFACE
- LARGE-SCALE MODELLING AND OPTIMISATION OF ENERGY SYSTEMS
- DATA-DRIVEN METHODOLOGIES FOR ENERGY SYSTEMS
- HEALTH CONDITIONS OF ELECTRICAL ASSETS UNDER SMART GRID OPERATION
- CYBERSECURITY AND IOT FOR ELECTRICAL INFRASTRUCTURES

TEC4
AGRO-FOOD



TEC4
ENERGY



TEC4
HEALTH



TEC4
INDUSTRY



TEC4
SEA





TEC4 AGRO-FOOD



Co-shaping the digital (r)evolution in Agro-Food and Forestry through research and technological development in Information and Communication Technologies and Electronics (ICT&E) and Robotics.

Main Innovation Services

- Smart Precision Agriculture and Forestry
- Bioeconomy
- Food Security



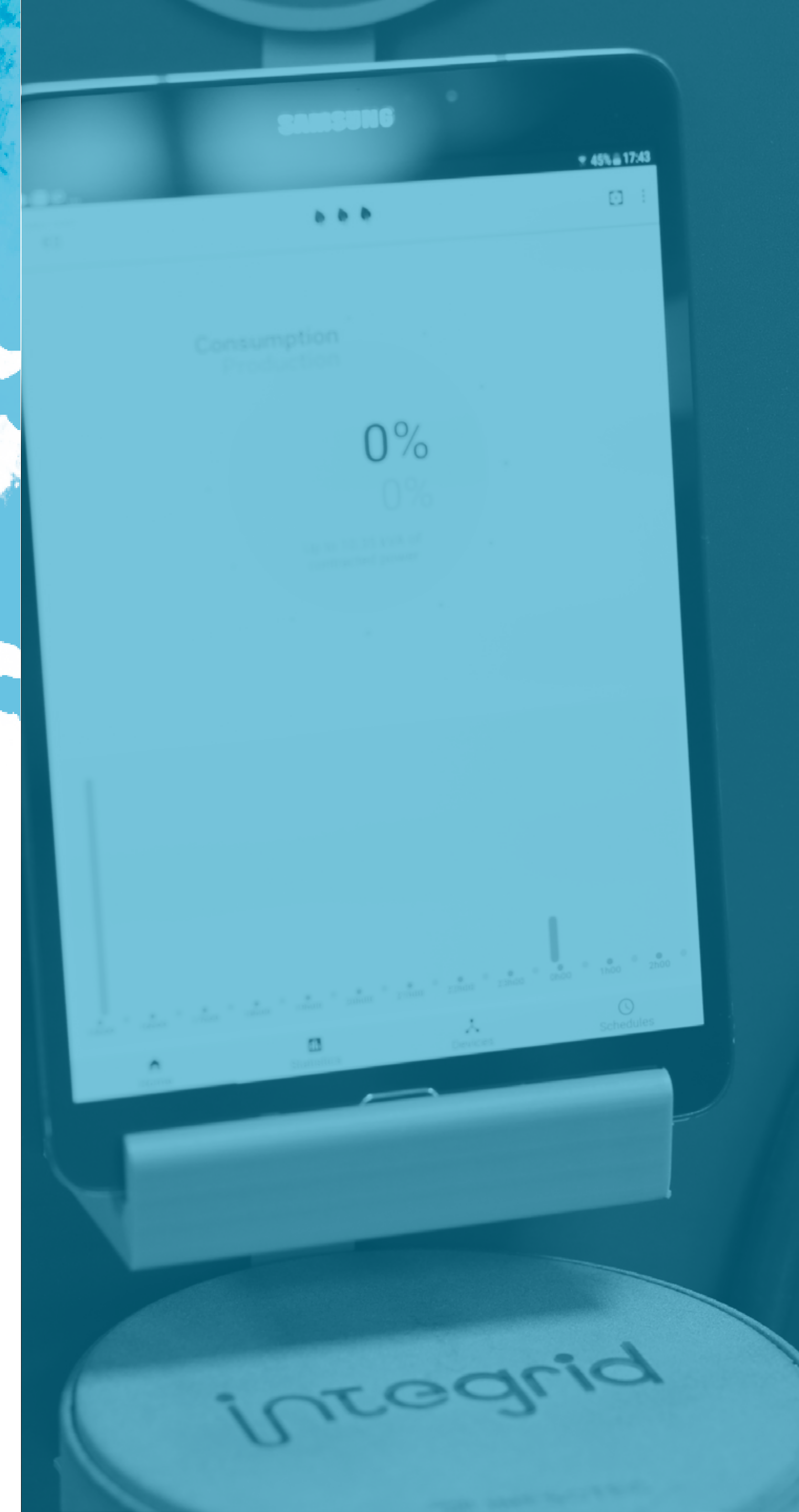
TEC4 ENERGY



Decarbonisation and digitalisation of the energy sector, which will be heavily digitalised, decentralised, under a user centric and market-based approach, involving a large-scale integration of renewable power sources.

Main Innovation Services

- Energy Conversion and Efficiency
- Electrical Network Operation and Optimisation
- Electric Mobility
- Asset Management and Predictive Maintenance





TEC4 INDUSTRY

Generating a convergence of knowledge and competences into producing solutions for the Retail and Manufacturing Industry.

Main Innovation Services

- Factory design and operational planning
- Future industrial robotics and collaborative robotics
- Logistics and Retail
- Predictive Maintenance and Consumer Forecasting
- Digital transformation



TEC4 HEALTH

Inducing human centered systems engineering towards personalised medicine, healthier life style and better health systems management.

Main Innovation Services

- Artificial Intelligence Enhanced Healthcare
- Predictive Analytics
- TeleHealth and Information Systems
- Healthcare Sensing and Monitoring



TEC4 SEA



Inducing R&D activities targeting sea and deep-sea challenges towards a sustainable Sea Economy.

