



ACTIVITY REPORT

2024.

Editorial Notes

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GLOBAL ACTIVITY REPORT 2024

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Executive Summary

The year 2024 unfolded against a backdrop of global uncertainty, strategic realignment, and rapid transformation. These dynamics demanded resilience and adaptability. They also reinforced the importance of research and innovation as tools for navigating complexity and driving meaningful progress.

Geopolitical tensions, driven by the ongoing war in Ukraine and renewed instability in the Middle East, continued to reshape the global order, marked by multipolarity, energy insecurity, and a heightened emphasis on strategic autonomy. In Europe, these developments translated into increased support for initiatives like the European Defence Fund and the Chips Act, reflecting a collective effort to strengthen technological sovereignty and industrial resilience.

In parallel, the accelerating pace of digital transformation continued to reshape economies and societies. Breakthroughs in artificial intelligence, quantum computing, and cybersecurity expanded the frontiers of possibility while raising pressing ethical and regulatory challenges. The convergence of these technologies created new avenues for innovation and competitiveness, reinforcing the central role of research in shaping policy and enabling responsible progress.

Sustainability remained a defining imperative in 2024, as the escalating impacts of climate change, biodiversity loss, and resource depletion amplified calls for systemic transformation. Public and private actors faced growing expectations to embed sustainability across their strategies and operations. From clean energy systems to circular economy models, the momentum behind climate-resilient innovation continued to build, challenging institutions to redefine their role in shaping a more sustainable and inclusive future.

Against this complex backdrop, INESC TEC continued to grow in 2024, expanding its community, strengthening its scientific activity, and deepening its capacity to produce and disseminate impactful research. The year also brought notable advances in technology valorisation, knowledge transfer, and scientific outreach, further reinforcing the institute's role as a driver of innovation and societal benefit.

INESC TEC also strengthened its strategic positioning in 2024 through deeper international collaboration and leadership in key emerging technologies. The approval of INESC TEC.OCEAN as Portugal's Centre of Excellence in Ocean Research and Engineering, under the Horizon Europe Teaming for Excellence programme, and the launch of POEMS, the national Competence Centre in Semiconductors, reflected the institute's growing contribution to critical European priorities. In parallel, INESC TEC played an active role in shaping future European research and innovation policy, participating in debates on AI, data, and robotics, contributing to the AI roadmap for power systems, and publishing a position paper on the 10th Framework Programme.

A strong focus on talent development marked 2024, with INESC TEC helping secure 20 professorships under the FCT-Tenure initiative, strategically aligned with 14 new permanent research positions in areas such as AI, quantum computing, bioengineering, robotics, and energy systems. The institute also took important steps to strengthen institutional capacity, advancing the deployment of a new ERP system and initiating the restructuring of key elements of its organisational architecture. National presence was further extended through the creation of a new research hub in Madeira, reinforcing INESC TEC's territorial reach and regional engagement.

Operational capacity remained a key enabler of INESC TEC's success in 2024. The institute implemented a new Reporting Channel for Corruption and EU Law Breaches and continued to roll out its new ERP system. Progress was also made in building internal capacity for sustainability certification, aligning operational processes with environmental goals. Infrastructure development included work on the Leixões Blue Hub, scientific missions with the Mar Profundo vessel, and support for offshore renewable energy testing – reinforcing INESC TEC's contribution to the blue economy and energy transition.

In parallel with structural improvements, INESC TEC continued to invest in its internal culture and community well-being. The new Human Resources model continued its development alongside a merit-based progression path for early-career researchers, complemented by the co-organisation of a European workshop on research careers with FCT and DG RTD. The Diversity and Inclusion Commission maintained an active role, while community-building initiatives such as INESC TEC on Foot, Volunteer Day, and

Laughter Yoga fostered cohesion and belonging. A new mobile app was launched to support internal communication, and the institute proudly took part in the national 4-Day Week pilot as the only R&D institution involved. Ethical reflection was also promoted through the first two public sessions of the INESC TEC Talks on Ethics in Research and Defence.

INESC TEC deepened its engagement in science and innovation policy in 2024. The Foresight and Public Policy Office expanded its scope of activity, reinforcing the institute's capacity to anticipate trends and support strategic decision-making. INESC TEC co-organised the first National Chapters Forum of the Coalition for the Advancement of Research Assessment (CoARA), contributing to a growing European movement for reforming research evaluation, and joined the European Commission and the NCBR Office in hosting a high-level event on RDI leadership in the AI era, which led to the 7th edition of the Science & Society magazine, focused on AI, governance, and leadership. Institutional contacts with PlanAPP were renewed, and several digital technology-based projects were approved to support public administration in key domains such as health, infrastructure, environment, and transparency.

Overall, INESC TEC successfully delivered on its key initiatives for 2024, adapting to evolving circumstances where needed and launching several significant new actions. These efforts contributed to a substantial 17% increase in activity volume, continuing a trajectory of sustained institutional growth.

By the end of 2024, INESC TEC hosted over 980 integrated researchers, including more than 400 with a PhD. Human resources continued to expand, with a 16% increase in R&D employees and a 14% rise in the number of grant holders, reflecting the institute's growing capacity and attractiveness as a research environment.

On the scientific front, a central focus of 2024 was the completion of key phases of the FCT R&D Unit Evaluation process. This effort reflected a strong alignment with INESC TEC's scientific strategy and was carried out with meticulous preparation, institutional commitment, and active engagement. Final results are expected in 2025, following the conclusion of the evaluation cycle.

In 2024, INESC TEC reached €33.6 million in activity, representing a 17% increase over the previous year and extending more than a decade of continuous, sustainable growth. The most significant increase occurred in National Cooperation Programmes with Industry, which grew by 51%, driven primarily by the execution of Innovation Agendas and Green Agendas funded through the Portuguese Recovery and Resilience Plan (PRR). These PRR-funded projects accounted for €11.7 million in total funding. Widely recognised as strategic instruments, these Agendas support Portugal's economic development and social progress toward 2030. European programmes also remained a cornerstone of INESC TEC's portfolio, representing 38% of total project funding across 115 projects.

Strengthening international engagement was a key achievement in 2024, with INESC TEC's community showing increased participation in mobility programmes and international funding schemes. Notable initiatives included OpenInnoTrain, the ERCIM Alan Bensoussan Fellowship, and the NII International Internships Programme. The latest edition of the INESC TEC International Visiting Researcher Programme attracted a record number of submissions and applications. The institute also deepened its global reach through active membership in more than 25 international organisations and expanded cooperation with partners worldwide. A particularly significant milestone was the launch of a joint exploratory research call with NARLabs (Taiwan), reinforcing a strategic bilateral partnership.

INESC TEC further strengthened its role in shaping research and innovation ecosystems by joining several key international networks, including BDVA, GAIA-X, IAM-I, INOMMOB, and RISC-V. The institute helped convene high-level discussions on AI, HPC, and industrial innovation through the ATTRACT DIH event, and contributed to the EARTO Economic Footprint Study and the TTO Circle, reinforcing its voice in European policy and technology transfer arenas. Strategic cooperation was advanced not only with Taiwan but also with Brazil, and INESC TEC played an active role in the renewal of Portugal's longstanding transatlantic collaborations with U.S. universities.

Scientific output continued to grow in 2024, with a 3.5% increase in indexed publications, a 13% rise in conference papers, and a 13% growth in journal articles published in first-quartile (Q1) journals. Notably, the number of conference papers presented at Core A* rated venues also increased to 13. INESC TEC supported more than 280 PhD and 450 Master's students across its research activities in 2024, reinforcing its commitment to education and talent development in close collaboration with higher education

institutions. Of these, INESC TEC researchers directly supervised over 200 ongoing PhD theses, with 74 completed during the year. Members of the research community held over 100 editorial roles in scientific journals and took on more than 55 organisational responsibilities in conferences, including serving on committees and chairing sessions. The R&D Centres also hosted over 90 conferences, workshops, and scientific sessions, attracting more than 5,500 participants. In advanced training, 19 courses were delivered, in addition to the launch of the Executive Master in Cybersecurity in partnership with Porto Business School, and the participation in the new Digital Health and Biomedical Innovation degree at the Faculty of Medicine, University of Porto. Initial steps were also taken toward a new student engagement initiative, aimed at broadening research opportunities for higher education students.

Technology transfer continued to advance in 2024, marked by strong performance in patents, licensing, and spin-off development. INESC TEC ranked 4th *ex aequo* in the Portuguese European Patent Office (EPO) Patent Index 2024, maintaining a solid presence in the Top 10 since 2017. During the year, nine new patent applications were filed, bringing the total to a record 42 active patent families. New areas of patent activity included marine robotics, energy, and smart communications, while instrumentation and medical devices sustained their momentum. Valorisation efforts led to five new licensing agreements, including three international contracts and two involving spin-offs. A key milestone in spin-off development was INESC TEC's formal entry into the equity of iLoF – Intelligent Lab on Fiber, a digital health venture leveraging machine learning and photonics for drug discovery. It was joined by ten other spin-offs in development, spanning fields such as photonics, robotics, systems engineering, and AI, supported through technical assistance for commercial proof-of-concept projects.

In 2024, INESC TEC contributed to more than 300 active projects aligned with the United Nations Sustainable Development Goals, particularly in areas such as clean energy, healthcare, infrastructure, and environmental sustainability. The institute worked closely with public and private actors, collaborating with over 68 SMEs and 128 large enterprises, and delivering 106 direct contracts that reflect its practical engagement with the economy. It also engaged with 12 Clusters and 11 CoLABs to bridge research and application. Its role in regional development was reinforced through contributions to the Smart Specialisation Strategy for Northern Portugal. At the international level, INESC TEC collaborated with the Linha de Saúde 24h initiative in Guinea-Bissau to extend digital healthcare to remote areas. In the industrial innovation domain, the newly launched Industry Club, developed in partnership with NOS, COTEC, and Porto Business School, brought together over 250 members to foster digital transformation across sectors.

Alongside its research and innovation activities, INESC TEC remained deeply committed to science communication and societal engagement in 2024. The second season of the “INESC TEC Ciência e Sociedade” podcast and videocast was launched, along with new episodes of the “Science Bits” podcast, focusing on high value-added industries. These efforts expanded the institute's digital outreach across platforms such as YouTube, Blubrry, Engenharia Rádio, and the BIP newsletter. A new science communication format – “INESC TECWatch” – was also introduced, offering accessible insights into key scientific topics. INESC TEC hosted and co-organised major international conferences, including IAMOT 2024, one of its field's most prestigious events, which welcomed 230 participants from over 30 countries. Visibility was further enhanced through the promotion of summer schools, workshops, and open days, and through the institute's presence at major global events such as Hannover Messe, OCEANS 2024, and Enlit Europe, where INESC TEC showcased its technological achievements to international audiences.

INESC TEC's work received notable recognition in 2024, with several awards highlighting the institute's scientific and technological impact. The iLoF technology earned the EARTO Innovation Prize in the “Impact Expected” category, marking the first time a Portuguese institution received this distinction. iLoF's potential in personalised medicine is now being realised through commercial applications by an INESC TEC spin-off. Pocket-Vet secured first place in the 'Food and Nutrition Security' category at the Crédito Agrícola Entrepreneurship and Innovation Awards, while the PETALL (PeT) project was awarded second place at the IN3+ Award, receiving €250,000 to support privacy-preserving digital services. The Modular-E robotic platform earned a Silver Medal at FIRA 2024 and first place at the Prémios Inovação Agricultura 2024, along with the €10,000 TIMAC Agro Expresso Agriculture Innovation Award. Additionally, INESC TEC's robots EVA and Turtle III made history at REPMUS 2024 by reaching a depth of 830 metres.

As the 2024-2026 term begins, the new Board of Directors extends its sincere appreciation to the entire INESC TEC community for their dedication and contributions. While reflecting on the achievements of the

past year, the Board is equally focused on building the future – advancing the institute’s mission with renewed purpose and energy.

In a global context marked by uncertainty and rapid change, INESC TEC remains committed to making a meaningful contribution through science, technology, and innovation. Guided by its values and strategic vision, the institute will continue working toward a more sustainable, inclusive, and impactful future.

1 Introduction

This document presents the scientific and technological activities, as well as the results of INESC TEC during 2024.

Section 2 offers a summarised presentation of the institute's profile, vision, mission, organisational model, policy priorities, institutional objectives and research and innovation goals. Section 3 presents the highlights and main activity indicators for 2024, namely those regarding Human Resources, Activity in Projects, and Publications.

Research at INESC TEC is developed by thirteen Research Centres covering eight core scientific domains: Artificial Intelligence (AI), Bioengineering (BIO), Communications (COM), Computer Science and Engineering (CSE), Power and Energy Systems (PES), Photonics (PHT), Robotics (ROB) and Systems Engineering and Management (SEM). Section 4 presents these eight Domains and their scientific outcomes in 2024.

Section 5 focuses on the TEC4 initiatives, platforms that articulate the activity towards economic and societal impacts, presenting their main achievements in 2024 for the following areas: AGRO-FOOD, ENERGY, HEALTH, INDUSTRY and SEA.

Section 6 presents the scientific and technological activities developed by the 13 Research Centres, including their research and innovation outcomes.

Section 7 describes some of the institute's main research infrastructures that support both research and technology transfer activities, besides its active participation in several national Research Infrastructures, and Section 8, dedicated to special projects, introduces the coordination of the UT Austin Portugal Program.

Section 9 reports the activities of the Support Services, including the Business Development Services, the Management and Organisation Services and the Technical Support Services.

2 INESC TEC Presentation

2.1 Purpose, Vision, Mission and Values

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 University of Porto, INESC, the Polytechnic Institute of Porto, the University of Minho and the University of Trás-os-Montes e Alto Douro are INESC TEC's associates. INESC TEC's sites are located in Porto, Braga and Vila Real. At the end of 2024, INESC TEC hosted more than 980 integrated researchers (403 PhDs), including academic staff, R&D employees, grant holders and affiliated researchers. INESC TEC's team also includes technical and administrative support staff and trainees.

INESC TEC's purpose is to create a fulfilling and sustainable future through impactful science, technology, and innovation.

Its history and purpose are deeply intertwined with those of its academic associates. As set out in the bylaws, its purpose is to carry out excellent research and then to enhance their involvement and intervention in the development of the economic and social fabric, thus contributing to improve the performance and competitiveness of companies and institutions.

INESC TEC aims to be an inspiring and empowering force, driving the science and technology of digitally-enabled systems into overcoming society's challenges.

Pursuing this vision, the institution aspires to continually innovate across all the mission areas of academia, emphasising research and innovation but also contributing distinctively to education and furthering a flourishing collaborative environment, bridging it to the economy and society. The institute endeavours to be an international reference in its fields of activity, underpinned by the excellence of its research and innovation.

As a free-thinking and diverse community, INESC TEC's mission is to take on bold science, technology, and innovation challenges, empowering talent, collaborative ecosystems, and public policies that make a difference in our economy and society.

INESC TEC is a people-centred organisation that cultivates an inspiring discovery and learning environment where a diverse, critical- and free-thinking, venturesome, and creative talent community thrives. It values excellence and openness in science and technology. As such, the institute seeks purpose and meaning in its research as it bridges its scientific domains to societal challenges and problems. It collaborates with academia and other stakeholders to develop talent and build science, technology, and innovation awareness and capability, transforming its ecosystems at all levels and supporting policy- and decision-makers in implementing and formulating public policies.

The **merit of INESC TEC in accomplishing its mission** has been formally acknowledged by the Foundation for Science and Technology, with the institute's recognition as an **Associate Laboratory**, and by the Portuguese Ministry of Economy, with its recognition as a **Technology and Innovation Centre (CTI)**.

INESC TEC's **six guiding principles adopted as the shared core values** of its community are: 1) **Rigour and excellence** – Thoroughly embed rigour in all work, from ideation through realisation to evaluation; 2) **Freedom to create and think** - Autonomy in pursuing intellectual agendas, free of unreasonable interference; 3) **Integrity** – Remain true to the institution's principles and act with transparency and compliance with ethical standards; 4) **Collaboration** – Share, with each other and with partners, all successes and challenges, as a cohesive community; 5) **Creativity** - Explore new areas to advance science and innovation, with bold curiosity and accepting the risk of failing as intrinsic to creating new things; and 6) **People-centredness** - Place people at the centre of all activities, as a community in which everyone is welcome and fully supported in their development.

2.2 High-level View of Science and Innovation

Knowledge Value Chain

INESC TEC’s management and operational model implements the concept of end-to-end knowledge value chain, driving knowledge from its generation in research activities to its valorisation through different technology transfer instruments (Figure 2.1).

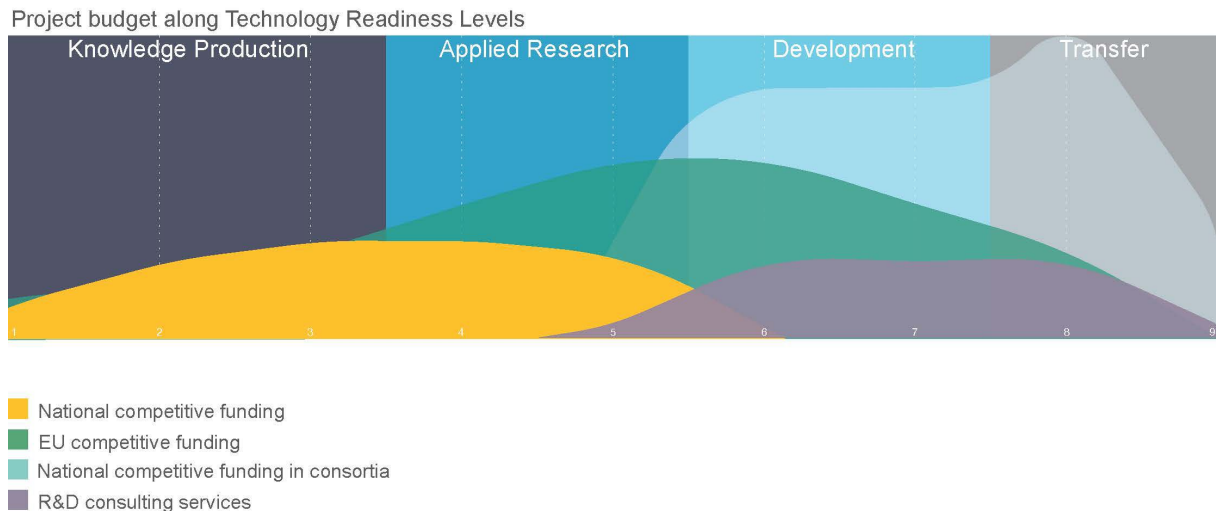


Figure 2.1 - End-to-end knowledge value chain: an integrated two-way pipeline

The concept is illustrated in a simplified manner in the figure above, which presents the knowledge value chain as a seamless integration of four stages – knowledge production, applied research, development, and technology transfer. Activities and outcomes of projects active in 2024 fall in different ranges of Technology Readiness Levels (TRLs) and are linked to different funding typologies. As with any model depicting a complex reality, the transitions between stages are fluid.

Centres, Scientific Domains and TEC4s



Figure 2.2 - High-level view of science and innovation at INESC TEC

Research and innovation at INESC TEC are undertaken in its 13 Research Centres.

Research is structured in eight broad Scientific Domains: Artificial Intelligence, Bioengineering, Communications, Computer Science and Engineering, Photonics, Power and Energy Systems, Robotics, and Systems Engineering and Management. Innovation is focused on main technology market drivers expressed internally through the TEC4 initiatives, currently TEC4AGRO-FOOD, TEC4ENERGY, TEC4HEALTH, TEC4INDUSTRY and TEC4SEA.

The Research Centres are INESC TEC’s R&D base organisational units, each focused on specific scientific and technological areas and responsible for its own planning, strategy and resources, reporting directly to the Board of Directors regarding budget and performance indicators.

The Scientific Domains structure the institute’s research competences and challenges promoting strategic thinking, trajectory monitoring, and science communication.

The TEC4 initiatives (TEC4AGRO-FOOD, TEC4ENERGY, TEC4HEALTH, TEC4INDUSTRY and TEC4SEA) articulate INESC TEC’s activity towards the main market sectors and address current societal challenges, defining market strategies and planning the interaction with major application areas. A TEC4 initiative establishes a network of external contacts and a dialogue with industrial and institutional partners and brings back major challenges and opportunities to multiple Centres.

2.3 Organisational Structure

The institution’s organisational structure (Figure 2.3) comprehends a Board of Directors composed of seven members and an Executive Board comprising four of those seven members, responsible for the high-level management of INESC TEC. The Boards act in close coordination with the Council of R&D Centres, meeting with the Centre Coordinators and the Managers of the different Support Services every other week. This ensures institution-wide coherence in vision, policy and operations, and joint responsibility and commitment in strategic and operational management decisions.

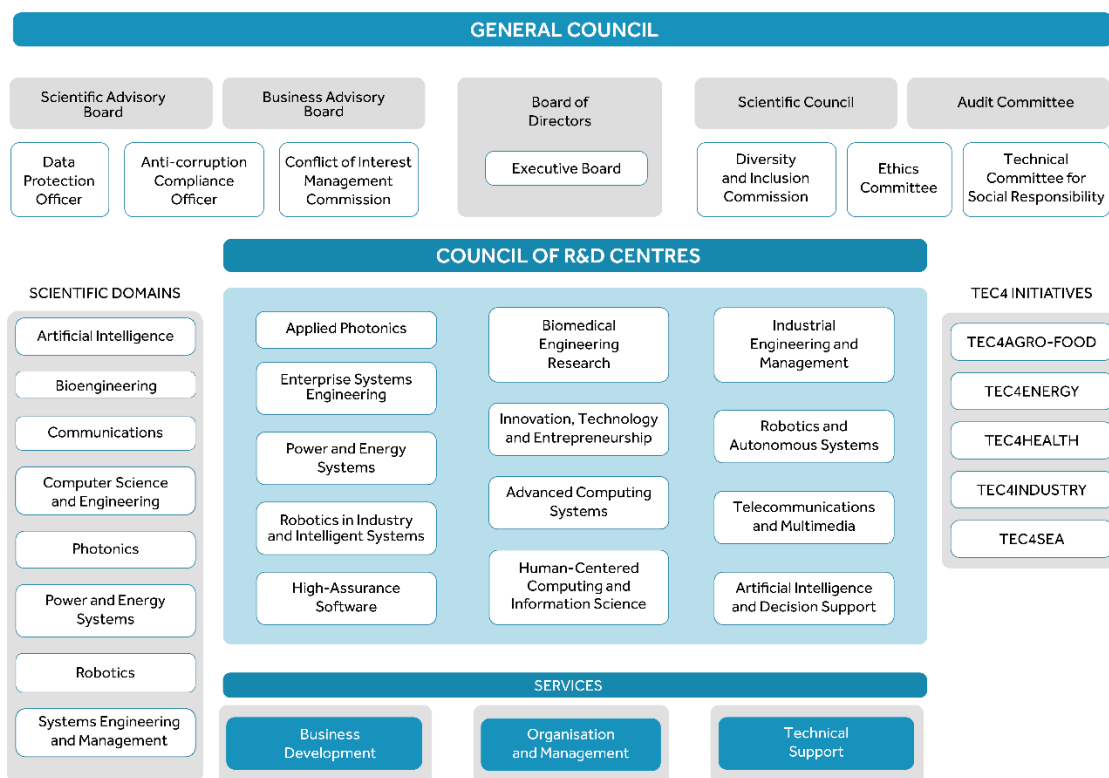


Figure 2.3 - Organisational Structure

The Scientific Advisory Board comprises twelve external internationally recognised scientists who support the institution's search for continuous improvement and excellence, building a vision for future research through a valuable benchmark at the international level. The external monitoring, orientation and evaluation of the technology transfer and innovation activities are entrusted to the Business Advisory Board, whose members have knowledge and experience in several economic sectors relevant to INESC TEC. The Scientific Council is an internal body responsible for monitoring and guiding scientific and technical activities, consisting of PhD researchers who participate permanently in INESC TEC's activities and includes one representative from each Centre and three additional members appointed by the Board of Directors.

The Audit Committee includes a Certified Public Accountant and oversees and validates the legal and financial behaviour of the Institute.

Six non-statutory bodies oversee aspects that INESC TEC particularly values. The Ethics Committee ensures the observance and promotion of integrity, honesty, and responsibility standards in research activities carried out by INESC TEC's members by implementing the institution's Code of Ethics. The Conflicts of Interest Management Commission (CGCI) and the Data Protection Officer are responsible for implementing the institute's Policy on Conflicts of Interest Management and the General Data Protection Regulation, respectively. The Anti-Corruption Compliance Officer is responsible for implementing the Compliance Programme for the prevention of corruption in articulation with other relevant organisational units. 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 encourages the organisation to implement practices that promote diversity and inclusion and develops long-term work in this field by proposing and implementing a D&I Program for INESC TEC, including gender balance as a major priority. The Foresight and Public Policy Office is dedicated hub for advancing policy engagement and foresight activities.

INESC TEC's activities are supported by a streamlined and dynamic team of highly qualified technical and administrative personnel, organised across the following areas: Business Development, Organisation and Management, and Technical Support.

Table 2.1 - Support Services

Business Development	Organisation and Management	Technical Support
SAL: Technology Licencing	AG: Management Support	SAS: System Administration
SAAF: Funding Opportunities	AJ: Legal Support	SIG: Management Information Systems
SRI: International Relations	CF: Accounting and Finance	SRC: Networks and Communications
SCOM: Communication	CG: Management Control	SGI: Infrastructure Management
	RH: Human Resources	
	COORD SEC: Secretarial Coordination	

2.4 Areas of Intervention and Responsibility of the Board of Directors

To effectively fulfil its responsibilities and address the challenges inherent in the management of the institution, the Board of Directors of INESC TEC defined the distribution of areas of intervention and responsibility among its members for the 2024–2026 term.

This allocation takes into account the need to balance effort, valorise the individual profiles of each Member of the Board, ensure articulation between related areas, and promote proximity to the functions of the Executive Board. The distribution encompasses the operational areas entrusted to each Board Member, the leadership of missions aimed at institutional change in strategic areas, and the responsibilities for closer supervision of Support Services and liaison with R&D Centres, Scientific Domains, and TEC4 initiatives.

João Claro, Chairman and Chief Executive Officer – Coordination of Strategic Management; Planning and Reporting; Coordination of Operational Management; Strategic Partnerships – Public Sector; General Council; Audit Committee; Foresight and Public Policy Office; Entrepreneurship and Spin-offs. Supervision of the Services AG, IBH, RH, SAL, and SCOM.

Gabriel David, Vice-Chairman – Strategic Partnerships – Associates and Higher Education Institutions; Institutional Governance; Institutional Bases and Policies: Rights and Duties, Researcher and Student Statutes, Data Protection; Advanced Training; Knowledge Management; Scientific Council.

Aníbal Matos, Member of the Executive Board – Coordination of Scientific Domains; Institutional Applications and Supervision of Cross-Cutting Projects – Science; Scientific Advisory Board; Students. Liaison with the Centres CRACS, CRAS, CRIIS, HASLab, HumanISE, and LIAAD. Supervision of the Services SAAF and SRI.

Clara Gouveia, Member of the Board – Industry Partnerships; Promotion of the R&D Services and Consulting Area; Liaison with Participations in Other Entities; Institutional Applications and Supervision of Cross-Cutting Projects – Innovation; Business Advisory Board.

Lia Patrício, Member of the Board – Internal Digital Transformation; Knowledge Transfer in the Digital Era; Ecosystem Orchestration for Societal Challenges; Citizen Engagement.

Luís Seca, Member of the Executive Board – Coordination of TEC4; Environmental Sustainability; Quality Management; Non-Legal Compliance and Operational Risk Management; Project Management Office; Management Training and Leadership Development; Institutional Bases and Policies: Social Responsibility. Liaison with the Centres CAP, CBER, CEGI, CESE, CITE, CPES, and CTM. Supervision of the Services SAS, SIG, SRC, and SGI.

Maria da Graça Barbosa, Member of the Executive Board – Legal Compliance and Risk Management; Institutional Bases and Policies: Ethics, Conflicts of Interest, Diversity and Inclusion. Supervision of the Services AJ, CF, CG, and CSECR.

2.5 Strategic Commitments

To accomplish its vision, INESC TEC has defined the following five core strategic commitments:

- C1. Excel and innovate across the missions of academia, harnessing the collective strength of our community.
- C2. Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.
- C3. Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.
- C4. Cultivate an attractive, people-centred and talented community.
- C5. Strive for a sound, sustainable and effective operational model.

Excel and innovate across the missions of academia, harnessing the collective strength of our community

INESC TEC will address significant challenges, such as the UN's Sustainable Development Goals, the EU's Societal and Grand Challenges, or the US National Academy of Engineering's Grand Challenges, through transformative science and technology. In service of public interest, it will contribute to implementing current policy priorities and help shape future policies addressing critical societal challenges. The institute combines creativity and freedom with action, maintaining a constant focus on excellence.

To that end, the institution's strategic objectives focus on increasing its contribution to regional and national R&I-based sustainable growth, better aligning the delivery of R&I with the industry's needs and the SDGs. Furthermore, it will contribute to the digitalisation of public administration and raise its involvement in informing debates on issues that matter to society. Finally, it will engage with the public to communicate scientific and technological achievements and their impact.

Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action

INESC TEC will take on the toughest challenges through transformative science and technology. It will work hard, acting in the public interest, contributing to implementing current policy priorities and shaping future policies tackling critical societal challenges. It will be boldly creative, blending novelty, freedom, and action through endeavour and a relentless focus on excellence.

To that end, the institution's strategic objectives focus on increasing its contribution to regional and national R&I-based sustainable growth, better aligning the delivery of R&I with the industry's needs and the SDGs. Furthermore, it will contribute to the digitalisation of public administration and raise its involvement in informing debates on issues that matter to society. Finally, it will endeavour to engage in direct dialogue with the public and to communicate scientific and technological achievements and their impact.

Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems

The institution will act in an integrated manner across the knowledge value chain, researching and developing technology-based systems and fostering sustainable innovation. Its paths to solutions will build on an integrated multidisciplinary approach. Striving for impactful innovation, jointly with its stakeholders, it will strengthen the technology and innovation capabilities of the ecosystems it is a part of.

To fulfil this commitment, INESC TEC's primary goals are to build more vital knowledge-based and multidisciplinary R&I ecosystems and to develop better linkages between knowledge production, development, and market uptake. Moreover, initiatives will be undertaken to increase strategic integration in national and international tech-intensive value chains and promote proactive participation in R&I agenda-setting at regional, national and EU levels. It will aim to expand its international networking, leadership, and competitiveness.

Cultivate an attractive, people-centred and talented community

INESC TEC will strive to attract and retain world-class talent, by motivating, recognising, and fully supporting individuals in their personal and professional growth. It will expand the diversity of its talent and be a welcoming home for international researchers, cultivating an inclusive and freethinking environment. It will promote a good working environment, fostering team spirit, engagement, and social responsibility. It will uphold openness, transparency, independence, and ethical principles in research.

The strategic objectives for this commitment encompass attracting and retaining world-class talent and ensuring opportunities and recognition for career achievements. In addition, they also entail expanding the diversity of INESC TEC's community, providing a more dynamic and fulfilling working environment, and,

finally, strengthening the institution's commitment to independence and compliance of research with ethical principles.

Strive for a sound, sustainable and effective operational model

The institute will endeavour for sustainability and resilience in its economic model, providing its community with the best conditions to create new knowledge that will impact society. It will promote and contribute to environmental sustainability, provide excellent facilities, and cultivate a discovery and learning environment, enabling its critical talent community to thrive.

This commitment's strategic objectives include strengthening the sustainability and resilience of INESC TEC's economic model, the improvement, management, and usage of its infrastructures and, to a more significant degree, cementing the distinctive aspects of its institutional model.

2.6 Research

Research at INESC TEC is centred around eight broad Scientific Domains. Researchers across INESC TEC come together in each domain to establish a critical mass of scientific competences and enhance scientific cohesion, strategy, impact and communication. These forums enable discussing and planning INESC TEC's longer-term research trajectory, becoming platforms for strategising, with medium to long-term goals leading to measurable results.

The institution's scientific strategy in each domain is fully articulated with the strategies of the R&D Centres, the organisational units that effectively plan, manage, and carry out the research activities at INESC TEC. INESC TEC's R&D Centres-based model is at the root of its sustainable growth and distinctive multidisciplinary.

Today's Grand Challenges, such as resilient responses to climate change, the decarbonisation and digitalisation of the economy, or the design of sustainable circular solutions, business models and value chains, present demanding multidisciplinary research challenges. INESC TEC draws on the expertise of its scientists in different fields to assemble multidisciplinary teams to tackle large-scale, time-sensitive projects addressing such critical social and economic challenges quickly and successfully with lasting impacts. To this end, four thematic lines that embrace scientific challenges that crosscut our scientific domains and are decisive to our vision were identified: digital models, sustainable transformation, tackling the extreme, and trustworthy technology.

This INESC TEC hallmark stems from its diversity, critical mass, and intrinsic purpose to cover the entire knowledge value chain. The joining of internal efforts is a crucial enabler for the higher impact of research achievements.

2.7 Innovation

Contemporary societies face multiple major social, economic, political, and cultural issues – societal challenges such as climate change, increasing demographic imbalances, shifting health challenges, shaped by contemporary megatrends such as technological advancements, growing energy needs, hyperconnectivity.

The sciences and technologies underlying digitally-enabled systems have a vital role in addressing these challenges, and INESC TEC has been fully committed to that endeavour, defining five main areas of intervention in the innovation arena:

- Market-pull innovation in which it aligns its strategy with relevant challenges of the main economic sectors;
- Large-scale innovation strategies to increase the level of intervention and impact, from sectors to societal challenges;

- Knowledge management and valorisation paving the way to take full advantage of the cross-sectorial nature of its research results;
- Entrepreneurship support to boost scientific knowledge valorisation and upgrade Portugal's economic fabric;
- Advanced training and capacitation to develop the conditions for adequate knowledge transfer, absorption, and transformation into impactful innovations.

Addressing the first area of intervention, INESC TEC created the TEC4 (“TEChnologies FOR ...”) internal initiatives as an organisational approach aiming at structuring and promoting the market-pull innovation process, targeting specific economic sectors. Each TEC4 addresses the market's regional, national, international, or global/societal challenges by mapping and linking its short, medium, and long-term needs (strategic agenda and roadmap) with INESC TEC's scientific and technological competences and experience.

In line with the above innovation strategy, as a Technology and Innovation Centre recognised by the Portuguese Ministry of Economy, its pluriannual action plan to promote science-based innovation with economic and social impact spans across eight axes: Networking and promoting new projects in companies; Promoting technology transfer and cross-fertilization; Internationalisation; Strengthening and boosting technological infrastructures; Attracting and developing talent; Digitising processes and continuous improvement; Sustainability and budget predictability; Developing relevant knowledge and technology in the circular economy and decarbonisation, artificial intelligence and cybersecurity.

3 Results Achieved in 2024

This section presents a short summary of the results INESC TEC achieved during 2024, including highlights of the activity and the main indicators for human resources, activity in projects, scientific publications, knowledge transfer and dissemination. The remaining sections of the document include detailed information for each Scientific Domain and R&D Centre, the TEC4 multidisciplinary initiatives, research infrastructures, special projects, and Support Services.

3.1 The Year 2024 in Review

The year 2024 was marked by a volatile global landscape, defined by strategic realignments, geopolitical instability, and the accelerating pace of technological and societal change. The ongoing conflict in Ukraine and renewed tensions in the Middle East contributed to a reshaped global order, characterised by multipolarity, energy insecurity, and a growing emphasis on strategic autonomy. In Europe, these developments translated into stronger support for initiatives such as the European Defence Fund and the Chips Act, reflecting a broader commitment to technological sovereignty and industrial resilience.

In parallel, digital transformation accelerated across all sectors of society, driven by breakthroughs in artificial intelligence, quantum computing, and cybersecurity. These advances expanded the frontiers of technological possibility while introducing new ethical, social, and regulatory dilemmas. The convergence of digital technologies continued to reshape the innovation landscape, underscoring the critical role of research in guiding responsible progress and policy development.

Sustainability continued to define the global agenda in 2024. The escalating impacts of climate change, biodiversity loss, and resource depletion deepened the urgency for systemic transformation. Governments, businesses, and research institutions alike were increasingly expected to embed sustainability into their strategies, operations, and innovation priorities. From clean energy to circular economy models, the momentum behind climate-resilient innovation grew stronger, calling on institutions to reimagine their contributions to a more inclusive and sustainable future.

Amid these converging challenges and opportunities, INESC TEC continued to grow and evolve. In 2024, the institute continued to grow both in terms of its community and overall activity, strengthening its capacity to conduct and disseminate impactful research. The year saw further progress in technology valorisation, knowledge transfer, and scientific outreach, reinforcing the institute's role in driving innovation and societal impact. This commitment was notably recognised with the EARTO Innovation Award in the "Impact Expected" category, awarded to the iLoF technology platform, the first time a Portuguese institution received this distinction.

Building on this momentum, INESC TEC reinforced its strategic positioning through international collaboration, institutional growth, and leadership in emerging technologies. The approval of INESC TEC.OCEAN as Portugal's Centre of Excellence in Ocean Research and Engineering under the Horizon Europe Teaming for Excellence programme, and the launch of POEMS, the national Competence Centre in Semiconductors, reflected the institute's growing role in addressing critical European priorities. INESC TEC also contributed to shaping future European research and innovation policy through the publication of a position paper on the 10th Framework Programme and its participation in the EARTO Economic Footprint Study.

In support of talent development, INESC TEC helped secure 20 new professorships in its Associate Higher Education Institutions, as well as 14 new research positions at the institute, aligned with key scientific domains such as AI, quantum, bioengineering, robotics, and energy. Institutional capacity was further enhanced through preparatory work for the deployment of a new ERP system, alongside the restructuring of key elements within the organisational architecture. Additionally, INESC TEC expanded its national presence with the establishment of a new research hub in Madeira, broadening its territorial reach and capacity for regional collaboration.

While the international landscape continues to present complex challenges, it also opens up valuable opportunities for institutions committed to advancing science, technology, and innovation. Looking ahead, INESC TEC remains focused on navigating change with purpose, deepening its scientific excellence,

strengthening its community, and contributing to societal transformation. Guided by its strategic commitments and shared values, the institute will continue working toward a more sustainable, inclusive, and impactful future.

3.2 Highlights in 2024

INESC TEC successfully advanced the core initiatives planned for 2024, with most being implemented as expected and some naturally adjusted in response to evolving circumstances. The year was marked by a 17% increase in activity, reflecting the organisation's continued investment in strengthening its foundations, deepening its engagement with national and international Science and Technology systems, and upholding its public mission.

This section highlights the most significant accomplishments of 2024, structured according to INESC TEC's five strategic commitments. These achievements illustrate the ongoing implementation of the Strategic Plan. Nonetheless, they do not capture the full breadth of institutional activity. Additional cross-cutting initiatives – driven by the efforts of R&D centres, services, and internal commissions – are detailed in other sections of this report.

C1. Excel and innovate across the missions of academia, harnessing the collective strength of our community.

- C1.1. Raise the contribution and visibility of our research

INESC TEC advanced its scientific profile in 2024 by deepening its engagement in academic training, expanding its research capacity, and achieving measurable gains in scientific output and visibility:

- Academic engagement and talent development – INESC TEC continued to play a central role in graduate education, contributing to over 20 PhD programmes and involving more than 280 PhD students and 480 Master's students. This engagement with Higher Education Institutions (HEIs) strengthened the research ecosystem and contributed to the attraction of new talent.
- PhD recruitment and funding leverage – The attraction of new PhD students was supported by the institute's involvement in emerging R&D projects and its active pursuit of funding opportunities within academic contexts.
- Strategic reinforcement of the research team – A targeted recruitment effort in key scientific areas led to a 16% increase in R&D employees, aligned with both INESC TEC's scientific strategy and national policy objectives for scientific employment.
- Growth in scientific output and visibility – The institute recorded a 3.5% overall increase in indexed publications, including a 13% rise in conference publications and a 13% increase in journal articles published in first-quartile (Q1) journals. Notably, 13 publications were presented at Core A* rated conferences.
- FCT R&D Unit Evaluation – INESC TEC successfully completed the main phases of the 2023/24 R&D Unit Evaluation process led by the Portuguese Foundation for Science and Technology (FCT). The institute ensured strong alignment with its scientific strategy and goals through rigorous preparation, institutional coordination, and active engagement. The evaluation will conclude in 2025, with final results pending.
- International recognition and researcher development – A funding model was defined to support the individual membership fees of INESC TEC researchers in international scientific societies and communities. This initiative supports the institute's strategy for international positioning and researcher development, with full implementation planned for 2025.

- C1.2. Increase our involvement in the leadership of scientific initiatives

The institute expanded its leadership role in major research and innovation initiatives at both national and European levels, while also reinforcing global scientific networks and strategic domains:

- INESC TEC.OCEAN approved as a Centre of Excellence – INESC TEC secured the approval of INESC TEC.OCEAN, Portugal’s Centre of Excellence in Ocean Research and Engineering, through a successful application to the Teaming for Excellence programme under Horizon Europe’s Widening initiative. Spanning from 2025 to 2030, this strategic initiative will promote cutting-edge research in marine structures, marine robotics, ocean energy, and ocean data – bridging deep-sea exploration with ocean–Earth–space systems. The Centre will foster knowledge transfer and innovation in collaboration with partners such as Fórum Oceano, Cluster do Mar Português, APDL, and the Norwegian research institute SINTEF.OCEAN.
- POEMS – Portuguese Competence Centre in Semiconductors – Also approved in 2024, POEMS is a strategic initiative under the Chips for Europe Initiative, focused on semiconductor technologies. The centre will advance capabilities in chip design, advanced packaging, and emerging technologies in microelectronics. It aims to position Portugal at the forefront of semiconductor innovation and production, reinforcing national capacity to address key global technological challenges.
- Ongoing leadership in emerging digital technologies – INESC TEC maintained a central role in national and European initiatives in High-Performance Computing (HPC), Artificial Intelligence (AI), and Quantum Computing, strengthening its scientific positioning in critical frontier technologies.
- International engagement through the CENTRA network – INESC TEC deepened its collaboration with the CENTRA network, a transnational platform for cooperation in cyberinfrastructure across countries such as Indonesia, the USA, Vietnam, and Japan. Participation in the most recent CENTRA event in Tokyo reaffirmed the institute’s leadership in fostering international scientific cooperation.

- C1.3. Improve the base conditions for technology commercialisation

INESC TEC continued to build a stronger foundation for innovation impact, marked by a sustained patenting record, growth in licensing activity, and active participation in international valorisation networks:

- Sustained leadership in patenting activity – INESC TEC ranked 4th *ex aequo* in the Portuguese Patent Index 2024 published by the European Patent Office (EPO), maintaining a consistent Top 10 position since 2017 and reaffirming its relevance in the national innovation landscape.
- Record growth in patent portfolio – The institute achieved a record high of 42 active patent families, including nine newly established in 2024. This growth was supported by an increase in technology pre-disclosures and a strategic focus on emerging areas such as marine robotics, energy, and smart communications, while maintaining strong activity in instrumentation and medical devices.
- Commercialisation through licensing – Five licence agreements were concluded, including three international contracts and two involving INESC TEC spin-offs, reflecting growing maturity in the translation of research outputs into commercial value.

- Global engagement in knowledge valorisation – INESC TEC maintained an active presence in international technology fairs and strategic industry events, while contributing to leading networks in innovation and technology transfer. These included the TTO Circle, EARTO, and both national (GAPI) and European (PATLIB) platforms. The institute also actively promoted the critical role of intellectual property (IP) as a strategic success factor for businesses of all sizes.
- C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

In 2024, INESC TEC prioritised connection and collaboration, organising sector-focused events and expanding dialogue with companies and communities to foster innovation ecosystems:

- Strengthened engagement with innovation partners – INESC TEC organised targeted workshops and networking events designed to foster dialogue with technology-based companies and stakeholders across key sectors. A notable example was the Energy Technology Open Day, a dedicated event focused on energy and innovation. The programme included research presentations, a roundtable on sectoral challenges, and a “happy hour” with live technology demonstrations. The event attracted over 150 participants, consolidating INESC TEC’s role as a trusted partner in shaping the future of the energy sector.
- C1.5. Provide innovative learning experiences

The institute enriched its educational offering through new programmes, interdisciplinary schools, and initiatives aimed at enhancing student engagement and researcher development:

- Expansion of advanced training programmes – A total of 19 advanced training courses were delivered during the year, alongside the launch of the Executive Master in Cybersecurity, developed in collaboration with Porto Business School. INESC TEC also contributed to the design and delivery of the new Digital Health and Biomedical Innovation degree at the Faculty of Medicine, University of Porto, expanding its interdisciplinary footprint.
- INVICTA 2024 spring school – The institute organised INVICTA 2024 – the INVICTA School of Vision, Computational Intelligence, and patTern Analysis, a spring school dedicated to artificial intelligence, computer vision, and pattern recognition. The event reached full capacity and attracted a diverse audience from both academia and industry, fostering cross-sector learning and collaboration.
- Student engagement initiative – A new initiative was launched to analyse and enhance the attraction and retention of students as young researchers within INESC TEC. This effort aims to strengthen pathways for student involvement in research and support the long-term development of scientific careers.
- C1.6. Increase the international embedment of our community

INESC TEC deepened its global presence by growing mobility opportunities, hosting international researchers, and establishing new partnerships with institutions across Asia and Europe:

- Broadened participation in international mobility programmes – INESC TEC increased its engagement in both inbound and outbound mobility schemes, including high-impact initiatives such as OpenInnoTrain, the ERCIM Alan Bensoussan Fellowship Programme – which enabled international fellows to carry out 12-month research stays at INESC TEC – and the National Institute of Informatics (NII) International Internships Programme, which

continued to facilitate medium-term research visits (up to six months) by Master's and PhD students to Japan.

- Expansion of the INESC TEC International Visiting Researcher Programme – A new edition of this programme was launched, providing international researchers with the opportunity to conduct research at INESC TEC for up to three months while remaining affiliated with their home institutions. The 2024 edition recorded the highest level of interest to date, with over 60 research topics submitted and more than 90 applications received.
- Strategic collaboration with NARLabs (Taiwan) – INESC TEC deepened its partnership with National Applied Research Laboratories (NARLabs) through the launch of a joint call for exploratory research projects. This marked a significant step forward in building long-term scientific cooperation between the two institutions.

- C1.7. Reinforce strategic alignment and close collaboration with HEI

The institute reinforced its institutional partnerships through new protocols, shared infrastructure, joint appointments, and collaborative academic programmes with its Associate HEIs:

- New partnership with UTAD and launch of the HCILab – A new institutional protocol was signed with the University of Trás-os-Montes e Alto Douro (UTAD), leading to the inauguration of the Human-Computer Interaction Laboratory (HCILab) at UTAD's School of Science and Technology. This initiative aims to enhance cooperation in research, innovation, and the sharing of human and material resources.
- Expansion to Madeira through a new research hub – INESC TEC established a research hub in Madeira through a protocol with the University of Madeira (UMa) and ARDITI – the Regional Agency for the Development of Research, Technology, and Innovation. This agreement formalised the creation of two new laboratories – the Ocean Technologies Laboratory and the Prototyping Laboratory – to support scientific research, knowledge transfer, and the training of human resources. The collaboration integrates UMa faculty members, contributes to the development of the future Degree in Maritime Sciences and Technologies, and builds on ARDITI's work in ocean technologies and robotic systems. It also strengthens INESC TEC's presence beyond Porto, Braga, and Vila Real.
- Advancement of collaborative protocols with Associate HEIs – Work continued on the implementation of protocols with INESC TEC's Associate HEIs, supporting the shared use and strategic alignment of human and infrastructure resources across institutions.
- New appointments through FCT-Tenure initiative – A total of 20 professorships were approved under the FCT-Tenure initiative, co-funded by INESC TEC and aligned with 14 permanent researcher positions at the institute. These appointments reinforce key scientific areas including Artificial Intelligence, Quantum Computing, Bioengineering, Robotics, and Energy Systems.
- Collaboration in advanced training programmes – INESC TEC maintained its active role in the design and delivery of Advanced Studies Programmes at several Associate HEIs, offering postgraduate training within the scope of R&D projects. These programmes combine hands-on experience with the development of transferable skills (e.g., innovation, entrepreneurship, leadership, and time management) and specialisation in technological domains.
- Collaboration with ISPUP on data protection and digital systems – The institute strengthened its partnership with the Institute of Public Health of the University of Porto

(ISPUP) through the joint design and adaptation of data protection procedures, improvements to ISPUP's information systems, and contributions to the development of institutional policies. This exchange of best practices supported both compliance and digital transformation efforts.

