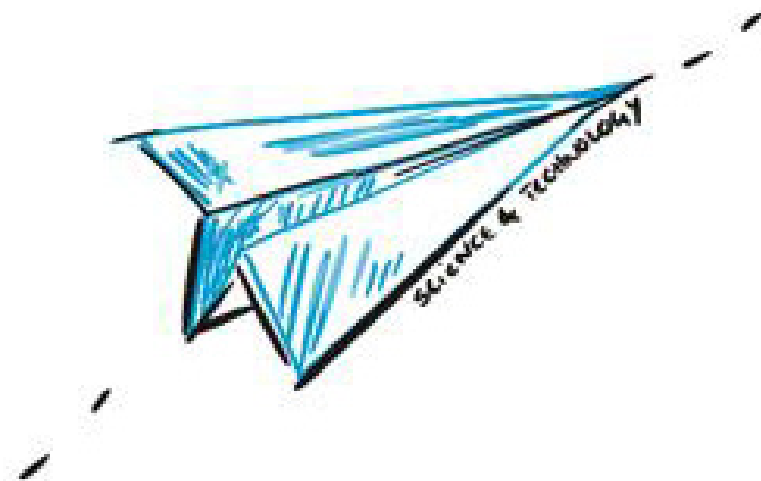# INESCTEC

ANNUAL REPORT //22

// WELCOME TO THE HOME OF SCIENCE, TECHNOLOGY AND INNOVATION

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MESSAGE FROM THE BOARD

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MESSAGE FROM THE BOARD
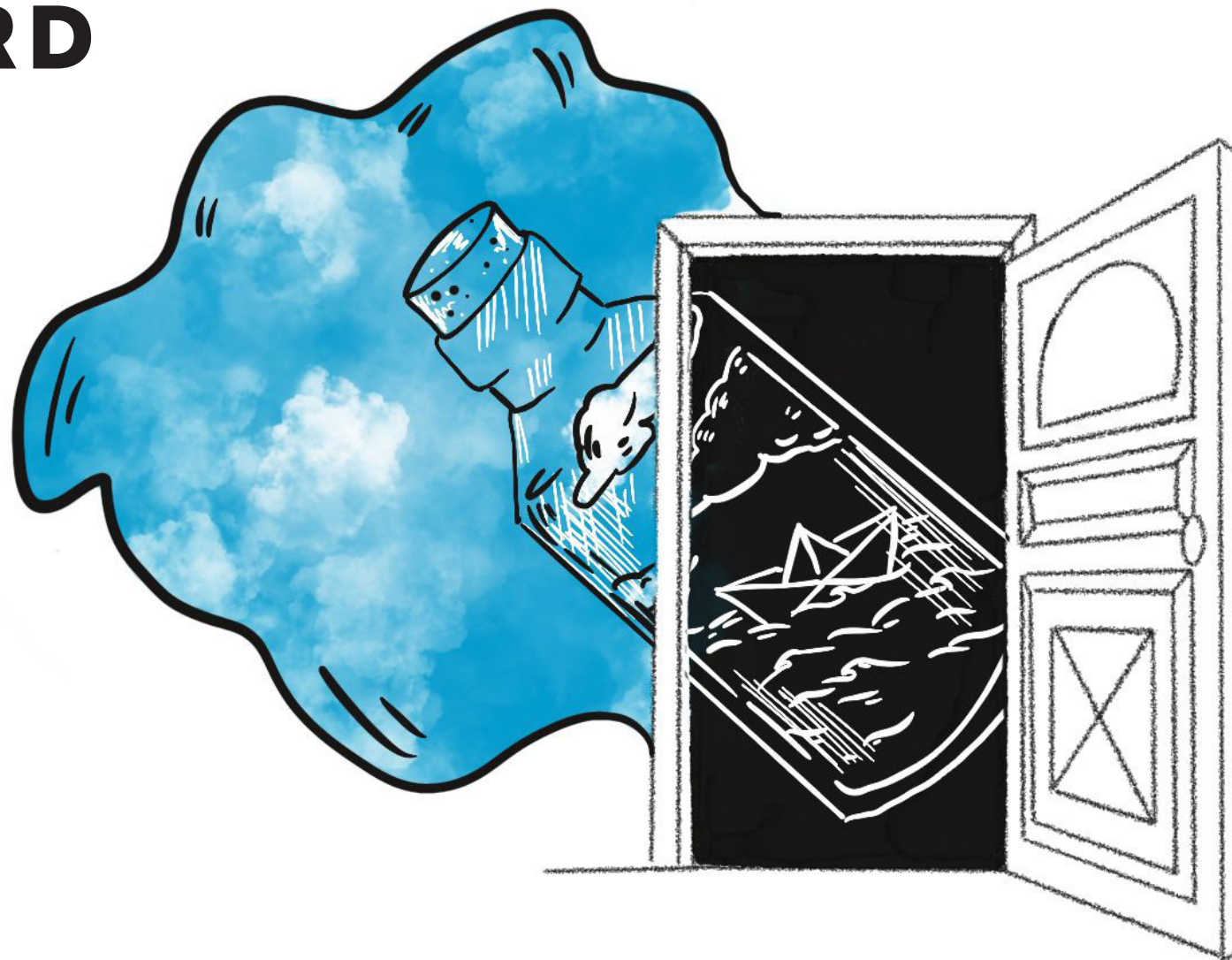
The Portuguese economy grew 6.7% in 2022, the highest value since 1987, with exports surpassing a record value of more than 50% of the GDP. Last year, INESC TEC's activity increased by 14%, to €23M, with an increase in terms of success rate and a quite relevant growth (36%) in European projects. In 2022, 37% of the institution's funding was international. **This improvement had a transformative influence on the institution, and generated relevant scientific, economic, and social impact.**

The intensified activity led to an increase in all categories of human resources. INESC TEC welcomes 364 PhD, with parity concerning the number of researchers working as lecturers at higher education institutions and core researchers. In addition to this global increment, the turnover of people also increased, with the departure of 33 members of our community with an employment contract (10% of the total), showing the enormous value that the market ascribes to INESC TEC's highly qualified human resources, but also bringing significant challenges. Throughout 2022, 350 people left the institution, thus materialising the transfer of knowledge through highly qualified professionals. **As an open and diverse institution, INESC TEC welcomes 80 foreigners from 30 nationalities, advancing the work towards diversity and inclusion.** The 26% of women demonstrate a slight increase, which only makes it clear how much there's to do in this regard.

The number of publications in indexed journals increased to some degree, with 465 papers - 68% of which in journals of the first quartile, maintaining the level of activity in the patents and spin-offs domains. Three examples represent and illustrate the impact of the numerous technical and scientific advances achieved in 2022:

- Bruno Loff, researcher at INESC TEC and Professor at FCUP, won a grant from the European Research Council to carry out his research in Computational Complexity;
- INESC TEC WETA robot won the annual international iF Design Award for the best farmer robot (Everythink, a start-up incubated at UPTEC);
- The UGR spin-off broke the world depth record (450 metres) with a robot fully developed and operated by the INESC TEC researchers who leads the project; this breakthrough took place at the deepest natural cave in the world, the "Hranice Abyss" in the Czech Republic.

The concrete participation in the calls for the Mobilising Agendas for Business Innovation of the PRR, led to 22 Agendas approved, adding three Agendas in Bioeconomy and two Agendas in the Sustainability of Agriculture - with a financing of more than €40€ until 2025. In terms of laboratory infrastructures, the leadership of the Leixões Hub Azul stands out, with an approved investment of €6M, as well as the control of Companhia de Energia Oceânica (Aguçadoura), following the Institute's strategic line of intervention for the Sea. In the meantime, the investment in the Industry and Innovation Lab has been completed. Finally, it is worth emphasising the approval of the three applications submitted to the European Network of "Digital Innovation Hubs" - one of which led by INESC TEC -, and the institution's acknowledgement as a Technology and Innovation Centre (CTI) and the ensuing approval of financing, through the PRR Missão Interface.

Contributions to public policies, in areas like energy, industry, sea, forestry and telecommunications, at the request of the Government, CCDR-N or regulators, as well as in the fields of science and technology, through the CLA and CNCTI, involved several senior researchers from INESC TEC.