Main Innovation Services

- 3D Mapping and data fusion in unstructured environments
- Development of optical and bio-sensors
- Broadband communications solutions for marine environments
- Data collection, processing and management



INESC TEC has active participation in eleven Collaborative Laboratories (CoLABs). This involvement opens opportunities to expand research into the CoLABs areas of application, ranging from Sea sectors to Energy, Agro-Food or Cybersecurity. Also, it strengthens knowledge sharing, creates highly qualified jobs for junior talent, and overall reinforces the institute's role as an interface institution of excellence.

The Collaborative Laboratories are a governmental initiative aimed to foster new institutions in Portugal designed to close the gap between research institutions and the market/industry as CoLABs focus their activities on Technology Readiness Levels (TRL) closer to the market and technology transfer.



AQUAVALOR

Aims to boost thermal and mineral waters as anchor products for regional development and promotion of tourism throughout the year, particularly in low-density territories.



VINES&WINES

The mission of the VINES & WINES CoLAB is developing and communicating knowledge and technology, in order to support the wine sector, preparing and adapting the national wine system for the major challenges it faces.



HYLAB

Aims to set up a network of competencies in R&D and new technologies aimed at the scientific and technological development of Green Hydrogen, covering the various components of the value chain.



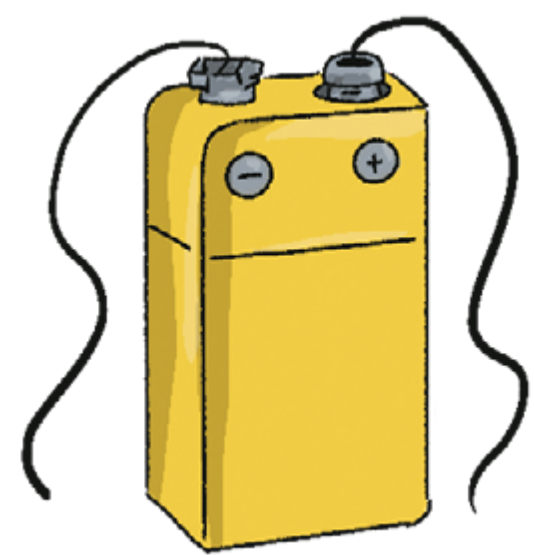
SMART ENERGY LAB

SeLAB aims to fill a gap in the academic/ industrial energy ecosystem by finding solutions that help the energy transition process of energy users, from the development and convergence of knowledge about key verticals in the industry.