C2. Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

- C2.1. Develop impactful research and innovation aligned with the SDG

INESC TEC continued to align its scientific agenda with the UN Sustainable Development Goals (SDGs), mobilising research capacity to address global and societal challenges across multiple domains:

- Alignment with the SDGs through R&D project portfolio – A total of 306 active R&D projects at INESC TEC directly addressed one or more of the 17 UN Sustainable Development Goals, with a particularly strong focus on affordable and clean energy (SDG 7), industry, innovation and infrastructure (SDG 9), good health and well-being (SDG 3), and life below water (SDG 14) and life on land (SDG 15). These efforts reflect the institute's commitment to producing knowledge and solutions with societal impact.
- Health technology for inclusive development in Guinea-Bissau – As a key partner in the “Linha de Saúde 24h” project, INESC TEC contributed to the development and deployment of advanced technologies in support of a free, round-the-clock healthcare phone service that now assists over two million people in Guinea-Bissau. The project, developed in collaboration with NGDO VIDA, the Ministry of Public Health of Guinea-Bissau (MINSAP), Camões I.P., UNDP-GB, and UNICEF, aims to strengthen the National Healthcare System by improving access to medical assistance in remote areas and promoting equitable healthcare access.

- C2.2. Increase our contribution to regional and national R&I-based sustainable growth

The institute expanded its contribution to Portugal's innovation ecosystem by supporting regional smart specialisation strategies and strengthening collaboration within national innovation structures:

- Strategic input to regional innovation planning – INESC TEC provided contributions to the consultation on future technology infrastructures aligned with S3 NORTE (Smart Specialisation Strategy for Northern Portugal), following the most recent meeting of the Northern Regional Innovation Council (CRIN). These contributions aimed to inform investment strategies in emerging areas with high potential for regional impact.
- Support for national innovation ecosystems – The institute supported the development and operation of 12 Clusters and 11 Collaborative Laboratories (CoLABs) in partnership with academia and industry. These initiatives are designed to bridge the gap between knowledge production and application, strengthen collaboration across sectors, and foster innovation-driven responses to complex societal challenges.

- C2.3. Better align and deliver R&I with industry's needs

INESC TEC reinforced its role as a strategic partner to industry, developing new platforms, securing contracts, and engaging stakeholders to better align research and innovation with market needs:

- Expansion of R&D collaboration – INESC TEC secured new research and innovation contracts with both national and international clients, reflecting growing alignment with industrial priorities and trust in the institute's technological expertise.

- Launch of the Industry Club – The institute launched the Industry Club, a collaborative platform for driving digital transformation in Portuguese industry, in partnership with NOS, COTEC, Kaizen Institute, and Porto Business School. Since its launch in May 2024, the Club has attracted 250 members, hosted seven initiatives, and welcomed over 200 participants, offering curated content, workshops, technical visits, and training in innovation and industrial management.
 - Strategic input from the Business Advisory Board – At its October 2024 meeting, the Business Advisory Board recommended the creation of a scientific consultancy arm to translate research into high-value services. The Board also emphasised the need to strengthen business development capabilities and tailor approaches for large firms and SMEs.
- C2.4. Contribute to the digitalisation of public administration

In 2024, the institute supported digital transformation efforts in the public sector, engaging in structured dialogue with national bodies and contributing research to priority areas such as health, infrastructure, and citizen services:

- Renewed contacts with PlanAPP – INESC TEC reinitiated contacts with PlanAPP – Centro de Competências de Planeamento, de Políticas e de Prospetiva da Administração Pública, following its recent leadership transition. The scope of the envisaged collaboration includes the identification of digitalisation opportunities in public administration and the development of related roadmaps and supporting initiatives, leveraging INESC TEC’s neutral positioning with respect to market solutions and providers.
 - Research initiatives aligned with public administration priorities – INESC TEC secured multiple project approvals under the FCT call on Artificial Intelligence, Data Science, and Cybersecurity in Public Administration, contributing to the digital transformation of public services in key areas such as health, infrastructure, environmental protection, and public transparency.
- C2.5. Raise our contribution to inform debates on issues that matter to society

INESC TEC deepened its involvement in national and European policy discussions, organised high-level forums, and advanced initiatives to ensure that scientific evidence contributes meaningfully to public debate:

- Public Policy Office consolidated and expanded – The Public Policy Office was further consolidated as the institutional anchor for INESC TEC’s engagement with policy processes. Its remit was expanded to include foresight functions, supporting the proactive use of scientific evidence in public decision-making and enhancing collaboration with policymakers. (See Section 3.5.1 for more detail.)
- Ninth edition of the Autumn Forum – INESC TEC hosted the 2024 Autumn Forum, dedicated to “Critical Infrastructures: Security and Resilience.” The event provided a platform for national dialogue on strategic issues at the intersection of science, technology, policy, and economic development.
- Leadership in research assessment reform – INESC TEC was a co-founder of the Portuguese National Chapter of CoARA – Coalition for Advancing Research Assessment, reinforcing its commitment to shaping the future of research evaluation. A major highlight was the co-organisation of the first CoARA National Chapters Forum, held in Porto in partnership with FCT, CoARA, and Science Europe. The event gathered national and

international stakeholders to share experiences and discuss the role of national chapters in advancing assessment reform. INESC TEC continues to contribute actively to both the Portuguese chapter and the broader European dialogue on research assessment.

- European workshop on research careers – In collaboration with FCT and the European Commission’s DG RTD, INESC TEC co-organised a European workshop focused on implementing the European Framework for Research Careers, under Action 4 of the ERA Policy Agenda. The workshop explored institutional mechanisms to support cultural change and improve research career paths.
 - Exploring RDI leadership in the AI era – INESC TEC organised an event on leadership in science and innovation in the age of artificial intelligence, in collaboration with the European Commission and the NCBR Office. The event convened researchers, research managers, and policymakers to reflect on how AI is transforming leadership models in science and innovation. It also inspired the 7th edition of the Science & Society magazine, dedicated to the intersections of AI, governance, and leadership.
 - Debate on research and public policy with Manuel Heitor – INESC TEC and the Faculty of Engineering of the University of Porto (FEUP) co-organised a presentation and debate session on “Que Pirâmide Humana?”, the most recent book by Manuel Heitor, former Minister of Science, Technology and Higher Education. The event also featured discussion of the High-Level Group report on FP10, Align, Act, Accelerate. Held in November 2024, the session brought together experts from academia, government, and research institutions to explore public policy options for research, innovation, and advanced training in Portugal and Europe, and to reflect on how scientific knowledge can support societal transformation.
 - Policy input at the European level – Through the INESC Brussels HUB, the institute continued to contribute to European R&I policy development, producing position papers and other contributions aligned with its research agenda and strategic priorities.
 - Engagement in national science policy forums – INESC TEC remained an active member of the Associated Laboratories Council, contributing to the preparation of draft legislation and funding instruments relevant to the national research and innovation ecosystem.
 - Launch of videocasts and podcasts – The institute introduced new audiovisual formats to engage broader audiences, promote scientific literacy, and encourage informed discussion on how research informs and shapes public policy.
- C2.6. Engage in direct dialogue with the public

The institute continued to promote science and technology among broader audiences through outreach programmes, cultural events, and initiatives designed to connect with citizens of all ages and backgrounds:

- Participation in national science outreach events – INESC TEC was actively involved in Ciência 2024, Portugal’s annual meeting on science, technology, and innovation, and Mostra U.Porto 2024, strengthening its presence in national initiatives aimed at connecting science with society.
- Summer internships to promote research careers – As part of its commitment to engaging young talent, INESC TEC offered 60 summer internship positions in Engineering, open to undergraduate and Master’s students. The programme aimed to provide hands-on research experience and encourage future careers in science and technology.

- "Bringing Science to IPO Porto" initiative – INESC TEC launched “Levar a Ciência ao IPO do Porto”, an outreach initiative designed to bring science to young children receiving treatment at the Portuguese Oncology Institute (IPO) in Porto. The programme aimed to inspire curiosity and foster interest in science and technology during their hospital stay.
 - Celebrating women in science and exploration – INESC TEC promoted the event “Women in Exploration: Breaking Boundaries” as part of its SOE’24 – Space, Ocean, and Earth Insights session at the GLEX Summit. Under the scientific coordination of INESC TEC researcher Ana Pires, the event brought together eight pioneering women to share their personal journeys and contributions to the exploration of Space, the Ocean, and the Earth, showcasing the transformative role of women in science and technology.
- C2.7. Communicate scientific and technological achievements and their impact

INESC TEC expanded its science communication efforts through new digital formats, international events, and public engagement initiatives, sharing its research achievements and societal contributions with diverse audiences:

- Expansion of science podcasts and videocasts – INESC TEC launched the second season of the “INESC TEC Ciência e Sociedade” podcast and videocast, focusing on high value-added industry, with distribution via YouTube and Blubrry. New episodes of the “Science Bits” podcast were also produced and released through Engenharia Rádio and the BIP newsletter, broadening the institute’s digital outreach and reinforcing its presence across multiple media channels.
- Launch of INESC TECWatch – A new format for science communication, INESC TECWatch, was introduced at the end of 2024. Published via the BIP newsletter, Substack, and Medium, the initiative offers timely and reliable insights on current scientific and technological developments, with four editions released during the year.
- Hosting and organising international conferences – INESC TEC hosted and co-organised several major international conferences, including IAMOT 2024 (International Association for Management of Technology), which welcomed 230 participants from over 30 countries. The institute also organised MELECON 2024 – the 22nd IEEE Mediterranean Electrotechnical Conference, and the 14th ACM Conference on Data and Application Security and Privacy, attended by researchers from 16 countries.
- Development of a new institutional website – Significant progress was made on the creation of a new institutional website, designed to enhance INESC TEC’s online presence and improve communication with stakeholders across the scientific community, industry, policy, and the general public. The new site is scheduled for launch in 2025.
- Public engagement through events and open doors – INESC TEC promoted summer schools, workshops, talks, and open days across its R&D Centres, welcoming participants from academia, industry, media, and society. These initiatives helped reinforce a culture of transparency, accessibility, and public engagement.
- International presence and visibility – INESC TEC showcased its research and innovation at prominent international expositions and fairs. Highlights included a panel at Hannover Messe 2024, participation in OCEANS 2024 Singapore and World FIRA 2024, and a strong presence at Enlit Europe, the largest European event on digital and sustainable energy solutions, where the institute presented and demonstrated its latest technological developments.

C3. Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

- C3.1. Build stronger knowledge-based and multidisciplinary R&I ecosystems

INESC TEC reinforced its participation in collaborative and cross-disciplinary initiatives, fostering research and innovation environments that connect diverse fields and institutional partners:

- Support for Collaborative Laboratories (CoLABs) – INESC TEC maintained a strong presence in the national CoLAB landscape, participating in eleven Collaborative Laboratories in partnership with academia and industry. These initiatives aim to bridge research and societal needs by transforming scientific knowledge into impactful, mission-oriented innovation. A detailed overview of CoLAB activity is provided at the end of this chapter.
- Engagement in European innovation ecosystems – The institute deepened its involvement in EIT Manufacturing, a European Knowledge and Innovation Community (KIC), contributing to collaborative projects that promote advanced manufacturing capabilities and industrial competitiveness.
- Expansion of institutional affiliations – INESC TEC joined five new national and international research associations, broadening its participation in strategic networks. These include the Big Data Value Association (BDVA), GAIA-X – The European Association for Data and Cloud, IAM-I – Innovative Advanced Materials Initiative, INOMMOB, and RISC-V International Association, reflecting a commitment to multidisciplinary and future-oriented R&I ecosystems.

- C3.2. Develop better linkages between knowledge production, development, and market uptake

In 2024, the institute enhanced the mechanisms supporting entrepreneurship and early-stage innovation, accelerating the translation of scientific knowledge into viable technological solutions:

- Integrated support for entrepreneurship – The institute set up an institutional initiative to stimulate and support technological entrepreneurship, building capacity to guide research teams through early innovation stages and toward market readiness.
- Support for spin-off development – A dedicated technical support programme for commercial proof-of-concept projects contributed to the initial steps of ten spin-offs under development in areas such as photonics, robotics, systems engineering and management, and artificial intelligence.
- Equity participation in a strategic spin-off – INESC TEC formally joined iLoF – Intelligent Lab on Fiber, a pioneering spin-off operating at the intersection of machine learning, photonics, and digital health, focused on accelerating drug discovery through biomarker analysis.
- Training and mentorship for early-stage innovation – The institute delivered four thematic workshops – on value proposition, demonstrators, performance, and impact assessment – to 15 teams selected through the SoTecln Factory open call. In addition, INESC TEC coordinated the EIT Jumpstarter 2024 accelerator programme, providing expert mentoring to European innovation projects.

- C3.3. Increase strategic integration in national and international tech-intensive value-chains

INESC TEC played a key role in convening industry, research, and policy actors to promote deeper integration across value chains and support digital and technological transitions:

- ATTRACT DIH high-level event fostering value-chain collaboration – As coordinator of the ATTRACT DIH project, INESC TEC organised a high-level event focused on digital transition, innovation, business empowerment, financing, and disruptive technologies. The event brought together nearly 100 participants, including representatives from ANI, the European Commission’s DG CNECT, CCDR-N, EDIH Südwestfalen, PRODUTECH DIH, the University of Minho, and companies such as Celoplás and Inductiva Research Labs. The event featured a series of debate sessions addressing the importance of cross-sectoral collaboration to explore technological solutions and funding opportunities. Special emphasis was placed on the role of high-performance computing (HPC) and artificial intelligence (AI) in driving industrial innovation.
- C3.4. Promote our pro-active participation in R&I agenda-setting at regional, national and EU level

The institute contributed actively to research and innovation policy development by engaging in strategic consultations, expert groups, and institutional dialogues at multiple levels:

- Position Paper on FP10 – INESC TEC published a Position Paper on the 10th European Framework Programme for Research and Innovation (FP10), outlining a forward-looking vision for Europe’s global leadership in science and technology. The document called for long-term strategic planning, investment in emerging technologies, and results-driven implementation aligned with societal challenges.
- Participation in EU expert policy groups – The institute was represented in the European Commission’s Expert Group on Technology Infrastructures, providing guidance on the coordination, accessibility, and strategic importance of infrastructures supporting Europe’s green and digital transitions.
- High-level policy engagement – INESC TEC strengthened its role at the science–policy interface through visits from senior national and European leaders, including the European Commissioner for Cohesion and Reforms, Portuguese Ministers, Secretaries of State, and the President of FCT.
- Contribution to EARTO economic footprint study – As a participating member, INESC TEC contributed financially and through data to the EARTO study on the economic impact of Research and Technology Organisations, covering the 2020–2022 period and supporting evidence-based policymaking.
- European-level policy contributions – The institute provided input to policy discussions on artificial intelligence, data, and robotics, including the development of an AI roadmap for power systems, reinforcing its expertise in digital and energy systems.
- Regional agenda-setting – INESC TEC was appointed to the coordination group of CCDR-N’s smart specialisation platform focused on agri-environmental systems and food, contributing to the alignment of regional innovation strategies with scientific capabilities.
- C3.5. Increase our international networking, leadership and competitiveness

INESC TEC continued to expand its international presence and collaborations, strengthening its position in global R&I ecosystems through strategic alliances, mobility, and participation in key networks:

- Full operation of the INESC Brussels Hub – The INESC Brussels Hub, representing INESC TEC and four other INESC institutes, operated at full capacity in 2024. It provided a strategic presence in Brussels, supported researcher engagement in European

programmes, and increased institutional visibility across key policy and funding platforms (see Section 3.5.2).

- Engagement in the UT Austin Portugal Program – During the programme’s 2024 no-cost extension, INESC TEC contributed to strategic planning for the next funding cycle (2025–2030), supported an independent evaluation process, and maintained progress in joint research, advanced training, and researcher mobility (see Section 8).
- Support for the renewal of international science and technology partnerships – INESC TEC contributed actively to the renewal of Portugal’s strategic international partnerships with UT Austin and Carnegie Mellon University (CMU). The institute played a key role in the preparation of the next phases of both programmes, participating in strategic discussions, bilateral visits, and high-level meetings. With the renewal now confirmed, INESC TEC reinforced its position in the internationalisation of national R&I policy and in fostering long-term transatlantic collaboration in advanced areas of science and technology.
- Broadened institutional engagement in international organisations – INESC TEC actively participated in over 25 international organisations, expanding its geographic reach and contributing to collaborative initiatives in diverse domains.
- Strategic partnerships with global R&D institutions – International collaboration was reinforced through ties with the National Laboratory for Scientific Computing (LNCC) and Eldorado Research Institute in Brazil, and NARLabs in Taiwan. These partnerships focus on areas such as high-performance computing, semiconductors, microelectronics, AI, and green technologies.
- Collaboration with SINTEF in ocean technologies – Within the scope of the INESC TEC.OCEAN project, INESC TEC established a close partnership with SINTEF (Norway), reinforcing its role in the international ocean research community.
- Consolidation of INESC P&D Brasil – The institute continued to support the stable growth and operation of INESC P&D Brasil, expanding its footprint in Latin America.
- Ongoing engagement in European innovation ecosystems – INESC TEC remained an active member of EIT Manufacturing, contributing to cross-border industrial innovation. It also strengthened internal monitoring of its participation in Horizon Europe, aligning institutional efforts with strategic funding opportunities.
- Contribution to the European Commission’s TTO Circle – The institute played a leadership role in the open-source software working group, collaborating with CERN, IMEC, and ESA, and contributing to benchmarking and best practice sharing within the European innovation community.
- International Visiting Researcher Programme (IIVRP) – INESC TEC coordinated the 2024 edition of the IIVRP, which recorded its highest participation since inception, with over 60 research topics submitted and more than 90 applications received.
- High-level international visits – The institute welcomed more than 15 delegations from academia, industry, government, and diplomacy, including visits from Chubu Electric Power (Japan), SG Innovate (Singapore), NII (Japan), and the U.S. Ambassador to Portugal. These visits helped to strengthen institutional ties and promote INESC TEC’s research and innovation agenda globally.

C4. Cultivate an attractive, people-centred and talented community.

- C4.1. Improve attraction and retention of world-class talent

INESC TEC continued to invest in structured human resources policies and strategic hiring initiatives to attract, integrate, and retain top talent aligned with the institute's scientific priorities:

- Implementation of the new Human Resources management model – The institute made significant progress in rolling out its updated HR model, completing work on job descriptions, competency frameworks, performance appraisal, career development, training, recruitment, onboarding, and the employee life cycle. A new IT system was acquired to support these processes and is scheduled for implementation in 2025 (see Section 9.4).
- Flexible work arrangements – INESC TEC maintained a hybrid work model, allowing employees to alternate between remote and in-person work, contributing to a more adaptive and balanced work environment.
- Talent reinforcement through FCT-Tenure initiative – The institute secured support for 20 professorships under the FCT-Tenure initiative, strategically aligned with 14 internal research positions. This reinforced key scientific areas including artificial intelligence, quantum computing, bioengineering, robotics, and energy systems.

- C4.2. Ensure opportunities and recognition for career achievements

In 2024, the institute introduced new career development mechanisms to support merit-based progression and provide clear pathways for researcher advancement:

- Career progression pathway for researchers – The institute introduced a new mechanism to support the transition from Junior to Assistant Researcher, establishing a transparent and merit-based progression model that complements traditional vacancy-driven approaches. This initiative strengthens internal career development and recognises performance and potential across the research community.

- C4.3. Expand the diversity of our community

INESC TEC strengthened its commitment to diversity and inclusion by expanding international mobility opportunities and promoting initiatives that support a more equitable and representative community:

- Expansion of international mobility – The institute broadened its participation in international exchange programmes, including OpenInnoTrain, the ERCIM Fellowship, and NII Internships, and launched a new edition of the INESC TEC International Visiting Researcher Programme, which recorded its highest level of interest to date.
- Support for diversity and inclusion initiatives – INESC TEC reinforced the work of its Diversity and Inclusion Commission, focusing on gender equality, interculturality, accessibility, and age diversity. More details on these initiatives are provided in Section 3.4.2.

- C4.4. Provide a more dynamic and fulfilling working environment

The institute implemented a broad set of initiatives to enhance well-being, strengthen internal cohesion, and promote a culture of engagement and organisational innovation:

- Community-building and internal events – A diverse programme of internal events was promoted by INESC TEC's Committees and Communications Service, including the Laughter Yoga Workshop, INESC TEC Anniversary, INESC TEC on Foot, INESC TEC on the

Move, Strategic Meeting, World Mental Health Day, Roasted Chestnuts Party, Volunteer Day, and the Season Party, which saw record attendance with over 400 participants. Events such as Team Building and the Strategic Meeting also experienced increased engagement.

- Improvement of physical workspaces – Several labs and facilities across INESC TEC buildings underwent renovation and upgrades to improve working conditions and overall comfort.
 - Launch of INESC TEC mobile app – The institute introduced a new mobile application offering services designed to streamline day-to-day interactions and provide useful information and tools to the internal community.
 - Occupational safety and wellbeing – INESC TEC joined the European campaign "Healthy Workplaces 2023–2025: Safe and Healthy Work in the Digital Age", promoting an internal information campaign and a series of webinars on occupational safety, health, and digitalisation.
 - Social responsibility and volunteering – On International Volunteer Day, INESC TEC engaged its members in volunteer activities across six partner institutions, reinforcing its culture of community involvement and civic engagement.
 - Participation in the national 4-Day Week pilot – INESC TEC concluded its participation as the only R&D institution involved in the Portuguese Government's 4-Day Week pilot, demonstrating a commitment to organisational innovation and flexibility. Outcomes and future implementation will be considered based on the results of the national evaluation.
- C4.5. Strengthen our commitment to independence and compliance of research with ethical principles

INESC TEC deepened its institutional approach to research ethics and compliance, while engaging with emerging ethical challenges in science and technology:

- Support for internal ethics and compliance structures – The institute continued to support and empower its internal Commissions and Committees focused on ethics, conflict of interest management, social responsibility, data protection, and anti-corruption compliance. Detailed plans and activities are outlined in Sections 3.3, 3.4, and 3.5.
- Ethical considerations in defence-related research – Initial steps were taken to address the ethical implications of EU defence-related funding, including internal discussions and the development of guidance on academic freedom, international collaboration, and researcher participation in defence-oriented projects.
- Launch of the 'INESC TEC Talks on Ethics in Research and Defence' series – The institute hosted two public conferences in 2024 featuring international experts on research integrity, artificial intelligence, and social responsibility, contributing to a broader reflection on ethics in contemporary scientific practice.

C5. Strive for a sound, sustainable and effective operational model.

- C5.1. Strengthen the sustainability and resilience of our economic model

INESC TEC continued to diversify and consolidate its funding model in 2024, combining competitive projects, service delivery, and internal systems development to support long-term financial stability:

- Active participation in European programmes – INESC TEC submitted 109 proposals to the Horizon programme, alongside 3 proposals under the Digital Europe Programme and 8 proposals to the European Defence Fund, reinforcing its presence across competitive funding instruments.
 - Execution of PRR projects – The institute continued implementation of 29 projects under Portugal’s Recovery and Resilience Plan (PRR), including 22 mobilising agendas, 3 bioeconomy agendas, 3 agriculture agendas, and 1 infrastructure initiative, supporting national transformation priorities.
 - Capacity-building as a Technology and Innovation Centre (CTI) – Following its formal recognition as a CTI, INESC TEC rolled out activities under a three-year base funding programme, focusing on capacity-building and market-oriented initiatives.
 - Research and innovation services – INESC TEC delivered 106 projects to national and international companies and public organisations, generating €2.9 million in direct service revenue, further strengthening the economic foundations of the institute.
 - European funding strategy monitoring – Continuous efforts were made to monitor and refine INESC TEC’s strategy for effective participation in European funding calls, particularly under Horizon Europe, to enhance institutional competitiveness.
 - ERP system preparation – Preparatory work and configuration began for the implementation of a new ERP system, developed in collaboration with other INESC entities. The system will replace the current Accounting and Financial Information System, with deployment planned for 2025 to support improved financial and administrative integration.
- C5.2. Promote and contribute to environmental sustainability

The institute advanced its environmental responsibility by investing in internal competencies and laying the foundation for future sustainability-oriented practices and structures:

- Capacity-building in sustainability certification – The institute allocated dedicated funding and training to enhance internal competencies in sustainability certification, with the aim of establishing a structured approach to sustainability within INESC TEC. These efforts support the development of a formal sustainability area and align with broader organisational goals in environmental responsibility.
- C5.3. Improve quality, management and usage of our infrastructures

INESC TEC maintained a strong focus on developing and upgrading its research infrastructures, supporting both institutional research capacity and collaboration with regional, national, and international partners:

- Support for regional infrastructure funding – INESC TEC provided technical assistance to 10 external applications submitted under the CCDR-N call for expressions of interest, supporting investments in priority thematic areas and target territories for technology infrastructures.
- Ongoing development of research infrastructure and laboratories – The institute maintained a programme of continuous investment and upgrades across its labs and facilities. Selected highlights are presented in Section 7 of this report.
- Operation of the research vessel Mar Profundo – The Mar Profundo supported six missions in 2024, including marine monitoring, infrastructure inspection, and participation in

national and European projects such as Trident, EU-SCORES, and EU-AIRSHIP. The vessel also participated in the REPMUS24 international robotics exercise and underwent a year-end upgrade, enabling autonomous dynamic positioning and extending its operational range to the Azores Archipelago.

- Launch of the Leixões Blue Hub (HAL) public tender – INESC TEC led the public tender for the construction of the Leixões Blue Hub – HAL, a new scientific and innovation infrastructure funded under the PRR and dedicated to the Blue Economy. The initiative is implemented by a consortium coordinated by INESC TEC, with partners including the Municipality of Matosinhos, CIIMAR, INEGI, Fórum Oceano, and APDL, and is part of the national Blue Hub Portugal Network.
- Support for offshore renewable energy testing – INESC TEC continued to support CEO – Companhia da Energia Oceânica, which manages a 4 MW offshore test zone in Aguçadoura, enabling the development and validation of marine renewable energy technologies at intermediate-to-high technology readiness levels (TRL 5–8).
- C5.4. Strengthen the distinctive aspects of our institutional model

In 2024, INESC TEC reinforced the core elements of its governance and compliance model, with renewed institutional leadership and mechanisms aligned with transparency and regulatory standards:

- Renewal of associative and scientific bodies – The institute appointed new members to key governance bodies for the upcoming terms, including the Board of Directors and Audit Committee for 2024–2026, and the Scientific Advisory Board and Scientific Council for 2024–2028, ensuring continuity and alignment with strategic objectives.
- Launch of a consolidated reporting channel – A new Reporting Channel for Corruption and Breaches of EU Law was launched to strengthen internal compliance mechanisms and ensure alignment with evolving European regulatory frameworks. This initiative reinforces INESC TEC’s commitment to ethical conduct and institutional transparency.

In addition, the following recognitions and achievements deserve special mention:

- Award of the 2024 EARTO Innovation Prize in the 'Impact Expected' category to INESC TEC for the development of the 'intelligent Lab-on-a-Fiber' (iLoF) technology – marking the first time a Portuguese institution has received this prestigious European distinction and underscoring INESC TEC’s leadership in personalised medicine and photonics innovation. The award highlights the potential of iLoF to enable non-invasive, AI-assisted patient stratification through biomolecular fingerprinting. Now commercialised by iLoF, an INESC TEC spin-off, the technology also shows promising applications beyond the healthcare sector;
- Recognition at GITEX GLOBAL 2024 with the Innovation in Artificial Intelligence Award, for INESC TEC’s work on classifying epileptic seizures using AI-powered 3D video technology – demonstrating the growing international relevance of our AI research in advancing medical diagnostics;
- Best World FIRA Robot – 2nd Place, Participants’ Choice (FIRA 2024) awarded to the Modular-E robotic platform, a cost-efficient, modular solution for precision agriculture. In addition to this international distinction, Modular-E also won the Silver Medal for Best World FIRA Robot 2024, first place in the Prémios Inovação Agricultura 2024, and the €10k TIMAC Agro Expresso Agriculture Innovation Award. It was also showcased for dual-use applications at ARTEX 2024;

- Award from the Spanish Statistics and Operations Research Society and BBVA Foundation for INESC TEC's research on kidney paired donation, recognising its contribution to increasing compatibility, equity, and effectiveness in transplant programmes;
- First place in the 'Food and Nutrition Security' category of the 11th Crédito Agrícola Entrepreneurship and Innovation Awards was granted to Pocket-Vet, an AI-based solution for early detection of bovine mastitis. In the same edition, Seedsight received an honourable mention from ANI ('Born from Knowledge'), and Orioos was shortlisted in the 'Transition and Carbon Neutrality' category;
- Portugal Digital Award 2024 for the EVFlex electric vehicle charging solution, developed by INESC TEC, for its innovative contribution to sustainable mobility. The system, already in operation at several Continente locations, combines dynamic pricing with consumer incentives and is accessible via the Continente Plug&Charge app;
- The PETALL (PeT) project, developed by INESC TEC in collaboration with the University of Minho, received €250k in the 4th edition of the IN3+ Award after securing second place, supporting the development and market integration of privacy-preserving and transparent digital services in sectors such as healthcare, education, and justice;
- Record-breaking participation in the 2024 edition of REPMUS, the world's largest robotic exercise, where INESC TEC's autonomous robots EVA and Turtle III reached an unprecedented depth of 830 metres – the deepest ever recorded by Portuguese systems. INESC TEC was also the only institution among 100 participants to demonstrate a solution for simulating threats to underwater cables;
- Inclusion of twelve INESC TEC researchers among the 2% most cited scientists worldwide, according to the latest Elsevier-Stanford study, with strong representation in Power & Energy, Photonics, and Artificial Intelligence.

Our spin-offs were also distinguished on the national and international stage:

- Seedsight was named one of the world's top 11 deep-tech startups by Nature, recognising its excellence in translating cutting-edge research into scalable impact;
- Seedsight also won the 2024 Altice International Innovation Award, receiving the €75,000 top prize for its technological and scientific innovation;
- Ubirider was internationally recognised with the 2024 AutoTech Breakthrough Award for “Public Transportation Technology Solution of the Year,” affirming its impact in promoting user-centric, digital mobility services.

Furthermore, several INESC TEC researchers received individual awards, prizes and recognitions for their research work or scientific contributions in international conferences and challenges. Some of them are presented in more detail in Chapter 6, contextualised in the activity of their respective R&D Centres.

3.3 Compliance Officers

3.3.1 Anti-corruption Compliance Officer

Officer: Ana Maria Mendonça

Presentation

The Regulatory Compliance Programme for the Prevention of Corruption, whose implementation is mandatory by law, includes the appointment of an anti-corruption compliance officer, who ensures and controls the application of said Programme and performs her duties independently, permanently and with decision-making autonomy.

At INESC TEC, the anti-corruption compliance officer also takes on the duties of implementation, control and review of the Risk Prevention Plan (PPR), which is an integral part of the above-referred Programme.

Highlights in 2024

In April 2024, a consolidated version of the Reporting Channel on Corruption and Breaches of EU law was launched.

At the same time, the dissemination of the Compliance Programme for the Prevention of Corruption was addressed in two sessions, one in Portuguese and the other in English, for targeting all the members of the INESC TEC community. In each session, a general presentation of the programme was performed, mainly aiming at the promotion of awareness against corruption.

To evaluate the progress of the PPR implementation and facilitate the preparation of the annual report, a meeting was held in October with the individuals responsible for executing the prevention measures. In this meeting, the methodology for collecting information on the risks set out in the PPR, and for eventually including new risks and corresponding prevention measures, was presented and discussed. Individual follow-up meetings on this topic were scheduled for the beginning of 2025.

Other activities that were accomplished during 2024 include:

- Review of the PPR for reflecting the changes in the management structure of the Board of INESC TEC;
- Elaboration of the interim evaluation report of the PPR execution during 2024 (in the period between January and September);
- Continuous monitoring of the reporting channel on corruption and breaches of EU.

3.3.2 Data Protection Officer

Data Protection Officer: Vasco Rosa Dias

Presentation

According to its legal statute the DPOs 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.

Highlights in 2024

- Monitoring of the implementation, updates and awareness raising of the approved data protection internal procedures.
- 2024 revealed a new increase and diversification of the activities led by the DPO's team.
- A large number of data processing and joint controllership agreements was negotiated and implemented.
- Application of INESC TEC model master data processing agreement in agreements which were negotiated namely with health and academic institutions.
- Continued implementation of the cooperation agreement established with ISPUP in the field of Data Protection. Design and adaptation of new procedures for the ISPUP environment. Contributions to improvements in the information system of ISPUP and associated policies.
- Continuous update of the processing activities' Records. Implementation of new methodology to assess legitimate interest and associated templates.
- Monitoring of R&D projects. Advise and follow up of Data Protection Impact Assessments performed in the context of R&D projects of INESC TEC and ISPUP, as well as in the wider context of general internal operations.
- Presence in several data protection and ethics governance bodies in H2020 projects coordinated by INESC TEC. Occasional participation in Privacy related activities of EU projects, with emphasis to the HEU project CONVERGE, led by INESC TEC, and the external HEU project Living Soil, coordinated by UTAD.
- Monitoring of data protection related aspects of Data Management Plans in several H2020 projects, in articulation with AG.
- Strengthening of the training plan for staff members and researchers, combining existing tools like the online course and open talks with thematic sessions held at R&D centres.
- Issuing of DPO's opinions and recommendations in English version for wider dissemination at INESC TEC community.
- Monitoring and internal auditing activities were conducted, making use of the procedures and tools enriched in the previous year, according to the plan. CCTV systems and building entry records and procedures, as well as INESC TEC controlled websites, were subject to internal planned audits. Planning of complementary auditing activities.
- Active participation in external fora (professional and academic) in the field of data protection.
- Monitoring and studying new legislation/initiatives (e.g. AI ACT, NIS2, EHDS).

3.4 Internal Commissions and Committees

3.4.1 Conflicts of Interest Management Commission

Chairperson: José Carlos Marques dos Santos

Presentation

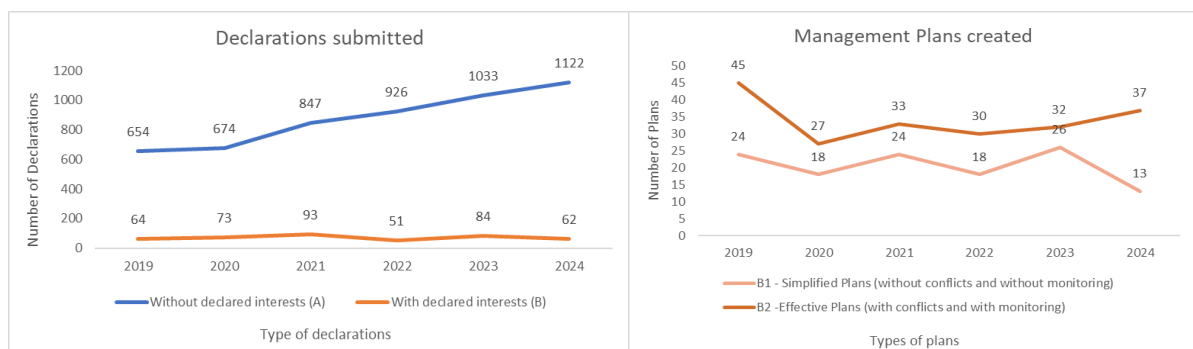
INESC TEC has a Conflicts of Interest Management Policy, which applies to all integrated human resources. The Conflicts of Interest Management Commission (CGCI) has the responsibility to ensure compliance throughout the Institution, namely by:

- Assessing the declarations of interests and identifying the conflicts of interest;
- Agreeing with the collaborator and proposing to the Board, the terms of management plans for identified conflicts of interest, as 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;
- Formulating general recommendations concerning conflicts of interest management.

Highlights in 2024

During 2024, within the scope of its mission, the CGCI carried out a series of activities, including:

- Monitoring compliance with the Policy across the Institution on an ongoing basis;
- Responding to various requests for advice from the Board of Directors and the General Council Ad-hoc Committee;
- Disseminating relevant guidelines on the Conflicts of Interest Management Policy, either via the intranet or through targeted messages via the CGCI mailbox;
- Enhancing the IT platform, particularly to support the preparation of the monitor's report. However, final testing was not completed due to factors beyond CGCI's control. Additionally, the automatic alert regarding an EER's involvement in internal operational process - supplier requisition - was improved, to facilitate the detection of potential conflicts of interest;
- Organising and delivering four training sessions for monitors;
- Drafting and submitting to the Board a proposal outlining the procedure to be adopted at INESC TEC for registering the receipt of goods valued at €150.00 or more by an INESC TEC collaborator, from a third party, as provided for in the Code of Conduct for the Prevention of Corruption, which is part of INESC TEC's Regulatory Compliance Programme for the Prevention of Corruption;
- Conducting regular analyses of submitted Declarations of Interest (DI) and, when necessary, prepared Conflicts of Interest Management Plans (PGCI), which were then submitted to the Board for potential approval following the employee's agreement. The main indicators of this activity were:



3.4.2 Diversity and Inclusion Commission

Chairperson: Ana Sequeira

Presentation

The INESC TEC Board of Directors established the Commission for Diversity & Inclusion (CDI) in September 2021. The CDI is chaired by Ana Filipa Sequeira and, throughout 2024, was composed of diverse INESC TEC collaborators: Ana Lopes, Tiago Silva, Tiago Gonçalves and Aurora Libânia Teixeira. The CDI's work is supported by the Internal Advisory Group - a representative set of collaborators contributing through brainstorming, discussion, and validation; and the External Advisory Group – a set of key players in the D&I field providing strategic counselling.

Highlights in 2024

In 2024, the CDI focused on raising awareness, developing skills, monitoring the D&I landscape, and promoting events in three priority areas: 1) Gender Equality; 2) Interculturality and 3) Accessibility.

CDI Internal Advisory Group: CDI invited new members from INESC TEC to join its advisory group to maintain diversity after some members left. Recently, CDI convened a work session to gather feedback on the activities planned for 2024, identify emerging needs, and brainstorm initiatives for 2025.

Regarding Gender Equality, the CDI started the monitoring of the Gender Equality Plan.

Awareness-raising and competence-building actions: The CDI organised several training actions, events, and communications with this objective.

Training actions:

- Workshop “Embracing Cultural Diversity” - Navigating Difference, Bridging Understanding and Strengthening Connections at INESC TEC, with NECI-PT (01/03).
- 2nd Workshop of "Self-Defence for ALL": At this event, the entire INESC TEC community was challenged to learn Krav Maga self-defence techniques (16/03).
- Workshop “Promoting Health Work Environments” with Tânia Gaspar (15/07).

Events:

- "Sensorial Experience", event by the Association of Blind and Visually Impaired People of Portugal (ACAPO) (04/04).
- Eid al-Fitr: The entire community, friends and families were invited to participate in this celebration, which marks the end of the Ramadan period. (12/04).
- “Breaking Barriers in Technology: Women in Computing at Carnegie Mellon and Global Perspectives” with Jeria Quesenberry (28/06).
- Invited Speaker at the "Porto Summit Women In Tech - WiT KIDS" (01/07).
- Participation as a speaker at the event "EIT Manufacturing fostering a more inclusive industry" (17/04).

Communications: Institutional video to mark the “World Day for Cultural Diversity for Dialogue and Development”; D&I Book Reading list for INESC TEC's Book Club; Email to mark the "LGBTQ+ Pride Month" (June); Email to raise awareness about the "International Day for the Elimination of Violence against Women" (27/11); Several articles have been published in BIP.

Awards: The CD&I applied for the prize "Accessibility Awards, Best Practices", promoted by Associação Salvador, under the scope of the "Accessibility Award" and “Deaf Accessibility Award”.

3.4.3 Technical Committee for Social Responsibility

Chairperson: Joana Coelho

Presentation

Social Responsibility is “a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis”, as defined by the European Commission in 2011. Based on that, in 2019, the Technical Committee for Social Responsibility was created with the goal of working on INESC TEC's philanthropic dimension from an internal point of view, i.e., issues related to the institution itself and its employees; and from an external point of view, i.e., how INESC TEC can support the local community.

Highlights in 2024

- Organisation of several activities regarding physical and mental health of various activities to celebrate World Mental Health Day, including a nutrition workshop, an awareness session on the importance of sleep, and a Pilates class.
- INESC TEC was, once again, an official nominator of the Earthshot Prize, a global environmental prize and platform for impact, dedicated to finding and growing solutions that will repair our planet this decade. INESC TEC received 10 applications and endorsed two solutions under the “fix our climate” Earthshot.
- Promotion of the initiative *Levar a Ciência ao IPO do Porto*, which aims to share the research carried out at INESC TEC engaging young children undergoing hospital treatment in science and technology;
- Association with the student community through representation in the consortium of the “Escolhas com Futuro” project;
- Information campaign about the European initiative “Healthy Workplaces” 2023-2025: “Safe and healthy work in the digital age” that organised several webinars in topics related to occupational safety, health and digitalisation.
- Donation campaign to some North and Centre corporations of Firefighters to provide some help for the operatives fighting wildfires, in September.
- Awareness campaign related with the Childhood Cancer Awareness Month, by sharing initiatives from the Portuguese institution “Acreditar”.
- International Volunteer Day activities: a total of 37 INESC TEC members participated as volunteers in 6 different institutions - Hospital de São João, ACAPO, Vida Norte, CROAM, Canil do ICBAS, and Quinta Pedagógica (Braga).
- Participation of the community of INESC TEC in Braga in a blood donation campaign promoted to the blood bank of the Hospital de Braga;
- Donation of some school supplies to a school in Braga, including notebooks, pens and lanyards (excess material of completed R&D projects);
- Promotion of the initiative to recycle all coffee capsules used at INESC TEC buildings, contributing to “Reciclar é Alimentar” project, promoted by Nespresso since 2010;
- Donation campaign: donation of 170 products to pregnant women and babies at risk, which are supported by the Associação Vida Norte.

3.4.4 Ethics Committee

Chairperson: Pedro Guedes de Oliveira

Presentation

The INESC TEC Ethics Committee (E.C.) was appointed by the Board of INESC TEC in 2022 and is chaired by Pedro Guedes de Oliveira, Professor Emeritus at the University of Porto. The committee includes Susana Magalhães, who holds a PhD in Bioethics and is the Coordinator of the Unit for Responsible Conduct in Research at I3S and a professor at Fernando Pessoa University; Vasco Rosa Dias, Data Protection Officer at INESC TEC and ISPUP; Cristina Ribeiro, a retired professor at the Faculty of Engineering; and Alípio Jorge, a professor at the Faculty of Sciences, both from the University of Porto and researchers at INESC TEC. Lia Patrício, a former member of the E.C., resigned to become a member of the Board of INESC TEC.

The Ethics Committee is responsible for promoting standards of integrity, honesty, and responsibility in all activities undertaken by INESC TEC members, particularly in their research endeavours, through adherence to the institution's Code of Ethics.

Highlights in 2024

In 2024, the IT support tools for project leaders to submit their ethics questionnaires online—whenever their projects involved human subjects, personal data, artificial intelligence, or autonomous systems—continued to be widely and intensively used. These tools serve as the basis for the E.C. to conduct an initial assessment of projects and approve them if the responses align with expectations and no particular concerns are identified.

In 2024, a significant number of new projects were submitted to E.C. programme calls. Given that the general likelihood of success for such proposals is low, provisional assessments were conducted, with final submissions expected only if the projects were ultimately approved.

To date, no project has received a negative evaluation from the E.C. However, in various instances, a dialogue has been established with principal investigators (PIs) to clarify uncertainties or improve supporting documentation.

A new issue arose in 2024 due to the acceptance of EU funding for projects related to defence. This includes both the acceptance of dual-use technologies in standard programmes and the launch of calls specifically targeting defence-related topics.

As this presents several ethical challenges, E.C. members convened multiple times to discuss how best to advise both the INESC TEC Board and researchers. This resulted in two key actions:

- The preparation of a position paper submitted to the Board of INESC TEC, addressing topics such as academic freedom of publication, international collaboration, and guidance on how INESC TEC researchers should respond if they object on ethical grounds to participating in defence-related research.
- The organisation of a series of conferences titled INESC TEC Talks on Ethics in Research and Defence. These were held online and open to all, though prior registration was required. In 2024, the first two conferences of this series took place:
 - On 1 October, Catherine Tessier, Director of Research and Research Integrity and Ethics Officer at ONERA, delivered a talk titled "My Facial Recognition System is 100% Accurate—Is It Good News?"
 - On 26 November, Virginia Dignun, professor at Umeå University (Sweden) and a member of the EC's High-Level Expert Group on Artificial Intelligence, spoke on "Balancing Innovation and Social Responsibility."

Both conferences attracted a large audience, particularly among INESC TEC researchers. They facilitated meaningful discussions between speakers and attendees and are available for viewing on the INESC TEC YouTube channel.

Finally, relevant updates to position papers and legislation were made available on the INESC TEC Ethics Committee website.

Once again, we extend our gratitude to INESC TEC researchers for their thoughtful and responsible conduct, which has made our work both manageable and rewarding.

3.5 Other Institutional Initiatives

3.5.1 Foresight and Public Policy Office

Team: C. Pedroso, J. Claro, A.P. Alves, J.C. Caldeira, J.M. Mendonça, P.G. Oliveira, R. Miguéis

Presentation

The Foresight and Public Policy Office is INESC TEC's dedicated hub for advancing policy engagement and foresight activities. Its mission is to enhance the institute's impact on public policy at regional, national, and international levels by bridging research and policy, fostering evidence-based decision-making, and contributing to the design and implementation of transformative policies. The office works to align INESC TEC's research and innovation activities with societal priorities while strengthening its contributions and recognition in strategic foresight and public policy engagement.

Highlights in 2024

In 2024, INESC TEC deepened its policy engagement at all levels. While the office played an active role, policy-relevant activities spanned our broader community. Collaboration was key, with the office both supporting and benefiting from initiatives led by others. Board, INESC Brussels HUB, Communications, Management Support, Executive Assistants, and Advisor to the Chairman, among others, were instrumental in advancing policy engagement. The office also transitioned into the Foresight and Public Policy Office, broadening its focus to long-term policy planning. While this section highlights selected key initiatives, INESC TEC's policy engagement extends well beyond them.

Reflecting its mission, the office's activities were structured around four strategic action lines:

1. Identify and Disseminate: Key to advancing policy impact dissemination, a repository for access to policy-relevant research was finalised. An FP10 policy paper reinforced INESC TEC's role as a thought leader in European R&D policy. The preparation of the 7th edition of Science & Society fostered AI, leadership, governance and ethics discussions. The office also continued fieldwork and analysis on the sustainability transition at INESC TEC, aligning innovation with policy and sustainability goals.

2. Connect and Raise Impact: Policy presence was enhanced, with contributions at the European level to discussions on AI, data, and robotics, the AI roadmap for power systems, and the European Commission's Expert Group on Technology Infrastructures, as well as the organisation of the Autumn Forum, focused on critical infrastructure resilience. INESC TEC co-organised the inaugural CoARA National Chapters Forum, co-coordinated Portugal's National Chapter, and engaged actively in research careers policy as part of a European Mutual Learning Initiative and a joint event with FCT and the European Commission. INESC TEC also reinforced its role at the science-policy interface, hosting high-profile visits, including the European Commissioner for Cohesion and Reforms, the Ministers of Science and Education, the Secretaries of State for Economy and Maritime Affairs, and the President of FCT.

3. Support Collaborative Strategies for Impact: INESC TEC played a key role in advancing Portugal's blue economy policies, contributing to the creation in the country of a Teaming-supported Centre of Excellence in Ocean Research and Engineering, and advocating for EU policies leveraging Portugal's coastline for sustainable growth. The office contributed to expanding INESC TEC's role in AI policy and governance, supporting the creation of opportunities to lead discussions on the future of R&D leadership in the AI era and the impact of AI-driven transformations on science and innovation. In European R&D policy, INESC TEC engaged regularly in RTO policy discussions. Collaboration across INESC TEC was crucial to embed policy impact efforts across the institute. In European R&D policy, INESC TEC engaged in RTO policy discussions and EARTO's economic footprint study. Collaboration across INESC TEC was crucial to embed a policy impact drive across the institute.

4. Experiment and Innovate: INESC TEC launched INESC TECWatch, an innovative initiative designed to bridge the gap between research, policy, and public debate by providing expert, science-based insights on pressing societal and technological issues. By addressing topics such as artificial intelligence, data science, and robotics, INESC TECWatch seeks to ensure that complex technological advancements are clearly communicated and contextualised for decision-makers and the broader public. This initiative represents a new model for proactive engagement, reinforcing INESC TEC's role as a trusted source of knowledge in policy discussions.

3.5.2 INESC Brussels Hub

Coordinator: Ricardo Miguéis

Presentation

In 2024, the INESC Brussels HUB became a cornerstone of INESC TEC’s European strategy, significantly reinforcing the institution’s presence, influence, and credibility at the heart of EU policymaking. This year marked an important Shift, as INESC TEC, moved beyond its traditional role as a participant in European projects to becoming an active contributor to policy development - co-designing future R&I programmes and instruments at both European and national levels.

This evolution is aligned with INESC TEC’s Strategic Plan 2030, reinforcing its international leadership, strengthening its involvement in European partnerships and Research and Technology Infrastructures (RTIs), and positioning it at the forefront of industrial and societal transformation agendas.