Aware of the relevance and multiplicity of said contributions, and the potential of the institution, we decided to create a Public Policy Support Office to improve work in this dimension.

In order to comply with the commitment to our associates, we initiated the development of INESC TEC's Strategic Plan during the second half of 2022. After analysing the strategic processes of international reference institutions as good practices, and with a concrete involvement of internal stakeholders and consultation with relevant external stakeholders, we extended the development of the Plan for the beginning of 2023 - in time to present it to all members at the upcoming April 2023 General Council.

As we reflect on the past and look at the future, we deeply thank our community, researchers, and staff, for making the most of the opportunities created in 2022, and for their unwavering energy and commitment to our purpose.

We remain firm in our conviction that, with science and innovation, we can continue to contribute to improve society, facing all headwinds. Success is a long-term prospect, measured in years and decades, but it starts with actions we take now.

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OUR FOUNDATIONS
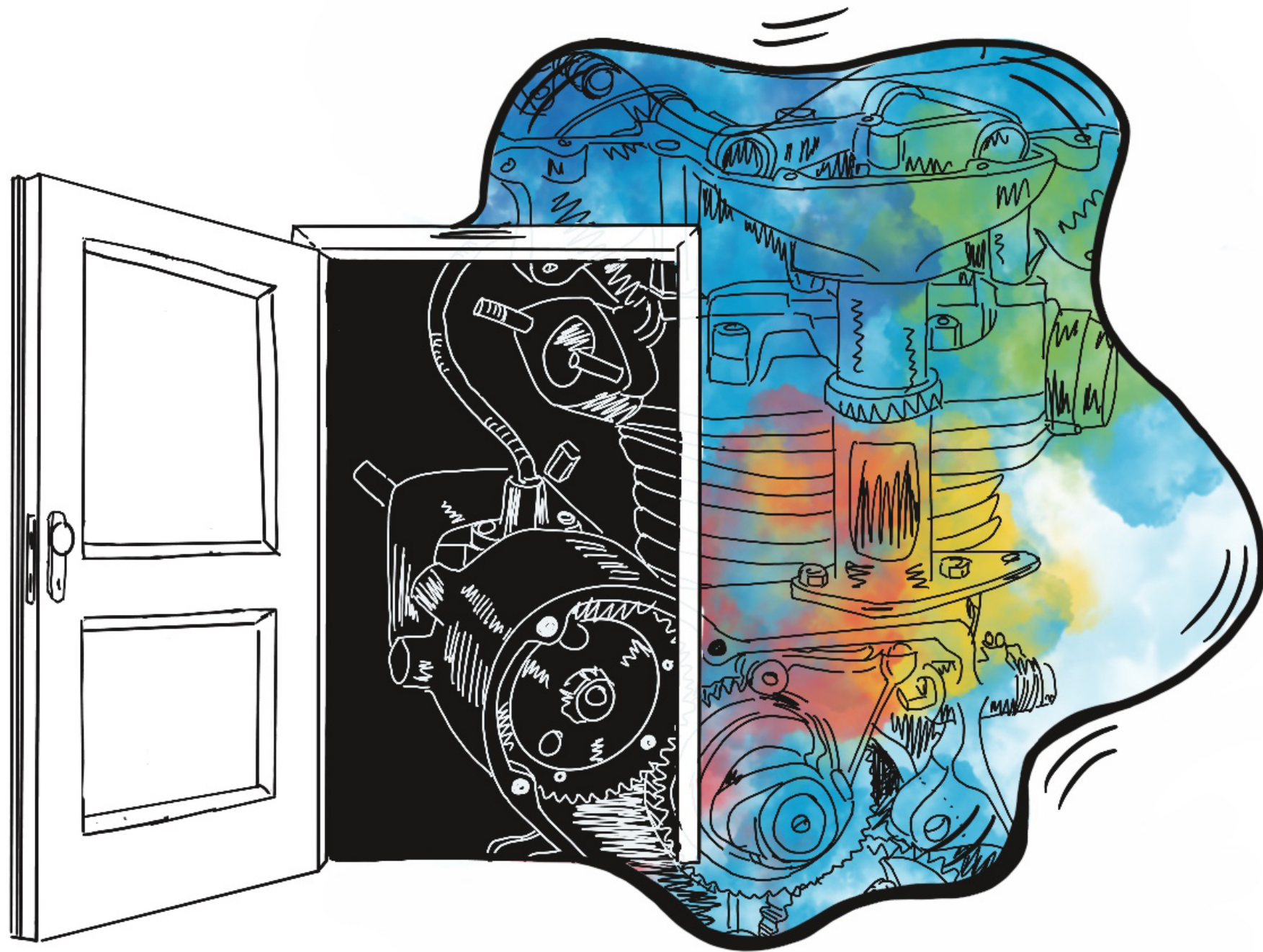
THIS IS WHAT WE ARE

INESC TEC is a private, non-profit association with Public Interest status, dedicated to scientific research and technological development, technology transfer, advanced consulting and training, and pre-incubation of new technology-based companies.

The primary goal of INESC TEC is to **exceed performance in research, while considering its social, environmental, and economic impact, with a commitment to the scientific and technological contribution to foster pervasive intelligence.**

As so, INESC TEC endeavours to be a relevant international player in Science and Technology in several domains, such as **computer science, energy systems, artificial intelligence, communications, power and energy systems or robotics.**

Being an institution that operates at the interface between the academic and business worlds, bringing academia, companies, public administration, and society closer together, **INESC TEC generates new knowledge as part of its research, and leverages that knowledge in technology transfer projects, seeking impact through both value creation and social relevance.**
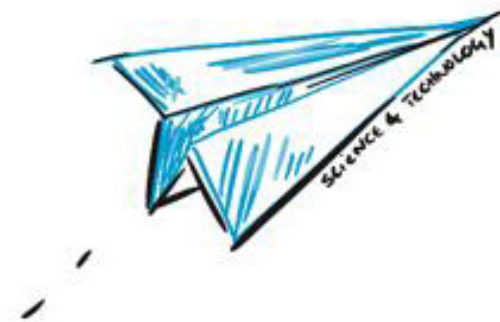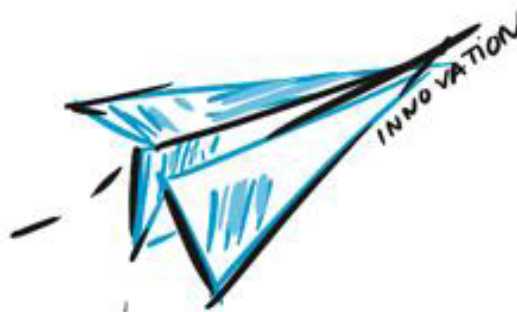
Acting from **KNOWLEDGE GENERATION** to **SCIENCE-BASED INNOVATION**, INESC TEC performs collaboratively in search for a more sustainable, responsible and improved world.

THE SCIENCE THAT WE DO

NETWORKED INTELLIGENT SYSTEMS

World first demonstration of successful integration of Thin-Film-Transistor (TFT) and memristor, resulting in proof-of-concept for cost-effective, flexible artificial neural networks hardware.

Novel antenna array design method demonstrated at 12.5 GHz enabling the reduction by 25% of the number of phase shifters of a beam-scanning reflect-array.

Traffic- and energy-aware placement algorithms for slicing-aware aerial networks that enable significant gains in network performance and resource efficiency against state-of-the-art counterparts.

Simulation platform for multimodal underwater communications enabling faster evaluation of underwater data muling communications solutions and the reproduction of past experiments.

A new large-scale dataset of symbolic music paired with emotion labels in terms of valence and arousal, two orders of magnitude larger than the existing datasets.

A Portuguese text corpus created from online newspapers with a total of 394 825 480 tokens and 33 089 734 sentences.