FORESTWISE

Led by INESC TEC, FORESTWISE aims at developing applied research, innovation and transfer of technology activities, in order to enhance the competitiveness of the Portuguese forestry sector, and minimise the negative effects of wildland fire.



VASCO DA GAMA

VG-CoLAB - Energy Storage is focused on providing high technology services and added-value products, as well as innovative solutions for its partners and the market, particularly in the field of electrochemical energy storage.



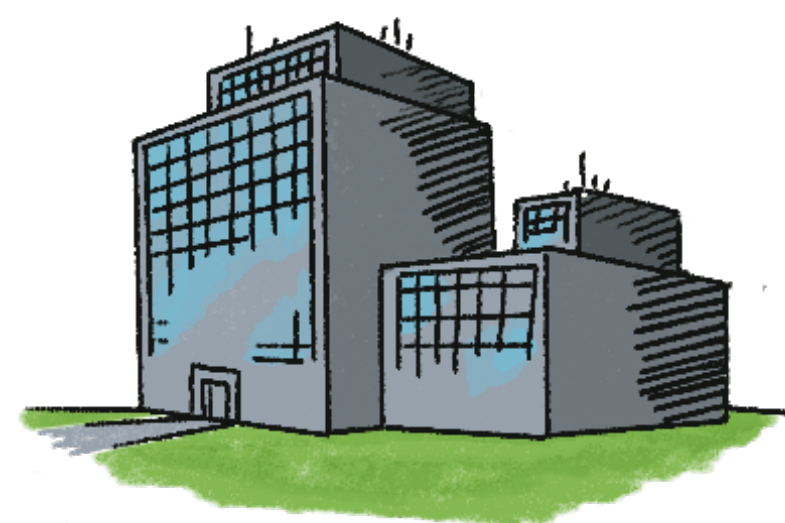
SFCOLAB

Generator centre of innovative digital solutions and automated for efficient resource management, and to maximise the added value of domestic products of horticulture, fruit growing and viticulture.



B2E

B2E aims to promote the creation of highly skilled jobs that will actively contribute to increase the economic and social value of products and services – according to new and existing biological processes, including the internationalisation of national scientific and technological expertise.



BUILT

The BUILT CoLAB aims to develop innovative solutions for adaptable, smart, resilient and sustainable infrastructure and buildings, leading to a common value creation model that will contribute to the transformation of the Architecture, Engineering and Construction sector.



FEEDINOV

Aims to improve safety along the food chain, with an impact on the safety of animal products, increasing consumer confidence in domestic production and strengthening the role of the animal feed industry in the production of healthy, sustainable and environmentally friendly products.



VORTEX

Vortex aims to become the largest international hub for accelerating innovation and knowledge and technology transfer in the areas of cybersecurity and cyber-physical systems, actively contributing to innovate and develop cutting-edge technologies.



3.3. BORDERLESS SCIENCE

Because we believe that science and technology have no borders and that collaboration is a source of strength and a pathway to thriving, INESC TEC has been building relationships with institutions from other countries and exploring opportunities and synergies around the world, namely North America, South America, and the European Union. Three particular initiatives stand out:

UT Austin Portugal Program, creating a genuinely transatlantic collaborative R&D ecosystem and bringing together Portuguese stakeholders with UT Austin's counterparts.

INESC P&D Brasil, promoting important relationships between Portugal and several public Universities in Brazil, while achieving a particular status as science and technology partner.

INESC Brussels Hub, building internal capacity, representation, and visibility, lobbying and networking in the capital of the European Union.





UT Austin Portugal

COORDINATORS José Manuel Mendonça and Rui Oliveira

The UT Austin Portugal Program is a partnership between the Portuguese Science and Technology Foundation (FCT) and The University of Texas at Austin (UT Austin). For over a decade, these two long-standing transatlantic partners have thrived on creating a genuinely collaborative R&D ecosystem that brought together universities, research performing institutions and laboratories, technology transfer offices and companies in Portugal with UT Austin's counterparts.