Through strategic representation, thought leadership, intelligence gathering, and the organisation of flagship events, the HUB has played a key role in enhancing INESC TEC’s institutional visibility and in contributing to the design of the future European framework - particularly in relation to FP10, competitiveness, digital sovereignty, and technology governance.

Highlights in 2024

Strategic Representation and Engagement

Platform / Activity	INESC TEC Involvement & Impact
European Commission and Presidency events	Participated in over 25 strategic dialogues on topics including FP10, industrial strategy, and ERA reform. Provided direct institutional input, contributing to policymaking processes.
Science Business	INESC TEC maintained an active institutional presence through senior participation in high-level panels—covering topics such as deep-tech ecosystems and global R&I foresight—as well as in foresight roundtables, the Presidents’ Dinner, and the Science Business Annual Conference. Additionally, 16 institutional updates were published on the Science Business platform, highlighting INESC TEC’s research excellence and policy positioning to an audience of over 32,000 European R&I stakeholders.
EARTO (7)	Active member across seven EARTO Working Groups. Contributed to four official EARTO position papers focused on FP10, Public-Private Partnerships (PPPs), Defence, and Widening.
ADRA	Coordinated two flagship workshops on Energy and AI for Science. Helped open new collaboration pathways and positioned INESC TEC for future participation in strategic European calls.
CoARA National Chapters (Porto)	Co-organised the National Chapters Forum in Porto with FCT. Strengthened INESC TEC’s leadership in research assessment reform and implementation of ERA policy measures.
Institutional missions (IMEC, TNO)	Carried out strategic benchmarking missions with leading European institutions and INESC TEC Chairman. Supported institutional development and laid foundations for new collaborations.
Bilateral support to INESC TEC positioning	Provided continuous strategic support through intelligence sharing, targeted briefings, and alignment activities. Played a key role in the preparation of the FP10 Position Paper, ensuring coherence between INESC TEC’s vision and evolving EU priorities.

Flagship Events

Event	Focus and Key Outcomes
Winter Meeting 2024 (Porto)	The event focused on FP10 priorities, European competitiveness, and digital sovereignty, gathering over 300 participants.
Summer Meeting 2024 (Brussels)	The event focused on leadership in research and innovation in the age of AI, supporting INESC TEC’s institutional positioning within the ADRA ecosystem and broader digital policy dialogues.
SME Access to RTIs Workshop (Brussels)	Co-organised with the European Commission and key European research infrastructures, the event delivered concrete policy recommendations.

Strategic projects portfolio

Project	Role	Focus Areas
RITIFI (INFRA)	Partner	RTI governance, industrial policy
ERA-FABRIC (WIDERA)	Partner	ERA hubs, regional innovation
DG CNECT Studies	Subcontractor	Digital policy advice
Frontex Framework	Subcontractor	Security R&I intelligence
ATTRACT Phase 2	Communications partner	Deep-tech dissemination
AI-SECRET (DEP)	Partner (start 2025)	AI for education and creativity
RIFF (HEU)	Partner (start 2025)	Infrastructure resilience, science diplomacy

Throughout 2024, the HUB reinforced INESC TEC’s institutional credibility by hosting more than six high-level project review meetings in Brussels, engaging over 200 participants and fostering direct relationships with European Commission officers and strategic partners.

Complementing this visibility, the HUB has delivered substantial intelligence and policy contributions – ranging from authoring the report “What do Europeans want for the next Framework Programme?” to active participation in the European Commission’s Expert Group on Technology Infrastructures, strategic input into the Portuguese National Semiconductor Strategy, and co-shaping recommendations for the “Align, Act, Accelerate” (Heitor) report. By combining intelligence gathering, proactive positioning, and engagement in a strategic portfolio of projects that influence European governance frameworks and industrial policy, the HUB has consolidated its role as a strategic think tank within INESC TEC.

This approach enables INESC TEC not only to anticipate opportunities and policy shifts, but also to position itself as a contributor to the design of Europe’s R&I agenda – translating knowledge and strategic foresight into concrete institutional advantage.

3.6 Human Resources

Global Indicators – Headcount as of 31 December

Table 3.1 and Figure 3.1 show the breakdown of Human Resources by type of contractual relation with INESC TEC and its evolution since 2022. The number of Integrated PhDs is also shown (403 at the end of 2024).

Table 3.1 - Evolution of Human Resources (Headcount)

Type of Human Resources		2022	2023	2024	Δ 2023-24		
Integrated HR	Core Team Research	Employees	189	238	276	38	16%
		Academic Staff	185	187	188	1	1%
		Grant Holders and Trainees	354	400	454	54	14%
		Total Core Researchers	728	825	918	93	11%
		Total Core PhD	272	290	308	18	6%
	Affiliated Researchers	73	66	71	5	8%	
	Administrative and Technical	Employees	115	126	137	11	9%
		Academic Staff	10	9	9		
		Grant Holders and Trainees	6	2		-2	-100%
		Total Mgmt, Admin and Tech	131	137	146	9	7%
Total Integrated HR		932	1028	1135	107	10%	
Total Integrated PhD		364	381	403	22	6%	
Curricular Trainees		16	10	31	21	210%	
Visiting Researchers				11	11		
External Research Collaborators		241	249	277	28	11%	
External Administrative and Technical Staff		9	11	10	-1	-9%	
External Students		239	238	224	-14	-6%	
Total		1437	1536	1688	152	10%	

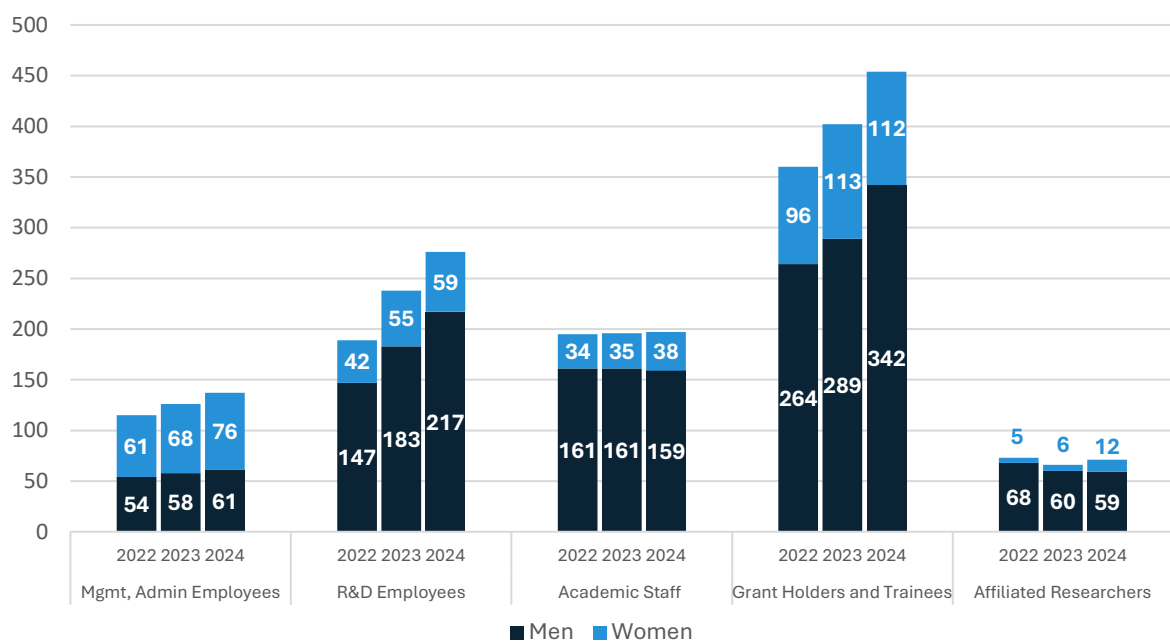


Figure 3.1 - Evolution of Human Resources (Headcount)

Global Indicators – Person-Years in 2024

In previous reporting, the organisation’s staffing profile has been presented primarily through headcount figures, capturing the number of individuals engaged in research activities.

While this approach provides a general overview, it offers only a static snapshot at a given point in time and does not account for the numerous changes and movements that occur throughout the year.

To provide a more faithful representation of actual research capacity, this section introduces person-year data. By reflecting the cumulative effect of varying levels of engagement over time, person-years offer a more accurate and meaningful view of the organisation’s effective capacity throughout the full year.

Table 3.2 - Evolution of Human Resources (Person-years)

Type of Human Resources		2022	2023	2024	Δ 2023-24	
Integrated HR	Core Research Team					
	Employees	174	215	254	39	18%
	Academic Staff	183	184	194	10	5%
	Grant Holders and Trainees	356	376	439	62	17%
	Total Core Researchers	714	776	887	111	14%
	Total Core PhD	268	280	305	25	9%
	Affiliated Researchers	66	70	65	-6	-8%
	Administrative and Technical					
	Employees	108	118	131	13	11%
	Academic Staff	11	9	9		-4%
Grant Holders and Trainees	5	4		-4	-100%	
Total Mgmt, Admin and Tech	124	131	140	9	7%	
Total Integrated HR	903	977	1092	114	12%	
Total Integrated PhD	356	373	394	20	5%	
Curricular Trainees	37	63	78	14	23%	
Visiting Researchers			11			
External Research Collaborators	234	242	256	15	6%	
External Administrative and Technical Staff	8	9	10		4%	
External Students	214	232	244	12	5%	
Total	1397	1524	1690	166	11%	

Global Indicators – Team Profile and Composition

In addition to overall capacity, a closer look at demographic and organisational characteristics provides insights into the structure and diversity of the INESC TEC team.

This section presents a detailed profile of the organisation’s personnel, with a focus on essential demographic and organisational features.

By examining variables such as gender distribution, age groups, and types of contractual connection, it aims to provide a clearer understanding of the composition and characteristics of the team. These indicators offer valuable insights into the organisation’s demographic balance, inclusiveness, and long-term staffing structure.

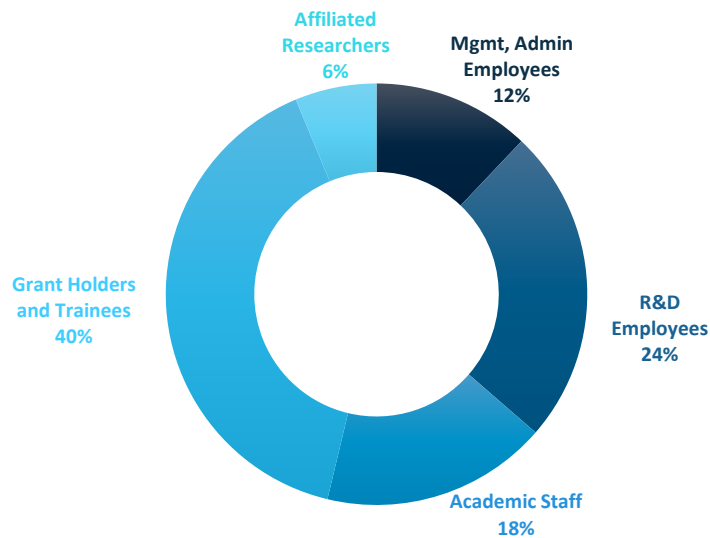


Figure 3.2 - Distribution of Human Resources (2024 Headcount distribution)

The continued increase in R&D personnel mirrors INESC TEC’s rising activity levels and reinforces its capacity to deliver on national and European research agendas.

As seen in Figure 3.2, grant holders and trainees remain the largest human resources group (40%) at INESC TEC, showing a growth trend (Figure 3.1). However, the most significant surge was observed in the count of R&D employees (16% in 2024), notably comprising PhD researchers. This growth aligns with INESC TEC's strategy to recruit talent in pivotal areas and is in line with the Portuguese Government’s policy on scientific employment.

The increase in Human Resources in the Support Services aims at supporting the continued growth of the institute’s activity and the operationalisation of strategic objectives.

The team composition closely adhered to the profile outlined in the 2024 plan, with the number of grant holders exceeding the projected figure. This outcome was anticipated, as the projected number is typically conservative, reflecting only ongoing projects and those anticipated with a certain degree of certainty for 2024. However, the total count of R&D employees slightly fell short of the planned estimates.

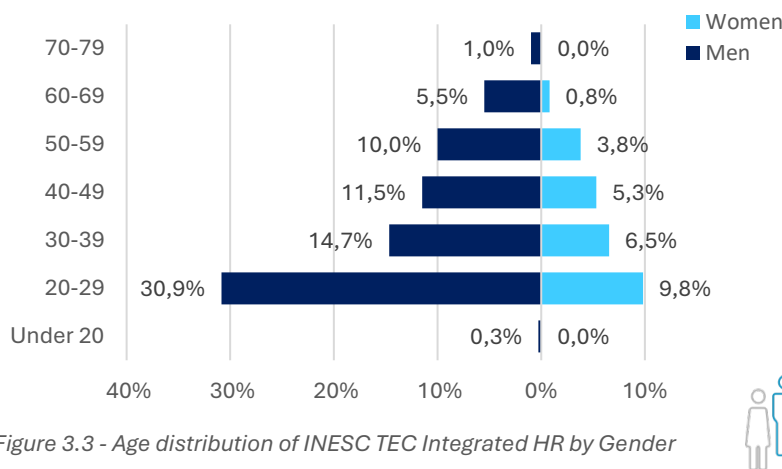


Figure 3.3 - Age distribution of INESC TEC Integrated HR by Gender

With growing attention to Diversity and Inclusion (D&I), INESC TEC has been actively monitoring key indicators related to gender balance and broader demographic composition. The age and gender

distribution of the research and support staff reveals a predominantly young team, with the highest concentration in the 20-29 age group, reflecting a strong presence of early-career professionals. Gender distribution improves slightly in the 30-49 range but remains uneven, with men still in the majority. A notable imbalance is also evident in the 20-29 age group, where men account for 31% and women only 9.8% of the total staff. Male dominance becomes more pronounced in the older age groups.

Despite ongoing efforts, the percentage of women in the institution has remained relatively stable over recent years - 26% among Integrated HR and 23% among Integrated Researchers – highlighting the structural nature of the challenge and the need for sustained, long-term action. These and other aspects of D&I are being addressed by the Diversity and Inclusion Commission and are central to the Gender Equality Plan currently under implementation (see Section 3.4.2 for further details). Overall, the data underscores the importance of continued focus on gender equity, particularly in supporting career progression and retention across all age groups.

Global Indicators – Team Mobility and Dynamics

While static indicators help understand team structure, the dynamics of mobility - who joins, who leaves, and how frequently - reveal important aspects of INESC TEC’s organisational sustainability and talent flow. Figure 3.4 explores these mobility patterns in greater detail.

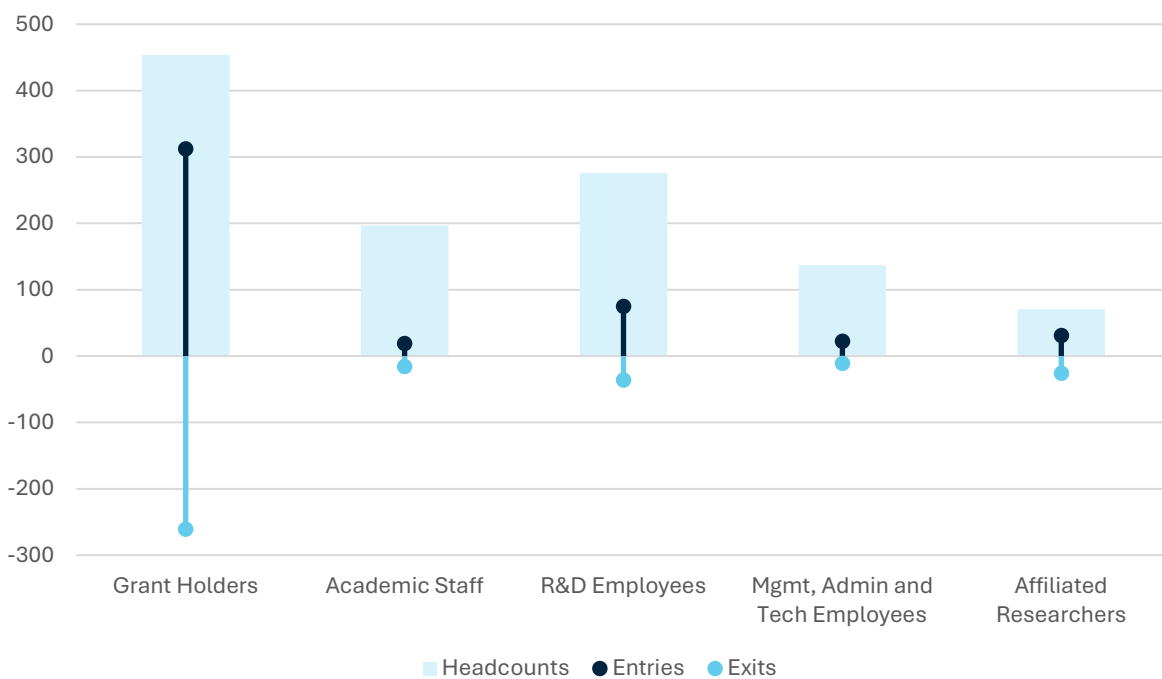



Figure 3.4 - Mobility Patterns by Types of Connection



Turnover

Grant Holders: 69.2%

Academic Staff: 8.53%

R&D Employees: 16.9%

Mgmt, Admin and Tech Employees: 8.4%

Affiliated Researchers: 37.9%

Figure 3.4 illustrates the distribution of headcounts, entries, and exits across various roles within the INESC TEC community, highlighting distinct patterns of personnel mobility.

Grant Holders show a turnover rate of 69.2%, reflecting the naturally high mobility of this group, as they are students typically involved in project-based activities with defined durations.

R&D Employees exhibit moderate mobility, with a turnover rate of 16.9%, while Academic Staff and Management, Administrative, and Technical Employees have lower turnover rates (8.53% and 8.4%, respectively), indicating more stable positions.

Affiliated Researchers, although fewer in number, present a higher turnover rate of 37.9%, suggesting a more transitional or short-term nature of this type of affiliation.

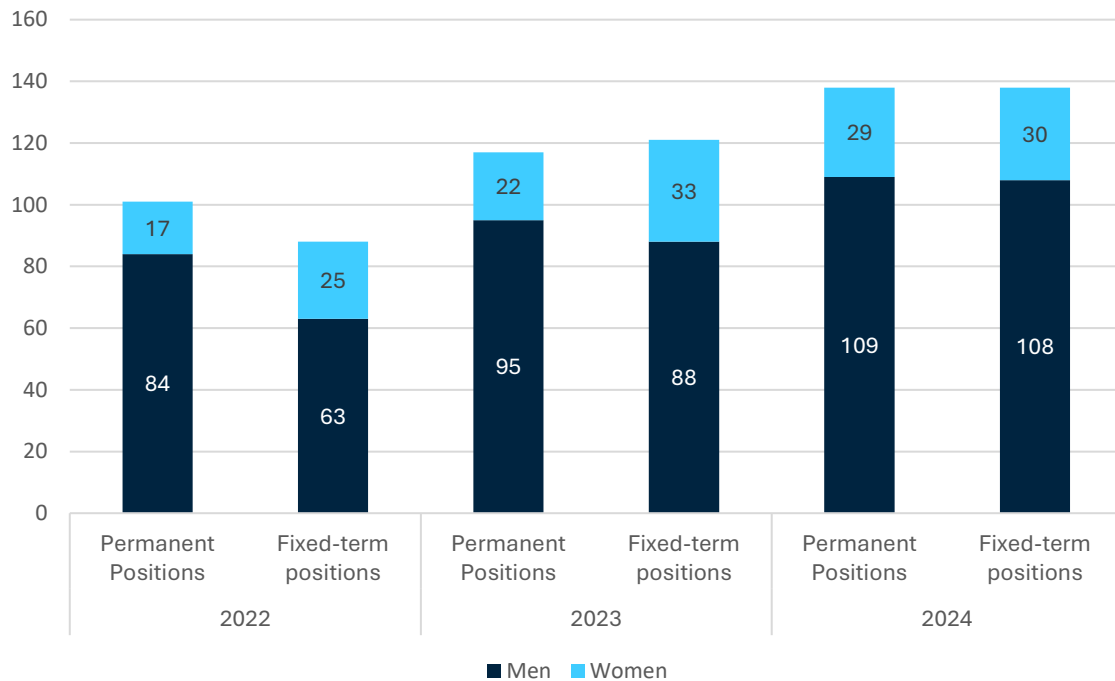


Figure 3.5 - Contract Types of R&D Employees by Gender

Figure 3.5 shows the distribution of R&D Employees at INESC TEC from 2022 to 2024, distinguishing between permanent and fixed-term positions while also highlighting gender representation.

There is a steady increase in the total number of R&D Employees, with growth across both contract types. In 2024, 60% of R&D staff hold permanent positions, a positive sign of growing career stability within the institution. This is particularly significant given that many new hires typically start on fixed-term contracts, often linked to specific projects or external funding. The continued rise in permanent roles reflects a strategic commitment to talent retention and the creation of long-term career paths.

R&D Centres Indicators

The number and structure of Human Resources in each R&D Centre is detailed in Table 3.3 by type and R&D Centre.

Table 3.3 - Human Resources by type and R&D Centre (2024 Headcount distribution)

Type of Human Resources	Total R&D Centres	R&D Centres														Special Projects
		CTM	CAP	CRAS	CBER	CPES	CESE	CRIS	CEGI	CITE	HUMANISE	LIAAD	CRACS	HASLAB		
Integrated HR	Employees	276	14	14	31	8	83	31	30	12	6	22	11	2	12	
	Academic Staff	188	16	7	11	4	10	7	14	20	2	32	24	16	25	
	Grant Holders and Trainees	454	78	20	46	19	64	12	55	35	3	39	20	11	52	
	Total Core Researchers	918	108	41	88	31	157	50	99	67	11	93	55	29	89	
	Total Core PhD	308	27	18	19	9	37	19	26	29	5	40	31	17	31	
	Affiliated Researchers	71	8	2		2	2	7	1	4	3	29	8		5	
	Administrative and Technical	Employees	25	1	2	6	1	3	2	3	1		1	1	4	
		Total Admin and Tech	25	1	2	6	1	3	2	3	1		1	1	4	
	Total Integrated HR	1014	117	45	94	34	162	59	103	72	14	123	64	29	98	
	Total Integrated PhD	377	35	20	19	10	39	26	27	33	8	69	39	17	35	
Curricular Trainees	31	2		3	6	2	4	7			7					
Visiting Researchers	11	1		1		3		1	1		2	1		1		
External Researchers	253	33	5	5	15	19	18	13	25	12	39	38	7	23		
External Administrative and Technical Staff	5					1		1	2	1						
External Students	223	47	9	4	19	5	8	9	7	6	52	30	3	24		
Total	1537	200	59	107	74	192	89	134	107	33	223	133	39	145		

R&D Centres:

CTM	Centre for Telecommunications and Multimedia
CAP	Centre for Applied Photonics
CRAS	Centre for Robotics and Autonomous Systems
CBER	Centre for Biomedical Engineering Research
CPES	Centre for Power and Energy Systems
CESE	Centre for Enterprise Systems Engineering
CRIS	Centre for Robotics and Intelligent Systems
CEGI	Centre for Industrial Engineering and Management
CITE	Centre for Innovation, Technology and Entrepreneurship
HUMANISE	Centre for Human-Centred Computing and Information Science
CITE	Centre for Industrial Engineering and Management
LIAAD	Laboratory of Artificial Intelligence and Decision Support
CRACS	Centre for Research in Advanced Computing Systems
HASLAB	High-Assurance Software Laboratory

Support Services Indicators

The Human Resources figures by the end of 2024 for the Board of Directors, the TEC4 teams, and the Support Services are provided in Table 3.4.

Table 3.4 - Human Resources by type and Service (2024 Headcount distribution)

Type of Human Resources	Total	Support Services															
		Board and Advisors	Business Development Services							Organisation and Management Services					Technical Support Services		
			TEC4	SAL	SAAF	SRI	SCOM	DPO	AG	AJ	CF	CG	RH	SAS	SIG	SRC	SGI
Employees	112	19	7	5	2	5	11	2	3	4	11	13	8	4	7	4	7
Academic Staff	9	6	3														
Total Integrated HR	121	25	10	5	2	5	11	2	3	4	11	13	8	4	7	4	7
Total Integrated PhD	26	13	5	4		1			1	1	1						

Support Services:

AG	Management Support ¹
AJ	Legal Support
CF	Accounting and Finance
CG	Management Control
RH	Human Resources
SAAF	Funding Opportunities
SAL	Technology Licensing
SRI	International Relations
SCOM	Communication
SRC	Networks and Communications
SIG	Management Information Systems
SAS	System Administration
SGI	Infrastructure Management

¹ Includes Secretarial Coordination

3.7 Activity in Projects

Global Indicators

Table 3.5 presents the breakdown of funding sources and their evolution from 2020 to 2024. In 2024, the total income reached €33.6M, a 17% increase over 2023, sustaining the positive trajectory of recent years.

Table 3.5 - Funding sources and evolution

Sources	Value (k€)					Δ (k€ %)	2023-24
	2020	2021	2022	2023	2024		
PN-FCT National R&D Programmes - FCT	3 524	2 295	1 522	1 428	1 370	-58	-4%
PN-PICT National R&D Programmes - S&T Integrated Projects	22	49	154	103	5	-98	-96%
PN-COOP National Cooperation Programmes with Industry	1 250	2 189	3 720	7 507	11 343	3 836	51%
PUE-FP EU Framework Programmes	4 903	5 529	7 642	9 273	9 315	42	0%
PUE-DIV EU Cooperation Programmes - Other	300	449	534	590	580	-10	-2%
SERV-NAC R&D Services and Consulting - National	2 899	3 519	3 527	2 726	2 528	-198	-7%
SERV-INT R&D Services and Consulting - International	547	678	326	579	446	-133	-23%
OP Other Funding Programmes	955	560	713	797	828	31	4%
Total Projects	14 399	15 270	18 137	23 003	26 415	3 412	15%
National Strategic Programme - Pluriannual	2 396	2 257	3 062	2 442	2 810	368	15%
National Strategic Programme - RHAQ	289	520	507	128	0	-128	-100%
National Strategic Programme - EEC	460	484	509	732	780	48	7%
National Strategic Programme - CTI	599	836	28	1 461	2 357	896	61%
National Strategic Programmes - Other	10	241	350	584	475	-110	-19%
Other Revenues	102	520	443	469	741	272	58%
Total Revenues	18 255	20 127	23 036	28 819	33 577	4 758	17%

Figure 3.6 illustrates the evolution of project funding sources from 2020 to 2024. While the overall level of activity has grown, the relative contribution of each funding source has shown some variation, reflecting the cyclical dynamics of national and European funding programmes.

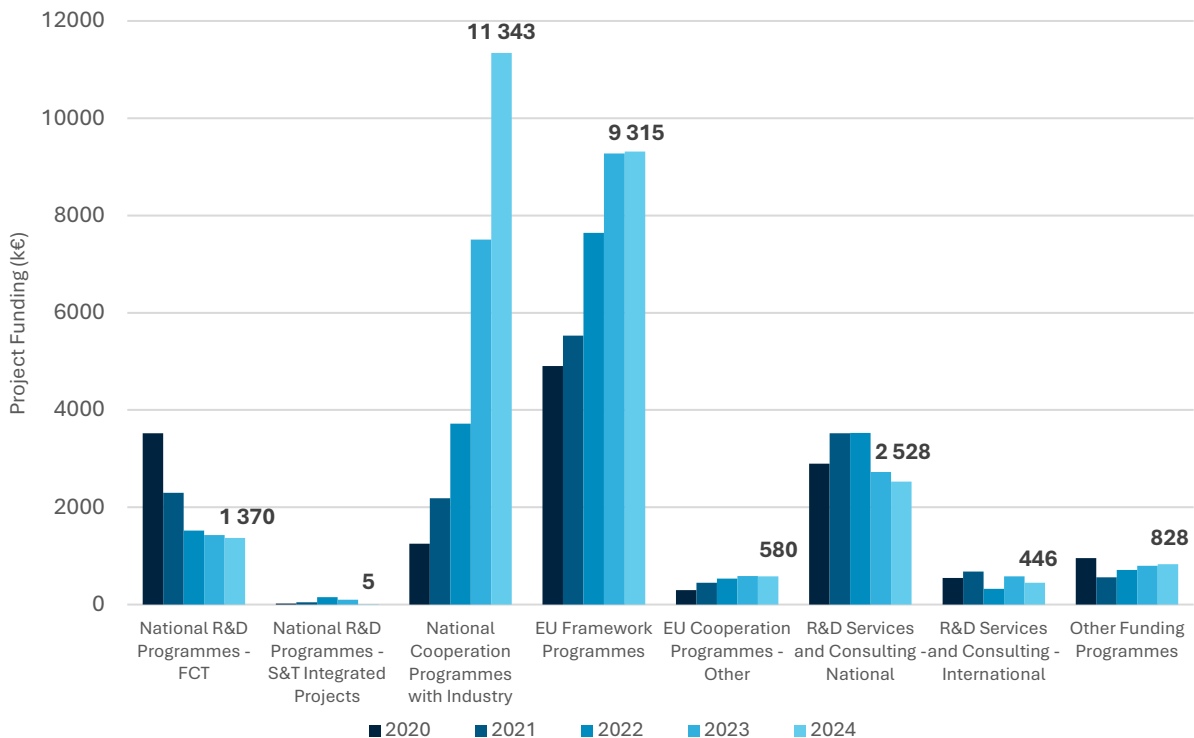


Figure 3.6 - Evolution of project funding by source (k€)

Figure 3.7 provides a snapshot comparison of the funding structure between 2023 and 2024.

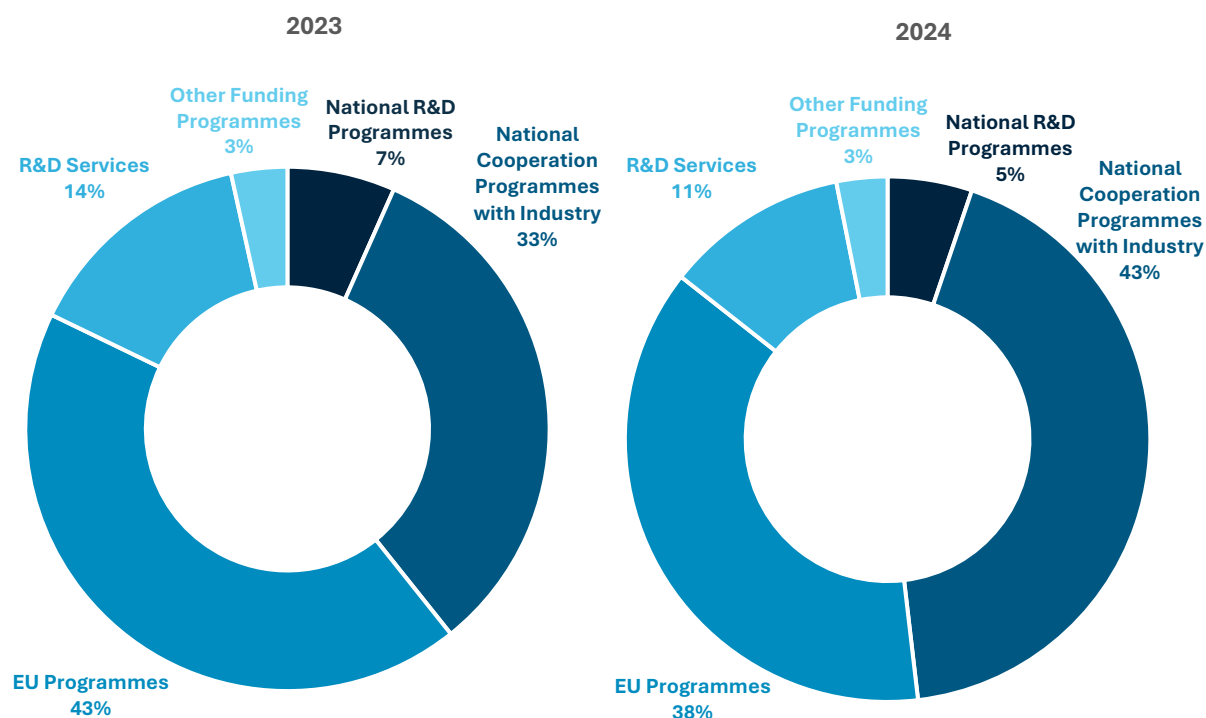


Figure 3.7 - Distribution of project funding by source – 2023 and 2024

Table 3.6 complements these indicators with the number of active projects and the average funding per project, by funding source.

Table 3.6 - Number of active projects and average funding by source

Type of Project	Number of Active Projects					Δ (%)	Average Funding (κ€)		
	2020	2021	2022	2023	2024		2023	2024	
PN-FCT	National R&D Programmes - FCT	68	61	48	33	30	-3	43	46
PN-PICT	National R&D Programmes - S&T Integrated Projects	0	1	1	1	1	0	103	5
PN-COOP	National Cooperation Programmes with Industry	33	46	63	71	39	-32	106	291
PUE-FP	EU Framework Programmes	72	67	76	96	99	3	97	94
PUE-DIV	EU Cooperation Programmes - Other	18	15	21	19	16	-3	31	36
SERV-NAC	R&D Services and Consulting - National	126	125	121	116	95	-21	24	27
SERV-INT	R&D Services and Consulting - International	20	20	16	25	11	-14	23	41
OP	Other Funding Programmes	40	27	18	19	15	-4	42	55
Total		377	362	364	380	306	-74	61	86

Based on the global indicators outlined above, the following key conclusions emerge regarding INESC TEC's project activity in 2024:

- In 2024, INESC TEC consolidated its trajectory of growth, reaching €33.6M in total income, a 17% increase over the previous year, and managing more than 300 active R&D projects. Despite shifts in the relative weight of different funding sources, the institution maintained a diversified portfolio, reinforcing the robustness of its funding model and its capacity to adapt to evolving national and European programme dynamics.

- Nationally funded activity grew by 31% in 2024, largely driven by the execution of 22 major collaborative projects under the Portuguese Recovery and Resilience Plan (PRR), which alone accounted for €11.7M in funding. These mobilising agendas represent a central pillar of INESC TEC's engagement with national industrial and innovation policy.
- European programme funding remained at a high level in 2024, with €43.9M already approved under Horizon Europe across 68 projects. This strong performance consolidates the institution's position as the third-largest Portuguese beneficiary of Horizon Europe, after two universities, and reflects its sustained capacity to lead and collaborate in highly competitive international research and innovation ecosystems.
- INESC TEC's growing leadership in European programmes is also evidenced by its coordination of nine Horizon Europe projects and its role in the recently launched INESC TEC.OCEAN Teaming initiative, which alone secured €11M in funding. This reinforces the institution's strategic positioning in the European research landscape and its capacity to anchor large-scale international partnerships.
- Income from direct R&D and consulting services declined by 4% in 2024, reflecting a broader shift in company engagement patterns. The strong involvement of companies in PRR-funded collaborative projects, coupled with delays in the launch of Portugal 2030, led many firms to postpone new bilateral R&D contracts. This trend highlights the impact of public funding cycles on private-sector demand for direct research services.
- The National Strategic Programme ("Pluriannual") accounted for 8% of total funding in 2024. Despite its modest share, it plays a vital strategic role by providing stable and flexible support, enabling INESC TEC to maintain core institutional capabilities and pursue long-term initiatives beyond the scope of project-based funding.
- The multi-annual base funding for technology transfer activities (CTI), amounting to €2.4M, continues to be a key enabler of INESC TEC's long-term capacity to promote knowledge valorisation and engagement with industry. This funding supports dedicated structures and activities beyond the scope of competitive project funding, reinforcing the institution's mission in innovation and impact.
- The higher average funding per project in the National Cooperation Programmes reflects the naturally larger scale of PRR-funded mobilising agendas. EU Framework Programme projects, although prestigious and numerous, tend to involve smaller funding amounts per participating institution. R&D and consulting service contracts, typically shorter in duration and more targeted, also naturally result in lower average funding levels.
- The decline in FCT project funding in 2024 resulted from the conclusion of several ongoing projects and delays in the launch of new calls. While such fluctuations are to be expected in competitive funding cycles, they highlight the importance of maintaining continuity in national research funding to ensure stability and long-term planning capacity for research-performing organisations.
- With PRR funding currently scheduled to conclude by the end of 2025, though with a likely extension into mid-2026, the institution faces a strategic inflexion point. While the short-term outlook remains strong, anticipating and preparing for the post-PRR funding landscape will be critical to maintaining the current scale and diversity of activity. A forward-looking approach to national and European funding opportunities will be essential to ensure the continuity and sustainability of INESC TEC's research and innovation mission.

R&D Centres Indicators

A detailed view of the total funding by source per R&D Centre is given in Table 3.7 and Figure 3.8.

Table 3.7 - Project Funding (k€) per R&D Centre

Funding Source	Total (k€)	R&D Centres													
		CTM	CAP	CRAS	CBER	CPES	CESE	CRIIS	CEGI	CITE	HUMANISE	LIAAD	CRACS	HASLAB	Special Projects
PN-FCT	1 370	169	40	570	61	77	-1	26	207	0	51	95	-3	78	0
PN-PICT	5	3	-5	0	0	7	0	0	0	0	0	0	0	0	0
PN-COOP	11 343	939	469	664	261	3 176	1 315	2 114	434	217	810	392	94	459	0
PUE-FP	9 315	1 256	382	1 892	152	2 111	618	732	441	192	716	257	79	367	120
PUE-DIV	580	13	4	317	0	-1	4	0	-4	19	89	-61	20	119	61
SERV-NAC	2 528	30	72	184	62	1 075	139	81	10	1	545	54	0	256	18
SERV-INT	446	0	0	65	38	243	20	16	0	0	0	65	0	0	0
OP	828	23	109	3	12	0	68	11	0	-4	0	0	20	257	328
Total Funding	26 415	2 432	1 071	3 695	586	6 688	2 163	2 979	1 088	425	2 211	802	210	1 537	527

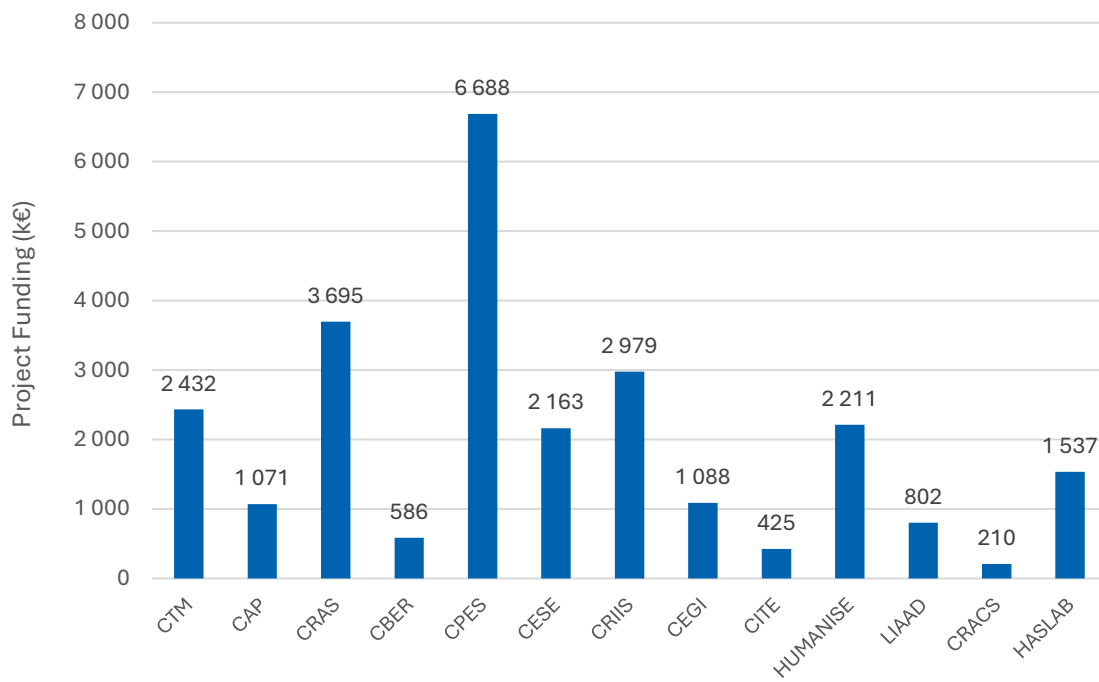


Figure 3.8 - Total Project Funding per R&D Centre (k€)

3.8 Publications

Global Indicators

Table 3.8 and Table 3.9 along with Figure 3.9 and Figure 3.10, present the evolution of INESC TEC’s scientific publications since 2020. Two distinct data sets are shown:

- Consolidated data, calculated three months after year-end, and used for the annual activity report;
- Closed data, calculated eleven months after year-end, used in institutional planning.

This two-stage process accommodates the inherent time lag in the indexing and validation of scientific outputs.

Publication data is sourced from multiple indexing systems (ISI, Scopus, and CORE via the Authenticus platform). Publications involving multiple Centres are counted once per Centre, with the institutional total adjusted to avoid duplication.

Table 3.8 - Number of publications by type (consolidated data, 2020–2024)

Publication Type	2020 (Consolidated)	2021 (Consolidated)	2022 (Consolidated)	2023 (Consolidated)	2024 (Consolidated)
Indexed Journals	398	440	465	489	461
Indexed Conferences	317	362	349	427	482
Books	2	3	3	7	3
Book Chapters	25	34	45	31	21
PhD Theses – Members	28	30	31	25	45
PhD Theses - Supervised	46	58	43	38	74

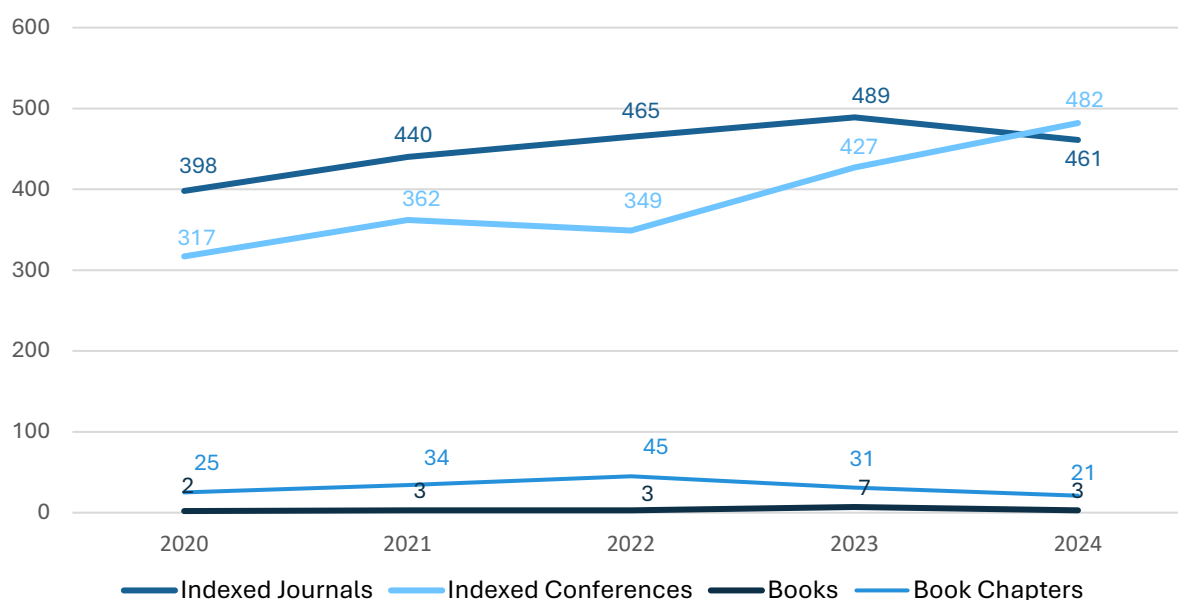


Figure 3.9 - Evolution of publications by type (consolidated data, 2020–2024)

Table 3.9 - Number of publications by type (closed data, 2020–2023)

Publication Type	2020 (Closed)	2021 (Closed)	2022 (Closed)	2023 (Closed)
Indexed Journals	444	451	539	524
Indexed Conferences	413	471	446	538
Books	2	4	4	11
Book Chapters	25	33	40	31
PhD Theses – Members	28	30	31	25
PhD Theses - Supervised	46	58	43	38

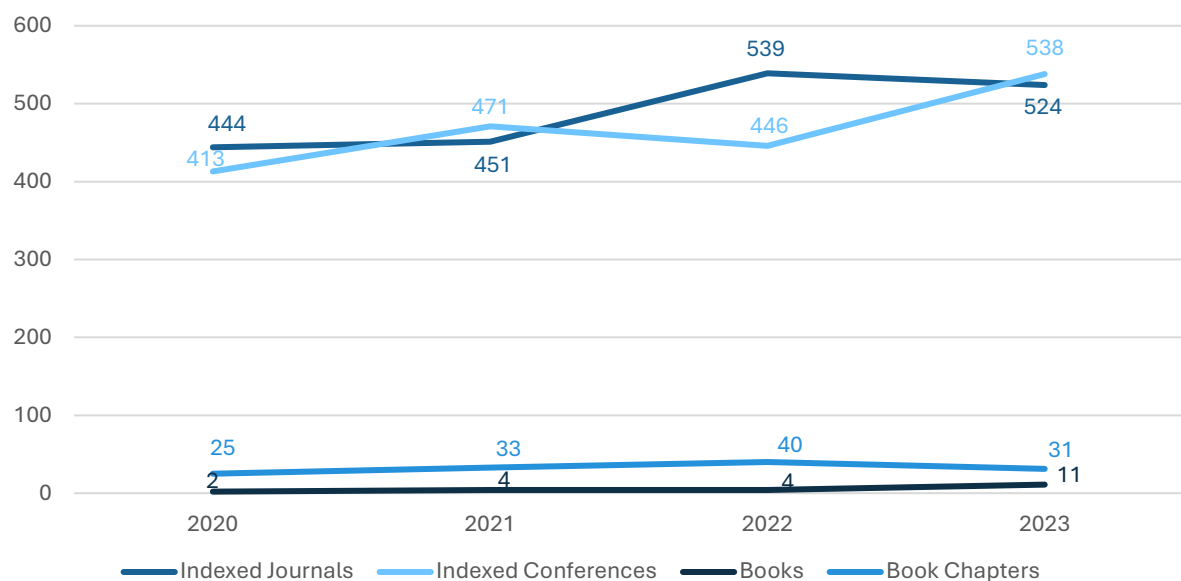


Figure 3.10 - Evolution of publications by type (closed data, 2020–2023)

INESC TEC’s 2024 performance in indexed publications exceeded the targets set in its annual plan, which had projected 404 journal articles and 309 conference papers. Although the number of journal articles saw a slight year-on-year decline, the institution registered a 3.5% increase in overall indexed output. Conference papers rose by 13%, and the number of journal publications in first-quartile journals grew by 13%. Additionally, 13 papers were presented at CORE A* conferences, the highest rating awarded by the Computing Research and Education Association of Australasia.

An analysis of publication intensity per researcher (Figure 3.11), based on consolidated data, shows a small decline in indexed journal articles per Core PhD compared to 2023, while the corresponding indicator for conference publications improved.

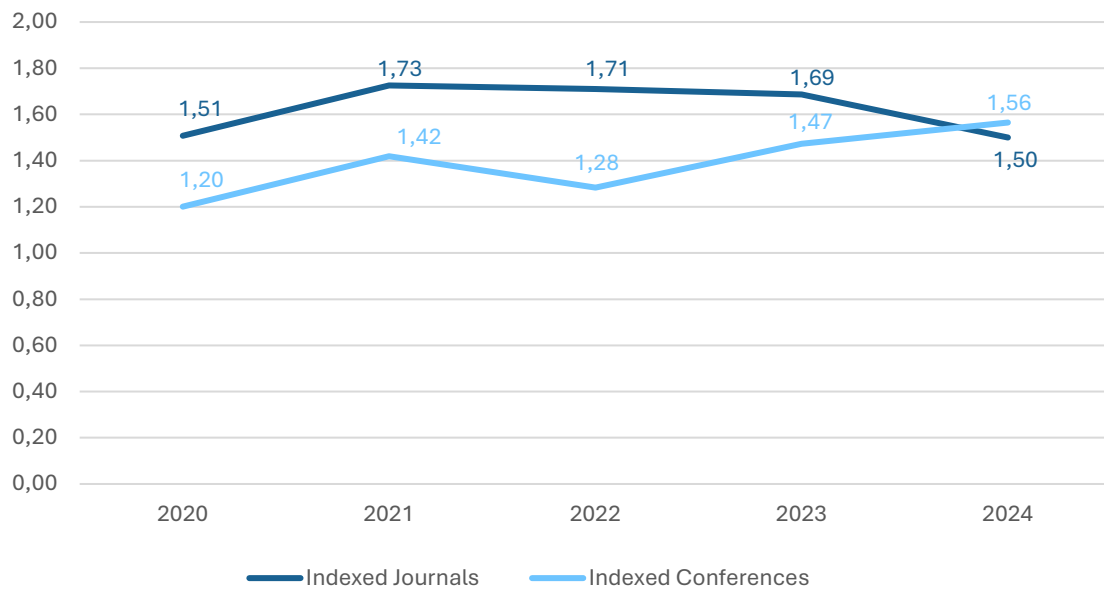


Figure 3.11 - Indexed publications per Core PhD (consolidated data)

In journal publications indexed by Scopus, 72% of articles in 2024 appeared in first-quartile journals (332 out of 461), a slight increase from 295 in 2023 (Figure 3.12). This continues to reflect a strong orientation toward quality and visibility.