Semi-Supervised Approach for EGFR Mutation Prediction on CT Images, a novel end-to-end lung cancer characterisation, using CT images, in a semi-supervised approach.
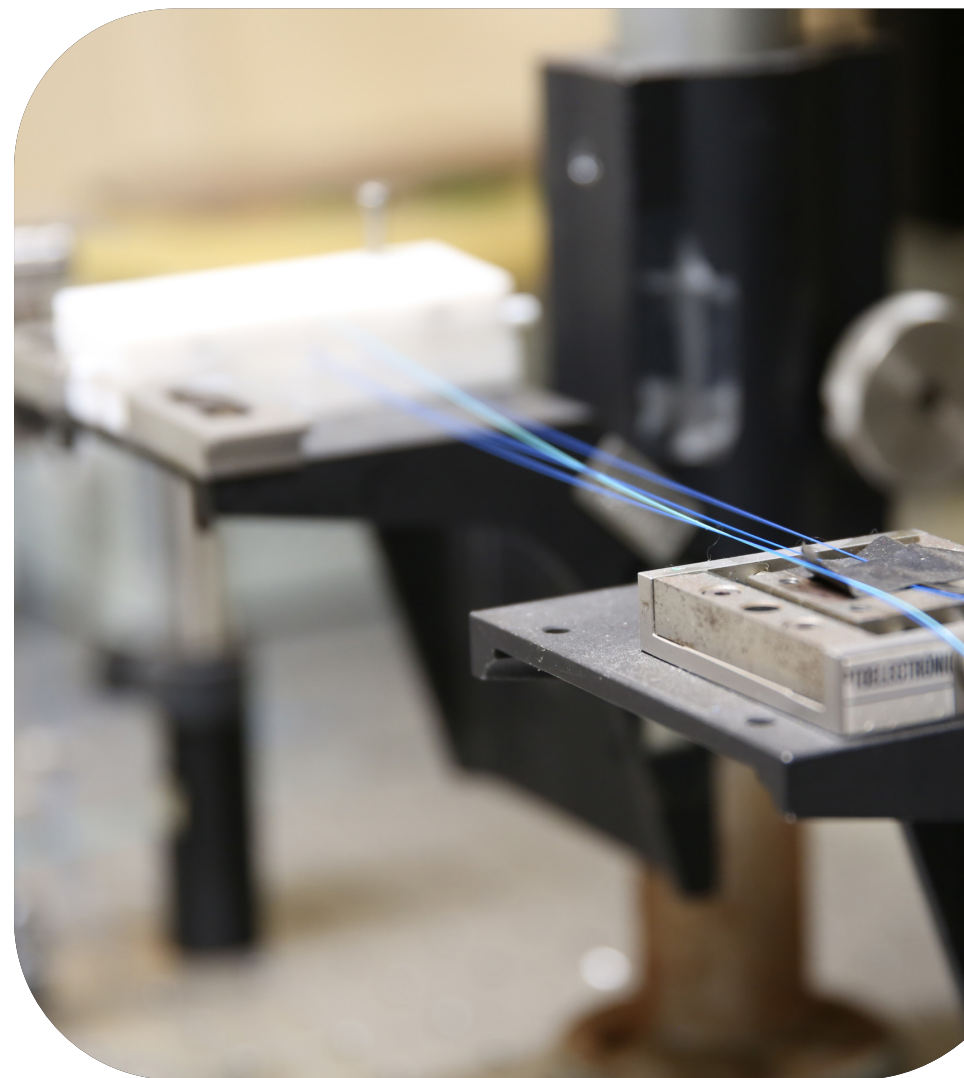
Synthetically Generated Structure-Aware Occlusions, a challenging, realistic, and diverse, publicly available occluded face recognition benchmark.

Fabrication of long, uniform and glass embedded 3D metallic electrodes, that will be employed for optical signal processing.

Large area microfluidic devices for biomedical research were produced having in mind vesicle separation, devices that find use in liquid biopsy applications.

Fabry-Perot cavity sensors were developed, with a sensitivity of 100 micrometers at 50 Kelvin, and a dimension of 80 mm, as part of the LIRA project.

A White-light interrogation system was also developed for absolute temperature measurement and with the ability to read at 1KHz.

A high-power laser at 1550 nm for micro-thermoelectric generators arrays was fabricated, within the scope of the WipTherm project.

A linear cavity laser was developed for index measurement.

Optimisation 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.

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

A Processing pipeline for LIBS analysis of complex mineral samples was implemented and validated with real mining samples.

Development and deployment of an **experimental setup for the realisation of quantum light fluid analogues.**

Both UNEXUP and Insite EIT RM European projects finished successfully, with important results, the first one, in autonomous explorations of flooded confined environments, and the second, in the exploration of underwater application of LIBS for mineral explorations.

Hipersea P2020 project was concluded and had developed and tested the first underwater system in the world for the capture of deep-sea species and bringing them to surface ensuring the same pressure and temperature conditions.

POWER AND ENERGY

Methodologies and tools for multi-energy infrastructures operation (day-ahead and real-time) that include electrolysers and ammonia production plants.

Quantification of the benefits of electrolizers participating on automatic frequency restoration reserve and frequency containment reserve.

Development of a reduced-order digital twin of multiple interconnected control areas to analyse frequency stability problems.

Optimisation tool to determine the most adequate share of hybridisation technologies for existing offshore farms (Wind+Wave+Offshore floating PV) considering metocean data.

Predictive algorithm for flexibility procurement by the system operator (flexible assets and procured active and reactive power in short-term markets). Reduces the human cognitive load when analysing multiple options and trajectories, setting a human-in-the-loop approach (Smart4RES project).

Rule-based adaptive control strategy for grid-forming inverters in islanded power systems for improving frequency stability.

Fault-ride-through strategies for grid-tied and grid-forming smart-transformers suited for islanding and interconnected operation in multi microgrids.

Preliminary model for the MIBEL market model (CEVESA) optimal allocation of the interconnection capacity among single-price areas for both energy and automatic frequency restoration reserve.

A general framework for energy sharing and settlement of renewable energy communities, including advanced business models.

A P2P-validation tool that simulates a local energy market with positive or real dynamic allocation coefficients and activates local flexibility.

Methodology and software tool to segment medium voltage grids into grid zones, enabling the DSO to publish flexibility needs per grid zones.

Methodology and tool for planning the expansion of generation systems with uncertainty, based on Monte Carlo Tree Search.

Methodology and tool to assess the reliability of distribution systems with storage, renewable generation, and demand response, via Pseudo-Sequential Monte Carlo simulation.

Methodology and tool to size H2 facilities for security of supply purposes based on the outcomes of the Sequential Monte Carlo Simulation.

Predictive network coordination framework (EUniversal project), that can forecast technical problems in MV and LV networks and coordinating the mobilization of flexibility resources.

Data-driven method based on smart meter data, to estimate sensitivity factors, for three-phase unbalanced LV grids, respecting a privacy-preserving protocol.

Experiment conducted with 105 participants from the energy industry in the framework of IEA Task 26, to investigate existing psychological barriers in the industry to adopt probabilistic forecasts and to better understand human decision processes (published in Meteorological Applications journal).

New stochastic security constrained multicriteria unit commitment, with temporal trajectories of renewable production and the operators set goals for operation cost, required additional power, RES curtailment, and compliance with the dynamic security constraints (Smart4RES project).

Development of a social welfare maximisation framework for data markets in renewable energy forecasting.

INDUSTRIAL SYSTEMS AND ENGINEERING

A simulation-optimisation DSS to manage disruptions in a biomass supply chain is being developed in the P2020 COMPETE project replant.

The research on reinforcement learning (RL) for decision support in manufacturing systems resulted in **a new approach to WIP management in Assembly Manufacturing Systems.**

In the FCT project **FuturePharma, a simulation model has been developed to support strategic decision-making in the design of more efficient, flexible and resilient supply-chains.**

Interoperability architectures for data and information management in inter-organisational contexts research has been developed in the CircThread project, in the confluence of Digital Enterprise Architectures and Industrial Data and Information Management research topics.

The activities in developing a design theory for the development of digital-twin based architectures led the **study of the role of Industry 4.0 reference architectures in digital transformation processes.**

A decision support tool is being developed in the FCT exploratory project e-LOG, to assist the design and assessment of innovative services in urban logistics, with particular focus on the "last mile" and the environmental impacts of parcels distribution.

An architecture for a robotic grasping planner that is easily configurable, modular, portable, and unified has been developed, offering a large selection of tools for producing a list of potential grasping positions while considering both the geometry of the object and the tool of the robotic arm.