INESC Brussels Hub

HEAD OF THE OFFICE Ricardo Miguéis
COORDINATOR OF INESC BRUSSELS HUB AT INESC TEC José Carlos Caldeira

The HUB is the European representation of the five INESC institutes (INESC Coimbra, INESC ID, INOV, INESC MN and INESC TEC) in the capital of the European Union. Its goal is to affirm INESC as a European reference organisation, both for its research and innovation excellence and capacity to contribute to society, policy and the economy. In 2021 the HUB gave continuation to the strategy redesigned at the beginning of the previous year, when the pandemic started being felt in our activity through lockdown measures, heavily impacting an initiative focused until then on physical presence and networking. In this way, one can consider the year 2021 as a year focused on building internal capacity, representation and visibility, lobbying and networking.



INESC P&D BRASIL

COORDINATOR Vladimiro Miranda

INESC P&D Brasil is a successful initiative of INESC TEC, joining together the institute in Portugal with several public Universities in Brazil in a private non-profit R&D institution with administrative headquarters in Santos, São Paulo. The leadership and science management philosophy are clearly recognised as being rooted in INESC TEC, which receives widespread support among Brazilian associates. This amounts to increased visibility and credibility of INESC TEC in South America, having conquered a particular status as science and technology partner under Brazilian eyes, different from any other foreign institution. Such perception improves the possibilities for INESC TEC to increase its participation in activities in Brazil and reduces objections or resistance to the presence of a foreign agent, which is easily triggered in that South American country.

3.4. PROMOTING OUR VALUES

At INESC TEC, progress is all about people, science, and organisation. Therefore, we have been playing our part in changing people's lives. The Technical Committee for Social Responsibility promotes internal and external activities, addressing issues related to our internal community, and supporting the local community and society in general. Also, and with the creation of the Commission for Diversity and Inclusion, we have been developing a non-discrimination and equality policy, committing to a more proactive approach to a diverse and inclusive community.

Moreover, we established a Conflicts of Interest Management Commission to deal with possible conflicts of interest. We also rely on a Data Protection Office supporting all INESC TEC's Community complying with the General Data Protection Regulation (GDPR).

Lastly, we approved the Code of Ethics of INESC TEC, which was an important milestone to establish the Ethics Committee, in 2022.



SOCIAL RESPONSIBILITY

TEAM Sara Brandão, Joana Coelho, Bernardo Silva, Lídia Vilas Boas, Miguel Melo and Rita Cardoso

INESC TEC's Technical Commission for Social Responsibility (CTRS) was created in November 2019 and aims to promote both internal and external actions, addressing issues related not only to the institution itself and its members, but also actions that support the local community and society in general. The Commission continues, together with INESC TEC Executive Board, to work in order to include Social Responsibility in its principles. Teleworking and the profound changes caused by the COVID-19 pandemic, still influenced the execution of the proposed actions. Virtual meetings and the fact that everyone sees their homes as the new workplace, also hardened implementation of some initiatives led by Technical Commission for Social Responsibility.