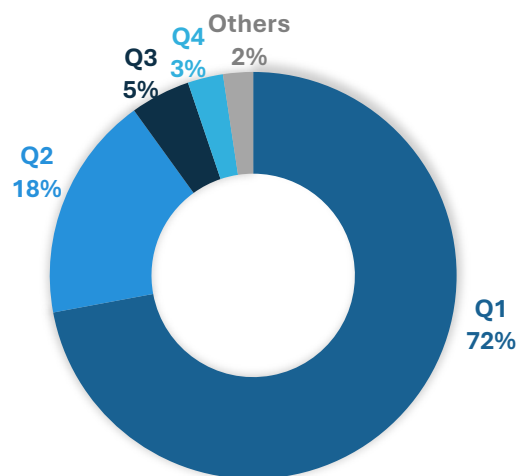


Figure 3.12 - Distribution of indexed journal articles by impact factor quartile (Scopus, 2024)

In terms of Open Access (OA), of the 982 documents indexed in Scopus as of March 2025, including journal articles, conference papers, and book chapters, 31% were OA (352 documents), with 21% classified as Gold OA. Focusing on journal articles alone (453 documents), 60% were Open Access, and 33% were Gold OA.

International collaboration remains a hallmark of INESC TEC’s publication profile. In 2024, 32% of all indexed publications involved co-authors from international institutions, rising to 38% for journal articles. This places the institution above the global average for international co-authorship (around 25%), underscoring its active participation in international research networks and cross-border scientific collaboration.

R&D Centres Indicators

Figure 3.13 presents the number of indexed publications in journals and conferences per R&D Centre.

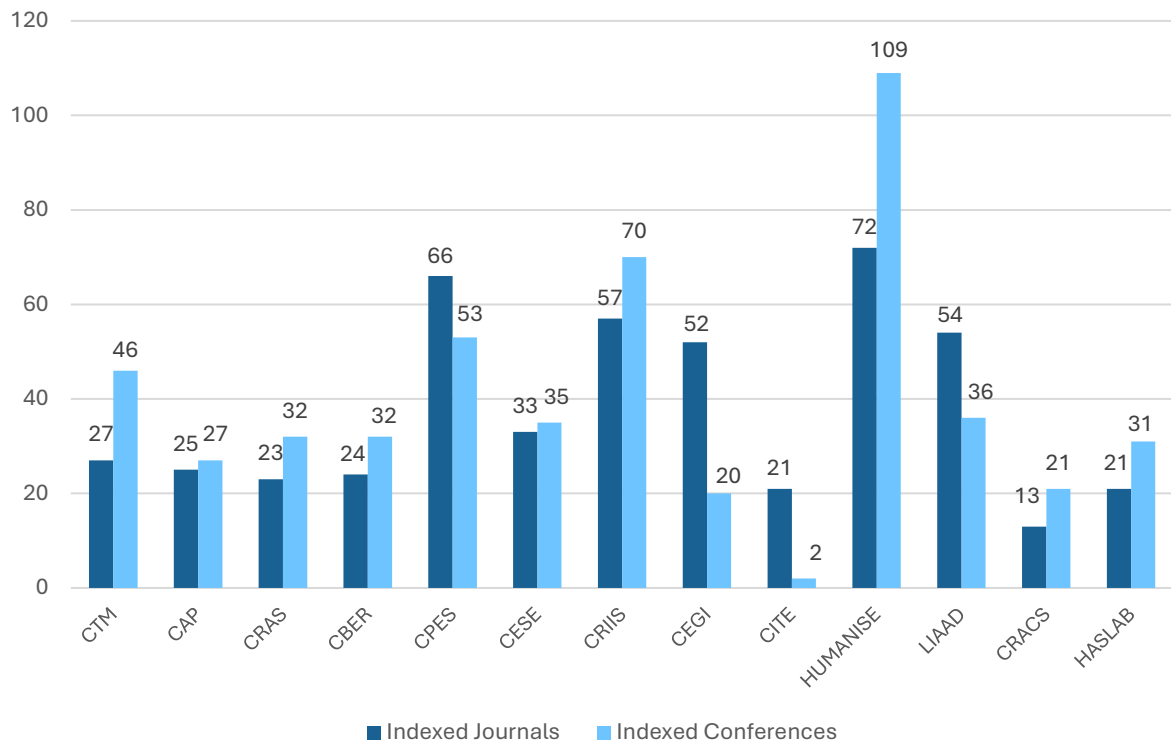


Figure 3.13 - Indexed Publications in Journals and Conferences by Centre

The breakdown of the publication indicators of each R&D Centre is presented in Chapter 10, in each Centre's section and in Annex I.

Research Data Publication

The publication of research data enhances transparency, fosters collaboration, and increases the impact of scientific work. INESC TEC is committed to open data practices, ensuring its research outputs are accessible, reusable, and contribute to scientific progress.

In 2024, 21 new datasets were published in RDM INESC TEC, one more than the number published in 2023 and slightly exceeding the average rate of 19 datasets published per year. These datasets covered fields such as biomedical imaging, robotics, artificial intelligence, environmental science, human-computer interaction and digital humanities. They support advanced methodologies, including deep learning, semantic interoperability, multimodal analysis, clinical information extraction, and wireless sensing, showcasing substantial potential for interdisciplinary research and technological innovation.

By the end of 2024, the repository housed 151 open datasets.

Table 3.10 outlines open datasets published in 2024 in the institutional data repository.

Table 3.10 - Open data published in the RDM INESC TEC repository

Dataset	Description
DADDI@CRAS – Durius Aerial Dataset with Diversified Information Rafael Marques Claro & Andry Maykol Pinto, 2024 https://doi.org/10.25747/zg3w-kh52	DADDI provides offshore structure data for multimodal inspections and 3D modelling to support maritime structure monitoring. The dataset was collected during the ATLANTIS project at the ATLANTIS Coastal Testbed.
BioPhotonics Signal Analysis: Phase-derived features for microparticles and nanoparticles identification Beatriz Barros & João Paulo Cunha, 2024 https://doi.org/10.25747/XTXJ-AV32	The Optical Fiber Tweezers (OFT) dataset supports the study of light-matter interactions with micron-sized bioparticles trapped in a laser beam. It includes five key functions from the biophotonic signal processing pipeline developed in the iLoF approach.
IMP Whole-Slide Images of Cervical Samples 2024 Sara P. Oliveira et al., 2024 https://doi.org/10.25747/9028-c140	The IMP-cervix dataset contains 600 cervical LEEP samples and surgical specimens, retrieved from the data archive of the IMP Diagnostics laboratory, Portugal, and were digitised with 2 Leica GT450 WSI scanners, at 40X.
IMP Whole-Slide Images of Colorectal Samples 2024 Pedro C. Neto et al., 2024 https://doi.org/10.25747/fb1q-j507	The IMP-CRS 2024 dataset contains 5333 colorectal biopsy and polypectomy slides, retrieved from the data archive of IMP Diagnostics laboratory, Portugal, digitised at 40X by 2 Leica GT450 WSI scanners.
Images to describe data: Summary of interview transcripts to assess the role of imagery metadata in data description Joana Rodrigues & Carla Teixeira Lopes, 2024 https://doi.org/10.25747/te4a-6544	This dataset includes 16 anonymised semi-structured interviews with researchers on the role of images as metadata in data description, conducted between November 2022 and January 2023.
Matrix profile analysis of Dansgaard-Oeschger events in palaeoclimate time series Susana Barbosa et al., 2024 https://doi.org/10.25747/T9GX-9729	This dataset includes time series data from the NGRIP ice core and associated computational tools for matrix profile analysis of oxygen isotope and calcium concentrations to advance the understanding of paleoclimate events.

Dataset	Description
<p>Labadain-30k+: A Monolingual Tetun Document-Level Audited Dataset</p> <p>Gabriel de Jesus & Sérgio Nunes, 2024</p> <p>https://doi.org/10.25747/ydwr-n696</p>	<p>Labadain-30k+ is a monolingual Tetun text dataset with 33,550 documents from June 2001 to September 2023 (excluding 2004–2005). Collected via web crawling, it includes title, URL, source, category, publication date, and content, with documents separated by two newlines.</p>
<p>Linked data descriptions of seven arrowheads dated between the Chalcolithic and the Early/Middle Bronze Age, from the archaeological site of Castanheiro do Vento</p> <p>Mariana Curado Malta et al., 2024</p> <p>https://doi.org/10.25747/XV1K-8M08</p>	<p>This dataset contains linked open data on arrowhead descriptions from the Chalcolithic to the Early/Middle Bronze Age (2800/2900 BC – 1500 BC), structured for semantic interoperability.</p>
<p>ANODE, an underwater dataset for sacrificial anode detection</p> <p>João Dionísio, Pedro Nuno Leite & Andry Maykol Pinto, 2024</p> <p>https://doi.org/10.25747/waw7-2f33</p>	<p>The ANODE dataset contains 18,230 images of sacrificial anodes collected at the ATLANTIS Test Center to support Deep Learning object detection for maritime corrosion protection.</p>
<p>SpecRF-Posture: Exploring Specular Reflections for Human Posture Recognition</p> <p>Mariana Fonseca et al., 2024</p> <p>https://doi.org/10.5281/zenodo.10911412</p>	<p>SpecRF-Posture is a novel system for human posture recognition using S21 parameters within the WiFi-6E frequency range, leveraging RF signals for accurate classification in wireless sensing.</p>
<p>Radon data from ENVRIplus TNA campaign RELECT at SMEAR II – HYTIALLA multi-disciplinary RI platform</p> <p>Susana Barbosa, 2024</p> <p>https://doi.org/10.25747/JBVT-0940</p>	<p>Radon concentration measurements (in Bq/m3) every 2-hours from solid state detector (Barasol).</p>
<p>Tribunal do Santo Ofício in ArchOnto – Extension of archival records through Wikidata and DBpedia properties</p> <p>Inês Koch, 2024</p> <p>https://doi.org/10.25747/SRYA-8115</p>	<p>This dataset contains mappings of archive record representations in ArchOnto, DBpedia, and Wikidata, showing how archival entities are depicted in linked data and enriched through cross-model integration.</p>
<p>Defect Detection Dataset: Porosities in Machined Aluminum Holes</p> <p>Rui P. Nascimento, Cláudia D. Rocha & Díbet Garcia Gonzalez, 2024</p> <p>https://doi.org/10.25747/KBZB-R124</p>	<p>This dataset contains 302 JPEG images (400×400 RGB) captured with an endoscopic camera to detect porosities in the inner walls of machined holes in cast aluminum parts.</p>
<p>Salary trends for public higher education teachers in Portugal (2002-2024)</p> <p>Isabel Rodrigues, Mário Queiróz & Mariana Curado Malta, 2024</p> <p>https://doi.org/10.25747/Q4Y1-W971</p>	<p>This dataset gathers data on the salaries of public higher education teachers in Portugal between 2004 and 2024.</p>

Dataset	Description
<p>Metadata and Analysis of Clinical Information Extraction Publications Using Large Language Models</p> <p>Tiago Rodrigues & Carla Teixeira Lopes, 2024</p> <p>https://doi.org/10.25747/CD12-0636</p>	<p>Data from a systematic literature review of 85 publications on Clinical Information Extraction using LLMs, from 2019 to 2023.</p>
<p>Wikipedia and Simple Wikipedia Lead Section Pairs for Nine Categories</p> <p>José Frederico Rodrigues, Carla Teixeira Lopes & Henrique Lopes Cardoso, 2024</p> <p>https://doi.org/10.25747/4VC9-ZS43</p>	<p>This dataset contains 9 CSV files, each with 10,000 lead section pairs from Wikipedia and Simple Wikipedia, including categories like Culture, Education, Employment, Entertainment, Health and Science.</p>
<p>Sematic representation of the registos de Registos de Baptismos da Paróquia de Aldoar (Porto, Portugal)</p> <p>Lucia Giagnolini & Inês Koch, 2024</p> <p>https://doi.org/10.25747/15YG-GD8</p>	<p>This dataset comprises mappings of archival from the National Archives of Portugal to the RiC-O (Records in Contexts Ontology) framework, namely the baptism registries of the Parish of Aldoar (Porto, Portugal).</p>
<p>RIS Based Hand Gesture Recognition Dataset</p> <p>Mariana Oliveira et al., 2024</p> <p>https://doi.org/10.5281/zenodo.13754235</p>	<p>This dataset, produced in the context of the CONVERGE project, contains images for gesture recognition collected using a wooden hand.</p>
<p>Raw atmospheric electric field and ancillary data collected on-board Sagres ship (ongoing-updated yearly)</p> <p>Susana Barbosa et al., 2024</p> <p>https://doi.org/10.25747/KJ7E-NQ84</p>	<p>This dataset includes raw atmospheric measurements from the Sagres ship, collected after the SAIL campaign during its 2020 circumnavigation, covering ship, sensor, and geosensor data.</p>
<p>DECEiVeR (DatasEt aCting Emotions Valence aRousal)</p> <p>Luis Aly, Hugo Plácido da Silva & Gilberto Bernardes, 2024</p> <p>https://doi.org/10.6084/m9.figshare.23579862.v3</p>	<p>A curated collection of physiological recordings from 11 professional theatre actors. The DECEiVeR dataset facilitates the recognition of a specific set of five emotions.</p>
<p>Artificial Intelligence and Infodemic: Video Dataset for Fact-Checked Health Communication and Synthetic Media</p> <p>Haline Maia, 2024</p> <p>https://doi.org/10.25747/TKJR-EV33</p>	<p>Videos created using prototypes and APIs for participatory research. The videos were used as technological probes presented to various stakeholders. This dataset was created in the context of Fact-Checking Chatbot Initiative.</p>

3.9 Technology Transfer

INESC TEC's results in technology transfer activities in 2024 (Table 3.11), overall, were in line with or exceeded expectations set in the annual plan, reflecting a strong institutional commitment by the R&D Centres and proactive scouting by the Technology Licensing Office (TLO, SAL).

Table 3.11 - Results in intellectual property protection, exploitation, and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	24	31	40
Technology Disclosures (TDF)	21	23	13
First Priority Patent Applications (New Inventions)	5	8	9
First Patents Internationalisation	2	5	5
First Patent Granted	2	7	1
Commercial Contracts (Licences, Options, Assignments)	1	3	5
Spin-offs established	0	1	1
Spin-offs in development	2	5	10*

**Proprietary information; further details will be disclosed in an upcoming report*

The year was marked by significant achievements in intellectual property (IP) protection and valorisation.

Notably, five licensing agreements were secured, three with international partners and two involving INESC TEC spin-offs. These outcomes reflect the growing strategic role of IP and spin-offs in enhancing the reach and impact of INESC TEC's research.

The TLO managed a record 42 active patent families, including nine first-priority applications in 2024.

INESC TEC was also ranked 4th *ex aequo* nationally in the European Patent Office's (EPO) 2024 Patent Index, maintaining its consistent Top 10 presence since 2017. Key areas of IP activity included marine robotics, instrumentation, and medical technologies.

During 2024, eleven patents were granted in major international jurisdictions, including Europe, the US, China, Japan, and Australia. More than 40 new R&D results with valorisation potential were also recorded, particularly in the field of industrial engineering.

Spin-off development continued to grow, supported by internal seed funding under the Commercialisation Proof of Concept framework. One highlight was INESC TEC's formal entry into the equity of iLoF – Intelligent Lab on Fiber, a spin-off combining photonics and machine learning for drug discovery. Ten other spin-offs were under development in areas such as photonics, robotics, systems engineering, and artificial intelligence, with the TLO providing structured support and technical guidance.

Technological entrepreneurship

INESC TEC actively supports the creation of spin-offs based on technologies developed internally, with a view to promoting innovation and market deployment. Table 3.12 provides an overview of recent spin-offs, highlighting key developments in 2024. Given the proprietary nature of some ventures still in development, further details will be provided in future updates.

Table 3.12 - Recent INESC TEC spin-offs and 2024 developments

Name and description	Main developments in 2024
<p>Ubirider Develop solutions to make urban mobility smarter and to improve travellers' overall experience. Pick is a universal app which integrates any mobility service for multimodal trip planning and mobile payment of fares. Year of incorporation: 2018 Sector: Digital mobility Employees (FTE): 19</p>	<ul style="list-style-type: none"> - First expansion out of Portugal mainland with UbiRider adopted by MobiAzores for public transport in Terceira, Azores. - Deployment of UbiRider in Cascais, enabling real-time transport service monitoring across public and private operators.
<p>Keyruptive Technologies Mobile app solution for secure cloud storage and management of digital assets such as crypto currency, using patent pending technology that enables the distribution of trust among multiple entities. Year of incorporation: 2019 Sector: Software security / Fintech Employees (FTE): < 5</p>	<ul style="list-style-type: none"> - Identified new targets using the T-P-M framework - Signed an IP agreement with INESC TEC to facilitate company closure
<p>Insignals Neurotech Wearable wireless devices to precisely measure wrist rigidity, helping surgeons place brain implants more accurately during surgery on patients with Parkinson's, epilepsy, and other neural conditions. Year of incorporation: 2019 Sector: Medtech Employees (FTE): < 5</p>	<ul style="list-style-type: none"> - Launch of a multi-centre clinical study with Maastricht UMC+ and Hospital Clínico Universitario de Santiago to validate the technology. - Initiation of iHandU's validation as a digital health product for patient symptom monitoring at home.
<p>iLoF Leverage machine learning to drastically reduce the cost and time of drug discovery, using a patented photonics and Artificial Intelligence system to identify unique features of various gold-standard biomarkers, capturing their signature on a cloud-based library. Year of incorporation: 2019 Sector: Medtech, Digital health Employees (FTE): 25</p>	<ul style="list-style-type: none"> - Secured a £1.2M clinical research contract for the largest clinical trial in pre-symptomatic Alzheimer's disease with 1,000+ participants (Bio-Hermes-002) - Established a strategic partnership with Hamamatsu Photonics Japan to accelerate technology deployment and expansion to the US and Japan
<p>UNEXMIN Georobotics Underwater mine exploration robotic system for commercial mine surveying, exploration and geoscientific purposes. Year of incorporation: 2021 Sector: Geological consulting Employees (FTE): 5</p>	<ul style="list-style-type: none"> - Finalising the development of a new, small ROV with high 3D photogrammetry capabilities and optical cable connection. - Development of a basic underwater wireless charging station.
<p>SeedSight Inc. Focus: Optical and advanced AI technologies combined with big data structures about seed and grains to mitigate food waste and fraud. Year of incorporation: 2023 Sector: Agro-food Employees (FTE): 5</p>	<ul style="list-style-type: none"> - Lab validation of an MVP to predict cereal grain flour extraction rate. - Top11 Spinoff Nature Prize 2024.

In 2024, two initiatives previously listed as spin-offs in development were no longer considered part of INESC TEC's spinoff portfolio. WeSENS, which had progressed to an early development stage, returned to a state of inactivity and is, for the moment, no longer being pursued as a spin-off. In the case of Mitmynd, as a natural part of its development process, the company early on converged toward areas no longer aligned with the original INESC TEC research that gave rise to the venture.

The institution continues to leverage its spin-off portfolio as a mechanism for knowledge valorisation, entrepreneurial learning, and societal impact. In 2024, spin-off activity spanned sectors from digital mobility and fintech to medtech and agro-food, showcasing the diversity of INESC TEC's innovation pipeline.

3.10 Dissemination Activities

INESC TEC researchers and R&D Centres maintained a strong level of engagement in scientific and technical dissemination throughout 2024, even as project activity and institutional growth continued to expand. Table 3.13 summarises the evolution of dissemination activity over the past three years.

Table 3.13 - Participation in dissemination activities (2022–2024)

Type of Activity	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	151	105	109
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	63	72	59
International events in which INESC TEC members participate in the program committees	228	258	222
Participation in events such as fairs, exhibitions or similar	43	92	104
Conferences, workshops and scientific sessions organised by the R&D Centres	76	66	92
Participants in the conferences, workshops and scientific sessions organised by the R&D Centres	3 549	3 347	5 596
Advanced training courses organised by the R&D Centres	10	11	19

Most dissemination indicators either matched or exceeded the targets set in the 2024 annual plan. Particularly noteworthy were the increases in participation in fairs and exhibitions, the number of events organised by R&D Centres, and the significant rise in event attendance, reaching over 5 500 participants.

The INESC TEC Autumn Forum, not included in the figures in Table 3.13 as it falls outside the scope of R&D Centre-specific activities, was held as usual in 2024 as part of the institute’s annual event calendar. It was organised alongside several other high-impact initiatives, including multiple summer schools and advanced training courses. A particular highlight was IAMOT 2024, one of the world’s leading conferences in Technology and Innovation Management, which brought together 230 participants from over 30 countries in July. INESC TEC also hosted two other major international conferences: MELECON 2024 – 22nd IEEE Mediterranean Electrotechnical Conference, and the 14th ACM Conference on Data and Application Security and Privacy, which welcomed 80 participants from 16 countries.

INESC TEC researchers continued to play leading roles as members of organising committees and general chairs of prominent international conferences, reinforcing the institution’s scientific visibility and leadership.

The institute also expanded its training portfolio, offering parallel programming courses and two executive programmes: “Programa Avançado em Indústria 4.0,” and “Digitalização Shopfloor”. These were attended by 24 professionals from industry. Customised training was also delivered to REN (Rede Eléctrica Nacional), focusing on workforce upskilling in the energy sector. Additional initiatives included a simulation workshop hosted in the iiLab as part of the EIT Winter School and the InnovatED project.

Finally, hybrid and virtual formats continued to play an important role, enabling broader global participation and contributing to the inclusiveness and international reach of INESC TEC’s dissemination efforts.

3.11 Participation in Other Entities

In order to promote knowledge and competence sharing, INESC TEC is currently a full member of more than fifty Associations, at national and international levels. Other than the participation in the General Assemblies where network and benchmark are added values, INESC TEC actively participates in several Boards, Committees, and Working Groups, thus gathering and sharing knowledge with top-of-the-art experts in its field of activity.

In 2024, INESC TEC expanded its network by joining five new associations: BDVA, GAIA-X, IAM-I, and RISC-V, while ceasing its participation in two associations: SFCoLAB and EIT Raw Materials.

Table 3.14 - INESC TEC's participation in other entities

NATIONAL ASSOCIATIONS	
National Competitiveness Clusters	ACPMR (Mineral Resources), ADVID (Vines&Wines), AEDCP (Space and Defence), APICCAPS (Footwear and Fashion), BATPOWER (Energy), CITEVE (Textile), Fórum Oceano (Sea), HCP (Health), MOBINOVA (Automobile), PFP (railway), PRODUTECH (Manufacturing), TICE.PT (CIT)
Collaborative Laboratories (See also Section 3.10.1)	AQUAVALOR (Water technologies), B2E (Blue Economy), BUILT (Built Environment), FEEDINOVA (Sustainable Animal Production), ForestWise (Fire and Forest), HYLAB (Hydrogen energy), Smart Energy lab (Energy Services), VG Colab (Energy storage), ADVID (Vineyard and Wine), VORTEX (Cyber-physical and cyber-safety systems), RAIL CoLAB (railway).
Dedicated to specific fields of knowledge	AdEPorto, IEP (Energy), APVE, ITS Portugal (Mobility), SPR (Robotics), APDIO, APGEI (Management), SmartWaste Portugal (circular economy), EASTRO (Space), INOMMOB (Wood Industry), STICHTING SPRINT ROBOTICS COLLABORATIVE (Robotics).
Support industry/business	AEP
Promotion of science	Ciência Viva
INTERNATIONAL ASSOCIATIONS	
EIT Knowledge and Innovation Communities	EIT Manufacturing
Specific fields of knowledge	ADRA, AIOTI, ASTP Proton, ATE, BDVA, CCILF, CERVIM, CIGRÉ, CENTRA, CRESYM, DERLab, EBRAINS, EARTO, EERA, EFFRA, EPIC, ERCIM, EES-UETP, ETSI, EuRobotics, EtherCAT Technology Group, Gaia-X, IAM-I, IEA Wind, IDSA, INESC P&D Brasil, RISC-V, ROS-INDUSTRIAL CONSORTIUM EUROPE, WA4ES.
COMPANIES (Non Spin-offs)	
CEO - Companhia da Energia Oceânica	<p>Since 2022, INESC TEC is the main shareholder of the company CEO – Companhia da Energia Oceânica, owner of an Aguçadoura's test zone with grid connection (4 MW of power), capable of supporting the development and testing of marine renewable energy technologies (TRL ~5-8), as well as other multi-purpose marine structures, marine robotics, telecommunications, advanced sensing, collection of ocean and environmental data for model development, among others.</p> <p>In addition to its strategic importance in the fields of Sea and Energy, it strengthens synergies with ongoing initiatives related to infrastructure, projects in progress, and research and development lines across various Centres.</p>

Participation in Collaborative Laboratories

The Collaborative Laboratories – Bridging the Valley of Death

The Collaborative Laboratories (CoLABs) initiative was launched by the Portuguese Government in 2017 to strengthen the interface between research institutions and the market. These entities aim to create high-quality jobs in Portugal by advancing the social and economic valorisation of knowledge through demand-driven research and innovation.

The primary challenge CoLABs seek to address is the “valley of death” between academic research and market application. To this end, they foster institutionalised collaboration between science, technology, and higher education institutions and the broader economic and social fabric – companies, the healthcare sector, cultural bodies, and civil society organisations.

CoLABs are independent legal entities, typically structured as private non-profit associations or companies, and bring together diverse partners: universities, research units, state laboratories, interface institutions, companies, business associations, and public and social sector entities. They are characterised by their strong consortia, financial commitment, and business-led governance, and they operate with a focus on implementing medium-term research and innovation agendas.

Alignment with INESC TEC’s strategy and evolution in 2024

As demand-driven, business-oriented institutions focused on high Technology Readiness Levels (TRLs), CoLABs provide a natural complement to INESC TEC’s applied R&D and technology transfer strategy.

INESC TEC’s engagement in the creation and development of several CoLABs reflects its commitment to bridging the “valley of death” and supporting public policy objectives related to innovation and competitiveness. By 2024, INESC TEC was formally associated with eleven CoLABs, all operating as private non-profit associations.

This participation reinforces INESC TEC’s role as a leading interface institution, contributing to the deepening of application-oriented research, accelerating the valorisation of knowledge, and supporting the creation of high-value jobs, particularly for early-career researchers. CoLABs also provide a platform for experimentation with new forms of interaction between research, innovation, and societal needs, facilitating technology transfer, improving the market relevance of products and services, and increasing the societal uptake of academic research.

The tables that follow provide an overview of INESC TEC’s participation in each CoLAB and key developments in 2024.

Table 3.15 - CoLAB AQUAVALOR

AQUAVALOR	
Name	AQUAVALOR - Centro de Valorização e Transferência de Tecnologia da Água – Associação
Description	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.
Areas of expertise	Health; Water technologies; Digital transition
Year of establishment	2018
No. of Associates / Accession of new Associates in 2024	26/ 0
HR hired	19
Competitive funding – submitted and approved proposals	Submitted: €704,631.56 Approved: €254,872.20 (Promove - 3Rs and Co-promotion Inov@lheira) Awaiting decision: €449,759.36
Main activities and achievements in 2024	Development of projects focused on the scientific and economic valorisation of regional resources, including GIAHS (autonomous environmental monitoring), ORALTHERM (thermal water for oral health), THERM4SKIN (bioactive properties of thermal spring water for skincare), SUSTAINABLE TROUT (innovative food products from surplus trout), WOODLAND FUNGI (sustainable wild mushroom collection), 3RS (optimising cultivation of underutilised species), and AQUAPRED (AI-based contamination control in mineral water). Additionally, INESC TEC prepared proposals for several competitive funding calls (FCT/BPI La Caixa Promove 2024, Compete, Norte 2020) and provided services supporting the digital transition of the Agrifood sector
Activities to foster Associates' involvement	Preparation of proposals for several competitive funding calls (FCT/BPI La Caixa Promove 2024, Compete, Norte 2020); The organisation of scientific and technical events.
Fulfilment of INESC TEC's strategic objectives related to this participation	<p>INESC TEC main objectives with this participation are: 1. To support the COLAB's development with its competencies and expertise in digital technologies; 2. To generate new opportunities and projects in that area; 3. To promote the development of low-density territories, mainly through retaining highly qualified human resources and developing higher added value economic activities.</p> <p>So far, the COLAB's development aligns with these objectives since several highly qualified human resources were hired for the organisation. INESC TEC is involved in some of its activities (namely projects and events), via the participation of its researchers.</p> <p>With the increase of the organisation's maturity level and the beginning of PT2030 execution, it's expected that the activity will increase and INESC TEC's involvement. To achieve this goal, a more proactive relation should be established between the relevant groups of the two organisations.</p>

Table 3.16- CoLAB B2E

B2E	
Name	B2E - Laboratório Colaborativo para a Bioeconomia Azul
Description	B2E is a key driver of innovation in the Blue Bioeconomy, promoting research, development, and market-oriented solutions that combine sustainability with technological and economic progress. It aims to enhance the economic and social value of marine-based products and services – both existing and emerging – while supporting the internationalisation of national scientific and technological capacities. With this approach, B2E contributes directly to two blue growth sectors with high potential: biotechnology and aquaculture.
Areas of expertise	Living marine natural resources; Marine biotechnology; Sustainable aquaculture
Year of establishment	2019
No. of Associates / Accession of new Associates in 2024	14/ 0
HR hired	2 new
Base funding planned	522 401,36 €
Competitive funding – submitted and approved proposals	Submitted: 5 Pending approval: 2
Main activities and achievements in 2024	In 2024, B2E acted as the Portuguese mirror platform of EATIP and served as a partner of the PICN Forum for the Decade of the Ocean. In collaboration with the Jean Monnet Centre of Excellence on Sustainable Blue Economy, B2E contributed to the development of policy briefs. B2E participated in several strategic projects, including the Horizon Europe INNOECOFOOD project, the PRR Pact for the Blue Bioeconomy and InsectEra Mobilising Agenda, and the FCT-funded Pufapods project. Its partnership with the Municipality of Matosinhos was further strengthened through its role as an advisory partner for the local blue strategy. B2E also expanded its international reach, securing its first international client, PanaSea Global (Panama). In parallel, the CoLAB continued to invest in education and public awareness, contributing to blue literacy campaigns and joining the postgraduate programme in Leadership in Sustainable Economy promoted by IPVC. Its visibility in the sector was further enhanced through its presence at key events, such as Aquaculture Europe 2024.
Activities to foster Associates' involvement	R&I projects with associates; Support to the implementation of associates' R&I priorities, while providing funding surveillance mechanisms; National and international networking events.
Fulfilment of INESC TEC's strategic objectives related to this participation	Boost the Blue Bioeconomy sector - particularly Aquaculture 4.0 – by providing services that support the development of R&D projects and the dissemination of funding opportunities.

Table 3.17 - BUILT CoLAB

BUILT CoLAB	
Name	BUILT CoLAB – Colaborative Laboratory for The Future Built Environment
Description	The BUILT CoLAB aims to develop research, innovation and knowledge transfer activities, with a view to increasing productivity, competitiveness and sustainable growth of the ecosystem of the AEC (Architecture, Engineering and Construction) sector, promoting the digital and climate transition of buildings and infrastructures, making them adaptable, intelligent, resilient and sustainable.
Areas of expertise	Digital and climate transition of buildings and infrastructures
Year of establishment	2019
No. of Associates / Accession of new Associates in 2024	20 / 0
HR hired	11 HR were hired by the CoLAB in 2024
Base funding planned	1 133 876,92€
Competitive funding – submitted and approved proposals	Were submitted: 8 Horizon Europe proposals, a LIFE-CET, a B4P innovation cluster recognition, a S3 Thematic Platform for Industrial Modernisation recognition, and a FCT Tenure. Approved: a HORIZON-TMA-MSCA-SE HORIZON, a PT2030 Copromotion I&D Empresarial, a PRR “Roteiro para a Descarbonização” for the construction sector via subcontracting, 3 FCT Tenure grants, and the recognition as B4P innovation cluster and as a S3 Thematic Platform for Industrial Modernisation.
Main activities and achievements in 2024	BUILT CoLAB has grown significantly in 2024 in number of projects, researchers, research, service provisions and external recognition. It has also a year of achievements in terms of European Projects, recognitions and the first service provisions to non-national customers. 2024, has also been a consolidation year in terms of the team, processes and methodologies. Several initiatives with Associates and with the AEC sector, in general, have also been developed in order to promote the twin transition of the Construction of all stakeholders and in several dimensions.
Activities to foster Associates’ involvement	Meetings with the associates to present the skills, needs and promote co-creation/collaboration; Development of common competitive funding opportunities; Invitation to events, communication initiatives or business opportunities; the involvement of some in DIGITALbuilt (an EDIH); the establishment of partnerships to licence and scale technology; and the development of several bilateral projects that will support activities in the twin transition of partners.
Fulfilment of INESC TEC's strategic objectives related to this participation	Open a new market for INESC TEC to apply its skills and apply technology already developed for other sectors. Participated in several large national and European project proposals.

Table 3.18 - CoLAB FEEDINOV

CoLAB FEEDINOV	
Name	FEEDINOV - Associação para a Investigação e Inovação em Nutrição e Alimentação Animal
Description	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
Areas of expertise	Safety, quality and sustainability of feed and food production; Competitiveness of the livestock sector; Environmental sustainability
Year of establishment	2019
No. of Associates / Accession of new Associates in 2024	18/ 2 available places in the consortium awaiting acceptance decision from the general assembly
HR hired	A base team of 14 HR, plus 4 hired by the CoLAB in 2024 within ongoing competitive projects. The associates have 6 HR's assigned part time (5-10%) to the CoLAB.
Base funding planned	1.1M€ from October 2023 to March 2026;
Competitive funding – submitted and approved proposals	7 competitive proposals were submitted. 1 proposal was approved (EU Agroecology partnership, €150,000 budget for the CoLAB, starting May 2025), with 6 proposals awaiting response.
Main activities and achievements in 2024	FeedInov continued to consolidate its activities, highlighted by a major dissemination event with over 400 participants. The year saw increased investment to secure private funding for its 1/3 share. Achievements included coordinating an international I3 consortium application with INESC TEC, launching the STEP-UP EU project, acquiring GreenFeed® equipment (Mission Interface funding), and organising the II Forum/XIII Symposium on Animal Feed with IACA. FeedInov also secured international contracts with IDELE and Lactogal.
Activities to foster Associates' involvement	The Animal Feed Forum showcased FeedInov's applied R&D to associates and stakeholders, with regular B2B meetings and all associates represented in the General Assembly. Impressions were gathered for an internal communications project to begin in 2025. FeedInov also collaborated on BSc and MSc theses with associates. In 2024, close collaboration with INESC TEC led to the submission of two competitive projects.
Fulfilment of INESC TEC's strategic objectives related to this participation	FeedInov CoLab has proven to be a promising partnership, with INESC TEC's involvement driving progress in Zootechny, an area previously underdeveloped. However, there is a risk that the CoLab may remain too focused on animal feed, relying heavily on IACA, rather than shifting towards precision livestock farming, which aligns more with INESC TEC's expertise.

Table 3.19 - CoLAB FORESTWISE

CoLAB FORESTWISE	
Name	ForestWISE – Associação para o Laboratório Colaborativo para a Gestão Integrada da Floresta e do Fogo
Description	Brings together multiple interdisciplinary areas for a holistic and cohesive approach to rural fires and the closely related issue of the valorisation of forest (market and non-market) products and services.
Areas of expertise	Sustainable Forest Management; Knowledge and Technology Transfer
Year of establishment	2018
No. of Associates / Accession of new Associates in 2024	16
HR hired	45 HR hired by the CoLAB by the end of 2024
Base funding planned	1 000 000€
Competitive funding – submitted and approved proposals	A total of 20 proposals were submitted, resulting in 10 new R&D contracts and raising €2,513,000. Consultancy services contributed over €314,000 to financial sustainability, with 93 national and 8 international entities involved in projects.
Main activities and achievements in 2024	The Integrated Project RN21 led to the Resinae brand, a traceability and quality seal for natural resin. Work continued on projects BioShoes4All and Be@T, as well as on the STOCK OC service for carbon stock quantification under power lines. Ongoing efforts include the submission of proposals for European funding, the implementation of the B-READY4FUTURE Training Program (reaching 180 trainees), and the development of microcredentials involving eight HEIs. The European FIRE RES project is progressing, alongside participation in a Horizon Europe application led by Coventry University and the HOPE Cost Action. Two AGIF tender proposals were awarded, and a consortium involving the CoLAB won a public tender. An international protocol was signed with SITOWISE, and the team was further strengthened. The CoLAB participated in 50 events, with roles ranging from participant to speaker and organiser,
Activities to foster Associates' involvement	ForestWISE participated in 50 promotion and dissemination events, enabling the sharing of knowledge and activities among actors involved in integrated forest and fire management. The newsletter remained a key tool for communicating with Associates, stakeholders, and the wider community, reaching over 3,000 subscribers. Activities within the three major consortia fostered regular, day-to-day interaction with a broad range of stakeholders.
Fulfilment of INESC TEC's strategic objectives related to this participation	ForestWISE has become a key strategic partner for INESC TEC, fostering collaboration through TEC4Agro initiatives. It has played a central role in promoting INESC TEC's involvement in the RePLANT and Transform Green Mobilising Projects, as well as in several European projects and industry contracts. These collaborations have reinforced INESC TEC's position in the development of cutting-edge technologies for the forestry and forest-based industries.

Table 3.20 - HYLAB CoLAB

HYLAB	
Name	HYLAB – Green Hydrogen Collaborative Laboratory
Description	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.
Areas of expertise	Green hydrogen
Year of establishment	2021
No. of Associates / Accession of new Associates in 2024	14 / 2
HR hired	21
Base funding planned	HyLab started the Research and Development activities in 2024, with a fast-paced development of HR, laboratory facilities and specialised software acquisition. At the end of 2024 the base funding execution reached 50%.
Competitive funding – submitted and approved proposals	<p>By the end of 2024 had two new projects approved:</p> <ul style="list-style-type: none"> -H2Czero – Development of a High-Performance Electrolyzer for the Production of Green Hydrogen, coordinated by ISPT, under the P2030. -HySEas - Hydrogen from Seawater Electrolysis, coordinated by CERTH, under the Horizon Europe – Clean Hydrogen Partnership
Main activities and achievements in 2024	<ul style="list-style-type: none"> - Membership of 2 new Industrial Associates (Smartenergy e CTG) - Start-up of the electrochemistry laboratory - Acquisition of specialised software and computing capacity - Approval of 2 new projects, representing around 1,1 M€ of funding - Start of the H2Talent project - Alentejo Green Hydrogen Valley - Start-up of Business Development activities - Development of national and international collaborations
Activities to foster Associates' involvement	<p>During 2024, HyLab visited all Associates and welcomed at HyLab most of them, to define and initiate collaborations areas.</p> <p><u>On-going projects:</u></p> <ul style="list-style-type: none"> - H2Enable (together with FEUP), H2GreenValley (Led by REN and together with IST and INL), Moving2Neutrality (led by Galp and together with IST), and H2Driven (led by CapWatt and together with FEUP) funded by RRP. - H2tALENT (together with Galp and EDP New) funded by HEU Clean Hydrogen Partnership. <p><u>Communication and Dissemination:</u></p> <ul style="list-style-type: none"> - Organisation of the session "Green Hydrogen - Industrial Needs and New Technological Developments", with Associates (INESC TEC included) at the Science 2024 Conference (Oporto, 5 July 2024) - Participation in the European Hydrogen Week (Brussels, 18-21 November 2024) with its own stand shared with associates
Fulfilment of INESC TEC's strategic objectives related to this participation	<p>INESC TEC has been looking at the opportunities hydrogen offers to foster the energy transition, namely regarding energy storage and security of supply of electric power systems, balancing ancillary services provision through electrolyzers and exploitation of gas networks with blended H2.</p> <p>HyLab provides the network of competences and synergies to further develop this strategic vision.</p>

Table 3.21 - RAIL CoLAB

RAIL CoLAB	
Name	RAIL COLAB - COLLABORATIVE LABORATORY FOR THE FUTURE RAILWAY SYSTEM
Description	Aims to promote and carry out of R&D initiatives and activities aimed at improving the railway system, through scientific support and technological innovation in the intervention of relevant players in the business, academic and economic fabric
Areas of expertise	Rail
Year of establishment	2022
No. of Associates / Accession of new Associates in 2024	17
HR hired	0
Base funding planned	0
Competitive funding – submitted and approved proposals	0
Main activities and achievements in 2024	<p>During 2024, there were negotiations with MEDWAY addressing a future Cargo Laboratory Train, the CoLAB website was created, and a generic roll-up was produced.</p> <p>Meetings were also held with governmental bodies and other CoLABs to solve the lack of base funding without results or even commitments.</p> <p>The activity carried out during 2024 was very limited, well below what was planned. The 2024 activity report claims that the plan proposed for 2024 was “too optimistic and unrealistic”.</p> <p>It should be stressed again that this CoLAB is still lacking base funding and only has its social capital. The proposal submitted to EU-RAIL at the beginning of 2024 had a good evaluation but was not funded due to budget limitations.</p> <p>Finally, CP and IP, that were invited to join the CoLAB, will not join, leaving their reserved quotas free. The CoLAB is looking for other members that could replace them.</p>
Activities to foster Associates’ involvement	Meetings with some associates.
Fulfilment of INESC TEC’s strategic objectives related to this participation	Not applicable, due to lack of activity in 2024.

Table 3.22 - CoLAB Smart Energy Lab

CoLAB SEL	
Name	SMART ENERGY LAB – ASSOCIATION
Description	Pioneering Innovation for Energy Transition and Economic Growth, committed to advancing electric renewable energy, SEL helps businesses drive economic value in the Energy Transformation and Decarbonization. Our innovative, market-ready solutions enable customers to optimise their energy use and transition to cleaner renewable energy.
Areas of expertise	New Energy Management Solutions, Electric mobility, Electrification
Year of establishment	2019
No. of Associates / Accession of new Associates in 2024	7 / 7
HR hired	21 new HR have been hired in 2024 adding to existing 35 in 2023, with a total of 56 people at 31st December 2024.
Base funding planned	Subsidies (state and other public entities): 4 276 040€ Donations: 277 194€
Competitive funding – submitted and approved proposals	<ul style="list-style-type: none"> - Horizon Europe: Submitted proposals: 2 (with a total budget: 690k€)/ Approved proposals: 0. Ongoing projects: 7 (with a total executed in 2024 of 287 k€) - Life +: Submitted proposals: 1 (with a total budget: 420k€) - EU Urban Initiative: Submitted proposals: 1 (with a total budget: 240k€) - PRR Agendas Mobilizadoras Ongoing projects: 3 (with a total executed in 2024 of 2,92 M€ and a total budget: 15,9 M€).
Main activities and achievements in 2024	SEL focused on 21 projects across three streams: Consulting, R&D Funded Projects, and IP/Product development, with a primary focus on EDGE (e-mobility) and REEF (energy management). Key 2024 highlights include the first European patent approval, participation in Enlit Milan, joining the SmartEN association, a brand refresh, a new website, the launch of REEF, and submissions for Life+ and EU Urban Initiative funding
Activities to foster Associates' involvement	Monthly board meetings with the Associates with representation from Industry and Academia. Direct interaction for PRR Agendas Mobilizadoras and Horizon Projects projects with joint work with Academia, namely with INESC TEC, CPES in topics of flexibility and e-mobility. Proactive contact for outsourcing request for CoLAB projects to academic partners.
Fulfilment of INESC TEC's strategic objectives related to this participation	The main active streams in 2024 include PRR Agendas Mobilizadoras (Consortium ATE) and Horizon Europe Projects (Enershare), where INESC TEC and SEL collaborate on E-mobility, Flexibility, and Energy Management Systems.

Table 3.23 - CoLAB Vasco da Gama

CoLAB Vasco da Gama	
Name	Vasco da Gama CoLAB – Energy Storage - Associação
Description	Focused on high-tech services, value-added products, and innovative solutions in electrochemical energy storage, aiming to support the European energy transition with world-leading technologies
Areas of expertise	Electrochemical energy storage; Electronic energy conversion; Intelligent energy management
Year of establishment	2019
No. of Associates / Accession of new Associates in 2024	8 / 0
HR hired	10
Base funding planned	1 041 K€
Competitive funding – submitted and approved proposals	In 2024, VG CoLAB submitted 11 proposals for competitive funding, totalling 28.22 million euros, with its own budget of 7.62 million euros. Of these, five were rejected, one was approved and five remain under evaluation. VG CoLAB coordinated four of the proposals, covering programmes such as Horizon Europe, COMPETE2030 and NORTE2030. The projects submitted focus on energy storage technologies, battery innovation and intellectual property protection. The applications were distributed throughout the year, with four in the first quarter, two in the second and five in the third.
Main activities and achievements in 2024	In 2024, VG CoLAB advanced its role in energy storage innovation, focusing on battery modules, converters, and supercapacitors. Key developments included LFP and sodium-ion battery prototypes, as well as improvements in high-frequency transformers and distributed control converters. Strategic partnerships strengthened, with new memberships in IPCEI EuBatIn and BEPA. Despite funding challenges, multiple national and European proposals were submitted. Organizational growth saw expanded training, relocation to UPTEC, and governance improvements. Media recognition highlighted VG CoLAB's impact on Europe's battery sector.
Activities to foster Associates' involvement	Periodic bilateral meetings with associates / Regular scientific committees with associates / Invitation for European projects / Execution of ongoing development projects
Fulfilment of INESC TEC's strategic objectives related to this participation	INESC TEC's participation significantly contributed to achieving the institution's strategic objectives, evolving from previously discussed opportunities and shared interests into concrete achievements in 2024. Ongoing projects (i-STENTORE and the Mobilizing Agenda 'NGS-New Generation Storage'), the application submitted to LIGHTEN (HORIZON-CL5-2024-D2-02-03), and the preparation of several Horizon Europe applications for 2025 demonstrate the materialisation of the international collaboration strategy.

Table 3.24 - CoLAB Vines&Wines

CoLAB Vines&Wines	
Name	Vines&Wines - Vinha e Vinhos Portugueses, Competitividade e Sustentabilidade
Description	Mission: Develop and communicate knowledge and technology to support the wine sector's goal of a 25% export value growth in five years and to adapt the national wine system to major challenges, particularly climate change
Areas of expertise	Viticulture; Agronomy; Oenology; Product and service development
Year of establishment	2019
No. of Associates / Accession of new Associates in 2024	199 / 6
HR hired	43 (33 from Associates + 10 from staff)
Base funding planned	338.628,94 €
Competitive funding – submitted and approved proposals	7 proposals submitted 2 proposals approved
Main activities and achievements in 2024	<p>Establishment of WICA - Wine Innovation Collaboration Alliance, addressing challenges in grape and wine production through intersectoral innovation with auxiliary companies and Business Support Organizations (BSOs).</p> <p>Release of a technical-scientific catalogue to showcase the capabilities developed by the Research and Innovation system to address sector needs.</p> <p>Collaboration on the development of an automated platform to explore grapevine metabolic pathways (Project OmicBots) and new starter yeast cultures (Projects Grapemicrobiota and BUGS@VINE&WINE PT).</p> <p>Development of a network of low-cost sensors to evaluate hydric stress.</p> <p>Supplementation of viticultural, climatic, and biological data to enhance yield prediction models in the Wine4cast project.</p> <p>Creation of a Good Practices Manual for Managing Vegetative Propagation Material, focusing on phytosanitary threats and promoting the use of certified polyclonal materials for vineyard resilience.</p>
Activities to foster Associates' involvement	<p>Workshops, seminars and dissemination including technical bulletins.</p> <p>Technology/machinery demonstration sessions in the vineyard.</p> <p>Collaboration for partnerships in R&D projects and funding applications.</p> <p>Assistance/supervision in the development of Sustainability plans.</p>
Fulfilment of INESC TEC's strategic objectives related to this participation	ADVID remains a valuable partner as the participation in the CoLAB continues to allow to easily put in place the “innovation triangle” in the wine sector, consequently increasing the chances for collaborative R&I projects in the sector, with countless examples of fruitful collaboration.