In order to detect objects in cluttered environments for pick and place operations, **an object detection pipeline was also developed, with deep learning used for 2D detection, and 3D point clouds** used for the final segmentation.

To facilitate the generation of data
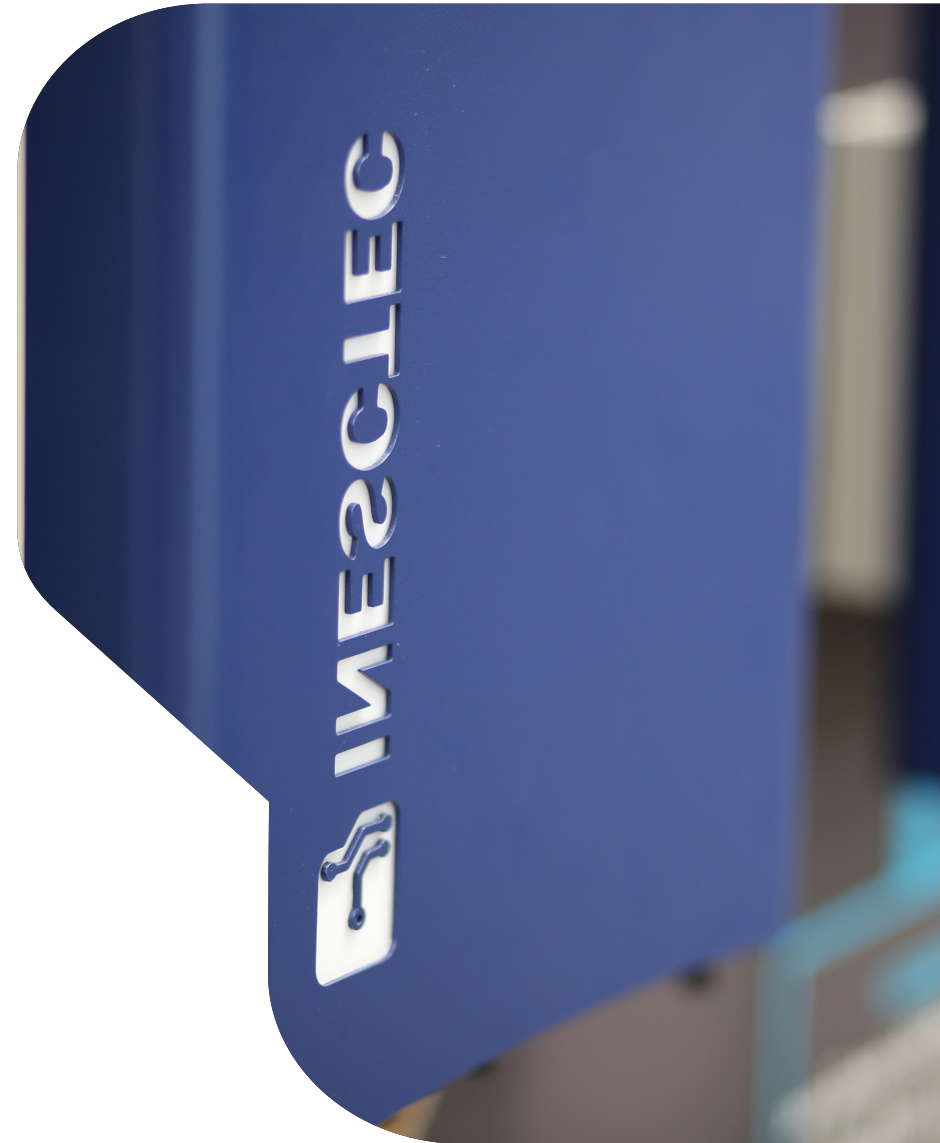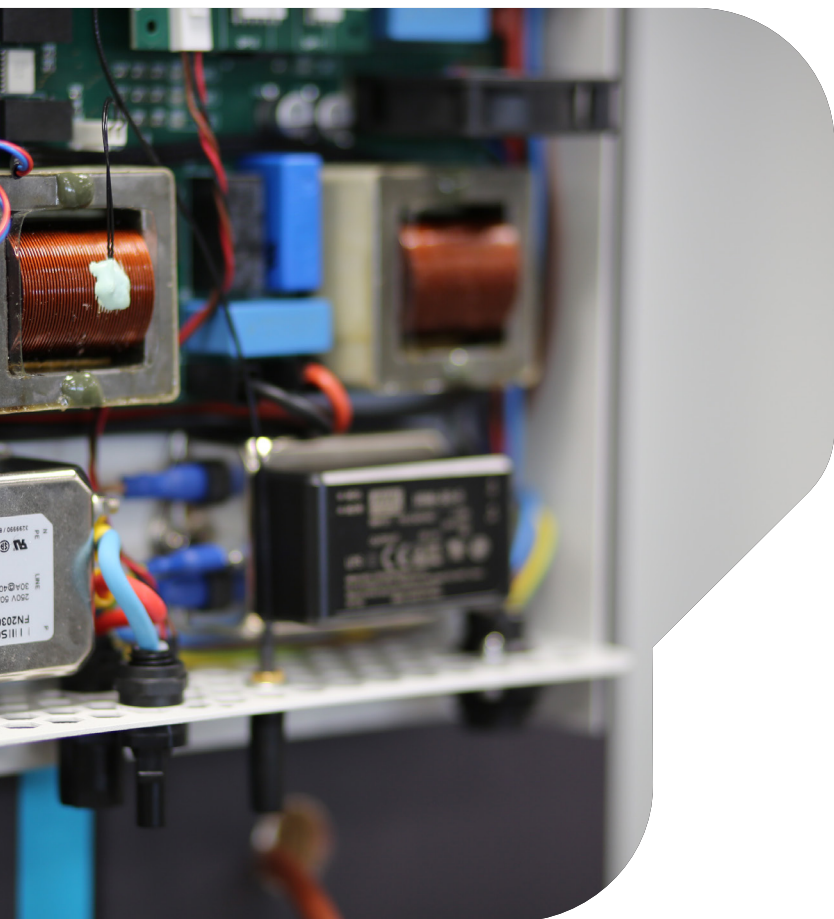
through simulation and **speed up the training of the AI model, a blender-based tool was created**.

Two variants of Variable Rate Technologies were developed with advanced perception systems for precision spraying robots.

Regarding the spatial augmented reality system, **a new portable solution was developed, for easy transportation and deployment,** considering constructions areas.

An augmented reality-based system was designed to improve human-robot interaction and safety in collaborative workspaces. The system monitors the operator's hands and head, allowing the robot to move concurrently with the operator if they maintain a pre-determined distance apart.

Development of a module called FollowMe, that can be used for robots to follow individuals performing agricultural tasks, in operations support logistics. FollowMe uses time-of-flight based sensors and a visual camera to understand where the human workers are and understand their actions.

An AI-based solution is being developed to keep the Digital Twin component (Advanced Plant Model) of the Open Scalable Production System (OSPS) continued, benefiting from the integration of cloud-based services.

The AgIoT module features were expanded and have reached V3.0 for SmartTrap (based on the AgIoT solution), and 10 units were deployed in real farms for a long pilot test. SmartTrap will enable the detection of agricultural disease vectors in a faster and more cost-effective way.

DeltaCP was a joint FCT-FAPESP project that ended, that aimed to **propose models and algorithms for the incorporation of uncertainty in the resolution of cutting and packing problems.**

Development of advanced optimization algorithms for pallet loading that are integrated into intelligent systems that control intralogistics flows and robotic palletization, namely in projects CrossLog and Produtech R3.

Development of a prototype that allows users to run any algorithm, and integrates interfaces specifically designed to interact with genetic programming (or other tree-based algorithms), while managing computing resources. Is the first version of the EU TRUST-AI framework, tested and made available in gitlab.

Qualitative and quantitative studies with citizens of two lighthouse cities and stakeholders of the eight cities to understand citizen engagement behaviours and drivers within the EU-funded smart city project POCITYF.

Development of an "Open Innovation Campaign Handbook", a tool to support the implementation of an Open Innovation Campaign at an International level in 2023.