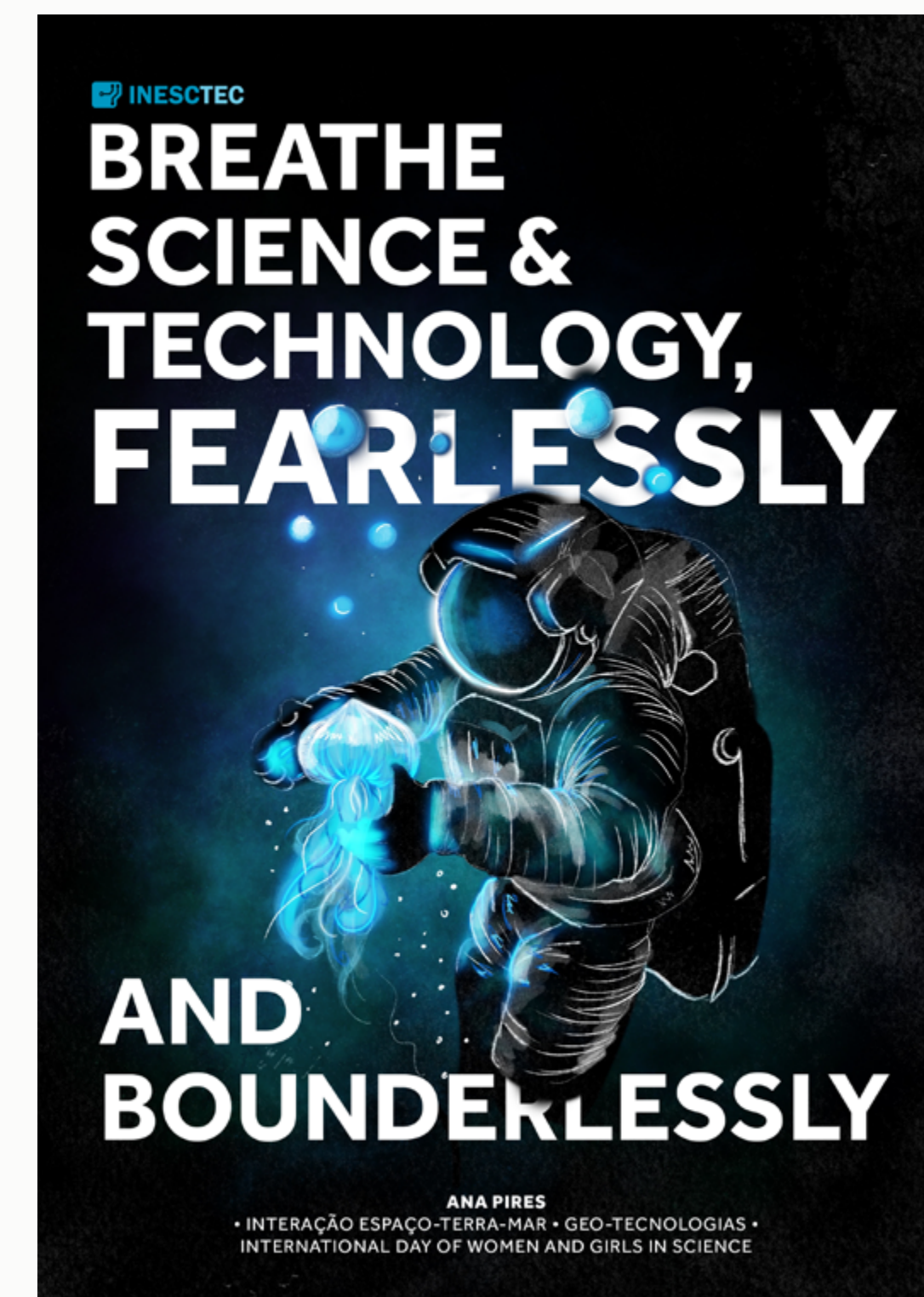
There was, however for the year of 2021, a better understanding of the pandemic, and the plan was made according to the limitations envisioned.



DIVERSITY AND INCLUSION COMMISSION

COORDINATOR Beatriz Brito Oliveira

Following the presentation of the Report of the Working Group for Gender Equality + Diversity and Inclusion, which took place on July 15 2021, the Board of Directors of INESC TEC established the Diversity and Inclusion (D&I) Commission in September 2021, whose main mission is to propose and implement a D&I programme, with gender equality as a priority concern. The Diversity & Inclusion Commission is composed of five INESC TEC collaborators, working in R&D and in support services: Ana Lopes, Beatriz Brito Oliveira, Nuno Moniz, Sheila Habib and Tiago Silva.



CONFLICT OF INTEREST MANAGEMENT COMMISSION

COORDINATOR José Carlos Marques dos Santos

INESC TEC's Conflict of Interest Management Commission (CGCI) is responsible for ensuring the implementation of the Policy, as well as:

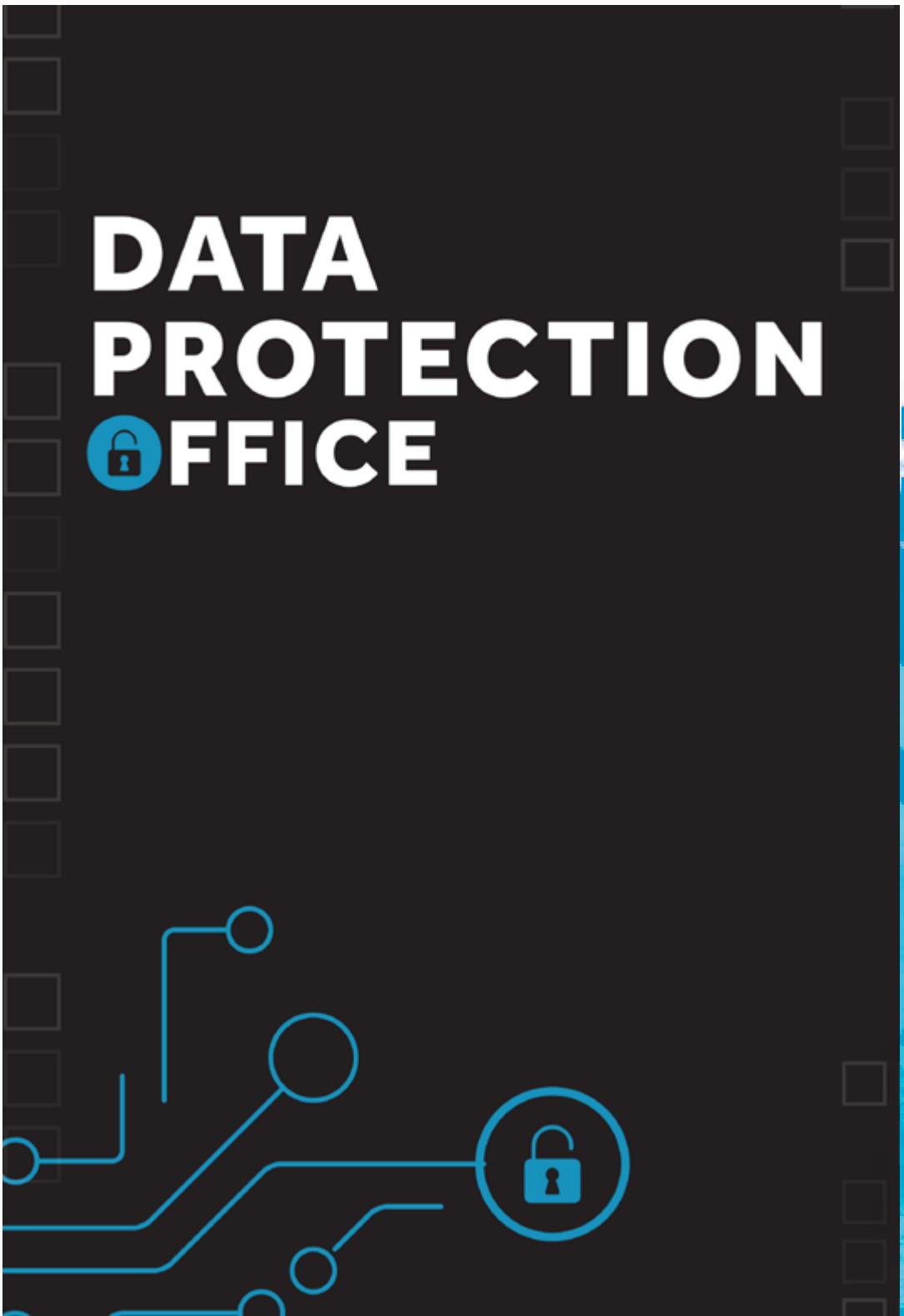
- a) Assessing the declarations of interest and identify conflicts of interest;
- b) Establish plans for the conflict of interest management with all members of INESC TEC community and present them to the Board of Directors, in order to reduce or eliminate said conflicts;
- c) Inform the members of the INESC TEC community of the conclusions of the evaluation processes and the terms of any Conflict of Interest Management Plans (PGCI);
- d) Provide general recommendations on conflict of interest management.