Table 3.25 - CoLAB VORTEX

CoLAB VORTEX	
Name	Vortex – Associação para o Laboratório Colaborativo em Sistemas Ciber-Físicos e Ciber-Segurança
Description	Aims to be National leader and European reference in Cyber-Physical Systems, accelerating solutions and technology blocks to enable co-creation and technology transfer
Areas of expertise	Cybersecurity and Cyber-Physical Systems
Year of establishment	2019
No. of Associates / Accession of new Associates in 2024	5 / -
HR hired	PhDs: 4 MSc: 6 (Total 10 new hired in 2024) Overall hired: 42
Base funding planned	764K€
Competitive funding – submitted and approved proposals	16 proposals submitted and 3 accepted
Main activities and achievements in 2024	<p>Research activity and scientific results: VORTEX-CoLab has developed key technological components to enhance the safety and security of embedded systems, addressing critical market challenges.</p> <p>Establishing a Robust Foundation: Substantial growth in the team and project portfolio highlighted areas for operational improvement, particularly in team structure and processes.</p> <p>Achieving Financial Sustainability: VORTEX continued to leverage base funding and competitive grants to strengthen expertise and accelerate technology development. However, achieving financial sustainability solely through competitive funding and commercial activity remains a challenge.</p> <p>Dissemination, Knowledge Transfer, and Outreach: The team published 8 papers, established 12 collaborations with industry and academia, and gave 14 presentations at key events, reinforcing its position as a leader in innovation excellence.</p>
Activities to foster Associates' involvement	Partners participate in advisory and supervisory activities and proposals for competitive funding are done in collaboration with partners.
Fulfilment of INESC TEC's strategic objectives related to this participation	The vision for VORTEX is one where Capgemini identifies new market opportunities at the international level, where expertise and knowledge available in academic partners is a crucial enabler. Capgemini's activity in the automotive market holds a potential for technology transfer in High-Assurance Software. In 2024 this had materialised in a joint EU proposal where CapGemini and INESC TEC join efforts to pursue R&D in the postquantum cryptography migration.

3.12 Activities within the Scope of INESC TEC's Recognition as a Technology and Innovation Centre (CTI)

Presentation

INESC TEC's recognition as a Technology and Innovation Centre (CTI) by the Portuguese Government was renewed in 2023. As a CTI, the institution reinforces its science-based innovation model, translating impactful research into relevant technologies and services aligned with the needs of competitive clusters and national companies. The CTI framework also ensures alignment with national and regional innovation priorities and industrial policies.

INESC TEC's mission as a CTI includes providing technical and technological support to companies, with a particular focus on promoting technology and innovation as drivers of competitiveness, value creation, and supply chain qualification, especially among small and medium-sized enterprises (SMEs).

The key objectives of INESC TEC's activities as a CTI include:

- Provide technical and technological support to companies, through the development of R&D and innovation activities, training and capacity building, increasingly fostering the circulation of knowledge between the national innovation system and the creation of more value in the business community;
- Development and scale-up of digital technologies that contribute to a sustainable and circular economy, while ensuring cybersecurity and the robust and safe use of artificial intelligence technologies;
- Participate in major international discussion forums to expand the CTI's network of strategic partnerships and the potential for Portuguese companies to interact and export with other international players and markets, and to position in international value chains;
- Contribute to the development of public policies for business or industrial development and their implementation, in close coordination with public and government institutions at regional, national and European level;
- Support the implementation of knowledge and intellectual property valorisation strategy by the TTO, through the internal knowledge management service and provide funds to protect new intellectual property, owned or co-owned by INESC TEC;
- Promoting the development or improvement of products, services and processes, supported by high-end research and technological laboratorial infrastructures;
- Strengthening the role of people in organisations, encouraging the hiring of highly qualified human resources and the training and qualification of existing profiles.

Highlights in 2024

Key developments in 2024 under INESC TEC's CTI recognition include:

- **Engagement with Industry:** INESC TEC's R&D activities, through competitive projects and direct contracts, involved more than 68 SMEs and 128 large enterprises.
- **Outreach and Dissemination:** Over 380 bilateral meetings with national and international companies were held. More than 14 sector-focused events were organised in collaboration with national clusters and CoLABs, including the Energy Technology Open Day (energy), the WAVES Workshop (marine technologies), and participation in international forums such as ENLIT and the ADRA Forum 2024.
- **Technology Valorisation and IP:** The TTO consolidated its capacity to monitor and protect R&D results, with 44 new disclosures mapped for potential IP protection. This included strategic dual licensing approaches for open-source software. Three licensing contracts were signed in the domains of energy, the sea, and health.

- **Talent Development:** Efforts to strengthen internal capacity included implementation of a career progression model, funding for tuition fees for researchers, and a system to publicise recruitment opportunities. A total of 9,051 hours of training were delivered to 494 participants, covering both technical and soft skills.
- **European Engagement:** INESC TEC reinforced its contribution to the European R&I agenda and its role in supporting national companies in international consortia. In 2024, 15 new European projects were launched, including two coordinated by INESC TEC.
- **Infrastructure and Testing:** Laboratory infrastructure was strengthened in robotics, autonomous systems, bioengineering, and advanced computing, enhancing testing and collaboration capacity, for example, through a new partnership in iiLAB with Critical Manufacturing.
- **Digital Transformation:** Key digitalisation initiatives included the integration of generative AI, launch of a new institutional website, formalisation of the Project Management Office (PMO), and implementation of a new ERP system for financial and HR processes.
- **Technology Development:** Highlights included the industrialisation of the RECreation and Predico renewable energy platforms, both subject to licensing agreements, as well as new developments in a digital product passport, AI solutions for post-stroke rehabilitation, and natural language processing tools. In cybersecurity, internal capabilities were strengthened and new services defined under the digital roadmap services for industry.

3.13 Environmental, Social and Governance

ESG Reporting: Sustainability values within the organisation mission and goals

The motivation for transparency aligns with the deferred obligation for ESG reporting on sustainability performance, following the simplified requirements and revised timeline of the Corporate Sustainability Reporting Directive (CSRD)². INESC TEC's commitment to sustainability - embedded in its values, mission, and goals - has guided this section of the activity report, which presents a growing summary of ESG initiatives, some launched in previous periods and reinforced during the 2024 implementation.

ESG Initiatives: Sustainability as three-fold responsible practices

Environmental pillar

INESC TEC implemented a range of measures aimed at decarbonising operations and reducing carbon footprint, in line with its commitment to a 30% reduction by 2030. Key actions during 2024 included:

Climate change

- Reduced electricity and gas consumption through replacement of equipment with energy-efficient alternatives, system maintenance, and optimised set points adapted to room conditions;
- Replaced over 30 lights with LED alternatives, integrated with PIR sensors;
- Fostered electric mobility (vehicle charging) among employees by providing information on charging moments when the CO₂ levels in electricity production are lower (including communication on the composition of electricity production), and means, contributing to the reduction of greenhouse gas emissions;
- Enhanced visibility on consumption and fostering the adoption of corrective set points according to weather conditions with the reformulation of HVAC control systems;

Water resources

- Installed sensors and timers to minimise water usage.

Circular economy

- Maintenance plans considering waste management;
- Increasing waste separation awareness with dedicated actions per building floor;
- Specific campaign on electronic waste;
- Advanced research efforts in circular economy, energy and green transition.

In a broader perspective, as an Official Nominator of the Earthshot Prize³, INESC TEC launched an internal call for innovative and sustainable solutions to save the planet, encouraging its research community to become ambassadors for planet-positive change.

Moreover, sustainability impacts are increasingly present across research and innovation projects at all 13 INESC TEC centres, spanning sectors such as energy, agrifood, industry, and marine. These efforts align with INESC TEC's strategic target of achieving two-thirds of project alignment with the SDGs and other major EU and international sustainability challenges, as well as the goal to increase the number of environment-related technologies by 30% by 2030

² https://ec.europa.eu/commission/presscorner/detail/en/qanda_25_615

³ <https://earthshotprize.org/>

Social pillar

INESC TEC has a multicultural (more than 30 nationalities), multi-institutional and multidisciplinary environment, which requires a set of concrete measures to foster everyone's inclusion and happiness at work. The people-centred initiatives reinforced during 2024 were:

Working conditions and cultural inclusion

- Collecting perceptions and understanding the needs of diverse people in terms of age, culture, nationality, ethnic origin, background, disability, sexual orientation, religion, etc., such as the Diversity & Inclusion (D&I) Survey;
- Maintaining the meditation room, introducing mindfulness at work and promoting mental health;
- Promoting well-being and work-life balance, and especially supporting parental or care responsibilities and flexibility for family duties, regardless of gender, job, position and status, and creating appropriate mechanisms to identify individual psychological issues and offer support to overcome them while implementing flexible work arrangements;
- Organising training sessions for intervention teams on self-protection measures;
- Providing fruit baskets in the workplace;
- Contributing to employees' healthy habits through the free "Multicare Vitality Programme" that included: "Stop Smoking" Programme; Nutritional Guidance; "Get in Shape" Programme; Psychology appointments; "Sleep Better" Programme; Stress and Anxiety Management Programme;
- Celebrating the Mental Health Day (October 10th) with activities: yoga, meditation, workshops (sleep importance, nutrition) and a book club on mental health theme, after the 18th January's "Laughter Yoga Workshop" success;
- Conducting a webinar focusing on Remote and Hybrid Work, as part of INESC TEC's partnership with the EU-OSHA European Campaign "Healthy Workplaces" 2023-2025: "Working Safely and Healthily in the Digital Age";
- Increasing communication and proximity between services and faculty, to reduce bureaucracy.

Equal treatment and equal opportunities

- Implementation of the "Gender Equality Plan" and promotion of initiatives such as "Women and Girls in Science";
- Guaranteeing gender pay equity in the performance appraisal exercise, reducing gender imbalances;
- Committing to interculturality to foster the inclusion of different cultural backgrounds, languages and religions;
- Hiring persons with disabilities, with concrete valorisation in the merit evaluation and ensure that individuals with disabilities or impairments are not prevented from accessing a place or a document or undertaking a task freely and independently by implementing universal accessibility;
- Survey to identify training needs, in order to prepare a 2025 advanced training plan;
- Launching a trainee programme to provide students with research team experience.

Economic and social rights

- Encouraged personal skill development and alignment between individual potential and organisational goals;
- Implemented salary increases at the start of the year, with special focus on lower income brackets to address inflation-related challenges;
- Promotion and support of specific training beyond the legal framework;
- Renegotiated healthcare coverage to include childbirth and expanded outpatient benefits.

Governance pillar

INESC TEC has consistently strengthened this pillar, including its leadership structure, ensuring transparency, accountability, and ethical conduct. Key 2024 actions included:

Corporate culture:

- Celebration of the National Sustainability Day (September 25th) with activities of dissemination among INESC TEC community promoting awareness, involvement and action towards a more sustainable future, and highlighting the importance of environmental, economic and social sustainability for the country and the world, marking the date of the United Nations' adoption of the Sustainable Development Goals (SDGs);
- Reinforced commitment, to sustainable transformation in the Strategic Plan 2023/2030, embracing the challenge of underpinning research on "the long-term preservation and improvement of social, economic, and environmental systems within the delicate balance of concurrent goals for each specific problem";
- Aligning R&I agendas with SDGs and engaging in national and international thematic associations, high-level networks and forums;
- Nurturing a science-policy interface, through open access research, and acting as consultation partners for policy and decision-makers, supported by the Foresight and Public Policy Office;
 - Focusing on critical cross-cutting themes in flagship initiatives along with nongovernmental organisations, public sector agencies and social enterprises, fostering Science for Social Good.

Protection of whistleblowers:

- Training on the General Corruption Prevention and Whistleblower Protection Regime.

Supplier relationship management

- Extending social responsibility practices to the supply chain, ensuring fair labour practices, particularly in cleaning and security services, promoting diversity and inclusion.

Harassment, corruption and bribery:

- Introduced a Code of Conduct for harassment prevention;
- Disseminated privacy-preserving computational solutions that comply with GDPR while enabling digital transformation;
- Compliance Programme for the Prevention of Corruption;
- Ensured research adhered to the Code of Ethics and promoted awareness of digital ethics (e.g., addressing algorithmic bias and responsible data interpretation).

Future Outlook:

Despite the updated ESG reporting phase (Omnibus⁴ implementation and standards simplification), INESC TEC remains committed to showcasing its ESG practices. These sections of the report will evolve into a comprehensive impact-performance framework, enabling not just transparency, but effective monitoring and cross-cutting sustainability management. The move toward full ESG reporting will highlight ongoing efforts and provide a structured foundation for tracking INESC TEC's contributions to a more sustainable planet.

⁴ https://ec.europa.eu/commission/presscorner/detail/en/qanda_25_615

4 INESC TEC Scientific Domains

As mentioned in Section 2, research at INESC TEC is centred around eight Scientific Domains – Artificial Intelligence (AI), Bioengineering (BIO), Communications (COM), Computer Science and Engineering (CSE), Power and Energy Systems (PES), Photonics (PHT), Robotics (ROB), Systems Engineering and Management (SEM). The next section presents those Scientific Domains and their objectives.

4.1 ARTIFICIAL INTELLIGENCE

Steering Committee: Andry Pinto, Alípio Jorge, Jaime Cardoso, João Gama, and Rita Ribeiro

Presentation of the Domain

Artificial Intelligence is a decades-old scientific domain which has recently boosted its importance and impact in science, the economy and society in general.

Stemming mostly from Computer Science, AI has strong influences from other scientific fields, namely mathematics, neuroscience, linguistics, psychology, philosophy, and physics. AI has made major advances since 2010, particularly in areas dominated by machine learning. The rise of deep learning and then generative AI revolutionised the interpretation and generation of speech, images and audio. Artificial Intelligence is already having a significant impact on every relevant sector and is also playing an increasingly important role in our everyday lives, from virtual assistants to online recommendation systems. The symbolic legacy of AI is very significant with roots in mathematical logic, linguistics, and psychology. Currently, neuro-symbolic approaches open avenues for explainability and transparency in AI systems.

Artificial Intelligence requires large volumes of quality data but simultaneously calls for a human-centric approach that guarantees trustworthiness, interpretability, safety and robustness.

The myriad of different interaction scenarios motivates research along many lines, such as human modelling (including the theory of mind), human-AI collaboration (including human oversight), interaction, usability and user experience, information visualization and visual analytics, explanations and verification of AI processes and results.

The power of current and future AI also requires the mitigation of AI risks and implications. AI solutions and deployment must be ethical by design, following European and International guidelines that defuse as much as possible any potential harm. From an algorithmic point of view, the current moment of AI is strongly influenced by the emergence of large models built using deep and reinforcement learning. These approaches are fundamentally statistical and extremely data-thirsty. While their stochastic nature dispenses human intervention and obliterates the knowledge engineering bottleneck, the need for labelled data is still demanding and costly. On the other hand, their statistical nature and complexity make them highly opaque and hard to scrutinise.

Research Challenges

A) Build highly valuable and reusable AI resources

- Algorithms are the central piece in AI development. We work on the combination and modification of classical and modern AI approaches in their symbolic and sub-symbolic flavours to answer every current AI challenge. We deal with different types of inputs and combine them in different regimes, from static to streaming;
- More than simply processing information, AI algorithms use and produce models that represent knowledge. Models are an increasingly important output. We produce reusable, expandable and refinable models. We develop live and responsive models such as digital twins;

- Models become complex and mutable. We work on the hard questions of how to continuously evaluate and manage them, using human centred and automated approaches. We develop AutoML approaches to automatically select and assess models and algorithms.
- Data is a highly valuable asset. We work on the transversal challenges of producing, collecting, curating, managing, disseminating, accessing and learning from data sources. We exploit data augmentation and artificial data to mitigate the lack of data in many scenarios;
- Intelligent systems require development and deployment pipelines that integrate AI and non AI components taking into account interaction with humans in challenging contexts. We work on the production of such pipelines as reusable assets.

B) Exploit models and algorithms for advanced tasks

- Foundation models (FM) can solve unseen problems. We study how to exploit FM, in a zero-shot or few-shot manner, with limited training, placed in AI pipelines, combined and stacked, used for obtaining representations with different levels of abstraction (probing), reused in completely new domains and queried using natural language (prompting).
- Exploiting models as complex entities, and almost natural phenomena, improving our understanding of the models and their algorithms leading to further developments.
- Symbolic algorithms and models, including network science approaches, do not compete with neural approaches for predictive ability, but can be used in specific cases, when there is little data, when there is external knowledge to convey and when communication with humans is important. We exploit neuro-symbolic approaches and the use of symbolic methods for more than optimising prediction error.

C) Produce AI models that humans can inspect, understand, learn with and contribute

- Human-AI interaction will become increasingly complex, requiring the combination of different specialities from computer science and human sciences. We work towards the development of effective collaboration between AI systems and humans which requires sophisticated modelling, trustworthiness and explainability.
- Enabling humans to inspect AI algorithms, pipelines and models is important for avoiding and correcting errors, increasing safety and trust. We work on the verification of systems and programs which is becoming more complex than with ordinary algorithms. We exploit visualisation.
- It is important to anticipate and mitigate the risks and the impact of AI systems in society and in individuals. We incorporate concerns of privacy, safety, freedom, employment and general wellbeing in every step of AI development and deployment.

D) Learn models and deploy AI Efficiently

- The data thirst of current AI solutions and the fact that data is more often than not an expensive asset motivates research in more data-economic approaches. We study new ways of exploiting and generating data as well as new algorithms that are able to propagate feedback from the environment as in reinforcement learning.
- New frameworks for machine learning can be based on alternative approaches. We work on photonics, combining the paradigms of extreme learning machines, reservoir computing and diffractive neural networks towards the deployment of all-optical AI processors and platforms, with advantages in processing speed, scalability, and energy efficiency.

E) Enhance perception in dynamic, noisy, and multi modal scenarios

- We work on the development of intelligent decision support systems combining audio-visual data understanding with any additional information available, coming from sensors or other external sources, to enhance the analysis and the decision process as well as the efficient handling of the large amounts of data produced.
- The enhancement of the analysis and the decision process, as well as the efficient handling of the large amounts of data produced, through the development of intelligent decision support systems that combine audio-visual data understanding with any additional information available, coming from sensors or other external sources.
- How to adapt the (deep) machine model's learning ability to the challenging conditions presented by audio-visual data focusing on: Compression and acceleration of Deep CV; Explainable and uncertainty aware deep learning architectures; Multimodal learning; Efficient annotation Learning; Open World Learning; Domain Adaptation; Domain knowledge and data integration.
- Bringing together the semantics of text, knowledge bases, ontologies, sound and images for multi-model Machine Learning and AI systems.

Featured Contributions in 2024

- The paper *More (Enough) Is Better: Towards Few-Shot Illegal Landfill Waste Segmentation*, by Moline et al., on the exploitation of AI tools to support the detection of illegal landfill waste was awarded **Outstanding Paper at PAIS**, the Prestigious Applications of Intelligent Systems track at ECAI, the European Conference on Artificial Intelligence.
- In the domain of health, the paper *Physio, an LLM-based Physiotherapy advisor* won the **Best Demo Paper Award** at ECIR 2024 (Core A).
- **Experimental demonstration of Hand Gesture Recognition enabled by a 6 GHz RIS prototype and Machine Learning** including the publication of a dataset for three different hand gestures. This work was awarded with the ANACOM-URSI Portugal award.
- The **Network of Excellence Humane-AI-Net** finished in August and enabled scientific links with European partners. LIAAD was involved in the macro-project "**Metrics for ethics**".
- The projects PT-Pump-UP, PTICOLA and StorySense produced several **NLP resources for European Portuguese**: such as the ACE 2005 in Portuguese dataset published at the Linguistic Data Consortium and the Lusa dataset (Text2Story Lusa: A Dataset for Narrative Analysis in European Portuguese News Articles at LREC 2024).
- **Graph mining**: (i) a novel approach for efficiently finding subgraph patterns in hypergraphs; (ii) a novel deep learning architecture designed for efficient representation learning on continuous-time dynamic graphs with low-latency inference requirements; (iii) two new efficient approaches (online and offline) for computing natural visibility graphs from times series.
- **Advanced Robotics and Artificial Intelligence for Industry**: A digital twin-based infrastructure has been successfully developed to support and monitor Advanced Robotic Systems, enabling real-time data integration and improved decision-making.
- The work "PIC-Score: Probabilistic Interpretable Comparison Score for Optimal Matching Confidence" received the **EAB Max Snijder Award 2024**.
- A collaboration of LIAAD and C-BER resulted in a patent application of a method for **supporting automatic labelling in medical images**.

- Computer aided detection of deep inferior epigastric perforators in computed tomography angiography scans, fully integrated in partner platform for medical daily-routine use.
- The work “Multimodal Learning-based Approach for Autonomous Landing of UAV” received the **Best Paper Award** in Applications of the IEEE/ASME International Conference on Mechatronic and Embedded Systems and Applications.
- The work “Evaluating the Impact of Pulse Oximetry Bias in Machine Learning under Counterfactual Thinking” received the **Best Student Paper Award** at the third workshop on Applications of Medical Artificial Intelligence (AMAI 2024).
- The work “An End-to-End Framework to Classify and Generate Privacy-Preserving Explanations in Pornography Detection” received the **Best Paper Award** at the 23rd International Conference of the Biometrics Special Interest Group.
- The work combining multi modal data using a deep learning for a precise 3D point cloud generation with texture information with a sub-centimetre accuracy for underwater inspection was published in the **Information Fusion**.
- The work in autonomous landing of UAVs in day/nighttime situations with centimetre precision resulted in a patent application for a **multimodal perception system**.

4.2 BIOENGINEERING

Steering Committee: Ana Maria Mendonça, Hélder Oliveira and João Paulo Cunha

Presentation of the Domain

The Bioengineering Scientific Domain of INESC TEC aims to promote scientific knowledge in bioengineering through fundamental and translational research, advanced training, and innovation. It focuses on several areas of R&D and is supported by a diverse staff of highly multidisciplinary researchers and students.

Bioengineering is a rapidly growing and evolving scientific domain at the intersection of engineering and the life sciences. It combines fundamental engineering principles, practices, and technologies in medicine, biology, and environmental and health sciences to provide practical solutions to problems in these fields. The domain includes (but is not limited to) the development of mathematical theories and models, physical, biological, and chemical principles, computational models and algorithms, and devices and systems for clinical, industrial, and educational applications.

With this vision, efforts are directed towards achieving the following objectives:

1. To generate interdisciplinary knowledge enabling innovation and technology transfer with economic impact;
2. To develop novel bioengineering methods and tools for the prevention, early detection, and diagnosis of diseases, ageing-related impairments, rehabilitation, occupational health and wellness, and environmental-biology interactions;
3. To advance the progress of cutting-edge innovations in engineering, medicine, biology, and other health and environmental sciences and then introduce them to the global market of the future; 4. To promote internal synergies and strategic partnerships involving different Centres of INESC TEC, clinical partners, research institutes, MedTech companies, and startups, and foster an extensive network of international cooperation with the best R&D Centres in the field.

Research Challenges

A) From Macro-to-Nano Scale Biosensing

Biosensing has been in a rapid evolution towards smaller and smaller scales, turning biosensing into a widespread commodity, many times connected to the internet by design and opening novel domains & opportunities to innovate in bioengineering.

The aim of this challenge is the design & development of novel biosensors (e.g. bio-electrochemical, optical and photonic micro & nano biosensors & actuators, etc.) to approach macro-to-nano life sciences environments such as wearables and snap-to-skin biosensing solutions for sports performance or the chronic disease management, implantable sensors and actuators/stimulators for adaptative modulation in neurological diseases (e.g. Parkinson's or epilepsy), cell & sub-cell activity (e.g. metabolome compounds specially their "carriers" extra-cellular vesicles) micro & nano sensing in different disease models (e.g. Alzheimer's) or environmental hazardous volatile components monitoring for protecting "connected" workers in their hostile work environments (e.g. firefighters, miners, etc.).

B) Novel Technologies for Personalised Health & Wellness

We are collecting increasing amounts of health data and gaining computing power, yet not fully leveraging it to deliver personalised solutions for today's health challenges like cardiovascular disease, diabetes, and Alzheimer's. Genomics is producing vast molecular data quickly and cost-effectively, opening new research paths while also creating challenges in data volume and analysis speed. To address this, we will use advanced genomic data science, including AI and machine learning, and develop new analytical strategies. Integrating omics data with wearable sensors, clinical records, and other sources will provide a comprehensive view of individuals' health, enabling insights into complex diseases and unmet clinical needs for patient benefit.

We aim to integrate data and knowledge through computational models and digital platforms, supporting personalised treatment strategies. This RC combines large-scale data (from patient records to genomics) with human-centred technology design to address health issues and support healthier, happier lives. INESC TEC's expertise—from Health Informatics and Computational Biology to Bionics and Wearable Technologies—will play a key role.

C) New Challenges in Medical Signal & Image Analysis

Based on two decades of R&D with worldwide recognition, we aim to approach new challenges in medical signal and image analysis, contributing with novel approaches the following sub-challenges:

- Cancer Image Analysis
- Cardiac Image and Signal Analysis
- Brain Imaging
- Eye Image Analysis
- Lung Image Analysis

D) BioRobotics & Human-Machine Symbiosis

Within the biorobotics challenge we aim at novel and innovative approaches:

- To develop surgery, molecular biology automation, and biological-inspired robots and exoskeletons,
- To fuse robots with humans “in-the-loop”, brain-computer interfaces (BCIs) and affective computing,
- In keeping biometrics algorithms computationally efficient and guaranteeing privacy, transparency and explainability,
- With generalisation capabilities to unseen or under-represented types of data, analyse attributes embedded in data assuring the veracity and detecting incorrect output predictions,
- To design and provide representations invariant to the domain of the sample making results more interpretable.

Featured Contributions in 2024

In 2024, SD BIO has published 23 international journal papers of which 19 (83%) in Q1 with several high-impact research results such as:

- **Breakthrough in bio-micro&nano-photonics:** we published a paper in the scientific publication “Nature Communications Engineering” and launched a patent – iLoF 2.0 - introducing a new method for extracting “bio-micro&nano-particles fingerprints” from laser backscattering photonic signals of bio-fluids (e.g. cell culture, plasma, CSF, etc.) with high sensitivity and robustness.
- **AI for gastrointestinal endoscopy:** in liaison with multiple international entities, we co-authored the first practical guide (in high-impact Gut Journal) to standardise annotation and reporting of endoscopic images, promoting research and accelerating the clinical translation of AI tools.
- **Interpretable machine learning system for colorectal cancer diagnosis:** Based on pathology slides imaging through a scalable AI combining mixed supervision, an efficient sampling strategy, and explainable predictions a ground-breaking method was published in the renowned journal Computers in Biology and Medicine that achieved high accuracy and robustness across multiple clinical datasets.
- Furthermore, our UPorto-CMU PhD student Tamás Karacsony won **IEEE AI Research Hub Prize @GITEX Global 2024** promoted by IEEE at the largest tech and startup exhibition in the world held in Dubai with his work on AI for neurology video processing.

4.3 COMMUNICATIONS

Steering Committee: Manuel Ricardo and Rui Campos

Presentation of the Domain

The Communications Scientific Domain is at the forefront of developing cutting-edge wireless communications technologies central to pioneering next-generation communication systems. INESC TEC aims to advance communications research across various sectors, including industry, energy, smart cities, mobility, health, the maritime domain, and agriculture. The research group focuses on developing advanced communications solutions that meet the evolving demands of these fields.

The forthcoming wave of mobile and wireless communications will revolutionise the landscape through ubiquitous multimodal sensing and localisation, service-oriented software architectures, the deployment of autonomous systems, including drones and high-altitude platforms, pervasive artificial intelligence, and the integration of edge and cloud computing. These technologies are key to facilitating on-demand virtual and physical networks, thus enabling a seamless, interconnected world.

The dual goals of addressing the need for bandwidth-intensive, latency-sensitive applications and bridging the connectivity gap for the unconnected, whether machines or humans, drive the scientific domain. The domain's primary challenge is the development of communications systems that are inherently context-aware and can be deployed on-demand in both terrestrial and non-terrestrial settings. This entails the development of systems capable of dynamically adjusting their operations to suit the communication context, considering aspects such as the physical environment, energy constraints, the entities involved in the communication process, and the specific requirements of the users or machines.

By focusing on these objectives, the domain aims to contribute significantly to the research and development landscape in wireless communications, pushing the boundaries of what is possible in communications technology. We anticipate that the work will profoundly influence the creation of innovative solutions essential for the progress of various verticals, guaranteeing that the upcoming generations of communication systems will be more adaptable, efficient, and able to satisfy the demands of our increasingly digital world.

Research Challenges

A) Autonomous Communications Systems

Next-generation communications systems must be fully autonomous, operating similarly to other self-managed systems such as autonomous vehicles. The ever-increasing complexity of technologies, the vast number of parameters requiring optimization, and the need for scalable, energy-efficient, and privacy-aware communications make the human-in-the-loop management unfeasible.

This challenge focuses on developing self-managing, self-controlling, and self-optimising networks through advanced optimization techniques and computational resources available at the cloud and edge. Our research aims to enable a secure, sustainable digital future by:

- **Developing adaptive networking infrastructures** using robotic platforms for flexible, on-demand coverage and capacity reinforcement.
- **Creating wireless network digital twins** to simulate and validate AI/ML-based communication algorithms efficiently, reducing the need for resource-intensive real-world testing.
- **Enhancing security mechanisms** across all network layers to ensure confidentiality, integrity, and availability in increasingly decentralised communication scenarios.
- **Developing AI-driven intrusion detection** for encrypted malicious traffic in zero-trust networks, using training data from both legitimate and malicious sources.
- **Integrating communications and power distribution** by leveraging distributed renewable energy sources and energy-aware networking.

- **Optimising baseband processing** through adaptive learning models, supporting multi-standard, multi-mode communications while considering interference, spectrum sharing, and hardware constraints.

By advancing these areas, we aim to build autonomous, intelligent, and resilient communication networks that meet the demands of future digital ecosystems.

B) Communications for Extreme Environments

Airborne, underwater, underground, space, and industrial communications present unique challenges due to harsh propagation conditions, inaccessible environments, and strict Quality of Service (QoS) requirements. Traditional wireless technologies are often inadequate, requiring new approaches to ensure reliable connectivity in these extreme settings.

This challenge focuses on developing advanced communication solutions for the ocean, industry, space, and disaster scenarios by:

- **Developing multi-tier communication architectures** that integrate space, air, underwater, and underground networks.
- **Investigating robotic-borne wireless networks** by using autonomous platforms (AUVs, ASVs, UAVs) to deploy mobile, adaptive networking infrastructures.
- **Creating digital twins** of extreme environments, including Network Digital Twins and multi-modal sensing aided human sensing and environment mapping, for efficient AI/ML algorithm validation, reducing reliance on costly real-world testing.
- **Enhancing underwater communications** through multimodal approaches that combine acoustics, optical, and radio technologies while adapting to environmental factors like salinity and noise.
- **Advancing industrial communication systems** with hybrid cabled-wireless solutions using multi-technology and multimodal approaches.
- **Applying geometric and probabilistic constellation shaping** for resilient and energy-efficient optical underwater communications.
- Developing free-space quantum communication solutions for ultra-secure wireless links.

By addressing these areas, we aim to enable robust, high-performance communication systems for extreme environments, supporting critical applications in defence, industry, and disaster response.

C) Integrated Sensing and Communications

Traditionally separate fields, communications and sensing are converging with advancements in millimetre-wave, sub-THz, and visible light wireless technologies. These high-frequency signals, with their line-of-sight characteristics, enable the integration of visual data for improved wireless channel prediction, high-definition 3D mapping, and enhanced positioning. Additionally, radio-based imaging and reconfigurable intelligent surfaces will strengthen computer vision applications, making them more resilient to occlusion and low-light conditions.

This challenge focuses on developing perceptive networks that integrate communication and environmental sensing by:

- **Designing scalable reconfigurable intelligent surfaces and signal processing algorithms** for large antenna arrays up to 170 GHz, enabling precise beamforming, and real-time digital control for sensing and localization.
- **Developing photonics-enabled communication and sensing devices** using radio-over-fibre and optical-wireless interfaces for RF sensing and high-frequency wireless communications.

- **Creating obstacle-aware robotic-borne networking solutions** that leverage computer vision and sensing for adaptive positioning of airborne infrastructure nodes, ensuring reliable line-of-sight communications in urban and indoor environments.

By integrating sensing into network design, we aim to advance mobile perceptive networks, achieving new capabilities for intelligent, adaptive, and context-aware wireless communication systems.

Featured Contributions in 2024

In 2024, the Communications Scientific Domain made significant advancements aligned with its three research challenges: Autonomous Communication Systems, Communications for Extreme Environments, and Integrated Sensing and Communications. The results demonstrate progress in autonomous network optimization, adaptive communications in extreme environments, and the convergence of sensing and communication technologies.

The major contributions include:

- **Development of a Reinforcement Learning (RL)-based UAV positioning approach**, optimising network performance by considering traffic and obstacles in urban environments – this work was published in the IEEE Access Journal;
- **Proposal of a sustainable multi-UAV placement algorithm for flying networks**, optimising flight trajectories to reduce energy consumption while maintaining performance – this research was published in the IEEE Access Journal and presented at IEEE WiMob 2024;
- **Design of a multimodal underwater wireless communications manager**, enhancing network performance in underwater environments – the results were presented at IEEE MELECON 2024;
- **Experimental demonstration of Hand Gesture Recognition using a 6 GHz Reconfigurable Intelligent Surface (RIS)** prototype and Machine Learning – the dataset covering three different hand gestures was published and the work received the ANACOM-URSI Portugal award.

4.4 COMPUTER SCIENCE AND ENGINEERING

Steering Committee: Ana Alonso, Ana Paiva, Hugo Paredes, João Canas Ferreira and Manuel Barbosa

Presentation of the Domain

The field of computer science and engineering is facing significant scientific and technological challenges, especially in the wake of the ongoing digital transformation, bringing about new and often unforeseen challenges that defy our knowledge and best practices.

These challenges arise from the complexity and scalability of computer and software systems, and the ever-increasing demand for their performance, interoperability, security, privacy, dependability, and sustainability.

Widespread use of digital sensing and instrumentation technologies, coupled with computing power enables us to effectively and efficiently collect, filter, curate, store, process, visualise and analyse the massive volumes of data generated.

We rely on these systems being trustworthy, fast, always available, and ethically responsible, making software development, verification, and testing have become crucial aspects in the critical path of any digital system.

As the computing pipeline is becoming more complex, research on computing architectures and non-functional aspects of software is essential for achieving the scalability, interoperability, and efficiency required for sustainable digital systems.

Research Challenges

A) Advancing the Software Development Ecosystem

Software systems are becoming increasingly complex, with unprecedented scale, integrity requirements and shorter time-to-market. In addition, they are increasingly developed in volatile, uncertain, complex, and ambiguous conditions. It is essential to create new methods, techniques and tools to advance the software development ecosystem, including processes, development tools, and education. This is to be achieved as follows:

- Design tools and techniques to improve developer-tool interaction in next-generation environments.
- Create new approaches to enhance the developer experience, providing quicker, better, and more informative feedback on software quality aspects, easy integration with traditional tools, and suggestions for improvement.
- Develop techniques to support software maintenance, including automatically generating test cases for novel system parts and calculating impacted test cases based on traceability information.
- Improve software engineering education with didactic approaches and learning tools covering all software development phases.
- Empower people with simpler approaches and tools to design and build applications for personal and professional needs.

B) Ensuring Software Correctness

Functional correctness is one of the key aspects of software quality: ensuring that software is free of defects and does precisely what is supposed to do, and no more (avoiding potential liability gaps). Our goal is to devise new methods and tools to ensure correctness in increasingly complex software systems, namely large-scale concurrent and distributed systems and cyber-physical systems that operate in uncertain and hostile environments, and emerging computing paradigms, particularly quantum computing. This is to be achieved as follows:

- Design scalable, rigorous methods, calculi, and logic to ensure program correctness throughout software development.
- Improve structured requirements specification languages to reduce ambiguity and automate software development, including repairing incorrect programs and generating invariants for verification.
- Design techniques and tools to enhance software testing in challenging environments, such as distributed or AI/ML systems, and leverage HPC.
- Contribute to innovative concurrent programming languages, APIs, and compilers for parallel and distributed computing, raising abstraction levels.
- Improve formal design techniques and tools for scalability and usability, enabling direct verification of complex protocols by domain experts.
- Integrate rigorous formal analysis and user-centred design practices for formally proving requirements and evaluating prototypes.
- Create foundations for emerging computing paradigms, including quantum computing, quantum software engineering, post-quantum secure systems, and cyber-physical systems.

C) Managing the Increasing Complexity of Critical Information Systems

Information production and consumption profoundly impact society, both personally and professionally. Two key challenges arise from information abundance: managing complexity and ensuring information quality and relevance.

Managing complexity involves managing the underlying infrastructure supporting information, such as storage, processing, and distribution. Ensuring these systems handle large volumes efficiently is crucial.

At the infrastructure level, size, diversity of software and services, multiple data sources, and compliance with laws and regulations contribute to complexity. Non-functional system characteristics, such as scalability, performance, interoperability, dependability, security, energy efficiency, information quality, quantity, and confidentiality, play a crucial role in ensuring trustworthiness and sustainability.

Accessing and managing information quality and relevance is another challenge. Finding specific data or content maximises productivity, while ensuring high-quality and relevant information is especially difficult in the era of fake news and misinformation.

Providing the best balance for each application or service requires a deep understanding of variables and composable multidisciplinary approaches. We envision the continued need to focus on improving:

The non-functional aspects of data management systems and infrastructures on:

- Heterogeneous data management and cross-sector applications on public and private infrastructures, such as cloud computing and HPC centres, while realising their interoperability and enabling control of the information life cycle.
- Data management systems underpinning data-centric and privacy-preserving applications such as machine learning, analytical, and database frameworks.
- Systems of the Edge-to-Cloud continuum and cyber-physical systems as these systems evolve towards distributed and virtualised architectures.
- Standard cluster management and task scheduling tools to prioritise energy efficiency in Cloud and HPC centres.

Information management through:

- Representation models, information governance frameworks and policies, until the level of global communities.

- Information life-cycle control in organizations by enhancing the authenticity and traceability of data provenance.
- Tools to support the different stages in the data management process, along with interoperability protocols.

Access to information through:

- Studies of users' information needs and their interactions with information systems, by contributing to relevance estimation algorithms, ranking algorithms, and the development of novel mechanisms for human information interaction.
- Increasing the efficiency and effectiveness of visual analysis and exploratory visualisation of complex and multidimensional information.
- Ameliorate the communication of complex narratives, through information extraction and representation techniques, and interactive visual storytelling models.

D) Designing and Deploying Heterogeneous Computing Architectures

Processor architectures shifted from single-core to multi- and many-core, including heterogeneous accelerators like ASICs and FPGAs. Flexibility shifted from software to hardware. However, new applications on the edge and IoT, including AI and ML, require stricter time constraints and power efficiency.

As performance requirements increase, heterogeneous systems offer a way to achieve it while minimising power consumption and cost. They allow hardware to be tailored to specific applications, meeting their demands and enabling software to effectively utilise it.

Designing these novel computing systems involves considering the holistic vertical continuum of hardware and software. Challenges include increased complexity, high-performance requirements on autonomous systems, dependability, and cybersecurity, spanning from digital components to instruction sets, compilers, languages, and APIs.

Within this hardware-software continuum, we focus on:

- Developing bio-inspired mixed-signal microelectronic circuits to improve power and area efficiency through event-driven computational architectures.
- Designing heterogeneous hardware platforms: methods and tools for design space exploration of accelerators, to optimise performance, power consumption, and area.
- Integrating CPUs with application-specific accelerators: this involves addressing challenges in interface design, memory hierarchy, coherence and consistency, programming model, and performance optimization.
- Devising novel compilation techniques to decrease the effort of scheduling and mapping computations to heterogeneous targets.
- Improving performance and predictability of computing systems, by appropriate management of HW and SW resources and components, including models for prediction of performance and energy efficiency of a heterogeneous application at design time.

E) Improving Computational Systems for a better Human-Technology Symbiosis

Humans and machines increasingly collaborate by sharing information, goals, and tasks, empowering and complementing each other.

Digital environments, combining immersion, collaboration, interaction, and narrative, provide rich and engaging experiences for users in learning, entertainment, workplaces, and industry.

The goal is to improve human-machine relationships by combining data, operations, processes, and awareness. It is focused on:

- Empowering humans with contextual awareness in increasingly complex extended reality systems, for areas such as education & training, information analysis, exploratory visual analysis, and decision-making processes.
- Integrating effective user-centred and co-creation design practices in computational systems and tools, to increase their effectiveness, adoption, and impact.
- Empowering domain and human-factors experts in the use of state-of-the-art model-based tools for automated verification, in particular in the context of safety-critical system, enabling them to model systems, define safety requirements, perform analysis and interpret the results.
- Empowering non-technical people in authoring activities, incorporating new interaction paradigms, supported by extended reality, natural user interfaces, new AI tools, and multimodal systems, enabling them to design and build personalised solutions.
- Leveraging multisensory stimulation and haptics to attain perceptually equivalent scenarios for extended reality systems.
- Reinventing symbiotic processes for learning, work, and well-being in digital environments, including serious games, gamification, and extended reality, optimising user experience.

Featured Contributions in 2024

Advancing the Software Development Ecosystem

Software engineering researchers contributed to various projects, including the Inno4Vac (IMI2/EU). Their key contribution focused on the design and implementation of novel architectures using federated repositories and privacy-preserving mechanisms to support federated machine learning. They also played a key role in organising major conferences like the top-ranked conference on the topic, the 46th International Conference on Software Engineering (ICSE'24), and others such as EuroPLoP'24, XP'25, and QUATIC'24. Research work on emerging topics, such as Live Refactoring and Developer Experience, led to two PhD thesis submissions, with another expected in 2025.

Ensuring Software Correctness

Contributions regarding Key Encapsulation Mechanisms and their correction resulted in publications at CRYPTO and the IACR Communications in Cryptology. A key contribution, published in the Quantum Journal, evaluates the ability to execute any Boolean function on quantum computers designed according to a measurement-based quantum computation model.

Managing the Increasing Complexity of Critical Information Systems

The key contribution on the dependability of data management resulted in a publication that presents LazyFS, a tool that simplifies the injection of database faults to reproduce data loss bugs, in VLDB, a top database conference. Minimum viable data spaces are being deployed as testbeds for several research initiatives, including PRR projects NewSpace and HfPT; and Horizon Europe project NOUS. Major research gaps are being addressed by the research teams and should constitute major research contribution in the upcoming years. A survey on the current state of the art in edge databases, discussing topics such as the hardware, latency performance, energy consumption, and privacy was published in ACM Computing Surveys. HPC European projects kicked-off: HANAMI, to bring Europe and Japan closer together in supercomputing, and EPICURE, to support users of the supercomputers of the EuroHPC JU network. Collaboration on edge-cloud computing and AI with the CENTRA network continued. A publication in IEEE Communications Surveys & Tutorials, a top-tier journal with an impact factor of 34, addresses the critical need for robust security in the rapidly expanding IoT ecosystem. Alexandra Mendes won the Atlantic Security Award, aiming to use an LLM trained on Dark Web data to design defence policies and strategies.

Designing and Deploying Heterogeneous Computing Architectures

Contributions on state-of-the-art compilation technology and RISC-V processor include an innovative compilation approach capable of targeting arbitrary languages, based on a given grammar, used to generate MLIR code that supports an in-house dialect for streaming computation.

Regarding memory-safety guarantees in C, at compilation time, cases of dangling pointers can now be detected, and we are working towards supporting idiomatic C constructs.

Advances in adapting C/C++ code to improve hardware synthesizability enabled the compilation of a version of llama2 to hardware that can send the predicted words to an output stream without halting the hardware kernel after our automatic transformations.

Improving Computational Systems for a better Human-Technology Symbiosis

Researchers enhanced the understanding of sensory integration in virtual reality and its impact on emotional engagement, providing valuable insights that can be utilised to develop more emotionally resonant and compelling virtual reality experiences.

4.5 POWER AND ENERGY SYSTEMS

Steering Committee: Clara Gouveia, João Abel Peças Lopes and Ricardo Bessa

Presentation of the Domain

The Power and Energy Systems Scientific Domain envisions supporting society's full and enduring decarbonisation by adopting a multidisciplinary strategy that acts on the whole energy value chain by planning and operating it across multiple energy carriers, infrastructures, and users in an integrated, interconnected, and digitalised energy ecosystem. This will be anchored on combining model-based and data-driven methods for modelling, optimising, and controlling energy systems while proposing novel policy and regulatory solutions. Research outcomes include concepts, models, methodologies, and tools helpful in addressing the decision problems of citizens, communities, multi-utilities, system operators, regulators, policymakers, and government bodies, divided into four research lines:

- Cost-effective decarbonisation and digitalisation of energy systems.
- Evolving and de-centralising energy-driven business models and markets.
- Resilience and reliability of energy systems.
- Smart control architectures and centres of the future.

A laboratory infrastructure for smart grids and electric vehicles enhances the research and innovation capabilities of the group by providing technological support for the development and validation of theoretical concepts.

Research Challenges

A) Cost-effective decarbonization and digitalization of energy systems

An efficient and sustainable energy system is crucial for global climate targets and a sustainable future as they provide critical services like electricity, heating/cooling, and transportation. Renewable energy systems can generate carbon-free hydrogen and ammonia are critical to decarbonise other economy sectors such as mobility (e.g. H₂ utilization in fuel cells) and industry (e.g. NH₃ utilization in chemical industry).

Digital technologies should be integrated in energy systems operation and planning to further increase the integration of clean energy sources, towards 100% renewable energy-based systems. This will support the development of new mathematical models for emerging technologies like electrolysers and thermal storage, novel methods to optimise the integrated management of multiple energy networks and vectors.

The main goal regards the development of new models, methods and tools to:

1. Optimise the operation of electrolysers to maximise the use of renewables and provide system services.
2. Develop advanced control solutions to manage natural gas networks when incorporating renewable gases (biogas and H₂).
3. Enable the implementation of P2P solutions associated with seasonal energy storage to guarantee security of supply.
4. Improve the integrated management and control of multiple energy networks, considering high shares of renewable electricity and gas production (in electricity and gas networks, respectively).
5. Aggregate multi-vector resources' flexibility for optimal participation in electricity, gas and carbon markets.
6. Design and operate 100% renewable systems for green hydrogen and ammonia production.

7. Implement reference architectures to facilitate secure data sharing in the energy sector – energy data spaces.
8. Design and develop interoperability frameworks that rely on open standards to ensure the compatibility of equipment and systems, while safeguarding the privacy and cybersecurity of users.

B) Evolving and de-centralising energy-driven business models and markets

Electricity markets have proven to be effective tools to improve the efficiency in the production and pricing of electricity commodities such as energy, flexibility and capacity, while providing appropriate economic signals to consumers and producers to induce them to adapt their short- and long-term behaviours to existing and expected demand and supply. As we face a shift towards distributed and decentralised energy systems, new technical and market challenges arise, namely:

1. Redesign and regulate wholesale electricity markets to integrate new resources and market players and assess their impact.
2. Develop and regulate new business models and local markets for collective self-consumption and energy communities, seamlessly integrated into existing wholesale markets and capable of fostering decentralised electricity trading and local renewable generation to empower end-customers in the energy system.
3. Unlock existing distributed flexibility to contribute to a better operation of the electricity system through more flexible and near real-time resource management systems and markets.

C) Resilience and reliability of energy systems

Transitioning from fossil fuels to sustainable energy sources under climate change can create vulnerabilities to severe weather events, resulting in energy shortages and damage to existing infrastructure. Conversely, digitalization of power systems presents new opportunities to enhance system reliability and resilience by developing planning and operation plans based on forecasts, real-time monitoring and control, and predictive maintenance strategies. By leveraging all these opportunities, power systems can become more efficient, reliable, and resilient, ensuring a stable and sustainable supply of electricity for consumers.

The envisioned research challenges are:

1. Develop models and tools for the assessment of the long-term adequacy of interconnected systems under climate change and extreme weather affecting bulk energy consumption.
2. Develop methodologies for establishing reliable and resilient expansion plans for coupled energy networks (electricity and gas) in converter-dominated systems.
3. Analyse the ability of the existing flexibilities in local energy grids for improving the continuity of supply during contingency events.
4. Leverage data-driven models to monitor the asset condition and to define optimal maintenance plans.

D) Smart control architectures and centres of the future

Electrical networks are under transformation as the ongoing decarbonization and digitalization introduces new assets and system devices (e.g., PMUs, IEDs). These changes directly impact the control centres and architectures of power systems with the need for higher interaction with neighbouring transmission, integration of weather-based energy resources, new market products, active distribution networks, microgrids, wider availability of data. Supervision systems in control rooms have grown unreasonably to remain cognitively manageable and redesign of human machine interactions becomes necessary. The envisioned research challenges are:

1. Promote coordinated operation between electricity markets, TSO and DSO, within an increasingly complex network and market operation context.

2. Assist human operators via a proactive collaboration in robustly operating the flows over a power grid, avoiding blackouts because of overloads, while minimising energy losses, as well as operator's cognitive load.
3. Structure the decision-making process, and design it explicitly for making decisions over tasks and not for monitoring (i.e., to avoid operating systems with information overload).
4. Let human operators become “navigators”, defining forecasted trajectories over time and choosing options ahead of time rather than reacting in real-time.
5. Distributed and decentralised protection, automation and control, benefiting from virtualization and distributed computation at the edge.