COMPUTER SCIENCE

Specific 3D Modelling, animation and printing educational scenarios in Northern Portuguese schools in the H2020/PAFSE project.

Bring the next generation of crowd computing systems, a **fusion of state-of-the-art AI algorithms with human computation macro tasks**, to support scientific discovery through unveiling patterns, correlations, trends, and gaps in publications.

Development of a virtual assistant in the NORTE2020/Walking PAD project.

Creation of a framework for the assisted creation and edition of virtual environments to be used collaboratively in Virtual Reality (VR) and Augmented Reality (AR) in project Painter.

Creation of one advanced training program with the industry for giving competencies on developing simulator platforms using game engines.

Logic programming: (i) survey reviewing the research in parallel logic programming covering the period since 2001; (ii) development of a type system for Prolog; (iii) development of a Prolog/Python interface for the Yap Prolog system; (iv) development of a system for prediciting hypoglicemia and hyperglicemia.

Expansion based on intersection types showing a clear relation between algebraic properties of intersection types and the substructural rules – idempotent intersection is related with the contraction rule and commutative intersection with the exchange rule.

Definition of a new notion of rank for the non-idempotent intersection types based on linear types.

Solution of a longstanding open conjecture relating weak linear lambda-terms and terminating terms, using a notion of minimal typing derivations in a non-idempotent intersection typing system.

Evaluation of the use of blockchain for identity management (IdM) in the context of the Internet of things (IoT) while focusing on privacy-preserving approaches and its applications to healthcare scenarios.

Controlled, policy-based and confidential searching/sharing of Indicators of Compromise (IoC) available in a group of Malware Information Sharing Platform (MISP), which makes use of encrypted search mechanisms and of a shared encrypted reverse-index of IoCs.

Development of an extension for Chrome to detect manipulated photos in a webpage.

Assessment of web interfaces by combining structural matching and functional testing.

Development of deep learning models with applications to Biology, Astrophysics, and indoor location.

Summarisation of large and massive semantic graphs using a quotient graph approach based on an equivalence relation on URIs.

Development of a novel concept of spatial network motifs able to characterise networks with spatial features.

Development of NetF, a set of features able to characterise time series through to the topological properties of several possible complex network mappings of the time series

Introduction of MHVG2TMS as a new mapping able to characterise multivariate time series using complex networks.

Development of a new extension to the Alloy language to address quantitative problems.

Conclusion of the first complete formal correctness proof of Kyber, one of the post-quantum cryptographic algorithms recently selected by NIST for standardisation.
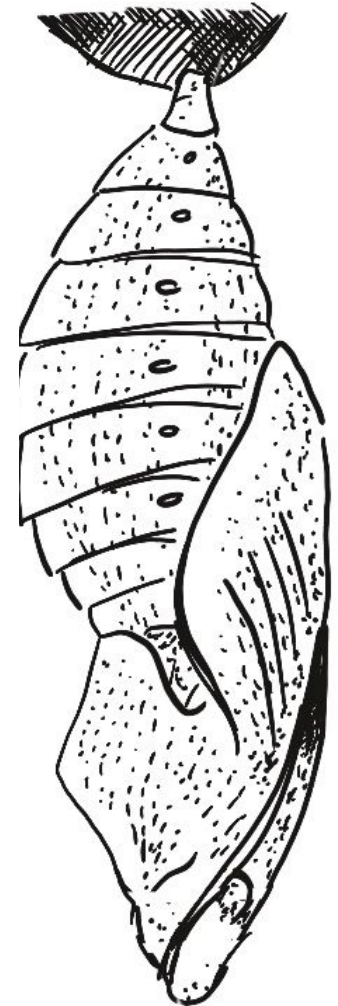
THE INNOVATION WE DELIVER

TEC4AGRO-FOOD

Communications Solution for Supporting the Digitalisation of a Farm, in partnership with a national company for remote monitoring environmental and production-related parameters and controlling farming systems.

Application of AI techniques, particularly Machine Learning, to identify and automatically count the insects that plague the olive groves, from images.

Development of an intelligent module to automate the process of pest identification from trap images placed throughout olive orchards.

Development of a collaborative information infrastructure, that will enable the collection and organisation of data to generate indicators and risk models of forest regions.

TEC4ENERGY

Study on 5G-based Wireless Communications for Utilities, to assess the suitability of 5G for supporting their operation, including smart metering and related applications within the use cases of an electric utility.

Grid-code compliance studies for eight PV farms (5 in Azores, 3 in Portugal mainland), including two cases of over-equipment, and a waste-to-energy powerplant (Azores).

CEVESA reengineering to include hybridisation to improve its outputs based on real market data (EEM 2022), to allow for multiple renewable generation profiles and to improve maintainability.

Microservice to assess the behavioural response of consumers to dynamic incentives, helping retailers and aggregators to identify responsive consumers and their expected reliability to provide flexibility.

Design and implementation of the fourth generation of a home energy management system (HEMS) within the InterConnect project.

Implementation of an ISO 15118 smart EV charger with edge computational capabilities supporting traditional centralized management platforms as well as distributed management of chargers.

Maintenance of the Elergone Energias load forecasting system (in production) and development of automatic bidding strategies.

Finalisation of the IOTA data market prototype.

Test with field data and integrate the low voltage state estimator of INESC TEC with ENEIDA DeepGrid.

TEC4HEALTH

Development of framework in partnership with a company for anatomopathological diagnosis of histological samples, making the process fully digital and automated.

A citizen science tool for evaluating ecosystem health.

Implementation of a repository agnostic security for immunogenetics.

TEC4INDUSTRY

Startup WeSENSS-Wearable SENSors for Safety obtained EIT Manufacturing 33k€ funding to WeSENSS startup to bootstrap the MVP of "connected worker" with partners in oil and gas and other hazardous professionals' security and wellbeing.

DIH services, mainly in the scope of Digital Twin Technology Adoption, were executed, both for national and international companies.

The application of **Genetic Programming** was explored in a consultancy project with retail industry.

In-store picking of online orders is being approached with Reinforcement Learning algorithms.

Creation of a new business area in pharmaceutical distribution, based on the digitisation of crucial supply chain activities, namely demand forecasting, inventory management and revenue management of the pharmacies.

Coordination of two international accelerator programs – EIT Jumpstarter and Tech2Market.

A digital learning tool has been developed on the topic of business creation and a learning path has been published in SkillsMOVE.

TEC4SEA

A custom underwater inspection system was demonstrated in Brasil, with the ability to assess sedimentation in underwater shafts with zero visibility.

A new concept of sensor network was demonstrated, based on the complementarity of AUVs and underwater long-range communications cables, within the K2D project.

Multiple UNEXUP field missions were performed around Europe. In Czech Republic, the world record in cave dives had been achieved; in Germany, a total distance of 8.5 km was completely mapped in one dive.

Participation in the NATO exercise REP(MUS)2022, organized by the Portuguese Navy.

Demonstration of robotic systems during the inauguration of the Madeira Oceanic Observatory.

APPLICATIONS IN SEVERAL DOMAINS

Patent filing of "Artuga", a fiducial marker for relative positioning of drones.

Development of a Digital Twin that replicates the operation of a PV power plant and uses near real-time field data.

Algorithms used to predict customer willingness to pay and cost to serve on on-line retail.

Under the umbrella of Enterprise Europe Network, services were provided to more than 150 SMEs and support given to 14 unique SME.

Creation of a data dictionary, to support the data management of a platform that includes the management of financial products, customers, risk and reporting to the sector's regulatory entities.