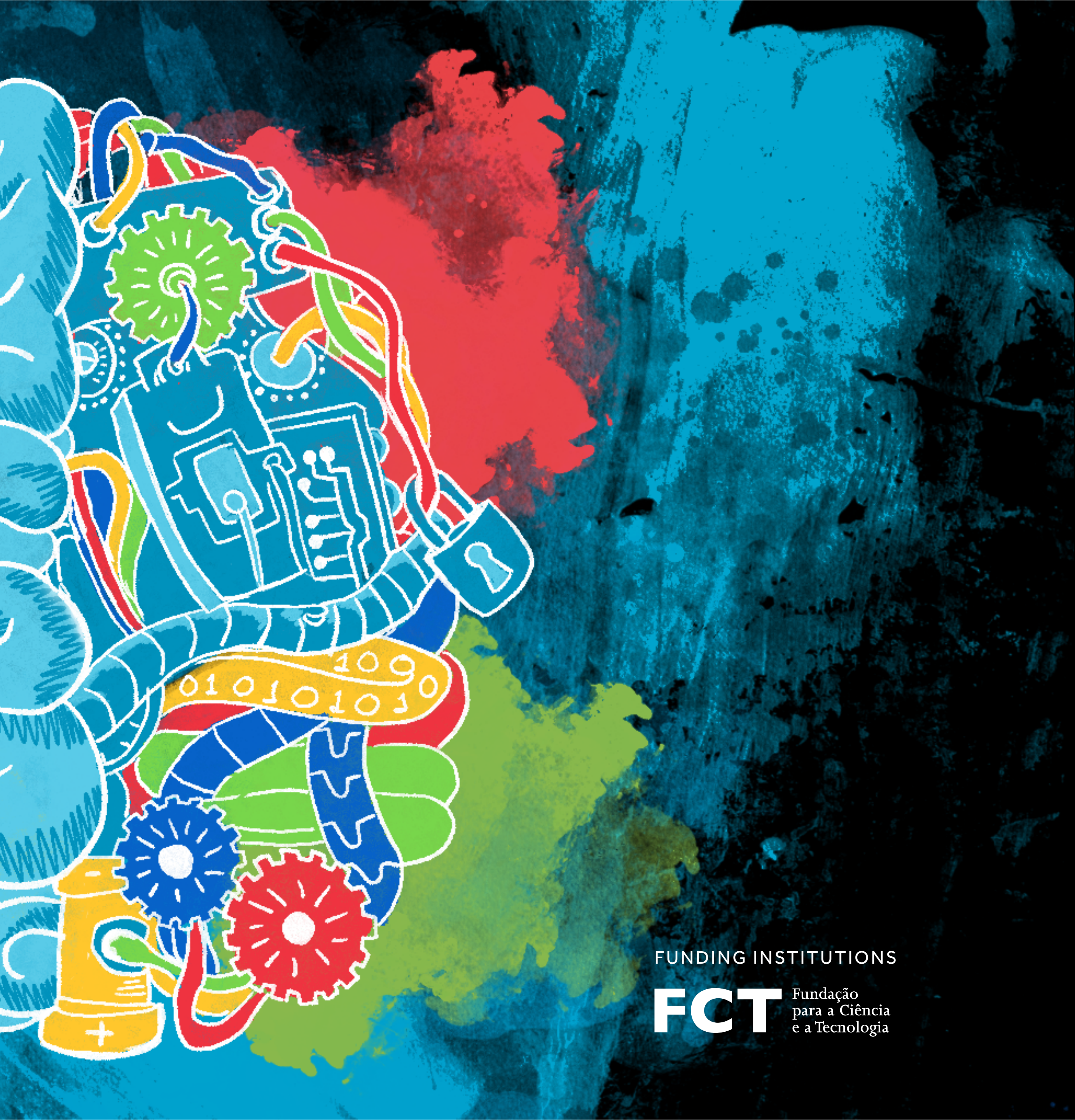


DATA PROTECTION OFFICE

DATA PROTECTION OFFICER Vasco Rosa Dias

According to its legal statute the DPO's principal role is to inform, advise about and monitor compliance with data protection law provisions and with the policies of the controller in relation to the protection of personal data, including the assignment of responsibilities, awareness-raising and training of staff involved in processing operations, and the related audits.





FUNDING INSTITUTIONS

FCT Fundação
para a Ciência
e a Tecnologia

FITEC
Fundo de Inovação,
Transferência de Tecnologia
e Economia Circular

PI PROGRAMA
INTERFACE

 Programa
Nacional
de Reformas

 REPÚBLICA
PORTUGUESA