Featured Contributions in 2024

Cost-effective decarbonisation and digitalization of energy systems

Main contributions are focused on Power-to-Hydrogen Systems (P2H), with the development of an optimization-based approach for Virtual Power Plant (VPP) dispatch integrated with full AC Optimal Power Flow (OPF), optimising green hydrogen use across CHP, industry, and local consumers, reducing electricity costs, boosting self-sufficiency, and enhancing renewable integration (Published in Int. J. of Hydrogen Energy).

For the design of 100% RES, a day-ahead optimisation algorithm for a hybrid RES system producing green hydrogen and ammonia, was developed to maximise profit in day-ahead spot and reserve markets (Published in EEM 2024 Conference). Optimization-based methods were also developed for offshore hybrid power plants' optimal sizing and energy management, integrating uncertainty and multiple conflicting objectives to maximise energy delivery and reduce power fluctuations (Published in J. of Cleaner Prod. and App. Energy).

Evolving and de-centralising energy-driven business models and markets

Considering the development of effective business models for local markets, a novel mathematical model for a local energy community (LEC) that considers three economic approaches to redistributing collective benefits and assets sharing, enhancing fairness and equity was developed (Published in IEEE Trans. on Smart Grid).

Regarding distributed flexibility for the operation of active distribution networks (ADNs), a two-step optimisation model capturing the P/Q flexibility area while considering grid technical constraints (Published in IET Ren. Power Generation).

Resilience and reliability of energy systems

Local energy islands are relevant case studies to the development of effective control strategies that will ensure the stability of future converter dominated power systems. A comprehensive assessment of large-scale hydropower deployment for frequency regulation services demonstrated the potential of hydropower inertia and variable speed technology to enhance frequency stability. Published in Int. J. of Elect. Power & Ener. Systems.

An inflow forecasting tool was deployed operating in real-time with weather data. A predictive dispatch tool integrating inflow forecasting tool for Madeira Island's hydro cascade system with pumping was also developed, considering hybrid energy storage systems (Published in the 2024 IEEE PEDG Symposium).

Smart control architectures and centres of the future

The increased complexity of future power systems requires new methodologies for network modelling, decision-making in operation, protection and automation. Automation algorithms for adaptive protection strategies in distribution networks with high distributed generation integration were developed, leveraging clustering algorithms to predefine adjustment groups (Published in PACWC 2024, CIGRE Session 2024, and MEDPOWER 2024) Research is supported by System-in-the-loop test system, supported by real-time digital simulation of distribution networks.

A perspective paper on foundation models for electrical grids was published in Joule through an EU-US international working group. Also, in AI, the novel evolving symbolic model concept was applied to real-time control of hybrid storage and dynamic security assessment, leading to a patent submission. Published in J. of Mod. Power Sys. and Clean Energy.

4.6 PHOTONICS

Steering Committee: Diana Viegas, Nuno Silva and Pedro Jorge

Presentation of the Domain

The Photonics Scientific Domain explores optical phenomena as a unique toolbox for cutting-edge science and technology, exploiting symbiotic S&T for a sustainable research model. Fundamental research, on the one hand, gives rise to novel sensing systems and inventive technology. On the other hand, using emerging technology to enable innovation in real-world applications, materialising the impact of science, and diversifying funding opportunities. This generic vision has materialised in the three major research vectors:

1. Development of sensors for chemical sensing and industrial applications: developing photon-based transducer mechanisms and signal processing techniques to enable label-free, reagent-less, and robust performance.
2. Photonic sensing for extreme environments: designing light-based sensors for operation in harsh environments, from mining operations to space and the deep sea.
3. Optical systems and devices for ultra-fast processing and quantum technologies: harnessing nonlinear optical systems to build analogue quantum simulators and computing platforms.

Adding to S&T, the domain is also committed to the development and training of a new generation of highly specialised researchers with a unique set of competencies and critical knowledge to foster a national research and industrial ecosystem emerging around photonics.

Research Challenges

A) Photonic-based platforms for environmental monitoring, medical diagnostic and industrial applications

This challenge addresses the development of photonic based diagnostic systems, using label free and reagent fewer sensing technologies, aiming for miniaturization, handling simplicity, speed of operation and long-term stability.

- Fabrication of optical devices based on advanced micro and nano technologies combined with microfluidic channels for high precision detection.
- Development of ultra high-sensitive spectral sensors functionalised with specific chemical and biological receptors for monitoring gaseous and liquid environments.
- Implementation of fully automated systems with development of dedicated optoelectronic interrogation devices and user interfaces in industrial applications for real time monitoring.

B) Photonic sensing for extreme environments

Real-time monitoring of large structures and environmental systems has become increasingly crucial due to the growth of human activities and the resulting environmental changes. Optical fibres, originally designed for communication purposes, can be installed in extreme environments, both on land and sea, making them a viable and sustainable solution to monitor external changes.

To address these challenges, new technologies utilising distributed measurement techniques and linear or non-linear effects have been developed, which enable the measurement of various parameters such as temperature, deformation, pressure, vibration, or acoustics. Furthermore, the new generation of techniques must allow for the remote transmission of measurement data over long distances, up to 100 km, using all-optical amplifiers with low noise.

The development of high-performance optical tools and techniques can significantly increase the safety, efficiency, and sustainability of operations in extreme environments, including space and deep sea. It will also enable early detection of any potential problems, allowing for timely corrective actions to be taken.

This can ultimately lead to cost savings, reduced downtime, and increased operational life of structures or systems.

C) Optical systems and devices for analogue quantum simulations

This research challenge explores the use of light as a multipurpose channel to encode, transmit and process information, leveraging on interference and nonlinear effects as processing elements. For the medium term, we envision a path in two distinct directions, intertwined in the competencies (e.g. wavefront shaping, high-performance computing and data analysis) and subjects (free space and nonlinear optics):

- Towards a top of the class analogue simulator of quantum fluids
 - Improving the versatility and circumventing the limitations (effective simulation time) of current setups.
- Towards a transparent framework to bridge optical computing and the end user
 - Explore neuromorphic paradigms easier to implement in the optical domain (e.g. Extreme learning machines, Reservoir Computing and Diffractive neural networks) to deploy a transparent and accessible platform for the end-user.

Featured Contributions in 2024

In 2024, the Photonics Domain made significant advancements aligned with its three research challenges: Photonic-based platforms for environmental monitoring, medical diagnostics, and industrial applications; Photonic sensing for extreme environments; and Optical systems and devices for analogue quantum simulations. These achievements have driven the development of robust industrial solutions, high-performance sensors for extreme environments, and unique quantum simulation capabilities.

In the field of **photonic solutions for industry**, a recently patented **Spectral Knowledge Distillation** method has enabled efficient knowledge transfer between spectral systems and automated training processes. This innovation is improving robustness in real scenarios, driving breakthroughs in industry-related applications, including **new tools for online process control of coatings in cork stoppers** and **real-time detection of critical contaminants in glass and wood recycling industries**.

A **world-unique versatile platform for analogue simulation of quantum fluids** was successfully implemented in our labs, featuring optical reinjection capabilities. This advancement significantly enhances operational performance and expands the potential for **topological matter studies** at the highest international level.

Leveraging our expertise in **interferometric systems**, we fabricated a **microcavity using direct laser writing techniques** in a glass material with zero thermal expansion. When integrated into a **white light interferometric setup**, this system achieved **temperature stability of 1 millikelvin (mK)**. Such ultra-high precision is particularly relevant for **space applications**, where maintaining stable thermal conditions is crucial for advanced scientific instruments. In extreme space environments, even minimal temperature fluctuations can impact **quantum experiments, high-sensitivity optical metrology, and the thermal management of satellite components**. This breakthrough positions our technology as a key enabler for next-generation spaceborne sensing and quantum applications.

4.7 ROBOTICS

Steering Committee: António Paulo Moreira, Bruno Ferreira and Eduardo Silva

Presentation of the Domain

The Robotics Scientific Domain is at the forefront of developing real multi-domain robotics. It combines intelligence, autonomy, and usefulness seamlessly across various uses on land, in the air, on the water, and underwater.

The focus on advancing autonomy is central, specifically empowering robots to operate effectively in complex and dynamic environments across multiple domains. This involves creating and maintaining intricate environmental maps, reacting swiftly to unforeseen events, and enabling unattended operations over extended periods.

The increasing interaction between people and robots is equally significant in all areas. INESC TEC's robotics research seeks to transform programming and communication interfaces, enhancing the simplicity and availability of assigning tasks to robots for operators from diverse backgrounds, regardless of the operational domain.

In each target domain, researchers at INESC TEC investigate new types of robotic action that go beyond conventional limitations. By doing so, they introduce innovative solutions tailored to the unique challenges of ground, air, water, and undersea applications. This interrelated investigation pushes the limits of conventional applications in each discipline and broadens the scope of what robotics is capable of.

Research Challenges

A) Increase the autonomy of robotic systems

Robotic systems operating in complex, dynamic, and long-term environments require greater autonomy, achievable by addressing all stages of the sense-perceive-plan-act cycle. Key challenges to enhance autonomy include:

- Improving positioning in GNSS-denied environments using novel landmarks and algorithms.
- Developing navigation methods that enable seamless switching between global and local localization.
- Creating robust distributed SLAM strategies that handle communication delays and failures.
- Planning trajectories for active perception and adaptive sampling in single or multi-robot setups.
- Designing fast optimisation and task allocation algorithms for real-time, dynamic scenarios.
- Proposing scalable mapping strategies for extended missions and environments, with single or multi-robot teams.
- Equipping robots with failsafe and degraded mode operation capabilities for subsystem failures.

B) Improve manipulation and other physical interaction capabilities

We aim to advance robotic manipulation and physical interaction with the environment across three key areas: final relative positioning (e.g., docking), manipulation of flexible objects, and mobile manipulators.

For positioning, challenges include: trajectory planning that ensures target observability and respects pose/DoF constraints and actuator control under dynamic physical constraints.

For flexible object manipulation challenges are: perception – new models/algorithms for shape variability; grasping – integrating deformation models into planning and control; and assembly – path planning that avoids entanglements via deformation modelling.

For mobile manipulators challenges are: coordinated base and end-effector control; systems to reject terrain disturbances; and control of actuators on floating/underwater platforms.

C) Enhance human-robot collaboration

Recent advancements enable autonomous robotic tasks, but human involvement introduces unpredictability due to factors like mental models, emotions, and perception. This challenge focuses on developing algorithms and tools for dynamic, collaborative human-robot interaction.

Key topics include: real-time human action and posture recognition to enhance safe, natural collaboration; methods for transparent, explainable robot behaviour using technologies like AR/VR and advanced human-computer interfaces; and algorithms that integrate human knowledge and skills through high-level programming, teleoperation, and shared control.

D) Design sustainable robotic systems

This challenge focuses on designing advanced robotic systems that overcome the limits of standard platforms. Sustainable development of robots capable of deeper operation, diverse tasks, or large-scale deployment relies on three key areas:

Modular and reconfigurable robots – Developing systems that are easy to set up or self-reconfigurable, integrating mechanical, electrical, communication, and software components for impactful modularity.

Robotics software development – Creating faster, safer, and scalable deployment through robot-specific practices like continuous integration, formal safety analysis, and novel distributed communication architectures.

New platforms and companion systems – Advancing current platforms for extreme environments, designing novel robots (e.g., legged, cable), and developing specialised devices like agricultural end-effectors or advanced docking stations.

Featured Contributions in 2024

Selected contributions aligned with the challenge increased autonomy of robotic systems are the following:

- **Underwater Space Mapping Using Sonar Data** resorting to a novel technique for mapping underwater spaces through free-space modelling with sonar data. The developed technique employs an inverse sensor model and the sensor's motion to iteratively construct 3D underwater maps by interpreting real-time data collected from sonars. This work led to a paper presented at the ICRA 2024 conference in Japan, one of the most prestigious robotics conferences worldwide.
- A compact, optically robust, edge-computing **hybrid imaging system for high-precision 3D inspection** of submerged critical structures, validated through controlled trials and real-world deployment, achieving millimetric accuracy in volumetric reconstruction of sacrificial anodes and revealing biofouling layers, demonstrating its potential to enhance underwater vehicle situational awareness for offshore maintenance. Work published in Elsevier's Ocean Engineering.
- **Application for pallet detection and localization:** researchers have advanced the development of an application based on the acquisition of RGB-D images and its treatment using AI algorithms to detect pallets and its 3D localization in space. This application is being generalised to the detection of metallic boxes used for parts transport in the automobile sector. During its development a large annotated dataset of pallets and its pockets, as well as metallic transport boxes has been generated, and will be made publicly available at the end of the Produtech R3 and GreenAuto Agendas.
- **Obstacle avoidance algorithm for challenging outdoor environments**, employing the developed AgroBPP-CA algorithm as an advanced collision avoidance for agricultural robots. This software utilises an iterative approach with parametric Bézier curves to navigate complex environments. By considering terrain inclination and the robot's center of mass, AgroBPP-CA ensures safe and efficient path planning, even in challenging off-road conditions. This method

allows for smooth and adaptive obstacle avoidance, enhancing the reliability and autonomy of agricultural machinery.

Under the scope of **advanced manipulation and other physical interactions** challenge, a **Large-Scale Dataset Generation Framework for Robotic Bin-Picking** was generated. The underlying challenge of generating labelled data for large-scale robotic bin-picking datasets was addressed by developing an easy-to-use automated framework for creating customised data with precise labels from CAD models. This framework utilises a photorealistic rendering engine integrated with physics simulation, reducing the gap between synthetic and real-world data. Models trained using the synthetic data generated by this framework achieved performance comparable to those trained on real-world datasets. This paves the way to further scientific achievements. An article detailing this work is currently under review in a peer-reviewed journal.

Important contributions related to **human-robot collaboration** were made by developing innovative solutions that enhance interaction, safety, and efficiency in industrial environments. AR applications based on head-mounted displays and projection mapping were deployed to assist operators in various tasks, including assembly processes, real-time monitoring, and programming of industrial and mobile robots. These AR-based tools provided intuitive interfaces that improve usability, reduce cognitive load, and enable seamless interaction between humans and robotic systems. This system incorporates real-time operator monitoring, leveraging advanced perception and tracking technologies to detect human movements and positions, enabling proactive collision warnings, enhancing workplace safety by preventing accidents and ensuring smooth human-robot coexistence. Additionally, the development of a VR-based teleoperation system has given its first results, allowing operators to monitor and intervene in the operation of mobile robots within warehouse environments. This system ensures seamless human oversight by allowing operators to track robot performance in real-time and take control when robots encounter situations they cannot autonomously resolve. By integrating intuitive interfaces and advanced communication technologies, our teleoperation framework enhances flexibility, efficiency, and reliability in warehouse automation, ensuring smooth collaboration between human operators and robotic systems in dynamic industrial settings.

Within the scope of the challenge **sustainable robotic systems**, the following contributions are noteworthy:

- A digital twin-based infrastructure has been successfully developed to support and monitor Advanced Robotic Systems, enabling real-time data integration and improved decision-making. Additionally, robotic systems have been integrated with the Industrial Internet of Things, allowing for better data exchange and remote monitoring, which has the potential to reduced downtime and maintenance costs. The incorporation of AI technologies, particularly in the domain of perception and environment inference, has driven innovations that optimise production and logistics processes.

The modular robots Modular-E, Modular-X, Weta, and Orioos robots were fully designed from scratch to address the challenges of sustainable agriculture and forestry. These autonomous, all-electric robots, each weighing less than one ton, were specifically developed to operate in demanding environments, including steep slopes, irregular terrain, and rocky landscapes.

4.8 SYSTEMS ENGINEERING AND MANAGEMENT

Steering Committee: António Lucas Soares, José Coelho Rodrigues, Lia Patrício and Beatriz Brito Oliveira

Presentation of the Domain

Systems engineering and management research seeks to advance the design, implementation, and improvement of systems for decision support, human-centred operations, intelligence, technology management, and innovation.

Major challenges arise from optimization in complex organizations and networks at multiple levels, customer-centric service design, and technology-based innovation management and policy, targeting improvements in business performance, productivity, innovation, resiliency, and economic, social, and environmental sustainability.

Research Challenges

A) Transitioning Socio-technical systems towards sustainability

Research challenge

Managing and supporting decisions in continuously complex environments with multiple stakeholders and overarching goals (e.g., sustainability) brings additional challenges to the research on these methods.

Research Questions

- How can firms innovate business models based on flexibility, self-sufficiency, or servitisation for sustainability transitions?
- How can innovation management practices evolve through the lenses of Responsible Research & Innovation for sustainability and impact, with a focus on circular value chains, open innovation and co-creation practices?
- How can firms develop new value propositions and service offerings for ecosystem transformation?
- How can firms and policy makers facilitate the effective adoption and diffusion of technologies for sustainability transitions?
- How can firms and policy makers develop strategies for citizen cocreation and engagement with sustainability transitions?

B) Developing Responsive and resilient end-to-end Value Chains

Research challenge

The prevailing current global supply chain models impose several challenges (including over-dependencies and logistics issues). Recent crisis (such as the COVID 19 pandemic and the war in Ukraine) have demonstrated the fragilities of those models, both in terms of resilience and sustainability (environmental, social and economic).

Research Questions

- How can digital technologies contribute to reduce the critical dependencies and weaknesses resulting of current global supply chain (SCs) models, including the identification of current and future severe disruptions?
- How can digital technologies contribute to manage the trade-offs and enhance the synergies that characterise the relationship between sustainability and resilience practices in complex value chain environments?
- How can end-to-end SC visibility, supported by emerging technologies, contribute to the development of resilient and sustainable SCs?

- How can digital technologies facilitate joint innovation activities to increase the circularity of products, processes, and overall SCs?
- What is the impact on the organizations' end-to-end performance (with respect to these challenges) to integrate and interface Marketing and Operations?

C) Managing Systems under uncertain, complex and dynamic environments

Research challenge

Managing and supporting decisions in continuously complex environments with multiple stakeholders and overarching goals (e.g., sustainability) brings additional challenges to the research on these methods.

Research Questions

- How to acknowledge, incorporate and intrinsically seize the properties of uncertain and dynamic settings in system modelling, not only as far as data is concerned, but also assumptions and scope?
- How to model complex relationships, including multiple stakeholders with multiple goals and incentives?
- How to improve and significantly fasten the decision-making process to tackle an uncertain and dynamic setting, through innovative solution methods and algorithms?
- What benefits can be derived from multi-disciplinary approaches (namely, the hybridization with qualitative and strategy-oriented decision-making models with state-of-the-art algorithms, or with enhanced risk assessment and management tools) in complex and dynamic applications such as urban mobility?
- How can AI methodologies be used to optimise critical parameters' trade-offs in designing adaptable production systems?
- How can hybrid simulation models and Digital-Twin-based approaches contribute to more effective operational management in Uncertainty and Complex Manufacturing Environments?
- How to design and manage innovative, more resilient, inclusive and sustainable urban mobility services (for people and freight) in the context of the smart city and the sharing economy?
- How to design and manage innovative global, more sustainable logistics and freight circular transportation services, based on synchro-modal operations and inter-modal hubs?
- Engineering Human-Centred Systems for Sustainability and Resilience

Research challenge

Demands for sustainability and circularity raise specific challenges to IIS such as trust, and confidentiality from one side, and systems adoption and user engagement on the other side.

The exponential growth of digital technologies applied to manufacturing foster the challenge to create awareness about the socio-technical strategies for technology adoption.

Research Questions

- How to design inter-organisational information systems, particularly industrial digital platforms that support collaboration, information management and collective action to foster and implement circular and sustainable business strategies?
- How to manage industrial data and information in individual organizations and value chains and networks to foster knowledge and unlocking value creation from data?
- How to assess the impact and derive design propositions for information systems based on emerging technologies leading to the creation of organizational capabilities that foster competitiveness and sustainability?

- How to leverage technology and data to create transformative services for value co-creation and system transformation?
- What are the factors that influence the adoption of green and emergent technologies?
- What are the drivers and barriers to the adoption of emergent technologies in the context of Industry 5.0?

Featured Contributions in 2024

Transitioning Socio-technical systems towards sustainability

Citizen engagement with Sustainable Energy Solutions (SES) is considered essential for the current energy transition. To address this opportunity, this study examines how different forms of the perceived value of SES (utilitarian, social, and environmental) influence different types of citizen engagement behaviours (information seeking, proactive managing, sharing feedback, helping other users, and advocating). This research was published in the Energy Policy Journal.

Developing Responsive and resilient end-to-end Value Chains

We progressed in the goal of researching how integrated optimisation/simulation hybrid approaches and process digital twins can help to design and reconfigure more adaptable and sustainable production systems, achieving a Digital Twin architecture for high-complexity and high-variability production environments, allowing a rapid reconfiguration of production systems in response to market demands while ensuring more efficient use of industrial resources, published in Computers & Industrial Engineering.

In the context of SoTeIn Factory, Reshape and Renéé projects, we have achieved results related to various aspects of SCM, including different sectors (e.g. textile, plastics, packaging, agri-food) and R-strategies (e.g. reduce, reuse, remanufacture), namely the characterisation of supply chain strategies in a global context: a customer value-based perspective, published in Supply Chain Forum.

Managing Systems under uncertain, complex and dynamic environments

Development of an innovative multidisciplinary approach for advanced mobility demand modelling, integrating comprehensive real-world data on user preferences and mode choices with economic choice models, data analytics, and demand learning techniques. The findings from this exploratory research were published in the Journal of Business Economics and Transportation Research Part E: Logistics and Transportation Review.

Development of a benchmarking tool to evaluate different operational points where the equipment health indicators represent wear and tear. It brings innovation by applying Data Envelopment Analysis in asset management to indicate the best dispatching rules with maximum power production and minimum wear and tear. This work was published in Utilities Policy.

Engineering Human-Centred Systems for Sustainability and Resilience

Concerning the adoption of advanced technologies in manufacturing, particularly the ones leading to more sustainable and circular models, a framework was developed to support decision-making in the adoption of collaborative robots, which was published in Technological Forecasting and Social Change.

5 TEC4 INITIATIVES

5.1 Overview

TEC4 (TEChnologies FOR...) is an organisational approach designed to structure the **market-driven** innovation process, complementing the naturally occurring **science-driven** research conducted within Research Centres. This approach fosters a **balanced** and **integrated** knowledge-to-value chain.

Short-term objectives of TEC4 initiatives include:

- Developing innovative, knowledge-based solutions and services with high export potential;
- Leveraging internationally competitive research and innovation capabilities;
- Contributing to the resilience and growth of the Portuguese economy.

Long-term objectives encompass:

- Identifying scientific and technical challenges across diverse fields;
- Harnessing the full potential of INESC TEC in application domains relevant to businesses;
- Establishing and sustaining **virtuous innovation cycles** within each TEC4.

Each TEC4 focuses on a specific market segment and fosters **cross-cluster, multidisciplinary projects**. They actively collaborate with businesses to develop solutions for technology transfer. Each TEC4 also maintains a **strategic agenda** aligned with its market domain, addressing:

- Stakeholder perspectives;
- Strategic roadmap and associated technological roadmap;
- R&D infrastructure evolution to maintain state-of-the-art capabilities and support the roadmap;

TEC4 application areas are aligned with European, national, and regional priorities, fostering internal R&D competencies around socio-economic pillars. Additionally, attracting **international partners** supports INESC TEC's internationalisation strategy, facilitates access to international partners for national companies, and fosters foreign direct investment.

Performance measurement for each TEC4 primarily considers:

- **Level of recognition and activity** within its market (including direct contracts with companies and stakeholders);
- Number of inter-Centre collaborations generated.

TEC4s are not directly involved in project development. Once an opportunity is identified, negotiations occur with relevant Centres, which then manage and execute the project.

Typically, a TEC4 comprises:

- **A defined market domain** represented by businesses and associations;
- **A group of INESC TEC Centres** with multidisciplinary expertise relevant to the market domain;
- **R&D infrastructure** supporting scientific and innovation activities and providing added-value services to businesses.

Each TEC4 follows a structured implementation plan encompassing the following stages:

- **Identification of market segments** where INESC TEC competencies can create value;

- **Assessment of market needs** to identify internal research lines with the highest potential impact on businesses;
- **Evaluation of R&D infrastructure** (laboratories, equipment, demonstration facilities, etc.) to support value-added services for businesses;
- **Identification of potential partners and stakeholders** who can contribute to the TEC4 and its innovation cycle;
- **Definition and alignment of the strategic agenda** for each TEC4 and creation of its advisory board.

The current TEC4 organisation comprises:

- **Five established TEC4s:**
 - TEC4AGRO-FOOD: Focuses on the agro-food and forestry sectors;
 - TEC4ENERGY: Addresses energy-related activities and the energy economy;
 - TEC4HEALTH: Targets activities and the economy related to health and well-being;
 - TEC4INDUSTRY: Concentrates on production technologies, manufacturing, distribution, logistics, and retail;
 - TEC4SEA: Focuses on sea-related activities and the maritime economy.
- **TECPARTNERSHIPS:** Primarily dedicated to promoting and supporting businesses in all other sectors, exploring new market segments, and incubating potential new TEC4s until they reach a sufficient maturity level.

TEC4s are dynamic organisational models that require periodic evaluation and adaptation to the evolving economic landscape.

5.2 TEC4AGRO-FOOD

Coordinator: Filipe Neves dos Santos

Business Developer: André Sá

Presentation

TEC4AGRO-FOOD is INESC TEC’s Initiative for Agro-Food and Forestry.

TEC4AGRO-FOOD’s mission is co-creating the digital (r)evolution in agro-food and forestry through research and technological development in digital technologies and robotics for the creation of long-term value for INESC TEC from customers, markets, and relationships.

TEC4AGRO-FOOD has as main application areas Smart (digitalisation) Precision (“right time, right treatment, right amount, right place”) Agriculture and Forestry, Food Security and Bioeconomy. TEC4AGRO-FOOD may act in all phases of the smart precision agriculture/forestry cycle, from variability measurement to action with variable rate technologies (VRT), encompassing data analysis and decision and prescription map:

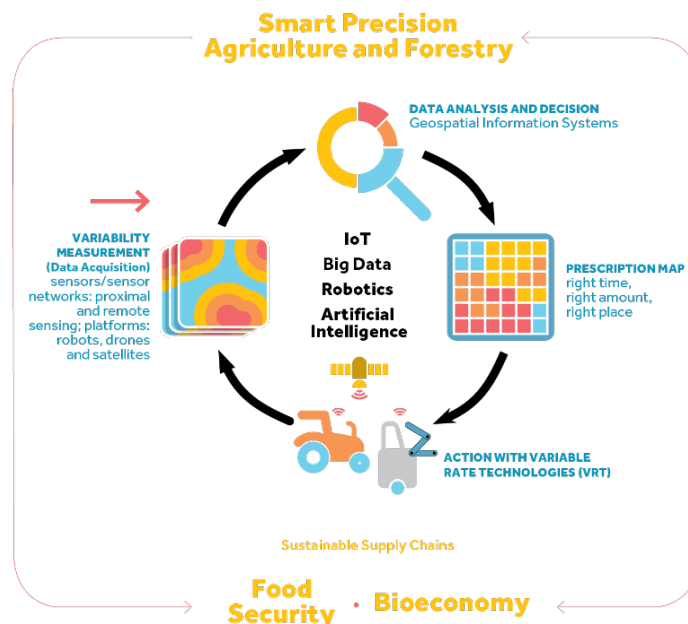


Figure 5.1 - Precision Agriculture/Forestry Action Cycle

TEC4AGRO-FOOD provides innovation services of advanced consultancy and research and technological development in the mentioned application areas.

TEC4AGRO-FOOD has proven to be a very cross-cutting initiative regarding INESC TEC’s R&D centres, with the majority of them being involved in it, being CRIIS, namely through TRIBE LAB - Laboratory of Robotics and IoT for Smart Precision Agriculture and Forestry, the most active one.

Main achievements in 2024

Continuing the overall strategy of full implementation of portfolio projects, namely at the level of the Recovery and Resilience Plan projects, and redoubling efforts with companies and at international level, as well as the strategy defined in the TEC4AGRO-FOOD’s Strategic Plan (as last year, with the exception of the establishment of the strategic partnership with the Volcani Centre, due to the situation in Israel), in 2024, TEC4AGRO-FOOD pursued its consolidation as the main national research and technological development partner in the scope of digital technologies and robotics for agro-food and forestry. At the same time, at European level, TEC4AGRO-FOOD has reached a sustainable position regarding research

and innovation programmes, namely Horizon Europe. The increased visibility (press, events, etc.) and the contribution to the public policies (RIS3 and CoLABs - INESC TEC participates in 3 CoLABs in the scope of TEC4AGRO-FOOD) should also be highlighted.

TEC4AGRO-FOOD's main achievements in 2024 are presented below:

- European Programmes approvals: (HEU) HURRICANE (CTM).
- R&D Services and Consulting approvals:
 - RLSENSEDEMO (CRIIS);
 - Sensewater (CRIIS);
 - DesCFoodScenarios (CPES and CESE);
 - CropsHealthPilot (C-BER);
 - PROBONO (CPES).
- Prizes:
 - Modular-E robot - second place in “Best World FIRA 2024 Robot”;
 - Pocket-Vet - first place in the 11th edition of the Crédito Agrícola Entrepreneurship and Innovation Awards;
 - Modular-E robot - TIMAC Espresso Agriculture Innovation Award (CRIIS).
- Intellectual Property Rights:
 - SHARPMETRIX patent internationalisation (PCT);
 - SpecTOM entry to national stages EP and US (internationalisation in 2022);
 - forSCOPE2 Preliminary and Technology Disclosure Forms;
 - Mapcrops Preliminary Form.
- Advanced Training:
 - André Sá's attendance at “Optimising vineyard operations using innovative techniques/technologies” Training Course (Vine & Wine PT);
 - “Sustainable Energy Transition in Agriculture” webinar series (Tools4AgriEnergy).
- Events:
 - INESC Brussels HUB Winter Meeting 2024; World FIRA 2024; Visit to Fundação City Council's research and innovation ecosystem related to agri-food and forestry; AgroIN 2024 (INESC TEC “RTD Partner”); EU CAP Network conference “EIP-AGRI Operational Groups: Innovation in practice”; Annual “transForm out” event; Brokerage Event ADVID - Mechanisation & Digitalisation: Meeting the Challenges of Winemaking; International Seminar Centre of Science for Development in Digital Agriculture São Paulo State Research Support Foundation - Fapesp - Semear Digital (co-organised); Agritec Day Herculano; GO WIDE; EuroAmericas Forum 2024 (Filipe Santos as speaker).
- André Sá appointed to the coordination group of the CCDR-N's regional platform for smart specialisation “agri-environmental systems and food”.

5.3 TEC4ENERGY

Coordinator: João Peças Lopes

Business Developer: Alberto Jorge Bernardo

Presentation

The main objective of TEC4ENERGY is to support the transition towards a decarbonised economy by promoting research, development, and innovation (R&D&I) activities in the energy sector. By bringing together various stakeholders including R&D institutions, businesses, and associations, TEC4ENERGY aims to increase collaboration with stakeholders, as well as to strengthen internal and external synergies, to successfully tackle the main challenges faced by society and, specifically, the energy industry, in the future. The initiative aims to stimulate the growth of energy-related industries and support the necessary transformations required for a more digitalised, sustainable and low-carbon future.

TEC4ENERGY collaborates with industry through advanced consultancy and training services, contract-based R&D activities with a particular focus on technology transfer, and strategic partnerships, aiming to drive innovation, support the energy sector in overcoming limitations and challenges, and contribute to the transition towards a digitalised and decarbonised economy both nationally and internationally. TEC4ENERGY focuses on bridging industry and all INESC TEC's Centres, towards leveraging their expertise, resources, and experience to implement successful projects and perform impactful services with the industry within the energy sector.

The mission of TEC4ENERGY is to promote and leverage the strong recognised expertise of INESC TEC in Electric Power Systems when developing new collaborative industrial and EU funded projects. The role of TEC4ENERGY is to promote more businesses and funded projects towards INESC TEC mission and goals accomplishment, which are aligned with the EU's goals of addressing societal challenges, promoting innovation, and transitioning towards a more digitalised, sustainable and decarbonised energy sector.

Overall, TEC4ENERGY plays a crucial role in driving innovation in the energy sector by identifying and leveraging projects that address the limitations of current technology provided by industry. Through its multidisciplinary and collaborative approach, TEC4ENERGY contributes to the advancement of knowledge and technology in the field of energy, benefiting both industry stakeholders and society.

Main achievements in 2024

TEC4ENERGY promoted targeted meetings with relevant Portuguese and international stakeholders, in the fields of renewable power sources integration, offshore wind power, definition of generation remuneration tariffs and renewables Levelised Cost of Energy assessment, PV self-consumption assets' impact, power market simulation and analysis, energy storage, batteries manufacturing, transformer asset management, etc., targeting the digital and energy transition towards a more decarbonised economy, mission in which INESC TEC is completely aligned with the directives of the European Commission.

Those activities were able to bridge different external stakeholders with distinct INESC TEC's technology Centres, namely in the fields of power and energy systems, industrial robotics, submarine autonomous drones, enterprise and engineering systems, applied photonics, human-machine interfaces, artificial intelligence and critical systems, among others.

Aiming at promoting a closer contact with international and national stakeholders, TEC4ENERGY organised the participation of INESC TEC at ENLIT (<https://www.enlit.world/events/enlit-europe-2024/>) which was held in Milan, Italy, between 22nd and 24th of October 2024.

ENLIT is the largest European event, with worldwide coverage, which brings together companies and partners operating in the energy sector, namely in generation, including renewables, in the distribution and transmission of electricity, as well as in green hydrogen. This event aims to discuss different topics related to a more digital, green and sustainable economy, in which industry and service providers, namely those with a scientific and a technological matrix – such as INESC TEC – could exhibit and demonstrate their latest and most innovative solutions. INESC TEC was present with a 12 sqm stand. At this stand, products and projects of a highly innovative nature were presented and demonstrated, with direct application in the

industries of the energy sector. INESC TEC's stand received many visits, from more than 50 different entities. Two opportunities and 31 business leads were identified.

TEC4ENERGY also organised an event called Energy Technology Open Day, which was held at the main auditorium of the Faculty of Engineering of the University of Porto, Portugal, on December 3rd, 2024.

This event was attended by 150 participants, from industry, network operators, academia, as well as from INESC TEC. During the event, there was a Pitch session called "Watt the Tech - Pitch for All", where 15 innovative projects and products were presented by INESC TEC researchers. There was also a round table called "Tech Talk Around the Power Table", moderated by Professor João Peças Lopes. The round table and its debate focused on topics such as the operation of gas and electricity distribution networks, renewable energies with emphasis on offshore wind, electric mobility, artificial intelligence applied to the energy sector, as well as the role of green hydrogen in the energy transition. Speakers of high national and international reputation with chairmanship, administration or management positions participated in the round table, namely from E-redes, Portgas (REN group), Efacec, i-charging and Critical Software, as well as from the Portuguese Energy Agency. These speakers also participated in the award jury for the best Pitch, whose prize was presented to the winner during the event. In the final part of the event, a cocktail was held, in a space where the 15 technologies presented during the Pitch Session were available to the participants, with demos and presentations made to each interested party.

Moreover, TEC4ENERGY has also made a considerable contribution to INESC TEC's business portfolio in 2024. In this regard, INESC TEC was able to secure around 900 thousand euros of advanced consulting services resulting from TEC4ENERGY activities, among which stand out the following projects:

- National
 - Madoqua
 - Evaluation of the reception capacities for new renewable power sources to be connected to the Portuguese transmission grid
 - EDA – Eletricidade dos Açores / Azorean Electricity Utility
 - Tariff study and Levelised Cost of Energy (LCOE) analysis for renewable and geothermal generation assets
 - BONDALTI
 - Impact study of the connection of self-consumption energy production units
 - Impact study of the connection of batteries on the internal electrical network of the Estarreja industrial plant
- International
 - CTGE - China Three Gorges Europe
 - Advanced Consulting Services – Power Market Analysis in Iberia (anticipating the evolution of the ancillary services needs and identifying new players for the provision of the ancillary services under market environment)
 - AETS – Application Européenne de Technologies et de Services

Project Preparation Facility Energy Resource Centre in Mozambique – Identifying relevant security criteria for the transmission system to accommodate new renewable injections for long term horizons and identification of the additional hosting capacity for renewable injections of the transmission network.

5.4 TEC4HEALTH

Coordinator: Miguel Coimbra

Business Developer: Carlos Alexandre Ferreira

Presentation

The Mission of TEC4HEALTH is to induce a market pull drive into R&D, targeting all the value chain actors and processes in the healthcare and well-being sectors. For accomplishing this, TEC4HEALTH aims to explore the activities within the health sector where technology needs and roadmaps indicate a high potential for applying INESC TEC's competences, seeking to promote synergies with its partners and leading to the development of successful projects, contracts, and technology transfers.

TEC4HEALTH monitors results in the TRL range 5-9 and focuses on applied research leading to products, processes and services that can be transferred in broad areas of application: i) healthcare providers (primary, secondary and long-term care); ii) auxiliary diagnostic and therapeutic means; iii) life support and monitoring (medical devices, e-health, m-health); iv) information and analytics systems for healthcare; v) pharmaceutical, pharmacy and clinical life science industries.

Mapping the experience of INESC TEC with current worldwide scenario led to the identification of key challenges to continue to be addressed in the next years: cancer (breast, lung, colorectal, prostate, pancreas, oesophagus/stomach, cervical, bladder, and neuroblastoma), neuro/brain diseases (epilepsy, depression, Parkinson and Alzheimer), cardio and respiratory diseases and active healthy living. INESC TEC's innovation services in artificial intelligence, biomedical instrumentation, information systems, medical robotics and health management make it a very attractive research institute for any type of partner working in these health challenges.

The Centres with scientific and technological competences more aligned with TEC4HEALTH challenges are: CAP (Applied Photonics), CBER (Biomedical Engineering Research), CEGI (Management and Industrial Engineering), CTM (Telecommunications and Multimedia), HumanISE (Human-centred Computing and Information Science) and LIAAD (Artificial Intelligence and Decision Support).

Main achievements in 2024

The activity of a TEC4 can be summarised in three main achievements: **internal** - with dissemination, brainstorming, mentoring and development of activities and beneficial practices; **external** - knowing the state of the art, meeting with established and new partners, being represented at events and in clusters and looking for new partnerships; coming as the last part the sourcing and development of **projects**.

Internal:

- **Contact points:** facilitating ad-hoc conversations with each point of contact from the different Centres, aimed at understanding desires and needs, ensuring appropriateness in the presentation of new opportunities for R&D projects.
- **TEC4 materials:** development and curation of a core TEC4HEALTH presentation featuring flagship technologies and projects for dissemination throughout 2024.
- **Research support and facilitation:** assisting with the structural tasks of ongoing projects, particularly in facilitating connections with industry. This includes responding to questionnaires and interviews, organising workshops, and introducing key stakeholders.

External:

- **Hospitals:** sustaining relations with some of the main hospitals in the northern region of Portugal, namely the Unidade Local de Saúde de São João (ULSSJ), Unidade Local de Saúde de Santo António (ULSSA), IPO Porto and Unidade Local de Saúde de Gaia/Espinho (ULSGE).

- **New leads:** meetings with approximately 30 new entities and reconnection with those with whom there were prior relations.
- **Companies (highlight of new strong connections):** opportunities in sectors such as information systems, health consultancy, and active and healthy ageing.
- **Promoting INESC TEC:** Ciência 2024 (focused on the theme of One Health), AgeingFit 2024, Innovating Health Together Conference, ENEEB, Symposium on Bioengineering, OneDigitalHealth and Atlantic Health Wellness Summit.
- **Representing INESC TEC:** Health Cluster Portugal (general assemblies and Smart Health Network), EARTO Health Working Group, EIT Health HUB Porto, HealthAI Community of Practice and CCDR-N PREI Ciências da Vida e Saúde.
- **Participation in the consultation and review of the European Commission's funding programmes.**

Projects:

- **HfPT Project:** internal and external facilitation of the development of our national mobilising project for health within the Recovery and Resilience Plan (PRR).
- **European:** dissemination of information and opportunities, support in proposal submissions, and brokering to enable the inclusion of INESC TEC researchers and their research lines in consortia targeted for various European Commission programmes (i.e., Horizon Europe, Mission Cancer, EU4Health, European Health Data Space, IHI, EIC, and EIT Health).
- **Services and Consulting:** seizing market opportunities and collaboratively developing proposals with the lead researcher to address the requests and challenges at hand.

5.5 TEC4INDUSTRY

Coordinator: Américo Azevedo

Business Developer: António Almeida

Presentation

TEC4INDUSTRY has the objective to leverage the science-based cross-sectoral innovation by promoting new added-value interactions and partnerships between INESC TEC and the industry towards a more competitive and sovereign national industrial ecosystem. In this sense, the TEC4INDUSTRY presents a double role internally within the INESC TEC ecosystem and externally for the national industrial ecosystem. At the internal level, the TEC4INDUSTRY must perform as the INESC TEC driver for added-value science-based research, promoting vision alignment between the 13 research centres and the industry needs. Externally, the TEC4INDUSTRY promotes a more vital national industrial ecosystem composed of added-value industrial companies and disruptive and unique technologies and consultancy companies.

Main achievements in 2024

In 2024, TEC4INDUSTRY leveraged its stakeholder management initiatives within the Recovery and Resilience Plan (PRR) to enhance service provision and optimise the use of domestic funds with enhanced national sovereignty in advanced production technologies. More importantly, the developments followed by INESC TEC's research and innovation teams has led to increased institutional reputation and reliability as a leading R&I technology centre, both at National and European markets. The prominence and impact of these initiatives has aided in securing European representation within strategic initiatives, either as prominent European consortia focused on Digital Twinning and AI in Manufacturing, or as delegates for EU efforts to provide better research, development and innovation strategies, such as EARTO's Technology Foresight Workgroup. TEC4INDUSTRY has also impacted the National landscape by establishing important partnerships, such as SIEMENS, Yazaki Saltano, IKEA Group and Bosch, with more than 70 contacts made (SMEs and MNEs, National and International).

Industry and Innovation Lab (iiLab)

During 2024, the iiLab infrastructure in the PORTIC building grew in terms of its impact to advancing scientific research within simulated industrial environments, as well as in terms of setting itself as a pivot to sustainable stakeholder development. TEC4INDUSTRY has aided in these initiatives by introducing and managing the Vertical Industry of the TestBed 5G NOS, a PRR initiative lead by NOS Telecommunications. Within this programme, the iiLab has received 7 different pilot projects, with an average entrance TRL of level 4, and of various sectors, both industrial and service-providing related.

The internal developments of these pilots within iiLab resulted in clearly demonstrated innovative developments, leading to outbound TRLs of 6 and above, with many solutions being ready-for-testing and deployment in industrial facilities. By defining, implementing, and securing technical requirements of these pilots, the iiLab infrastructure has become a reference point within northern Portuguese industries for innovative testing and piloting of technology-based solutions.

Plan Recovery and Resilience (PRR)

In 2024, TEC4INDUSTRY strengthened its role as a coordinator of INESC TEC's PRR initiatives, ensuring technological advancements aligned with industrial needs. Managing work packages across research centres and industry partners, TEC4INDUSTRY integrated expertise in digitalisation, AI, and advanced manufacturing to deliver high-impact solutions. A key focus has been intelligent intralogistics, with breakthroughs in visual monitoring systems, digital twins, and autonomous mobile robots (AMRs) enhancing traceability and warehouse efficiency, particularly in picking-by-line (PBL) environments.

The implementation of 5G connectivity has accelerated real-time industrial automation, while Industry 4.0 platforms with KPIs and continuous improvement modules have improved process control. Targeted innovations include digital tools for aerospace maintenance, augmented reality for engine disassembly, and AI-powered defect detection for textile looms. Additionally, decision-support systems for stone-

cutting optimisation and VR-based industrial training modules have enhanced workforce skill development.

Through structured project management, TEC4INDUSTRY continues to bridge research and industry, ensuring advanced technologies transition to real-world applications. This cross-disciplinary approach reinforces its role as a key driver of Portugal's industrial digital transformation.

Horizon Europe, Services, and Collaboration Proposals

In 2024, TEC4INDUSTRY reinforced its role in fostering research collaborations, securing funding opportunities, and developing tailored services that bridge innovation and industry needs. By leveraging multidisciplinary expertise across INESC TEC's research centres, the initiative has contributed to key Horizon Europe proposals, national projects, and international partnerships.

Under Horizon Europe, TEC4INDUSTRY has expanded INESC TEC's participation in battery production, Generative AI, and Manufacturing-as-a-Service (MaaS). Battery-related proposals such as Reaction, Spark, and Ecobaas focus on next-generation energy solutions, while SIMALFA and S2GAIIA target AI-driven automation and intelligence in manufacturing. The RasMaaS proposal explores cloud-based manufacturing, supporting scalable, on-demand production.

Beyond research, TEC4INDUSTRY has expanded service offerings, partnering with industrial leaders to address specific technological challenges. The RFIDCORK project with Amorim has improved logistics traceability using RFID technology. Collaborations with Dellent, Tlantic, TRH, and Grupo Empresa leverage AI and data science to optimise candidate selection, retail analytics, and workforce planning.

On the international stage, TEC4INDUSTRY has been instrumental in developing an AI-driven solution for aerospace Maintenance, Repair, and Overhaul (MRO) in collaboration with Pratt & Whitney and the Portuguese Air Force, aiming to enhance predictive maintenance in Portugal. Nationally, it has been actively engaged in SIAC projects for digitalisation and decarbonisation, working alongside the footwear sector and the Portuguese Business Association (AEP).

Through these initiatives, TEC4INDUSTRY continues to secure funding, deliver high-value services, and foster strategic collaborations, strengthening INESC TEC's leadership in industrial digitalisation and innovation.

Industry Club Initiative

In early 2024, INESC TEC played a pivotal role in establishing the Industry Club, a collaborative platform designed to accelerate the digital transformation of Portuguese industries. Developed in partnership with NOS, COTEC, Kaizen Institute, and Porto Business School, this initiative fosters knowledge exchange, innovation, and strategic collaboration between industry leaders, research institutions, and technology providers. The Industry Club enhances INESC TEC's stakeholder engagement efforts, broadening its client base and reinforcing its position as a key enabler of industrial digitalisation.

By leveraging this network, INESC TEC strengthens its stakeholder management strategy, ensuring continuous engagement with potential partners and facilitating new business opportunities. Since its launch, the Industry Club has attracted 250 members and hosted seven initiatives, including masterclasses on Data Engineering and AI 101, as well as the Speed Summit on Industrial Digitalization. These initiatives provide industry professionals with cutting-edge insights into digital transformation, artificial intelligence, and data-driven decision-making. Through its leadership role in this initiative, INESC TEC continues to drive industrial innovation, bridging the gap between research and business needs while reinforcing Portugal's competitiveness in the global digital economy.

5.6 TEC4SEA

Coordinator: Eduardo Silva

Communication, dissemination and continuous engagement: Ana Paula Lima

Presentation

The TEC4SEA initiative addresses the Blue Economy sectors, stimulating related industries and partners to overcome the future challenges in these sectors incorporating INESC TEC contributions and know-how. To this end, TEC4SEA brings together entities of the quadruple-helix (academia & research, business, civil society, and policymakers) in order to increase synergies and critical mass, raising up a north based Ocean Engineering Excellence Network capable of leading international initiatives in the Sea Economy.

The multidisciplinary application-oriented solutions addressed by TEC4SEA cover a wide range of industries confronted with numerous challenges and global transitions. From specific regional and national challenges to the Horizon Europe and Mission's objectives, the new European vision targeting 2050, all Blue Economy sectors are confronted with innovation demands. Aiming at bringing the autonomous and digital worlds to a sustainable sea economy, TEC4SEA promotes the following innovation services for the Blue Sectors:

- Development of optical and biosensors (for physical, chemical and bio parameters);
- Broadband communications solutions;
- Heterogeneous data integration and management;
- Development of customised visualisation tools, virtual and augmented reality solutions;
- Offshore RES & DER integration;
- Multiple energy vectors integration;
- Digital Twin and logistic optimisation solutions;
- Conception, development and optimisation of sea mission oriented robotic platforms;
- Customised processing solutions and on-board processing optimisation;
- Perception solutions for unstructured environments, 3D mapping and data fusion;
- Optimisation of underwater positioning systems and navigation algorithms.

The centres involved in TEC4SEA projects during 2024 were the following: CAP - Applied Photonics; CPES - Power and Energy Systems; CRAS - Robotics and Autonomous Systems; Humanise - Human-Centred Computing and Information Science; CTM - Telecommunications and Multimedia.

Main achievements in 2024

INTERNAL

- Continued internal consolidation with different centres, adapting to ongoing changes while pursuing relevant impact in both the Blue Economy sectors and society;
- Strengthened articulation with the work team to reduce barriers between the centres and TEC4SEA, enabling the execution of various actions, tasks, and projects. Developed ongoing efforts in synchronisation, strategy, and priority alignment;
- Developed and prepared initiatives with National and Regional authorities to launch INESC TEC.OCEAN;
- Led the construction of shared research infrastructures for ocean technologies and energy transition (Hub Azul de Leixões I);

- Continued the internal awareness and alignment with the medium-term strategy and action-plan (2030), fostering current and future strategic opportunities (e.g., H.E., EITs, national programmes, and direct contracts with industrial partners).