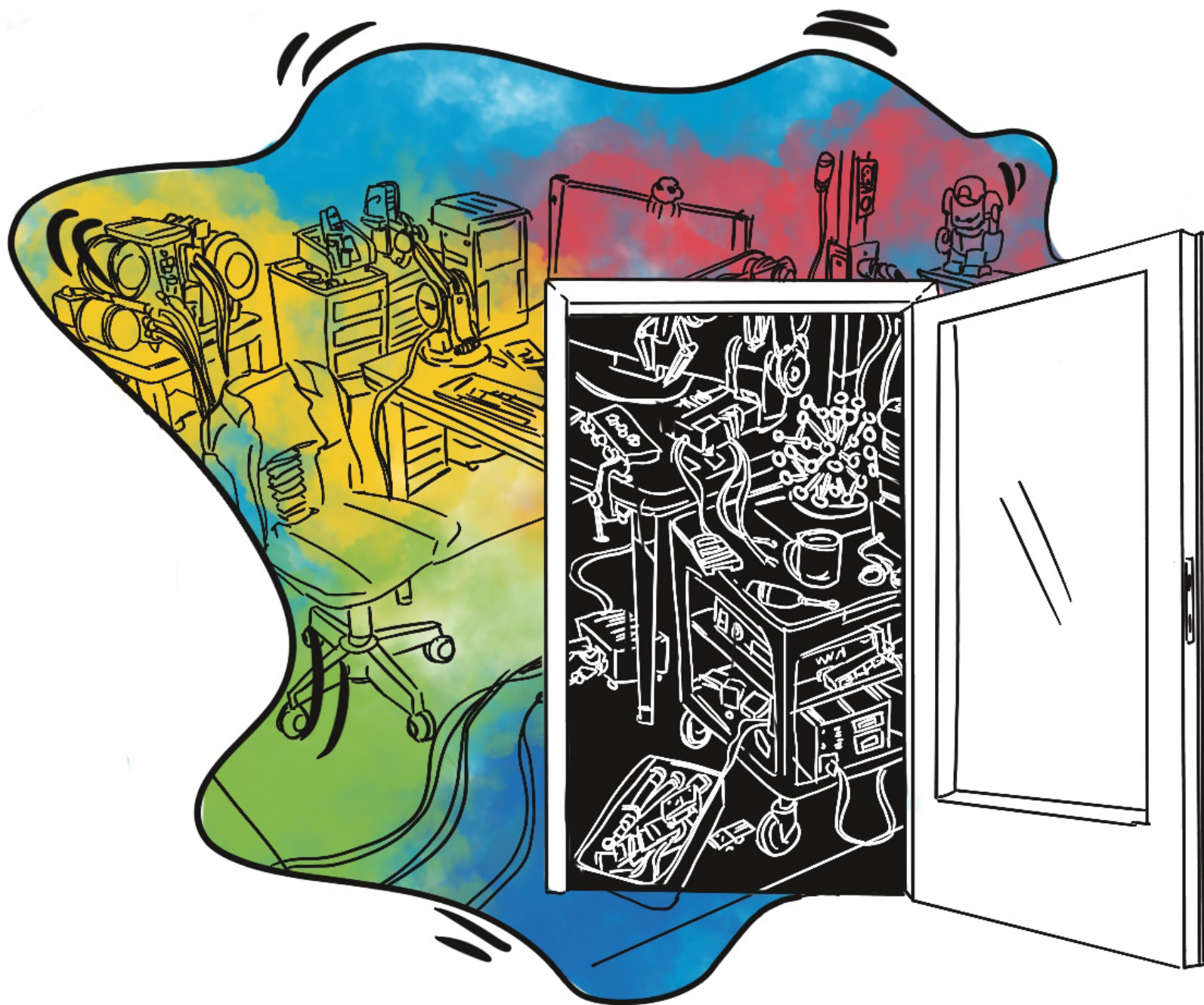**Participation in the development of a Massive Online Open Course (MOOC)** targeted to computer programming educators.

Development of tools and techniques to help verify infrastructure safety rules in railway network models.

//002

OUR HOME

HOW WE MANAGE SCIENCE AND TECHNOLOGY

INESC TEC organises its scientific research to maximise its collective impact in Portugal and abroad while preserving and encouraging individual scientific success.

INESC TEC has transitioned from an initial model of Research Clusters based on scientific affinities between centres to a more comprehensive and inclusive model to better capture the dynamics and multidisciplinary nature of the centres and individual researchers. Each domain connects INESC TEC researchers regardless of their centre and identifies the institution's competencies within that field.

The domains thus become forums for discussing and planning INESC TEC's research trajectory, and platforms for strategizing, with short to medium-term goals leading to quantifiable results.
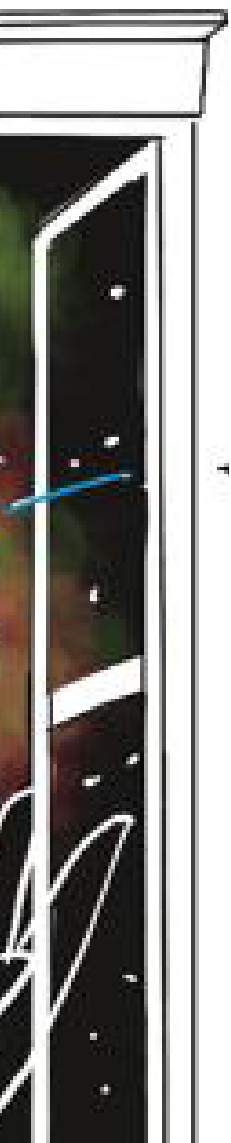
Research at INESC TEC varies in scope, from basic to applied, from established and well-known topics which INESC TEC is internationally renowned for, to strategic ones nearing critical mass.

Following contributions from individual researchers and centres' coordinators, a thorough and participative analysis was conducted that will lead to a more comprehensive set starting in 2023.

// OUR SCIENTIFIC DOMAINS

RESEARCH
DOMAINS BEHIND SCIENCE PUSH

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

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 hallenges 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.

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

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

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 SUPPPORTING CIRCULARITY AND SUSTAINABILITY

4 CORE
R&D DOMAINS
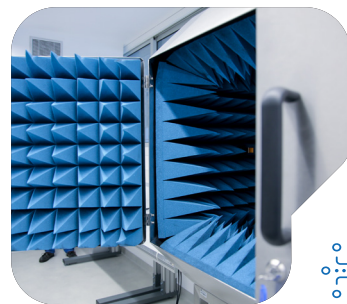
COMPUTER SCIENCE

INDUSTRIAL AND SYSTEMS ENGINEERING

NETWORKED INTELLIGENT SYSTEMS

POWER AND ENERGY

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

// OUR TEC4

INNOVATION
TEC4 BEHIND MARKET PULL

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

5 PLATFORMS
SOCIETAL CHALLENGES AND MARKET NEEDS

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
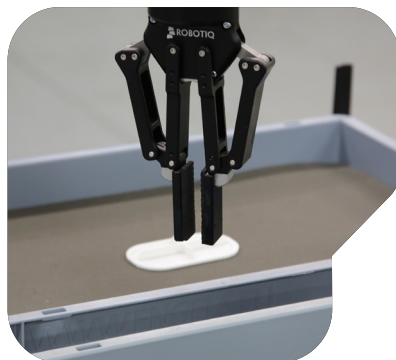
TEC4
INDUSTRY

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 lifestyle 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

//002.2

THE VALUES WE SUPPORT

INESC TEC baseline structure considers that the institutional progress relies on people. Thus, there are fundamental aspects that INESC TEC, particularly values, since **its major purpose is, first and foremost, impacting people's daily lives.**

The Ethics Committee ensures the observance and promotion of standards of integrity, honesty, and responsibility in research activities. The Conflict-of-Interest Management Commission is responsible for the implementation of the institute's Policy on Conflicts of Interest Management. The Technical Committee for Social Responsibility has as its mission the incorporation of social responsibility in the institution's organisational culture and practices. The Diversity and Inclusion Commission thrives to encourage the organisation to implement practices that promote diversity and inclusion.

SOCIAL RESPONSIBILITY

DIVERSITY & INCLUSION

CONFLICTS OF INTEREST MANAGEMENT

ETHICS

SOCIAL RESPONSIBILITY

CHAIRPERSON
Joana Desport Coelho

Corporate Social Responsibility (CRS) was defined by the European Commission (in 2011) as "the responsibility of enterprises for their impacts on society and outlines what an enterprise should do to meet that responsibility".
In November 2018, a work group composed of employees from different centres and services was established to perform a diagnosis of the social responsibility status in the institution. Following the results of said diagnosis, in October 2019, this Commission was formally established; the main mission is to incorporate social responsibility into INESC TEC's organisational practices and culture. The Technical Commission for Social Responsibility has a renewed mandate every two years.
Even thought the pandemic situation had a huge impact on the activities that were previously foreseen by the Commission, the conditions verified in the second semester of 2022 allowed to the return of certain activities.