EXTERNAL

- Promoted and disseminated the resources and capacities of the TEC4SEA Infrastructure, fostering R&D+i and subcontracting opportunities;
- Developed and pursued national and international mechanisms to establish INESC TEC's Sea domain as a Centre of Excellence;
- Consolidated INESC TEC's position in the Ocean Renewable Energies test site of Aguçadoura;
- Identified and established close collaboration mechanisms and protocols with leading international organisations (e.g., Sintef Norway and GCE Ocean, DMEC, EMSA, ISA, UN);
- Supported the successful implementation of all Sea-related initiatives within the “Plano de Recuperação e Resiliência”, (particularly the Hub Azul de Leixões I) leveraging these projects and corresponding impact with complementary initiatives (e.g., H.E., PT2030, Mar2030) and strategic partners in the domain (e.g., IPMA, Portuguese Navy, ISA);
- Continued the consolidation of international relations (e.g., Europe, South Korea, and the USA).

5.7 TECPARTNERSHIPS

Business Developers: Augustin Olivier, António Gaspar, José Nina de Andrade

Presentation

TECPARTNERSHIPS mission is to explore emerging market sectors where technological needs and roadmaps indicate high potential for INESC TEC's expertise. The aim is to assess viability and sustainability, integrating them into an existing TEC4 or creating a new one. Several markets were analysed, including the Internet Market, focusing on AI-driven services and consumer behaviour. The Financial sector encompasses banks, insurance, Fintech, and Insurtech, with opportunities in data processing and analytics. The Construction sector presents digital transformation potential through automation, robotics, digital twins, and AI. The Space sector benefits from ESA, EU programmes, and New Space activities, offering broad opportunities. Defence & Security has gained relevance due to geopolitical factors, with initiatives such as EDF and Horizon Europe Cluster 3 fostering collaboration. Public Administration is undergoing digital transformation, offering applications for Computer Science. The Mobility sector spans aeronautical, railway, ports, automotive, and soft mobility, supported by EU programmes and national railway investments.

Main achievements in 2024

In 2024, INESC TEC reinforced its strategic impact on the TEC4 market through technological innovation, strong industry collaborations, and international engagement. TECPARTNERSHIPS played a critical role in aligning R&I with industry needs, advancing digital transformation, and strengthening INESC TEC's global positioning.

Key contributions included expanding partnerships, leveraging Technology-based companies to foster industry connections, and supporting public administration digitalisation. The initiative also enhanced INESC TEC's presence in high-profile international events and EU-funded projects, ensuring leadership in key research domains. Efforts to secure international funding and optimise internal processes reinforced institutional resilience and sustainability.

By focusing on innovation, collaboration, and strategic positioning, TECPARTNERSHIPS has strengthened INESC TEC's role as a leader in technology-driven market transformation.

Participation on networking events:

The team actively participated in major networking events, both national and international, featuring B2B sessions and exhibition stands:

- AED DAYS 2024 Lisboa 7 May
- Portuguese Rail Summit 2024 Entroncamento 21 May
- Techinnov Paris 26 May
- SPACE ON EARTH 27 June
- QSP Summit 2024 Matosinhos 3-4 July
- ARTEX24-VIP DAY 5 July
- Luso-French Defense Conference Paris 2-3 October
- Rendez-Vous Carnot 2024 Paris 16 October
- DAMEN Shipyard Visit Netherlands 16-17 October

Interaction with businesses and results:

Building on previously identified lists of technology-based companies aligned with our strategy, we secured 382 meetings in 2024, including 77 with new entities and 108 with international organisations. These

structured engagements facilitated targeted discussions and led to 28 new leads (13 international). A total of 7 proposals were submitted, with a combined value of €3.6 million.

Highlights:

- Preparation of proposals for businesses under the PT2030 programme
- Involvement in European proposals under EDF and Horizon Europe Cluster 3, particularly the coordination of EDIFICE EDF proposal, involving several major European defence players, with a global budget of 15M€, and with an INESC TEC budget of 1,5M€, integrating several Centres: HUMANISE, CTM and CRAS.

Implementation of the Internationalization Strategy:

Progress Summary in French Market:

The internationalisation strategy in France advanced in 2024 with a focus on tax incentives, business development, and networking. The dossier for the renewal of the "Agrément CIR" was successfully prepared, ensuring continued eligibility for research tax credits for the next years. Strengthened relationships and targeted lead analysis supported business expansion. INESC TEC enhanced its market visibility by participating in three major B2B events— Luso-French Defense Conference, Techinnov, and Les Rendez-vous Carnot—with a joint stand with SAL in the last two. These efforts contributed to securing a finalised service contract valued at €65k.

Progress Summary in Other Markets

Beyond France, INESC TEC strengthened its international presence by engaging in strategic collaborations and attending high-profile global events. Partnerships with key stakeholders in European and non-European markets facilitated knowledge exchange and business expansion. Efforts focused on securing new contracts, expanding research opportunities, and reinforcing institutional positioning in Defence & Security, ensuring sustained growth in the international arena.

The most relevant transversal activities were:

- **CRM:** TEC4 monthly reporting through CRM.
- **AI Market Analysis:** Developed "AI Market Analysis – Perspectives, Opportunities, and Action Plan" to strengthen INESC TEC's position in AI. The strategy follows Inbound Marketing principles: attract, convert, sell, and retain. It highlights expertise in AI, IoT, Big Data, Blockchain, Cloud Computing, Computer Vision, and Cybersecurity. Objectives include increasing AI awareness, strengthening partnerships, and enhancing the accessibility of INESC TEC's solutions. Key actions involve producing promotional materials, boosting digital engagement, organising themed events, deploying media strategies, and executing direct marketing to solidify INESC TEC's impact in the AI landscape.

6 RESEARCH AND DEVELOPMENT CENTRES

6.1 CTM - CENTRE FOR TELECOMMUNICATIONS AND MULTIMEDIA

Coordinators: Filipe Ribeiro and Vitor Grade Tavares

Presentation

The Centre for Telecommunications and Multimedia (CTM) consists of about 100 researchers working on scientific and technological challenges related to Artificial Intelligence (AI), Bioengineering (BIO), Communications (COM), and Computer Science and Engineering (CSE) scientific domains. CTM is fully committed to the vision and mission of INESC TEC and specialises them as follows:

Vision: A lively and sustainable world where networked intelligence enables ubiquitous interaction with sensory-rich content.

Mission: To research and develop advanced systems and technologies that enable autonomous communications systems, media knowledge extraction, and immersive ubiquitous multimedia applications.

Aligned with the related scientific domains (SD), vision and mission, research at CTM is organised in five research lines: optical, radio and electronics engineering, wireless networking, media platforms and audio-visual content management, machine perception, and medical image analysis.

Research outcomes in 2024

The main broad research achievements obtained by **CTM** in 2024 were:

- 27 articles published in relevant scientific journals, 78% of them in Q1 journals.
- 5 PhD and 70 MSc theses were successfully defended.
- Awards: 7 FCT PhD scholarships, ANACOM URSI Portugal 2024 (best research work), 2 best paper awards (AMAI 2024, BIOSIG 2024), European Association for Biometrics Max Snijder Award (for contributions to the field of biometrics), 1 best MSc thesis award (from APRP), 1 PDEEC Best TRP 2024.
- 2 visitors under the visiting researcher programme (Di Kong, Univ. Oulu, and Miguel Gaitán, Pontificia Universidad Católica de Chile).
- Start of coordination of 1 European project (AI4Lungs) and participation in another (REPLICA).
- Organisation of INVICTA 2024, a spring school of artificial intelligence, computer vision and pattern analysis, and the summer school on sound and music Computing.

The main research achievements obtained by the **OET Area** in 2024 were:

- **Experimental demonstration of Hand Gesture Recognition enabled by a 6 GHz RIS prototype and Machine Learning** including the publication of a dataset for three different hand gestures. This work was awarded with the ANACOM-URSI Portugal award [SD: COM].
- **Proposal of a Multi-Level Intermediate Representation dialect compilation approach** capable of jointly representing streaming and vector processing operations suited for streaming-oriented hardware accelerators. This work was published in the ARC 2024 conference [SD: CSE].
- **Groundbreaking survey showing that light spectroscopy can be used efficiently to evaluate the diffusion properties of agents** in biological materials as well as to acquire both physiological and diagnostic data. This study was published in the Advanced Drug Delivery Reviews Journal [SD: BIO].

The main research achievements obtained by the **WiN Area** in 2024 were:

- **RL-based traffic and obstacle-aware UAV positioning approach**, allowing better network performance in urban environments. This work was published in IEEE Access Journal [SD: COM].
- **Sustainable multi-UAV performance-aware placement algorithm for flying networks**, optimising flight trajectories to save energy. This work was published in IEEE Access Journal and in proceedings of IEEE WiMob 2024 [SD: COM].
- **Multimodal underwater wireless communications manager**, improving underwater network performance. This work was published in proceedings of IEEE MELECON 2024 [SD: COM].

The main research achievements obtained by the **MCT Area** in 2024 were:

- **Models and algorithms for enhanced visual information processing and analysis**, new algorithms and models to improve the processing of visual information, augmenting performance and flexibility. This work encompasses models for analysis, description and representation/visualisation. This work was submitted to IEEE Access and IEEE Tran MM [SD: AI].
- **Movie trailer genre classification using multimodal pretrained features**, novel method for movie genre classification by intelligently fusing pretrained features. This work was published in the Q1 journal Expert Systems with Applications [SD: AI].

The main research achievements obtained by the **VCMi Area** in 2024 were:

- **Weather and meteorological optical range perception in autonomous driving**, through deep learning-based architectures, employing early and intermediate sensor fusion and multi-task strategies. Work published in IEEE Transactions on Intelligent Vehicles [SD: AI].
- **Medical case-based explanations anonymisation**, through a disentanglement mechanism that encode the images' identity and medical characteristics ensuring feature preservation. Work published in MEDICAL IMAGE ANALYSIS [SD: AI,BIO].
- **Interpretable machine learning system for colorectal cancer diagnosis from pathology slides** through a scalable AI combining mixed supervision, an efficient sampling strategy, and explainable predictions, achieving high accuracy and robustness across multiple datasets. Work published in Computers in Biology and Medicine [SD: AI,BIO].

Innovation outcomes in 2024

The main broad innovation achievements obtained by **CTM** in 2024 were the following:

- Participation in Discussion Panel at Hannover Messe 2024 and at the conference “5G in the Industry 4.0” organised by ANACOM. Organisation of the National Music Research Meeting and jury for the Masters R&D competition, Abilways Portugal, 2024.
- Submission of 1 patent.
- Implementation of the 4.5-day week phase two.

The main innovation achievements obtained by the **OET Area** in 2024 were the following:

- **Approval of 2 contributions to the standards group ISG ISAC, from ETSI**, ensuring the inclusion of 2 use cases on 1) vision-aided smart traffic management and 2) emergency vehicle route planning, included in the group report ETSI GR ISAC 001: “Integrated Sensing And Communications (ISAC); Use Cases and Deployment Scenarios” [SD: COM].
- **Development of a novel calibration method for microwave-based moisture measurement of cork-stoppers**, ensuring long term repeatability of measurements in factory environment [SD: COM].

The main innovation achievements obtained by the **WiN Area** in 2024 were the following:

- **Patent submission of an architecture to integrate real-time multi-modal sensing and telecommunications networks**, by integrating radio and video sensing data to enhance real-time decision making in Radio Access Networks (RANs), E.g., 5G/6G [SD: COM].
- **Development of a standard-compliant RFID reference architecture to integrate automatic asset tracking capabilities in an industrial setting**, contemplating the integration with legacy systems and the real processes and constraints of the cork industry [SD: COM].
- **5G Pilots validating the use of 5G cellular communications for industrial applications**, including remote video capturing over 5G for cloud-assisted computer vision applications, and asset localisation and tracking via active tags and 5G-enabled IoT gates [SD: COM].

The main innovation achievements obtained by the **MCT Area** in 2024 were the following:

- **Framework for multimodal speech prosodic irony analysis**, tools for irony and sarcasm classification, through prosodic feature analysis in a multimodal dataset (text and speech). This work is available as open source software (https://github.com/jfforero/Prosodic_Irony) [SD: AI].
- **VEMOCLAP**, a video emotion classification web application using pretrained features. Outcomes: published in IEEE ISM conference and as an online web application (serkansulun.com/app) [SD: AI].

The main innovation achievements obtained by the **VCMi Area** in 2024 were the following:

- **Computer aided detection of deep inferior epigastric perforators in computed tomography angiography scans**, fully integrated in partner platform for medical daily-routine use [SD: AI,BIO].
- **AI tool for visualisation of photographs of “similar” patients submitted to the same treatment**, can optimise the match of expectations of the patient before and after treatment and the satisfaction with actual results of breast cancer patients proposed for locoregional treatment [SD: AI,BIO].

Activity Overview

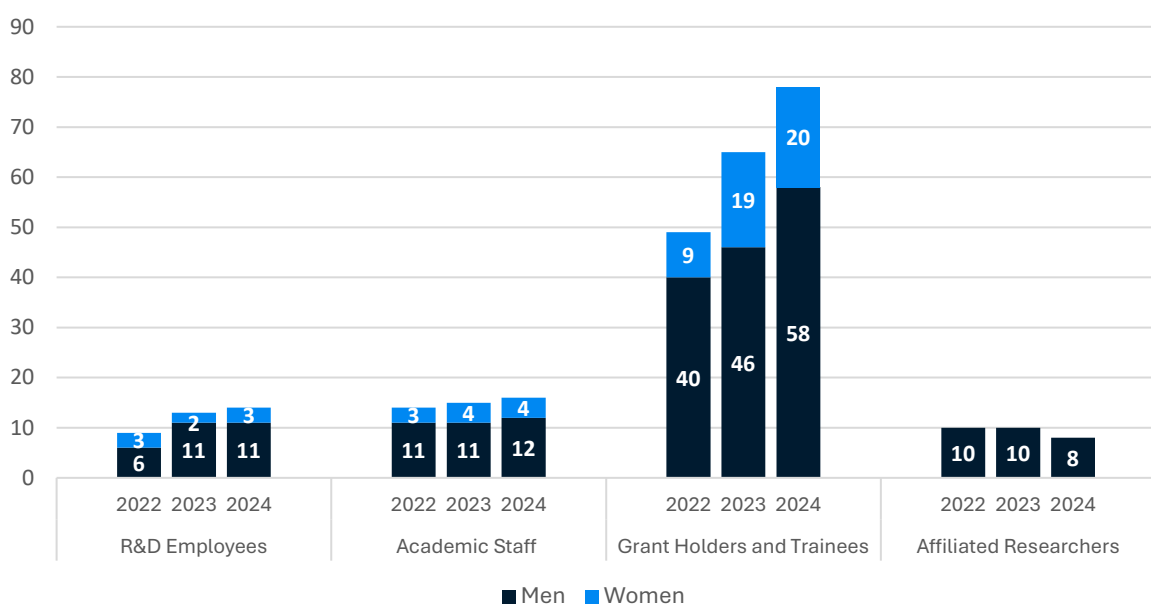


Figure 6.1 - CTM - Research team evolution

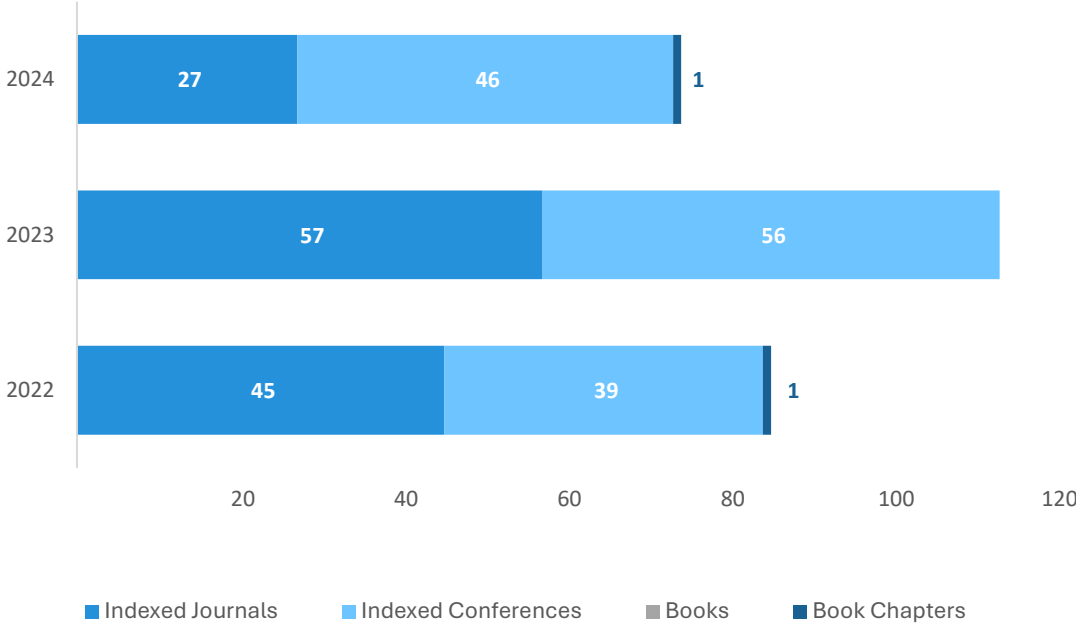


Figure 6.2 - CTM - Evolution of publications by members of the Centre

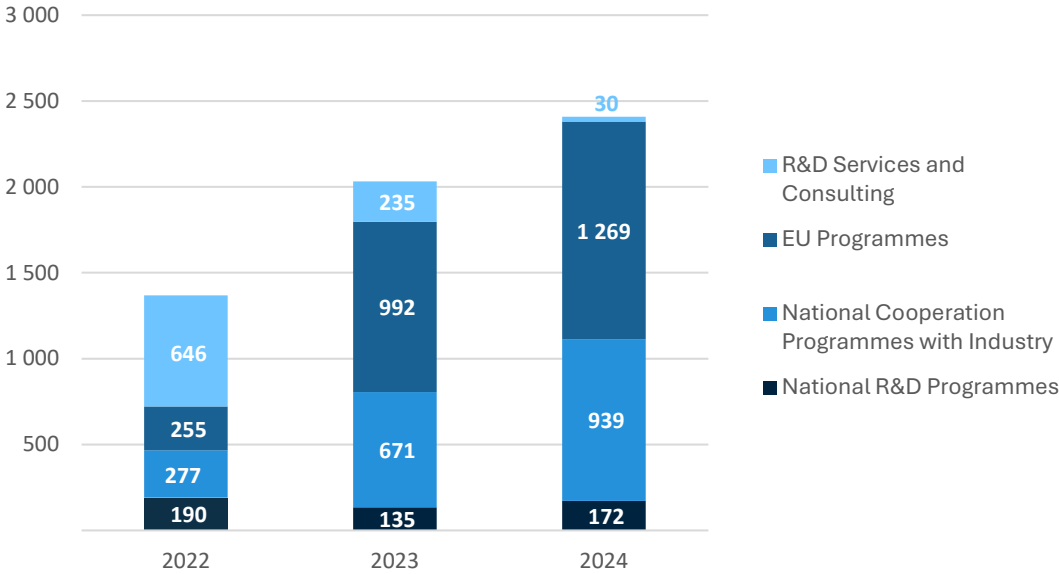


Figure 6.3 - CTM - Project funding evolution (k€)

6.2 CAP - CENTRE FOR APPLIED PHOTONICS

Coordinators: Paulo Marques and Ireneu Dias

Presentation

CAP accomplishes its mission within the Photonics Domain by directing its activities towards four main areas of research: integrated optics and microfabrication, optical sensors, comprising physical and chemical/biosensors, and quantum optical engineering. This organisation is non-hermetic and the development of solutions implies multidisciplinary and cooperative work from the different fields of the available expertise.

Of particular importance is the insertion of the Centre and its dissemination activities within the universe of the DFA (Department of Physics and Astronomy of the Faculty of Sciences of the University of Porto) that hosts the Research Centre, supporting advanced laboratory lectures of MSc and PhD teaching programmes.

Research outcomes in 2024

The main research outcomes can be aggregated according to three main areas of application.

Development of photonic based platforms for environmental monitoring, medical diagnostic, and industrial applications

Enhanced refractive index sensitivity (RIS) of plasmonic optical fibre sensors with Au nanoparticles, highlighting the roles of nanoparticle size and surface coverage. The exceptional RIS, attributed mainly to SPR effects, was validated through highly sensitive thrombin protein detection, showcasing the potential of these sensors in biomedical diagnostics, environmental monitoring, and chemical analysis.

Theoretical and experimental evidence of nanoparticle-induced SPR (NPI-SPR) in optical fibres, where light scattering from Au nanoparticles on a thin metallic film enhances SPR. This configuration enables highly sensitive biosensing, achieving a 0.004 nm detection limit for thrombin protein—20 times more sensitive than conventional SPR. Exciting Surface Plasmon Resonances on Gold Thin Film-Coated Optical Fibres Through Nanoparticle Light Scattering.

Numerically and experimentally demonstration of excitation of surface plasmon polaritons (SPPs) and Bloch surface waves (BSWs) in a 1D metal–dielectric photonic crystal composed of an Ag–TiO₂ thin-film stack. The results show that BSWs behave similarly to those in all-dielectric photonic crystals, while SPPs resemble those in metal–insulator–metal cavities. The sensitivity of these surface states to refractive index variations highlights their potential for optical sensing, offering a flexible platform for designing novel sensor structures.

Long-Term Stability Assessment of Pd-Coated Fiber Bragg Gratings protected with a thin PTFE layer, examining their viability as hydrogen (H₂) sensors after a decade. Results indicate that PTFE-protected Pd coatings retain their original sensitivity and exhibit greater longevity compared to unprotected films. These findings underscore the crucial role of protective polymer layers in enhancing the durability of Pd films, ensuring they meet the five-year operational lifespan required for practical H₂ monitoring applications.

Photonic sensing for extreme environments

A white light interrogation system was developed for precise absolute temperature measurements, with a reading capacity of 1 kHz. Resolutions as low as 1 millikelvin were achieved through the use of a reference cavity in integrated optics, manufactured from glass with zero thermal expansion in the temperature range of -10 °C to 40 °C.

Study and characterisation of azobenzene films for applications in polarimetric sensors. Quarter-wave plates were developed, and their application in optical fibres was initiated.

In the context of distributed fibre sensing technology, monitoring of high-power grids electric cables was achieved via its OPGW cable. Monitoring of the Sagres submarine cable within the scope of REPMUS, was achieved using a DAS system.

Optical systems and devices for analogue quantum simulations

Our work in 2024 continued along the two major research vectors that support our team:

Spectral Imaging for robust industrial applications

This topic aligns with Research Challenge 1: Development of photonic based platforms for environmental monitoring, medical diagnostic and industrial applications and envisions the design of industry-grade solutions. Highlights go to major achievements:

- Successful Consulting Services to BA Glass (Glass Recycling Process) and Egitron (Development of a LIBS-based product) which reinforces the go-to-market potential of the solutions we have been developing within this research line;
- The Spectral Knowledge Distillation technology (patent pending) was awarded with the BIP Proof Prize (2023) due to the potential of the technology. In the last year, the technology resulted in multiple high-profile publications in reputed journals like Scientific Reports.
- Proof-of-concept of a LIBS-based solution for online wood contaminant detection in recycling pipelines, validated with XRF technique, and scheduled to be implemented as a new prototype in 2025.

These advances, along with others not reported here in the subjects of sensor fusion and data processing, and innovative studies with Raman and XRF techniques as well as Augmented reality tools, strengthen our position closer to industry.

Quantum Simulation and all-optical processing

Aligned with “Research Challenge 3: Optical systems and devices for analogue quantum simulations.” we fulfilled the objectives for 2024, highlighting the major achievement:

- Deployment of a world-unique versatile platform for analogue simulation of quantum fluids, with optical reinjection capabilities and potential for topological matter studies.

Together with the significant upgrade of the research infrastructure with equipment to support high-profile quantum research (single photon sources, detectors, crystals), positioned us in an emergent role at national and international level. Indeed, multiple collaboration project proposals are now under evaluation, highlighting a recently funded bilateral project with the Sorbonne University.

Innovation outcomes in 2024

Optical and Electrochemical Sensor Integration - A novel methodology was developed to enhance sensor performance by integrating optical and electrochemical sensing. This approach leverages real-time plasmonic effects and specifically designed electrochemical electrodes configured on planar substrates. The fabrication includes selective membranes within a specially designed fluidic chamber to optimise detection capabilities. This technology is set for patent submission.

Fiber Optic-Based Sensing for Concrete Structures - Under the PRR ATE project, advancements have been made in developing different sensing prototypes utilising fibre optics for real-time monitoring inside concrete structures. These sensors measure humidity and temperature during the curing process of concrete fabrication and detect water penetration when deployed in ocean environments. This technology is in preparation for patent submission.

Methane Sensing in Natural Gas Distribution - Progress has been achieved in the development of a methane monitoring prototype under the PRR ATE project. This system measures real-time methane concentrations by detecting specific absorption bands at 1650 nm, providing accurate and efficient monitoring within natural gas distribution networks.

Hydrogen Leak Detection in Storage and Distribution Systems - Efforts under the PRR ATE project were focused on the development of hydrogen leak detection prototypes for storage and distribution systems. The goal is to detect hydrogen leaks as quickly as possible in multiple locations using dedicated electronic

systems and advanced nanotechnology to fabricate highly selective thin-layer materials. This technology is also set for patent submission.

Sensors for Aquaculture Systems under the INNOAQUA Project - Sensors for dissolved CO₂ and nitrates have been developed and prototyped for installation in aquaculture systems for algae cultivation, patent submission underway.

Phase-Shifted Fiber Bragg Grating by Selective Pitch Slicing for refractive index measurement.

Activity Overview

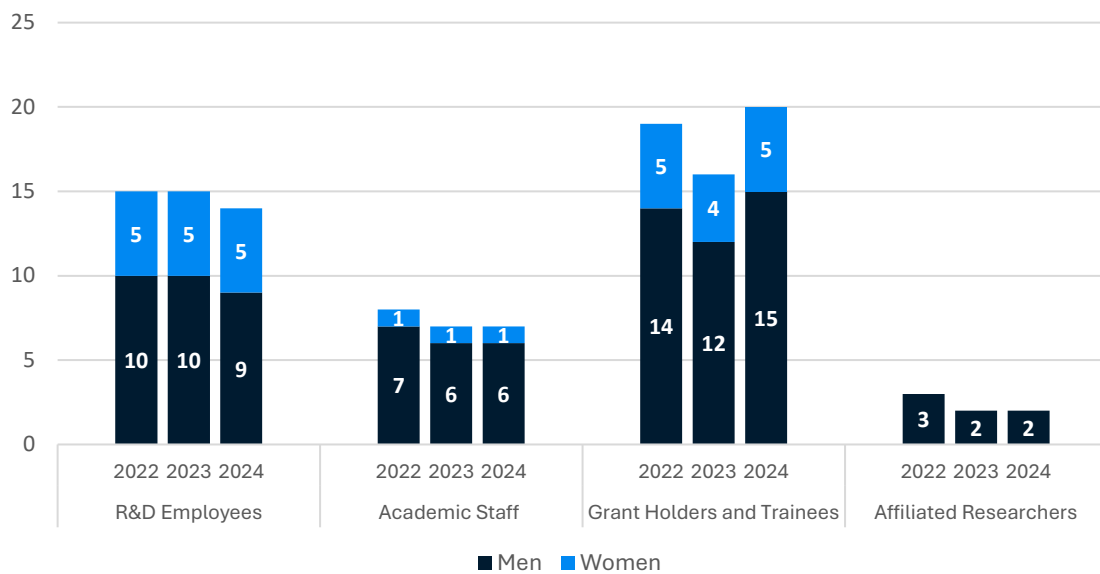


Figure 6.4 - CAP - Research team evolution

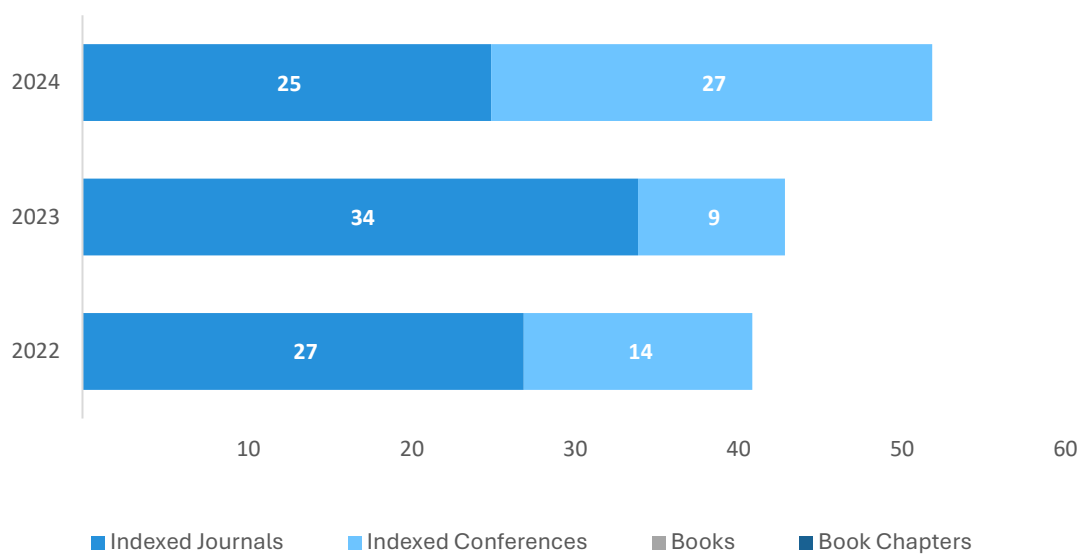


Figure 6.5 - CAP - Evolution of publications by members of the Centre

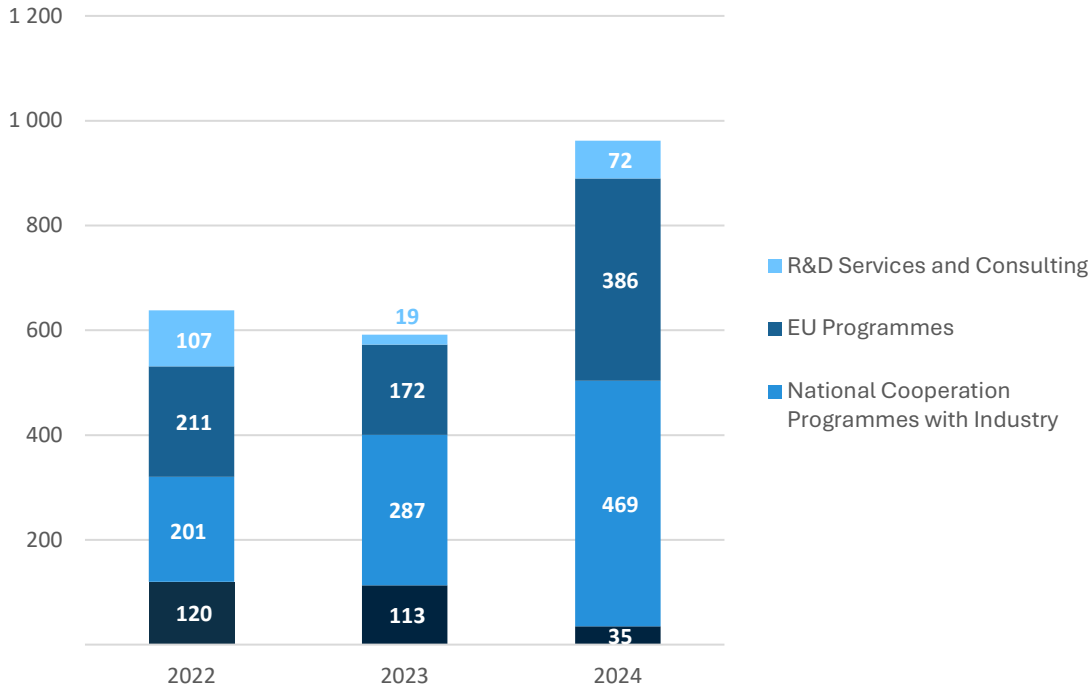


Figure 6.6 - CAP - Project funding evolution (k€)

6.3 CRAS - CENTRE FOR ROBOTICS AND AUTONOMOUS SYSTEMS

Coordinators: José Miguel Almeida and Nuno Cruz

Assistant to the Centre Coordinator: Bruno Fernandes

Presentation

The Centre for Robotics and Autonomous Systems (CRAS) brings together more than 80 researchers on scientific and technological topics associated with field robotics and autonomous systems. CRAS aims to be a world reference in the field of robotics and autonomous systems. It is already internationally recognised for its innovative robotics solutions for operating in complex environments - relevant examples are underwater environments and deep-sea waters.

CRAS has a unique scientific focus on multi-sensor perception, navigation, positioning, and sensor fusion competencies. CRAS fulfils its mission by directing its activities towards four main research areas: navigation and control (RL1), interaction with the environment (RL2), perception and mapping (RL3), and platforms and operations (RL4).

CRAS's activities are mainly at TRL levels 5-8, associated with the design, development, and integration of robotic platforms with increasing autonomy. These activities have contributed to deploying innovative solutions in multiple fields of application, such as security, protection and defence, underwater mining, environmental monitoring, deep sea exploration, and infrastructure inspection. These activities are organised into four innovation topics: prototyping and scaling up robotic systems (INOV1), navigation and mapping (INOV2), development of components for robotic systems (INOV3), and underwater acoustics for positioning, navigation, and communications (INOV4).

Research outcomes in 2024

In 2024, the Centre was involved in 29 research projects, covering all the research lines. Seven of these started in 2024, ensuring that the main research lines will continue to receive significant funding. This large number led to an increase in the number of researchers, four of whom completed their PhDs, the highest number of the Centre in a year. Their thesis provided significant contributions in underwater navigation and perception, as well as innovative approaches to operations with marine robotic systems (RL3 and RL4). Another milestone of the Centre was the first publication and presentation at the ICRA 2024 conference in Japan, one of the most prestigious robotics conferences. This resulted from another doctoral work by one of CRAS's researchers, allowing underwater spaces to be mapped using open-space modelling with sonar data. This technique allows for the iterative construction of three-dimensional underwater maps based on the interpretation of data collected in real time by sonars.

Overall, CRAS researchers published 23 journal papers in 1st quartile scientific journals, along with over 32 presented and discussed in prestigious international conferences. At the same time, there was an increase in the participation of CRAS members in Editorial Boards of major publishers and active involvement in the organization of international conferences. The international community has widely recognised the scientific merit of the Centre's researchers through several important signals. Several members were invited to give lectures during visits to partner institutions, both in Portugal and abroad. In addition, throughout the year, the Centre received international delegations of researchers, mainly renowned academics in the field of robotics, interested in establishing collaborations. As an important signal of recognition, during the summer of 2024, the Centre received a group of 6 French university students, who spent between 3 and 5 months in internships.

Main scientific results achieved:

- Innovative technique that allows the iterative construction of three-dimensional underwater maps based on the interpretation of sonar data in real-time. Work published and presented at the ICRA 2024 conference in Japan.
- A method for an underwater vehicle to approach a mooring line and take reference measurements along the cable for in-situ sensor calibration, using a Mechanically Scanned Imaging Sonar (MSIS) for cable detection through noise filtering, template matching, and a track-before-detect approach

with the Viterbi algorithm, achieving sub-meter accuracy in both pool and sea trials, with implementation code shared for reproducibility. Work published in IEEE Transactions on Mobile Computing.

- A compact, optically robust, edge-computing hybrid imaging system for high-precision 3D inspection of submerged critical structures, validated through controlled trials and real-world deployment, achieving millimetric accuracy in volumetric reconstruction of sacrificial anodes and revealing biofouling layers, demonstrating its potential to enhance underwater vehicle situational awareness for offshore maintenance. Work published in Elsevier's Ocean Engineering.
- A LiDAR-based autonomous UAV inspection strategy for offshore wind turbines, introducing a realistic simulation environment for testing and training inspection techniques, where the UAV estimates the turbine's pose, orientation, and blade configuration to perform close-range inspections, validated through simulation and mixed reality tests with real UAVs. Work published in MDPI Drones.

Innovation outcomes in 2024

As innovation results, the project entitled 'Innovation underwater cable condition inspection techniques based on Electromagnetic fields (EMF), supported by robotic platforms was contracted for the company China Three Gorges. This multi-year project aims to develop technological solutions to help assess the condition of underwater cables, based on autonomous underwater vehicles equipped with innovative sensors and technologies, as well as cutting-edge methodologies.

Another result of innovation was a joint mission with a team from the Underwater Technology Laboratory (LASUB) of the Federal University of Santa Catarina in Brazil, where it was possible to test the acoustic localisation technology used in underwater robots. Participation in the NATO REPMUS 2024 naval exercise included exercises related to the protection and monitoring of critical infrastructure in the deep sea, as well as a mission under the TRIDENT project on board the ship Mário Ruivo operating vehicles at a depth of 1,000 meters. The action to monitor sea noise and locate cetaceans off the Azores using synchronised acoustic sensors installed on buoys was also a result of CRAS innovation.

CRAS members have organised various workshops, seminars, and summer courses to share their results and competences. Some of these events were strategic, either because of the relevance of the topic or the profile of the target audience. Examples include:

Dissemination at technology discussion events:

- SOE'24 | Space, Ocean, and Earth Insights – a unique event to push the limits of science and technology in space and ocean-related research that took place during the GLEX summit.
- Oeiras Bluetech Ocean - A conference that brought together 200 experts from all over the world to debate technological advances and various innovation models linked to the Blue Economy.

Dissemination of CRAS technologies and solutions, by taking stands to relevant robotics events:

- WAVES 2024 - The second edition of WAVES 2024 - Workshop on Advanced Vehicles for Exploration of the Seas brought together the scientific and business community of the Azores to discuss the use of underwater equipment in tackling the region's challenges. Relevant case studies were presented, such as monitoring marine biodiversity and assessing the acoustic impacts of human activity. CRAS participated with an autonomous underwater vehicle (AUV) and drifting buoys to monitor Azorean waters, demonstrating the potential of these technologies for science and industry in the region.
- OCEANS 2024 Singapore – This is the flagship event of the IEEE Oceanic Engineering Society, attracting around 2000 international visitors, from academia, navies and industry. Having a booth at this major event ensured a large dissemination of capabilities.

Inviting organisations and representatives from targeted sectors to visit our laboratories to showcase our technological solutions:

- Visits of representatives of Public Organisations - Showcasing the facilities to demonstrate advanced equipment and techniques resulting from research that has led to technological innovations. We highlight the visits by the Secretaries of State for the Sea and the Economy.
- Visits of companies and representatives of industrial sectors – several visitors throughout the year attended demonstrations, exhibits and technical talks, highlighting the Centre technologies and competences.

Activity Overview

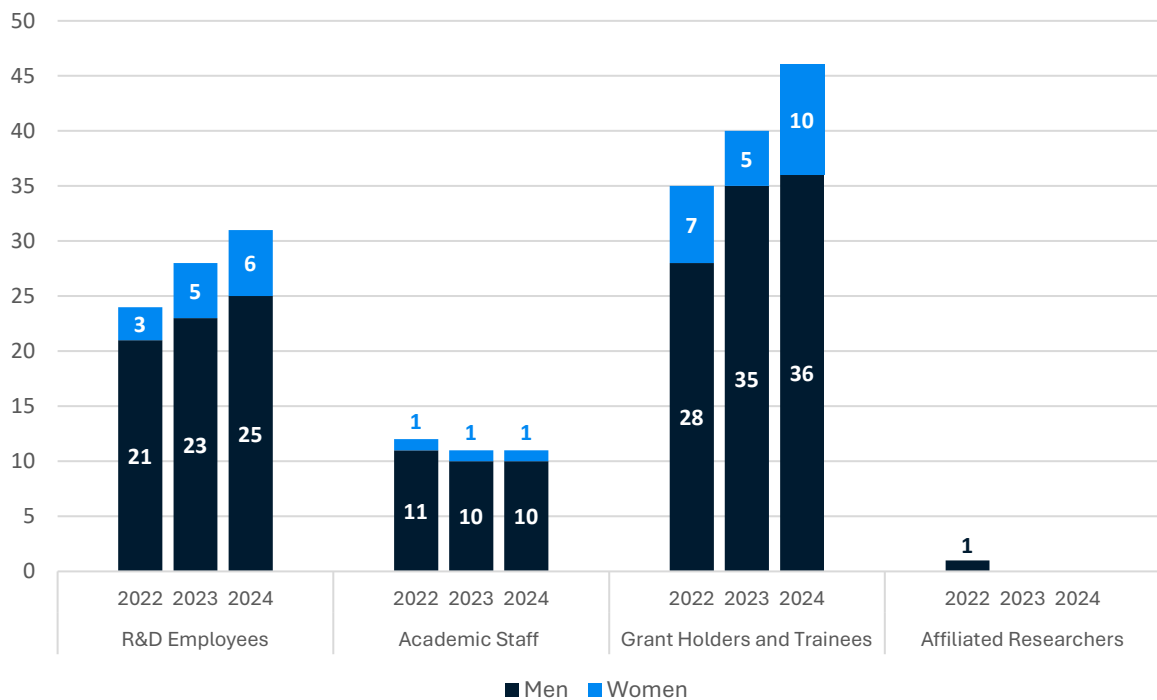


Figure 6.7 - CRAS - Research team evolution

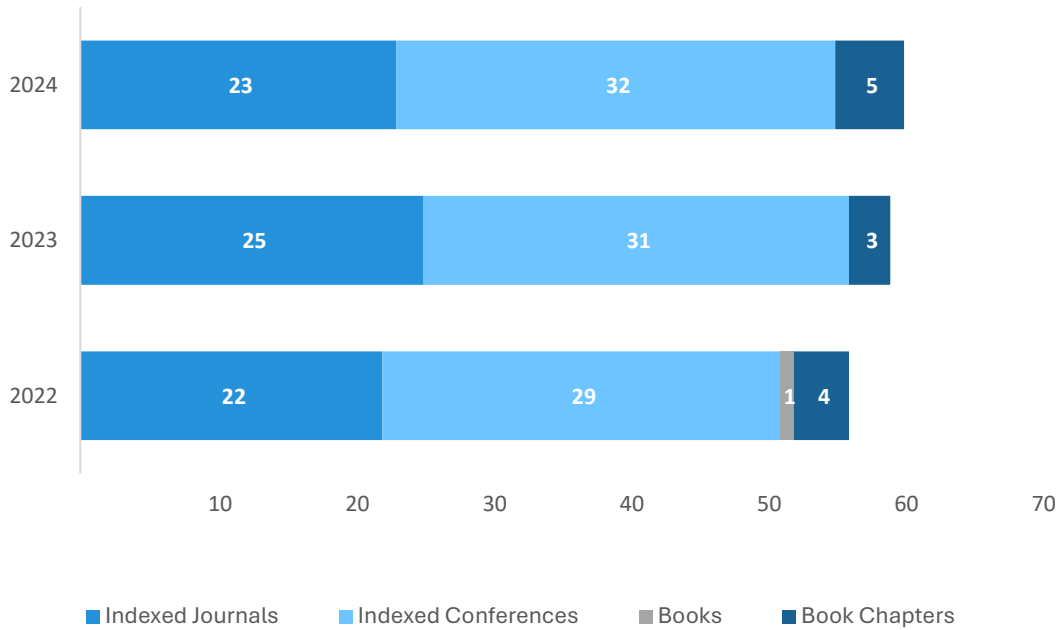


Figure 6.8 - CRAS - Evolution of publications by members of the Centre

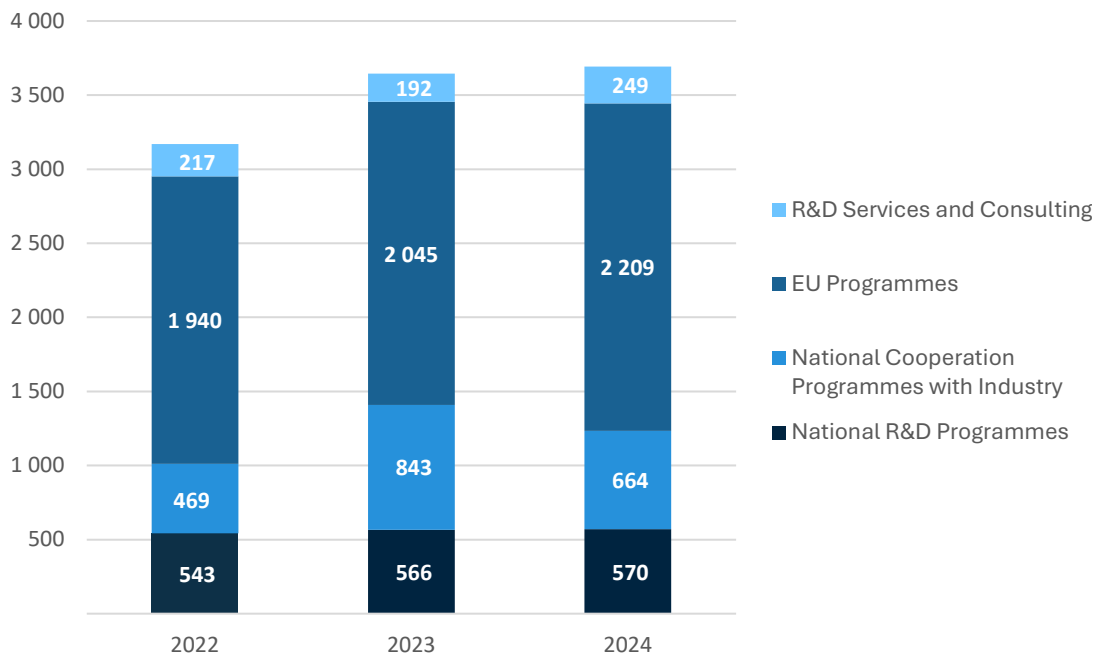


Figure 6.9 - CRAS - Project funding evolution (k€)

6.4 C-BER - CENTRE FOR BIOMEDICAL ENGINEERING RESEARCH

Coordinator: João Paulo Cunha

Assistant Centre Coordinator: Duarte Dias

Presentation

The Centre for Biomedical Engineering Research's (C-BER) main objective is “to promote scientific knowledge excellence through fundamental and applied research, advanced training and innovation in Biomedical Engineering”. Mainly focused on the Bioengineering domain, C-BER has a high level of multidisciplinary among its researchers, leading to research on other INESC TEC domains, such as Artificial Intelligence, Photonics and Robotics. To accomplish its mission, C-BER is organised into three Labs (Biomedical Imaging Lab, BioInstrumentation Lab and NeuroEngineering Lab), and is guided by the following strategic goals:

- **To create interdisciplinary knowledge** enabling innovation and technology transfer with economic impact;
- **To develop bioengineering** methods, products and tools for the prevention, early detection and diagnosis of different types of diseases, aging-related impairments, rehabilitation, occupational health and wellness;
- **To contribute** to the development of advanced **neuro-technologies** at the frontier of engineering and neuroscience;
- **To promote internal synergies and strategic partnerships** with other Centres of INESC TEC, clinical partners, research institutes, medtech companies & startups and foster international cooperation.

Research outcomes in 2024

Organisation, human and material resources: During this year, it was possible to contract the expected number of researchers, overcoming the difficulty from 2023, leading to double the number of researchers with contracts, namely two new post-docs and two new Masters. In 2024, there was a huge effort coordinating and performing R&D on what we can already consider a diverse portfolio of projects for a small research centre as C-BER: 4 European projects (1 coordinated), 2 FCT projects coordinated, 3 National projects with companies (PRR and P2020), 2 INESC TEC seed projects coordinated and 4 research contracts with companies. With such a diversity of projects, we believe C-BER is growing its research activity sustainably and reliably, always with a strong effort on the procurement for new projects, which has already led to the approval of two new projects at the end of 2024: one FCT and one National Project with a company (P2030). Compared with 2023, in 2024, C-BER also doubled its total income and is expected to continue such a trend in 2025.

An unexpected change was the reduction of two academic members, which will be overcome in 2025 to have less impact on the research activity.

Publications: From 2023 to 2024, C-BER was able to achieve its goal on the increase of publication relevance, with an estimation of 83% of the 20 publications in SCOPUS “1st Quartile”, which placed C-BER as the centre at INESC TEC with the highest publication indicator per FTE (full-time equivalent). Some of these high-impact papers are worth mentioning: two publications in Nature, one in Nature Communications Engineering Journal that focuses on biosensing with optical fibre tweezers⁵, and another in Nature Scientific Report journal that focus on explainable AI on chest radiographs⁶.