DIVERSITY & INCLUSION

CHAIRPERSON
Beatriz Brito Oliveira

The Board of Directors of INESC TEC established the Diversity & Inclusion (D&I) Commission in September 2021. Its main mission is to propose and implement a D&I program. The D&I Commission is composed of INESC TEC collaborators, from different structures/services: Ana Lopes, Beatriz Oliveira, Tiago Silva, Tiago Gonçalves (since May 2022), and Rita Costa (since October 2022). Nuno Moniz was part of the Commission up to May 2022, as well as Sheila Habib, up to July 2022. Two Advisory Groups support the Commission's work. The Internal Advisory Group is composed by a representative set of collaborators and supports the Commission through brainstorming, discussion, and validation, whereas the External Advisory Group is composed by key players in the D&I field and provides strategic counselling.

CONFLICTS OF INTEREST MANAGEMENT

ETHICS

CHAIRPERSON
José Carlos Marques dos Santos

INESC TEC has a Conflict-of-Interest Management Policy, which applies to all integrated human resources. The Committee for Conflicts of Interest Management has the responsablity to ensure compliance throughout the Institution, namely by assessing the declarations of interests and identifying the conflicts of interest; agreeing with the collaborator on the terms and proposing to the Board of Directors management plans for identified conflicts of interest, in order to reduce or eliminate those conflicts; informing the collaborators of INESC TEC about the conclusion of assessment processes and about the terms of possible management plans for identified conflicts of interest; and formulating general recommendations concerning conflict of interest management.
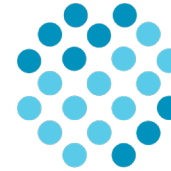
CHAIRPERSON
Pedro Guedes de Oliveira

In 2022, after the approval of the Ethics Code, the Board of INESC TEC appointed the Ethics Committee, after consulting the Scientific Board. The Board is chaired by Pedro Guedes de Oliveira, Professor Emeritus at the University of Porto and Senior Consultant to the President of the Board of INESC TEC, and integrates Susana Magalhães, who holds PhD in Bioethics and is the Coordinator of the Unit for Responsible Conduct in Research at I3S and Assistant Professor at the Fernando Pessoa University, Vasco Rosa Dias, Data Protection Officer at INESC TEC and ISPUP, and Lia Patrício and Alípio Jorge, professors, respectively at the Faculty of Engineering and Faculty of Sciences of the University of Porto and researchers of INESC TEC .

HOW WE ARE ORGANISED

// BOARD OF DIRECTORS

CHAIRMAN
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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

VICE CHAIRMAN/CEO
João Claro

Aníbal Matos

José Carlos Caldeira

Rui Oliveira

// 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

// SCIENTIFIC ADVISORY BOARD

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Chairman
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(USA)

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Università degli Studi di Brescia (Italy)

PERE RIDAO
Institut de Recerca en Visió Per Computador i Robòtica (Spain)

ROBERT LIEBERMAN
Member, U.S. National Academy of Engineering; President of Lumoptix LLC (USA)

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Universidad Pontificia Comillas (Spain)

VOLKER STICH
Aachen University of Technology (Germany)

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EDP
Member of the General and Advisory Board

ANTÓNIO MURTA
Pathena S.A.
Managing Partner and CEO

JOÃO PAULO OLIVEIRA
The Navigator Company
Member of the Board

JORGE VASCONCELOS
New Energy Solutions Chairman

LUÍS FILIPE REIS
Sonae Financial Services
CEO

// SCIENTIFIC COUNCIL

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(Chair) FEUP

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CEGI (ISEP)

AURÉLIO JOAQUIM CAMPILHO
C-BER (FEUP)

EDUARDO SILVA
CRAS (ISEP)

HENRIQUE FARIA SALGADO
CTM (FEUP)

JOSÉ NUNO FONSECA OLIVEIRA
HASLAB (UMINHO)

JOÃO JOSÉ PINTO FERREIRA
CITE (FEUP)

JOÃO PAULO SARAIVA
CPES (FEUP)

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CESE (FEUP)

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CRIIS (ISEP)

MARIA ANTÓNIA CARRAVILLA
(FEUP)

MARIA CRISTINA RIBEIRO
HUMANISE (FEUP)

PAULO VICENTE MARQUES
CAP (FCUP)

JOÃO GAMA
LIAAD (FEP)

SANDRA ALVES
CRACS (FCUP)

SUSANA ALEXANDRA BARBOSA
HUMANISE

//003
THE STAIRWAY

+800 //

INTEGRATED RESEARCHERS

At the end of 2022, INESC TEC hosted more than 800 integrated researchers, with a noticeable increase in R&D employees (+19%).

30 //

NATIONALITIES

+360 //

INTEGRATED PHDS

+350 //

PEOPLE GOING TO THE MARKET

PER YEAR

+350 //

ONGOING R&D PROJECTS

5 //

FIRST PRIORITY PATENT APPLICATIONS

7 //

ACTIVE SPINOFFS (TRACK-RECORD: +20)

23M € //

ACTIVITY

Despite a tumultuous year as 2022, INESC TEC community grew, and its economic activity increased 14%.

//003.1

WE PROMOTE TALENT

Talent leads to success.

And a commitment with a trustworthy Human Resources strategy is at the core of the support to the continued growth of INESC TEC's activity.

Moreover, with a growing attention to dimensions of Diversity and Inclusion, INESC TEC has been monitoring closely some related indicators, namely those relating to gender balance.

// 932

TOTAL INTEGRATED HR

// 131

MANAGEMENT, ADMINISTRATIVE & TECHNICAL EMPLOYEES
👤 54 | 👤 61

115
Employees

10
Academic Staff

6
Grant Holders and Trainees

// 728

CORE RESEARCH TEAM

189
Employees
👤 147 | 👤 42

185
Academic Staff
👤 161 | 👤 34

354
Grant Holders and Trainees
👤 264 | 👤 96

73
Affiliated Researchers
👤 68 | 👤 5

272
Total Core PhD

With a Community of more than 900 professionals, grant holders and trainees are still the largest group of human resources at INESC TEC.

WE PRODUCE SCIENCE

Surpassing the estimates included in the 2022 plan and the results of previous years, INESC TEC steadily increased the number of publications in indexed journals, the institute's main overall publication priority, 68% of which in first quartile journals.

Scientific production is at the bottom of INESC TEC's professional activity. Therefore, it is important to maintain these indicators firm and stable, at first, but mainly with an ongoing growth.

// 315

PUBLICATIONS IN 1ST QUARTILE

// 43

PHD THESES SUPERVISED

// 814

SCIENTIFIC PAPERS

465
Indexed Journals

349
Indexed Conferences

2
Books

45
Book Chapters

31
PhD Theses - Members
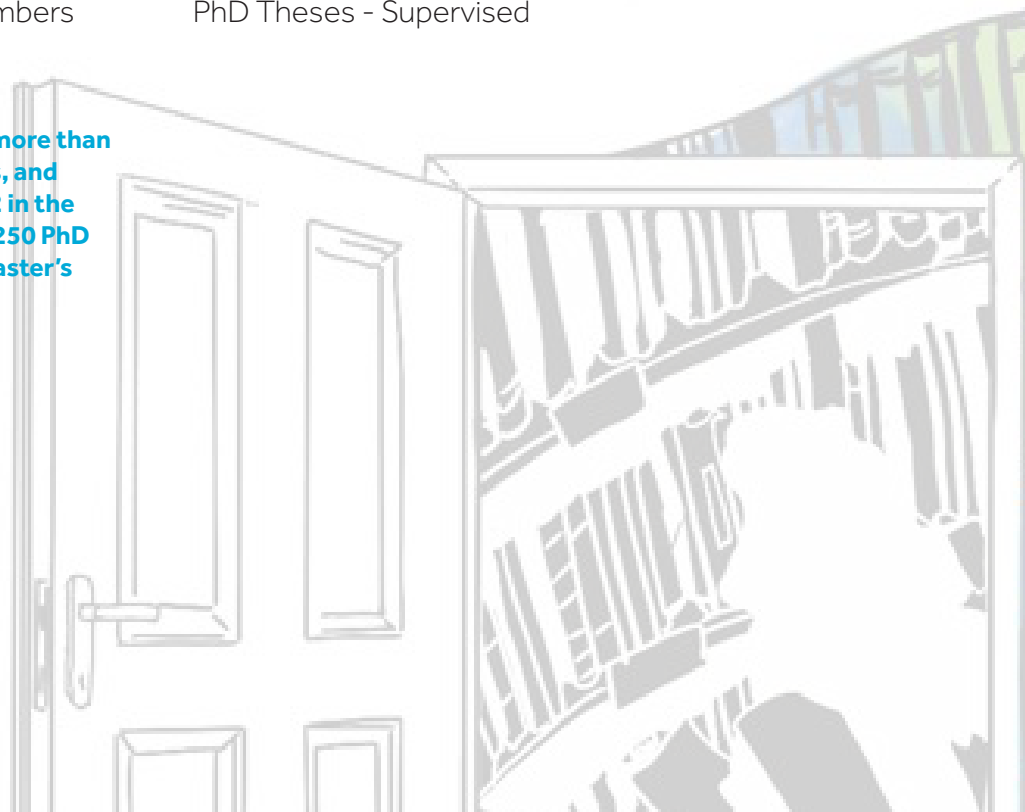
43
PhD Theses - Supervised

INESC TEC assists more than 20 PhD programmes, and was involved in 2022 in the supervision of over 250 PhD students and 650 master's students.

//003.3

WE GROW UP IN VALUE AND INVESTMENT

NATIONAL FUNDING

1522 K€
R&D Programmes - FCT

154 K€
R&D Programmes - S&T Integrated Projects

3720 K€
Cooperation Programmes with Industry

3527 K€
R&D Services and Consulting

EU FUNDING

7642 K€
Framework Programmes

534 K€
Cooperation Programmes - Other

INTERNATIONAL

326 K€
R&D Services and Consulting

OTHER

713 K€
Other Funding Programmes

// 356 ACTIVE PROJECTS

// 95 PROJECTS FROM EUROPEAN PROGRAMMES

INESC TEC reached 23 M€ of activity in 2022.

With more than a decade of a continuous and sustainable growth, the institution thrives to **maintain a diversified funding portfolio, with special emphasis on international funding sources (37% in 2022).**

//003.4

WE CONTRIBUTE TO PUBLIC POLICIES

In 2022, INESC TEC set up and prepared the launch of its newly created Public Policy Office. The mission of the office is to advance INESC TEC's policy engagement, collaborating with our community to develop and implement bespoke engagement strategies with impact, at individual, group and institution level. The office will offer support, services and programs to enhance our community's policy impact. The office was created having as a reference the state of the art on policy impact from research, a benchmark of leading policy impact units, and an analysis of INESC TEC's impact context. The main action lines for the office will be: **1) Identify and disseminate recent and current contributions; 2) Connect and raise the impact on public policy dynamics; 3) Support the design and enactment of strategies for policy development and engagement; 4) Experiment and innovate with approaches to policy engagement.**

Following the work carried out in recent years, contributions to public policies have involved in 2022 many senior researchers and staff in INESC TEC.
These contributions were significant in three main pillars:
- contributions on science, technology and innovation policies, through CLA, CNCTI and EARTO, both at national and European level;
- concrete policy-advice work, with an emphasis on the areas of energy, sea, telecommunications and forestry, for the national government, regional governments, regional coordination commissions, regulators and cities;
- active participation in FEUP's Doctoral Program in Engineering and Public Policies and in Seminars in Engineering and Public Policies.

UTAustin Portugal

UT AUSTIN PORTUGAL

COORDINATORS
José Manuel Mendonça
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. In the third phase of the Partnership, collaborations go beyond Austin to encompass another world-class institution part of the University of Texas System: the MD Anderson Cancer Center, based in Houston.

INESC BRUSSELS HUB

HEAD OF THE OFFICE
Ricardo Miguéis

COORDINATOR OF INESC BRUSSELS HUB AT INESC TEC
José Carlos Caldeira

INESC Brussels HUB articulates its effort through the work of teams composed of representatives from all the INESC institutes: INESC TEC, INESC Coimbra, INESC ID, INESC INOV and INESC MN, with multiple focus: strategy development, capacity-building, policy analysis, contributions to the development of public policy, and definition of funding priorities.

Developing a lobby to support the institution in influencing R&I agenda setting at EU level, these institutes also set the goals for INESCs' collaboration with other EU public and private research organisations, large and small industrial stakeholders, independent EU associations, networks, platforms, and the European institutions.

The purpose of this Hub is to position INESC as a European recognised key player, stating its role as an international reference organisation both for its research and innovation excellence and capacity to contribute to society, policy and the economy.

Following the objective of promoting the visibility and reputation of all the INESC research and technology development capacity in Europe and beyond, the INESC Brussels HUB representation office intends to tackle, through different activities, the activity conducted by INESC units and facilitate its dissemination all across Europe.

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 recognized 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.

WE BROADCAST OUR SCIENCE AND INNOVATION

Communication is mandatory concerning the purpose of scientific performance since building bridges between the different players at INESC TEC's universe requires sharing knowledge and results from research and innovation activities.

INESC TEC's researchers were able to maintain a dynamic activity in scientific dissemination events and other formats, contributing to the Institution value creation and social impact.

This dissemination activities detailed are limited to R&D Centres outputs, while other initiatives were implemented by the institution services.

DISSEMINATION ACTIVITIES

150 Participation as principal editor, editor or associated editor in journals

51 Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)

196 International events in which INESC TEC members participate in the programme committees

40 Participation in events such as fairs, exhibitions or similar

72 Conferences, workshops and scientific sessions organised by the R&D Centres

3048 Participants in the conferences, workshops and scientific sessions organised by the R&D Centres

11 Advanced training courses organised by the R&D Centres

FÓRUM INESC TEC **DO OUTONO**

INESCTEC SCIENCE BITS

Podcasts produced by INESC TEC (Science Bits)

INESC TEC Autumn Forum - annual initiative for discussing several issues of societal relevance.

Science Communication features on INESC TEC's Newsletter BIP (Spotlight)

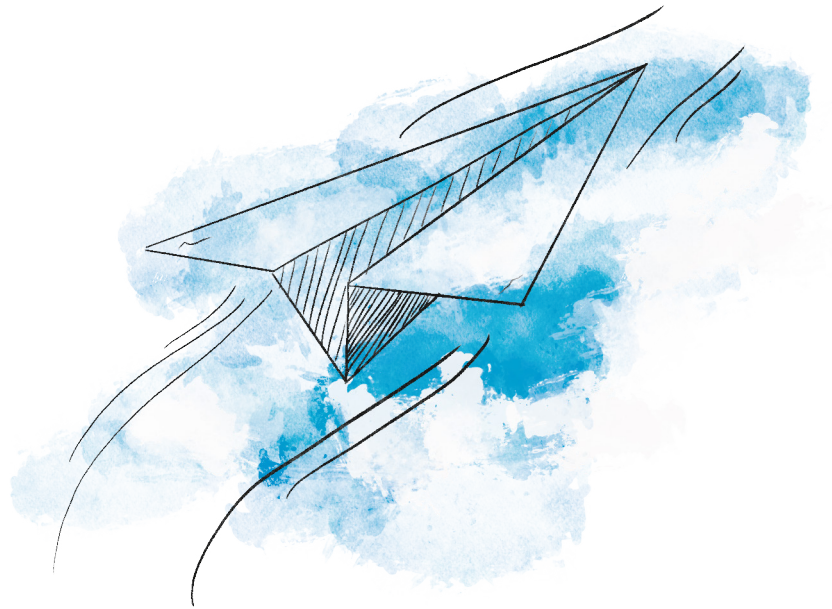**Magazine issues edited and published by INESC TEC** (INESC TEC Science & Society)

from **KNOWLEDGE GENERATION**

to **SCIENCE-BASED INNOVATION**,

INESCTEC

ANNUAL REPORT //22