⁵ <https://www.nature.com/articles/s44172-024-00240-1>

⁶ <https://www.nature.com/articles/s41598-024-82222-z>

Besides journal publications, C-BER also made a significant effort to publish in indexed conferences, with a total of 32 4-page papers. Two publications on movement analysis are also a 2024 landmark: one in the Computer Methods and Programs in Biomedicine Journal that focuses on Machine learning in gait analysis for motor-cognitive screening in older adults⁷ and another on Image and Vision Computing Journal focus on deep learning methods on clinical in-bed movement action recognition⁸.

Internationalisation: The strong internationalisation effort from previous years is now showing its results. Both Brazil and Rwanda partners are now collecting data for C-BER research on multiscope research lines, contributing to both newborn characterisation of pulmonary artery hemodynamic and rheumatic heart disease detection. C-BER hosted several international students and researchers: one post-doc from Polytechnic di Torino, one PhD from the University of Castilla La Mancha, and one PhD from Rice University (Robinson Lab). A CMU-Portugal PhD student from C-BER in 2024 did one year of his PhD at CMU at the Robotics Institute co-supervised by Prof. Fernando de La Torre and Prof. Lazlo Jeni, which resulted in very fruitful results, namely a high-impact research paper on movement action recognition (previously mentioned) and a patent that will be published in 2025.

Dissemination Actions: In 2024, our researchers were members of 18 Programme Committees of International Scientific Events, being key representatives at the MELECON 2024: 22nd IEEE Mediterranean Electrotechnical Conference that took place in Porto, Portugal. Members of C-BER were very actively involved (Chair and co-Chair) in the organisation of 3 conferences, including MELECON 2024, as well as others such as EURASIP – European Association for Signal Processing.

Innovation outcomes in 2024

Startups: C-BER in 2024 achieved its 4th generated spin-off startups. Following the “intelligent Lab-on-Fiber” (iLoF) technology developed for several years, a new company was established named Seedsight and won the Altice International Innovation Award. A strong cooperation with InSignals Neurotech is still being maintained with the support of two new clinical trials that the company is performing.

Innovation Infrastructures: According to the C-BER plan to improve Laboratories’ infrastructures, in 2024, C-BER equipped the BRAIN-Stim Lab with a new treadmill and physiological system to collect human multimodal data while performing controlled exercise in the Laboratory. This new system will be available in 2025 with a multimodal synchronised system for the research community. One of the key laboratories in the Faculty of Engineering focused on Mobile mHealth, which was improved with a set of wearable and medical devices for new projects with students, stimulating their knowledge and creativity in this area.

Patents & IP Creation: C-BER continued filling the patent pipeline in 2024. As a result of those actions, C-BER has 2 new patent applications and 1 internationalisation. Furthermore, C-BER during this year increased substantially the number of internal pre-disclosures from 1 (2023) to 8 (2024). This strongly indicates that new technologies will rise in 2025, as expected.

⁷ <https://www.sciencedirect.com/science/article/pii/S0169260724005017>

⁸ <https://www.sciencedirect.com/science/article/abs/pii/S0262885624000313>

Activity Overview

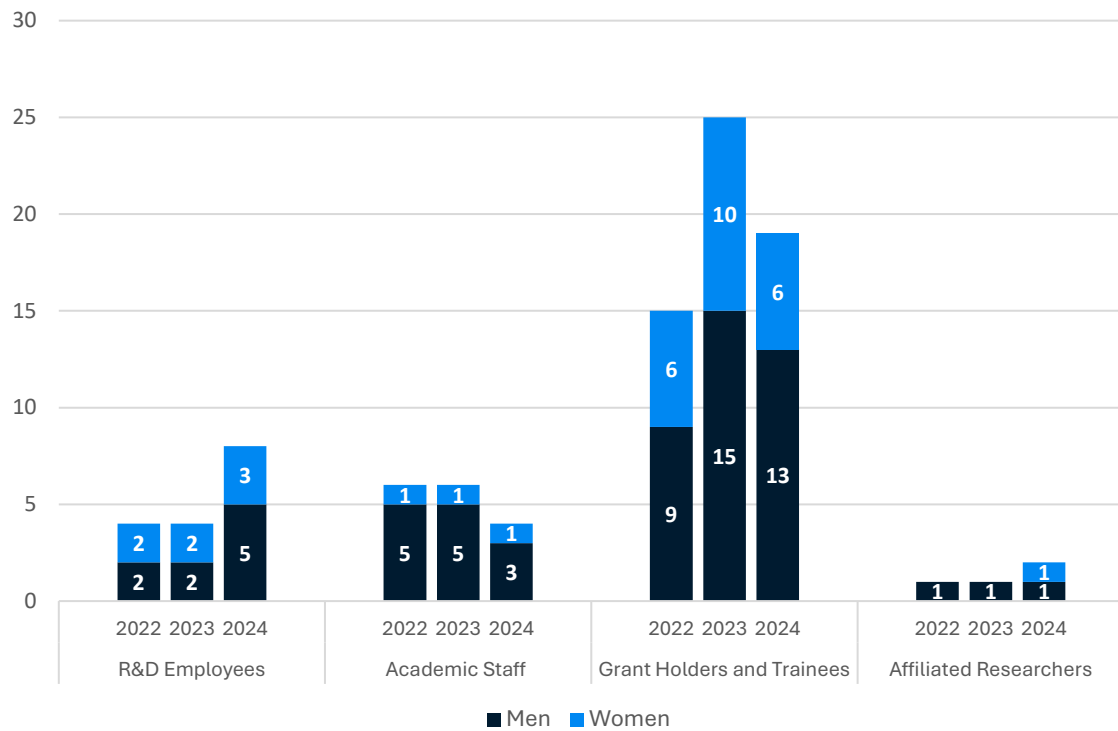


Figure 6.10 - C-BER - Research team evolution

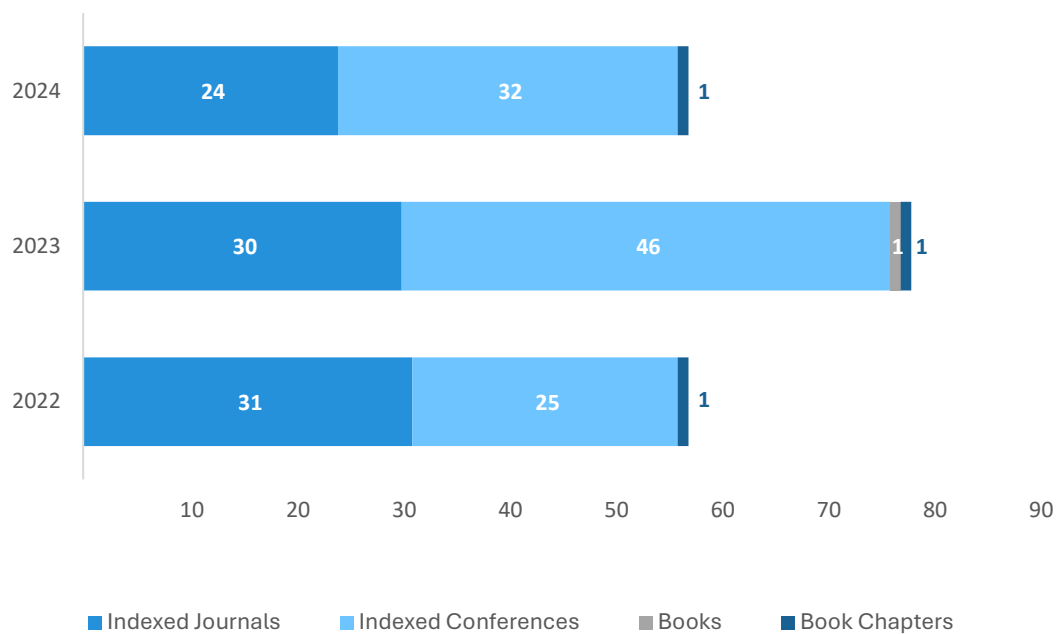


Figure 6.11 - C-BER - Evolution of publications by members of the Centre

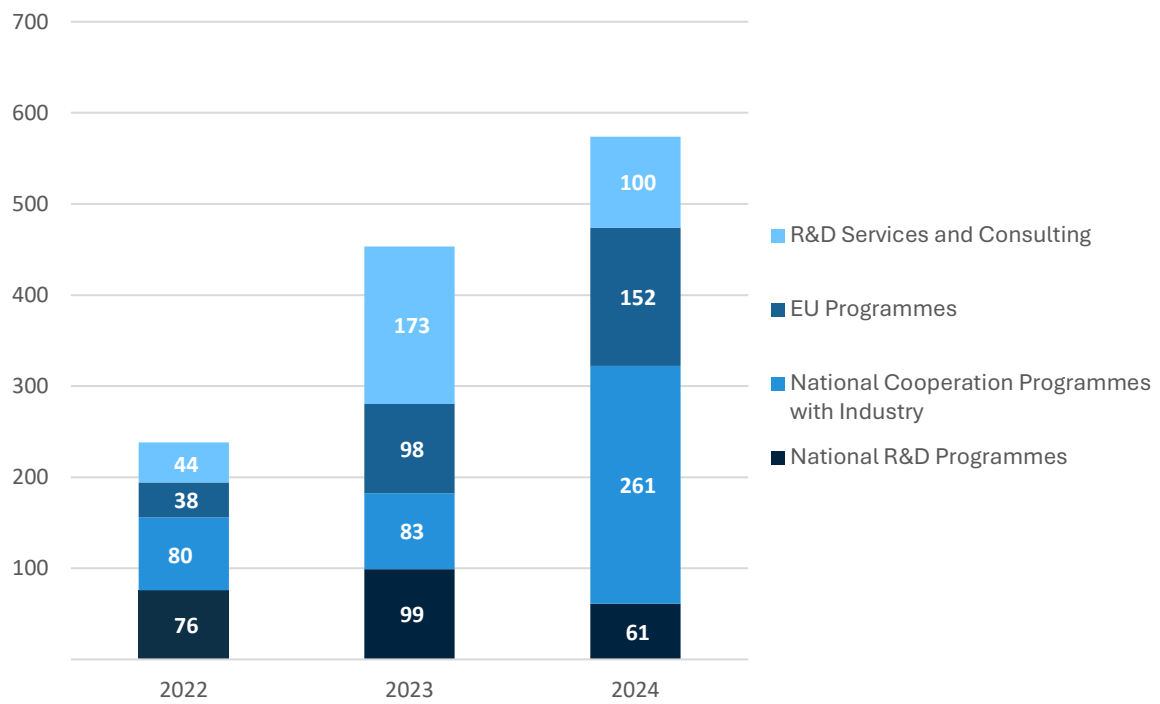


Figure 6.12 – C-BER - Project funding evolution (k€)

6.5 CPES - CENTRE FOR POWER AND ENERGY SYSTEMS

Coordinators: Manuel Matos and Ricardo Bessa

Assistant to the Centre Coordinator: Catarina Oliveira

Presentation

CPES supports the energy transition, leading to a reduction of greenhouse gas emissions via the decarbonisation of the energy system, large-scale RES integration in isolated and interconnected power systems, electrification of the society, and increased energy efficiency. This involves the combination of model (physical) and data-driven methods for modelling and optimising energy systems, leveraging emerging technologies like artificial intelligence, data spaces, and interoperability. Results include concepts, models, methodologies, and (close and open source) software tools useful for addressing the decision problems of citizens, communities, multi-energy utilities, system operators, regulators, policymakers, and government bodies.

Research outcomes in 2024

A novel mathematical model for a local energy community (LEC) that considers three economic approaches to redistributing collective benefits and assets sharing, enhancing fairness and equity. Published in *IEEE Trans. on Smart Grid*. Research on key factors affecting the active/reactive power flexibility area of active distribution networks (ADNs) led to a two-step optimisation model capturing the P/Q flexibility area while considering grid technical constraints. Published in *IET Ren. Power Generation*.

An optimisation-based approach for Virtual Power Plant (VPP) dispatch integrates Power-to-Hydrogen (P2H) with full AC Optimal Power Flow (OPF), optimising green hydrogen use across CHP, industry, and local consumers, reducing electricity costs, boosting self-sufficiency, and enhancing renewable integration. Published in *Int. J. of Hydrogen Energy*. A day-ahead optimisation algorithm for a hybrid RES system producing green hydrogen and ammonia, incorporating a large-scale Li-ion battery, was developed to maximise profit in day-ahead spot and reserve markets. Published in *EEM 2024 Conference*.

Optimisation-based methods were developed for offshore hybrid power plants' optimal sizing and energy management, integrating uncertainty and multiple conflicting objectives to maximise energy delivery and reduce power fluctuations. Published in *J. of Cleaner Prod. and App. Energy*.

A comprehensive assessment of large-scale hydropower deployment for frequency regulation services demonstrated the potential of hydropower inertia and variable speed technology to enhance frequency stability. Published in *Int. J. of Elect. Power & Ener. Systems*. An inflow forecasting tool was deployed for Madeira Island's hydro cascade system with pumping, operating in real-time with weather data. A predictive dispatch tool integrating inflow forecasting and hybrid energy storage optimisation was also developed. Both were published in the *2024 IEEE PEDG Symposium*.

Automation algorithms for adaptive protection strategies in distribution networks with high distributed generation integration were developed, leveraging clustering algorithms to predefine adjustment groups. Published in *PACWC 2024, CIGRE Session 2024, and MEDPOWER 2024*.

A perspective paper on foundation models for electrical grids was published in *Joule* through an EU-US international working group. Also, in AI, the novel evolving symbolic model concept was applied to real-time control of hybrid storage and dynamic security assessment, leading to a patent submission. Published in *J. of Mod. Power Sys. and Clean Energy*.

Contributions to energy policy include: (a) analysis of externalities' impact of RES, published in *Ren. and Sust. Energy Review*; (b) comparison of Portuguese and Italian regulatory approaches for LEC, published in *Energy Policy*; (c) a novel TSO settlement scheme for frequency containment reserve cooperation in Europe's electricity market, published in *Utilities Policy*.

The Centre released 38 software assets with open-source licensing on [GitHub page](#). Hosted Mladen Kezunovic (IEEE Life Fellow) during a sabbatical and created a positive list of journals and conferences.

Innovation outcomes in 2024

The Energy App demonstration generated voluntary demand response signals for forecasted energy scarcity events in European power systems. Published in *iScience*, with code released under an open-source dual license. Industrialisation and licensing of the RECreation software for LEC operations, integrated into the Grid Data and Business Network platform and SAP Cloud.

Integration of data-centric services in the Energy Data Space, including federated learning for energy time series forecasting, storage operation and failure prediction, and LEC sizing and business model evaluation. Implementation of the IN-DATA Data Cooperative (Innovation Energy Data Space) for real-time monitoring of 39 domestic consumers, contributing to the internal Sentinel open-data initiative. Published in *IEEE Power and Ener. Magazine*. It is a node of a Testing and Experimentation Facility for AI.

A consultancy methodology identified Portuguese transmission grid reinforcements for offshore wind power integration, considering various underwater grid architecture solutions. Feasibility studies assessed onshore renewable energy supply for Madeira Island using Monte Carlo Chronological Simulation to determine renewable capacity expansion needs based on reliability thresholds. Studies evaluated Mozambique's electricity demand coverage with increased renewable energy, developing capacity maps and identifying necessary transmission reinforcements.

Development of new AC chargers for electric vehicles with edge computing capabilities for local data collection, storage, and communication via APIs, supporting protocols like ISO 15118 and Open Charge Point Protocol (OCPP). Algorithms for estimating charging energy, predicting transactions, and forecasting station occupancy were also developed to support smart charging optimisation.

Support for the *Plano de Desenvolvimento e Investimento da Rede Nacional de Distribuição* (PDIRD-E) 2024, assessing investment impacts on supply security, service quality, grid efficiency, operational efficiency, and access to new services.

R&D services for *Elergone Energias* improved forecasting accuracy by 16% through enhanced data pipelines and tailored models. For Elia Group, an operational collaborative forecasting prototype was developed and is used daily by 20+ companies, with commercialisation potential beyond April 2025.

A cost-benefit analysis methodology for energy storage management strategies assessed arbitrage and system services for a 12MW/24MWh pilot, evaluating economic benefits, battery cycling, and degradation impacts using INESC TEC's storage management module, adapted for market participation.

An international contract was secured for developing distributed automation applications for GE Vernova's Zonal Autonomous Controller, with a transmission grid management application maximising renewable integration through grid asset flexibility. It was tested at the x-energy lab and demonstrated at *CIGRE Session 2024*.

A comparative analysis of AC/DC rectifiers for hydrogen electrolyzers included hardware validation of a buck circuit, simulation model completion, and LVRT/frequency response testing of the power conversion chain.

Testing and deployment of the first IEEE2030.5 legacy protocol converter were conducted in the x-energy lab. A new framework for fast and easy Semantic Interoperability (SEMAPTIC) was also presented at *MEDPOWER 2024*.

Active participation in international associations led to (a) open-source semantic interoperability framework contribution to ETSI; (b) ETIP SNET Energy Data Space policy paper; (c) Blueprint for the Common EU Energy Data Space; (d) CIGRE technical brochure on AI in system operations; (e) leading roles in CIGRE, IEA, and IEEE working groups and task forces.

Activity Overview

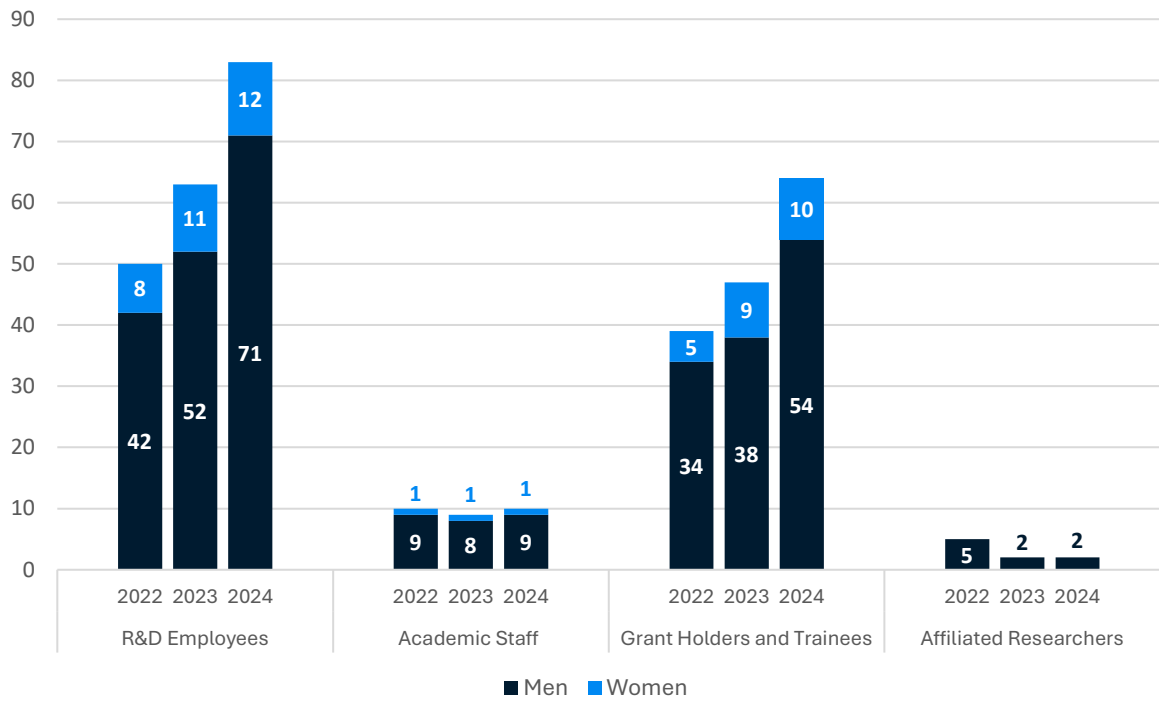


Figure 6.13 - CPES - Research team evolution

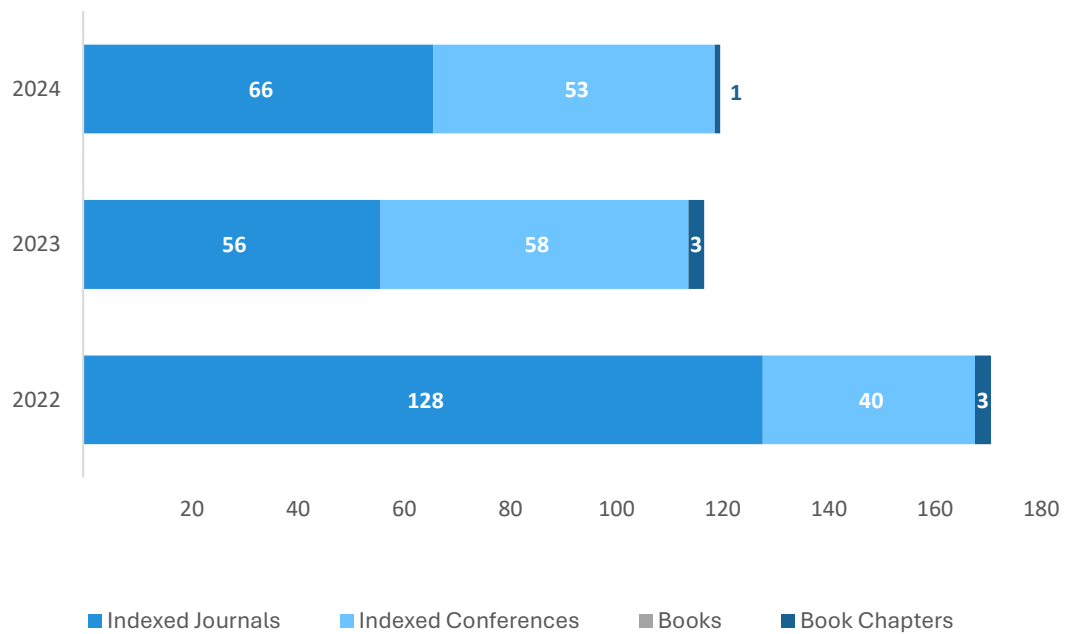


Figure 6.14 - CPES - Evolution of publications by members of the Centre

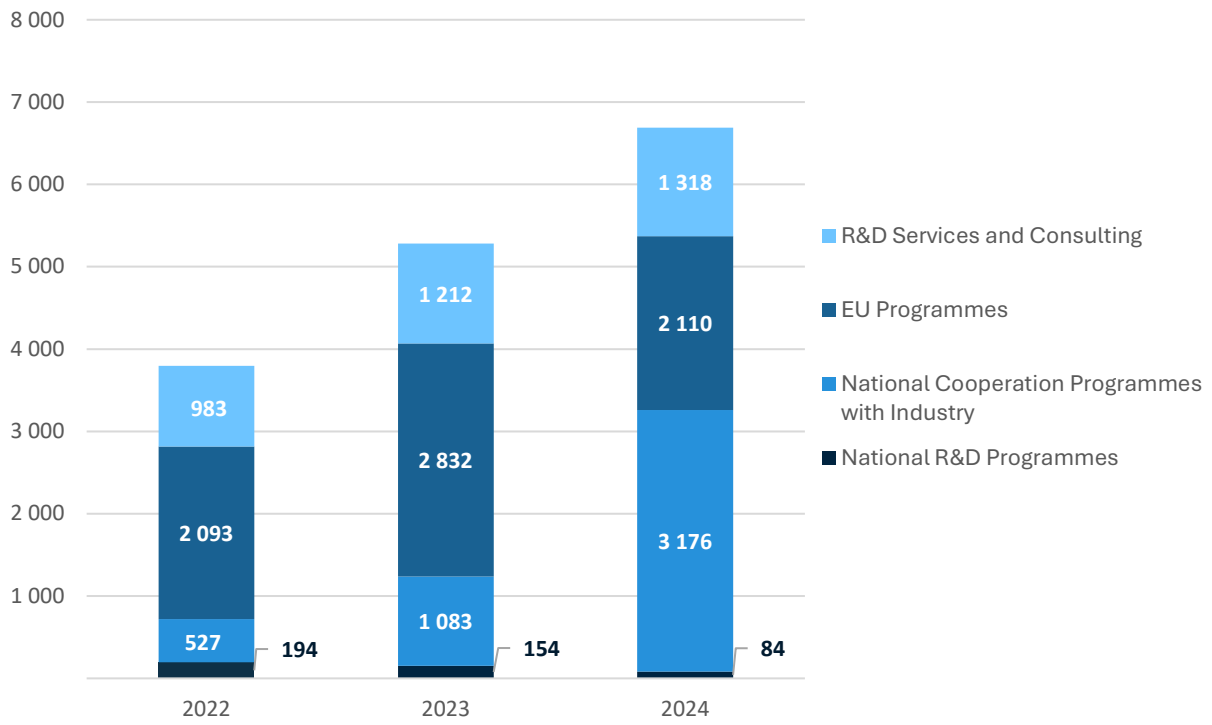


Figure 6.15 - CPES - Project funding evolution (k€)

6.6 CESE - CENTRE FOR ENTERPRISE SYSTEMS ENGINEERING

Coordinators: António Lucas Soares and Rui Rebelo

Presentation

CESE is a multidisciplinary research centre contributing to a sustainable, resilient, and human-centred industry through systems engineering. It plays the roles of both research and business partners in creatively co-developing solutions for complex challenges and developing industrial organisations' capabilities for an ongoing digital and green transformation. CESE's core scientific domain is Systems Engineering and Management, addressing five specific research lines: Manufacturing Design and Management, Supply Chain and Collaborative Networks Management, Industrial Information Systems, Technology Management in Industry and Transportation and Logistics.

Research outcomes in 2024

RL1. Manufacturing Systems Design and Management. We progressed in the goal of researching how integrated optimisation/simulation hybrid approaches and process digital twins can help to design and reconfigure more adaptable and sustainable production systems, achieving the following results:

- A Digital Twin architecture for high-complexity and high-variability production environments, allowing a rapid reconfiguration of production systems in response to market demands while ensuring more efficient use of industrial resources, published in Computers & Industrial Engineering [SD: SEM]
- The characterisation of the state of practice and an outlook of the potential of digital twins to achieve sustainability in seaports, published in the J. of Maritime Affairs [SD: SEM]
- A novel approach to energy efficiency in the manufacturing scheduling of footwear industries with onsite photovoltaic energy and storage, presented and published at the SEST 2024 conference. [SD: SEM]

In this period, we also did research work on the training aspects of digital manufacturing.

- The work on unveiling training needs and nurturing ecosystem support for empowering SMEs for the digital future was published in the European Journal of Engineering Education [SD:SEM]

RL2. Supply Chain and Collaborative Networks Management. As planned, this RL continued studying innovative supply chain (SC) models and strategies that support companies in facing the complexity and uncertainty of contemporary environments. In the context of SoTecln Factory, Reshape and Renéé projects, we have achieved results related to various aspects of SCM, including different sectors (e.g. textile, plastics, packaging, agri-food) and R-strategies (e.g. reduce, reuse, remanufacture):

- Characterisation of supply chain strategies in a global context: a customer value-based perspective, published in Supply Chain Forum [SD:SEM]
- A review of the role of consumers in the adoption of R-strategies, including a research agenda, was published in the Journal of Cleaner and Responsible Consumption. [SD:SEM]

A novel research topic began to be explored, addressing the integration of AI in SC management using a socio-technical systems perspective.

- The first result was a PoC of a method to characterise the socio-technical AI profile of a supply-chain company aimed at facilitating AI integration, published in PRO-VE 24. [SD:SEM]

RL3. Industrial Information Systems. In the research topic "Digital enterprise architectures", the two results, published in international conferences, were

- The design of an innovative platform for value chain traceability based on data spaces Industrial that is an important contribution to the development of data sharing ecosystems, PRO-VE24 [SD:SEM]

- The design of a new digital product passport architecture, contributing to the circularity in the footwear industry, published in Procedia Computer Science. [SD:SEM]

In the research topic "Industrial data & information management", the main results were:

- The analysis, comparison and tracing of the evolution of canvas as tools for digital platform design, work that was published in PRO-VE 2024. [SD:SEM]
- The research on digital twin applications and architectures resulted in two publications in international conferences addressing knowledge-based engineering (PLM24) and the Semantic Asset Administration in Cognitive Digital Twins, published in FAIM24. [SD:SEM]

RL4. Technology Management in Industry. Within our commitment to increasing the involvement of the centre in the leadership of scientific initiatives, we organised the IAMOT 2024 conference, which was a resounding success, bringing together 230 participants from over 30 countries with the theme "Human-Centred Technology Management for a Sustainable Future". [SD:SEM]

We continued pursuing the goal of studying the adoption of advanced technologies in manufacturing, particularly the ones leading to more sustainable and circular models, with relevant results:

- A framework to support decision-making in the adoption of collaborative robots was published in Technological Forecasting and Social Change. [SD:SEM]

RL5. Logistics and Mobility. In the research topic "Mobility as a Service", where the main goal was to develop a participatory design of innovative mobility services, we achieved the following results:

- The characterisation of configurations and features of demand responsive transports, published in Transportation Research Procedia. [SD:SEM]
- The design of participatory mobility planning at a metropolitan scale, as a way to achieve more inclusive mobility, published in Transportation Research Procedia. [SD:SEM]

In the area of Logistics, a key result was:

- A decision-support system for the many-objective sectorisation for last-mile delivery optimisation, published in Expert Systems with Applications. [SD:SEM]

A research outcome with considerable impact was the publication of the book "Sustainability and Social Inclusion in Public Transport Management: Decision Support Techniques", compiling a set of research contributions, co-authored by a set of elements of the opti-MOVES project (funded by FCT). [SD:SEM].

Innovation outcomes in 2024

We have strengthened our strategic direction on fundamental areas for the future of the industry through service provision, highlighting the decarbonisation of the agri-food sector as one of the main focuses of action, with the development of innovative solutions to reduce the carbon footprint. At the same time, we have advanced in the design of an RFID-based reference architecture for the Amorim Group, promoting greater efficiency and traceability in industrial processes. We also invest in the creation of 5G test beds for the industry, enabling the experimentation and validation of new applications with advanced connectivity. [SD:SEM]

Pursuing the goal of increasing the TRL from research results and providing consultancy services, we continued our activity in the simulation of industrial processes in several consultancy projects, providing operational optimisation and decision support in the implementation of AMRs (Autonomous Mobile Robots), and expanding automation and flexibility in productive environments. These initiatives consolidate our commitment to innovation and digital transformation of the industry. [SD:SEM]

In this period, we also developed a framework to guide SMEs in navigating the journey to the implementation of circular practices, while also providing a way for an enterprise to assess its circularity level and tested and validated a DPP architecture and functional prototype for the footwear sector. The architecture ensures all the requirements for the DPP, enabling transparency, traceability, and data

integrity. The next steps involve enriching this architecture through new pilot experiments and refining the implementation of the DPP, also considering other industrial sectors. [SD:SEM].

Activity Overview

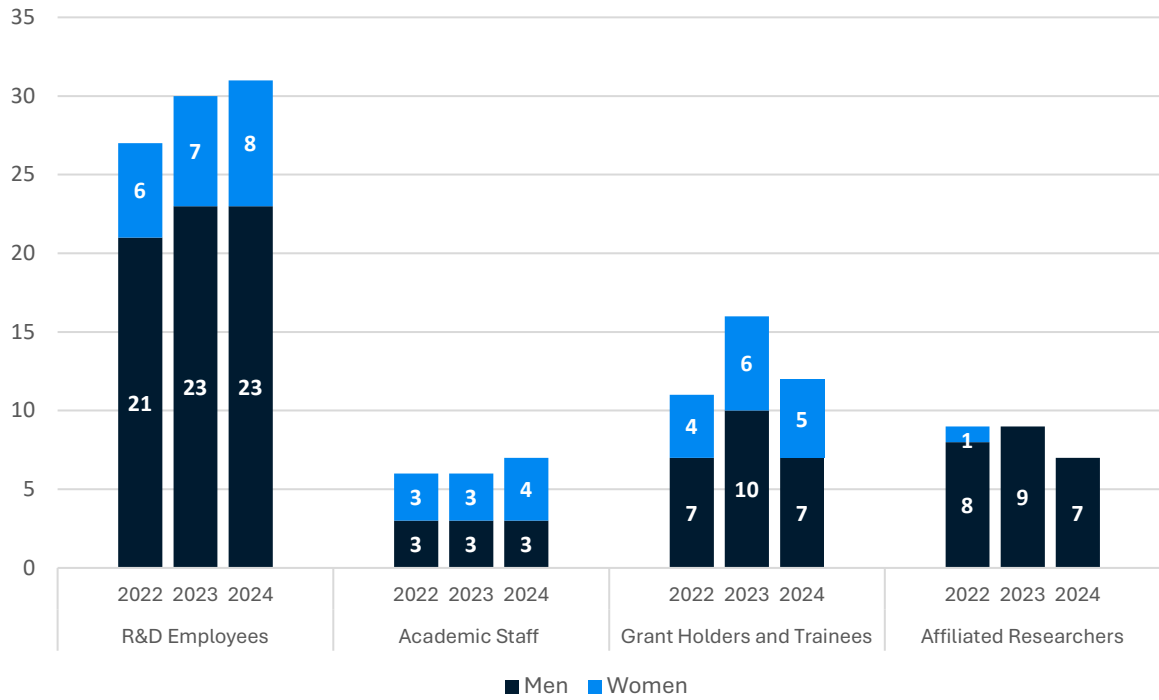


Figure 6.16 - CESE - Research team evolution

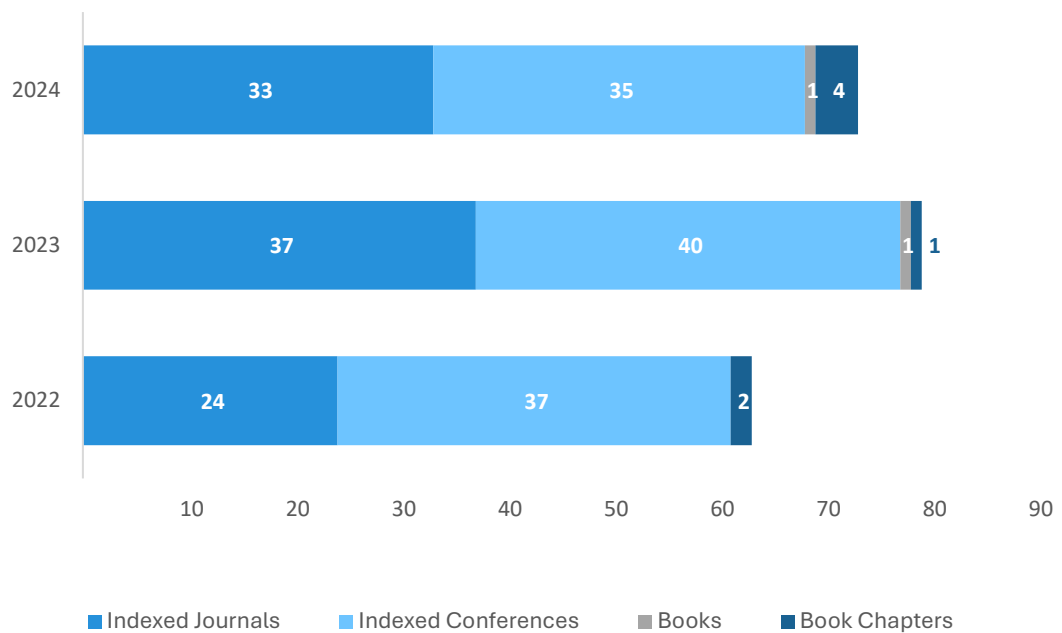


Figure 6.17 - CESE - Evolution of publications by members of the Centre

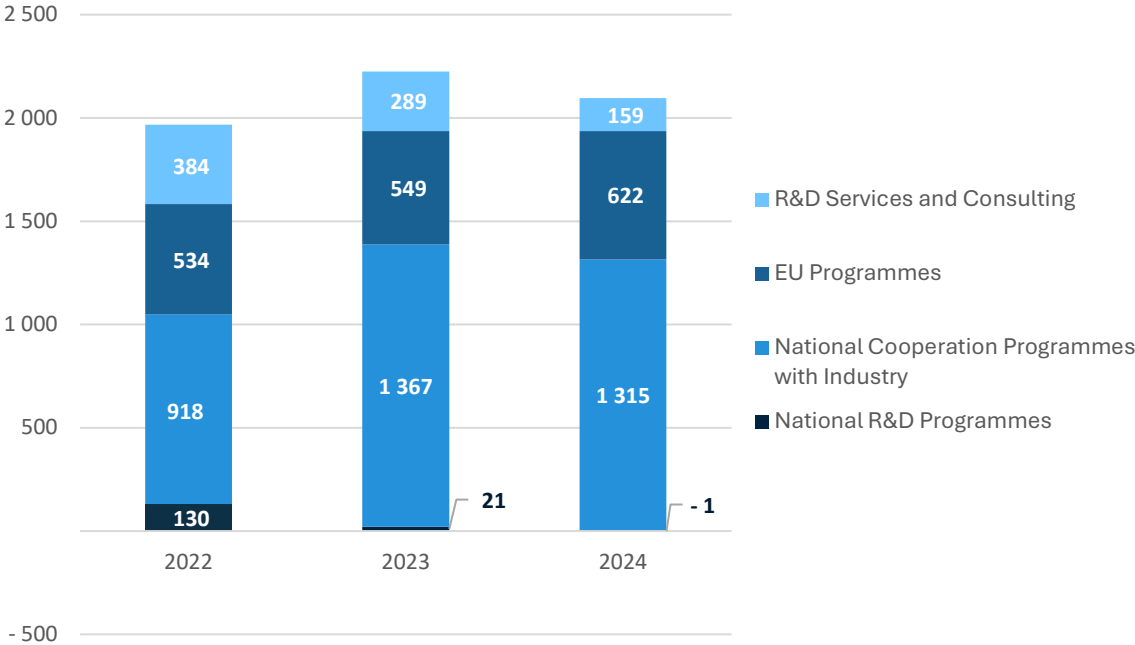


Figure 6.18 - CESE - Project funding evolution (k€)

6.7 CRIIS - CENTRE FOR ROBOTICS IN INDUSTRY AND INTELLIGENT SYSTEMS

Coordinators: Luís Freitas Rocha and Manuel Santos Silva

Presentation

The Robotics and Intelligent Systems Centre designs and implements innovative solutions within the areas of industrial, agriculture, and forestry robotics and intelligent systems. The Centre closely cooperates with companies, other INESC TEC Centres, and other institutes and universities, following the motto from research and development to innovation and passing through design, prototyping, and implementation.

Research outcomes in 2024

Large-Scale Dataset Generation Framework for Robotic Bin-Picking: CRIIS tackled the challenge of generating labeled data for large-scale robotic bin-picking datasets by developing an easy-to-use automated framework for creating customised data with precise labels from CAD models. This framework utilises a photorealistic rendering engine integrated with physics simulation, reducing the gap between synthetic and real-world data. Models trained using the synthetic data generated by this framework achieved performance comparable to those trained on real-world datasets. An article detailing this work is currently under review in a peer-reviewed journal.

Advanced Robotics and Artificial Intelligence for Industry: A digital twin-based infrastructure has been successfully developed to support and monitor Advanced Robotic Systems, enabling real-time data integration and improved decision-making. Additionally, robotic systems have been integrated with the Industrial Internet of Things, allowing for better data exchange and remote monitoring, which has the potential to reduced downtime and maintenance costs. The incorporation of AI technologies, particularly in the domain of perception and environment inference, has driven innovations that optimise production and logistics processes.

Application for pallet detection and localization: During 2024, CRIIS researchers have advanced the development of an application based on the acquisition of RGB-D images and its treatment using AI algorithms to detect pallets and its 3D localisation in space. This application is being generalised to the detection of metallic boxes used for parts transport in the automobile sector. During its development a large annotated dataset of pallets and its pockets, as well as metallic transport boxes has been generated, and will be made publicly available at the end of the Produtech R3 and GreenAuto Agendas.

Obstacle avoidance algorithm for challenging outdoor environments: In 2024, AgroBPP-CA algorithm was introduced as an advanced collision avoidance for agricultural robots. This software utilises an iterative approach with parametric Bézier curves to navigate complex environments. By considering terrain inclination and the robot's centre of mass, AgroBPP-CA ensures safe and efficient path planning, even in challenging off-road conditions. This method allows for smooth and adaptive obstacle avoidance, enhancing the reliability and autonomy of agricultural machinery.

Innovation outcomes in 2024

Modular and Cost-Effective Agricultural & Forestry Robot – Fully Functional: In 2024, Modular-E was successfully demonstrated in vineyards, forestry, and military contexts, proving its versatility and real-world applicability. Showcased at major events, it earned prestigious recognitions, including the Silver Medal for Best World FIRA Robot 2024 and first place in Prémios Inovação Agricultura 2024. Its modular, cost-effective design makes it a pioneering solution for precision agriculture.

Dexterous textile manipulation: CRIIS, and in the iiLab, has deployed two distinct demonstrations to advance circularity and sustainability in the textile industry. The first prototype, which has reached TRL 6, focuses on classifying the fibre composition of post-consumer clothing. This solution leverages hyperspectral imaging and artificial intelligence to accurately identify and categorise garments based on their fibre content, enabling efficient sorting and facilitating their upcycling. The second prototype, at TRL 5, demonstrates the use of a dual-arm robot to automate the sewing of hems on different shirts,

showcasing advancements in textile automation. This solution was presented through a video at the INESC TEC booth during the IROS conference in Abu Dhabi.

Mobile manipulator for logistic activities: In 2024, the mobile manipulator's (Friday) functionalities and capabilities in perception, grasping, and path planning were significantly enhanced. The robot reached TRL8 and was successfully demonstrated at Worten's warehouse in Azambuja during the final demonstration of the EIT Momaflex project. CRIIS is now exploring effective strategies for transferring this technology to the market. The prototype is also a permanent demonstration at iiLab, showcasing its advanced capabilities and serving as a platform for further research and development. Furthermore, an article titled "Friday: The Versatile Mobile Manipulator Robot" has been accepted for presentation at the European Robotics Forum 2025, taking place on March 25–27, 2025, in Stuttgart, Germany, further cementing its recognition in the robotics community.

Portable Mixed Augmented Reality Tool: A portable projection mapping solution was completed (TRL 8), designed to support human operators in tasks such as marking, cutting, welding, assembly, and more. The tool utilises a DLP projector, and a high-precision 3D sensor mounted on a tripod to project relevant information directly onto physical objects. This assists operators in task execution, reducing errors and significantly improving efficiency by expediting workflow. The solution was tested and validated at BRODOSPLIT SHIPYARD, a shipbuilding company localised in Croatia, during the final demonstration of the Mari4_Yard project.

Remote control of an autonomous mobile robot: By combining 5G connectivity, a 360° camera mounted on a robotic platform, and a Virtual Reality headset, human operators can remotely assist the robot in case of failures or deadlocks by transmitting direct low-level human intent. This solution, currently at TRL 7, is being demonstrated at the iiLab and was developed as part of INESC TEC's participation in the NOS Testbed. It was also showcased at the 360TechIndustry fair.

Software Engineering for Robotic Applications and Cloud-based Robotics: The centre has collaborated with Amazon Web Services (AWS) to harness cloud-based solutions for industrial robotics, resulting in an innovative roadmap that unfolds across three key areas: (i) Continuous Integration (CI) and Continuous Deployment (CD) solutions for robotics have been developed using cloud-based simulations and automated validation processes; (ii) a web-based robotic toolkit has been created, featuring containerisation technologies, over-the-air updates and monitoring; (iii) the scalability of cloud resources and AI services has been utilised to support robots in computationally intensive tasks, such as machine learning for perception and environment inference.

Expanding the application of AMRs to increasingly challenging environments: From dynamic scenarios to fleets of AMRs. In this context, the following solutions were developed: (i) a successful implementation of a reflector-based localisation system, tested in a real and highly challenging environment (PSA Mangualde) at TRL 7; (ii) a mechanism for the calibration of the intrinsic and extrinsic parameters of AMRs; (iii) a SLAM framework for long-term SLAM applications; (iv) the improvement of the fleet management system (graph decomposition and task scheduling), and respective integration with FlexSim simulator; (v) a new version of the docking system, enabling faster and more precise approach manoeuvres.

Activity Overview

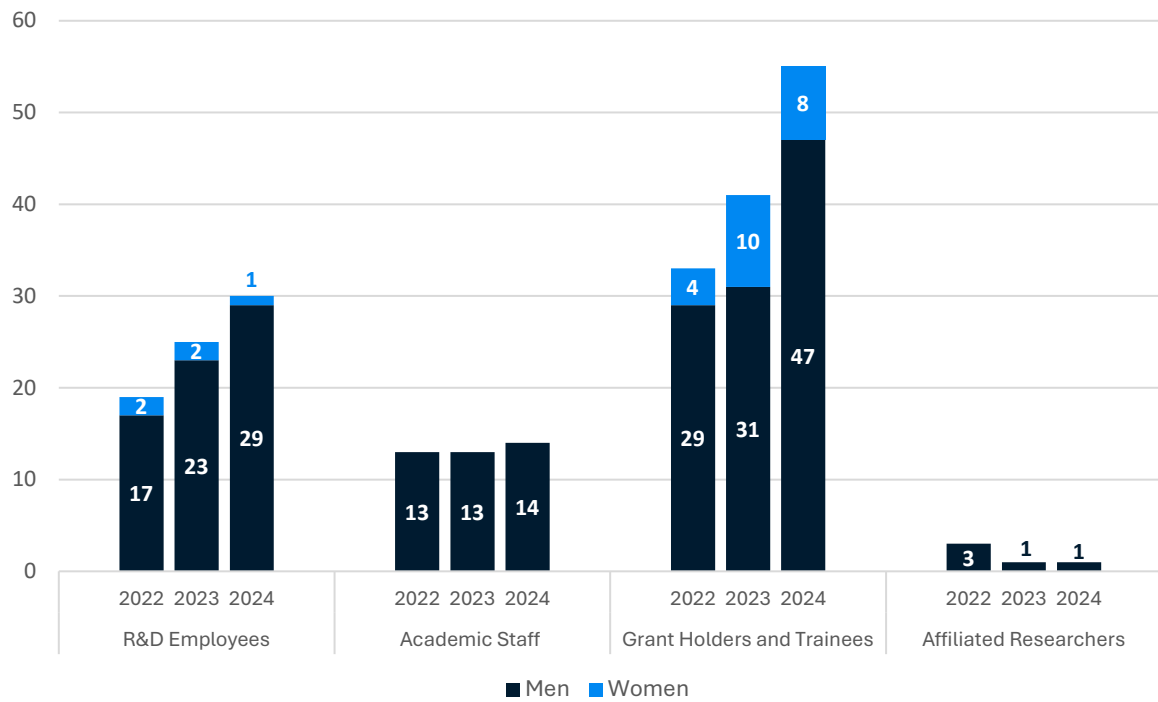


Figure 6.19 - CRIIS - Research team evolution

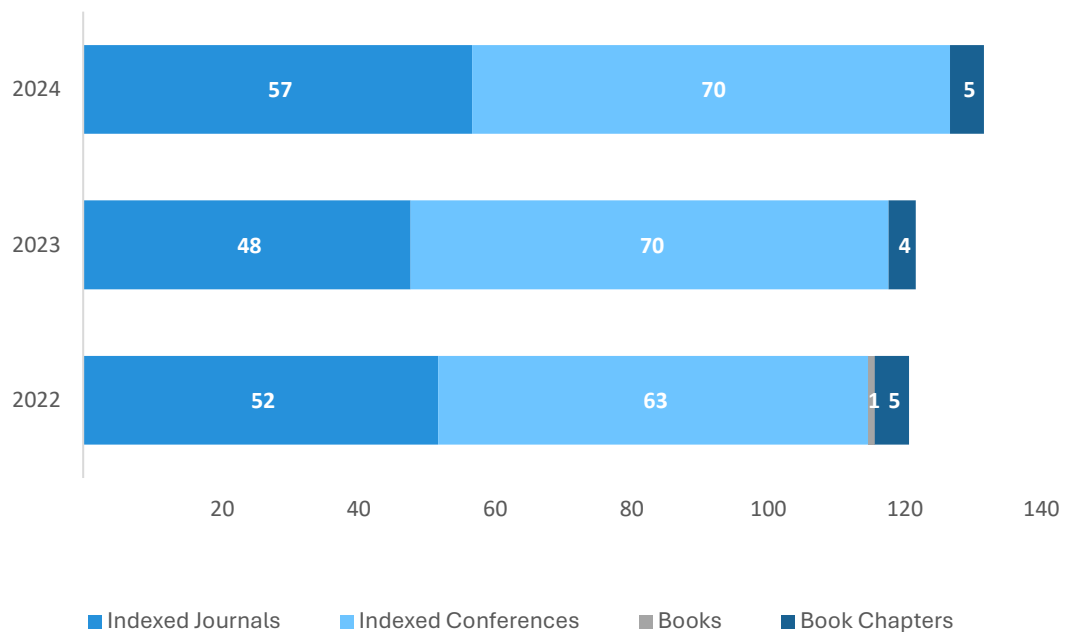


Figure 6.20 - CRIIS - Evolution of publications by members of the Centre

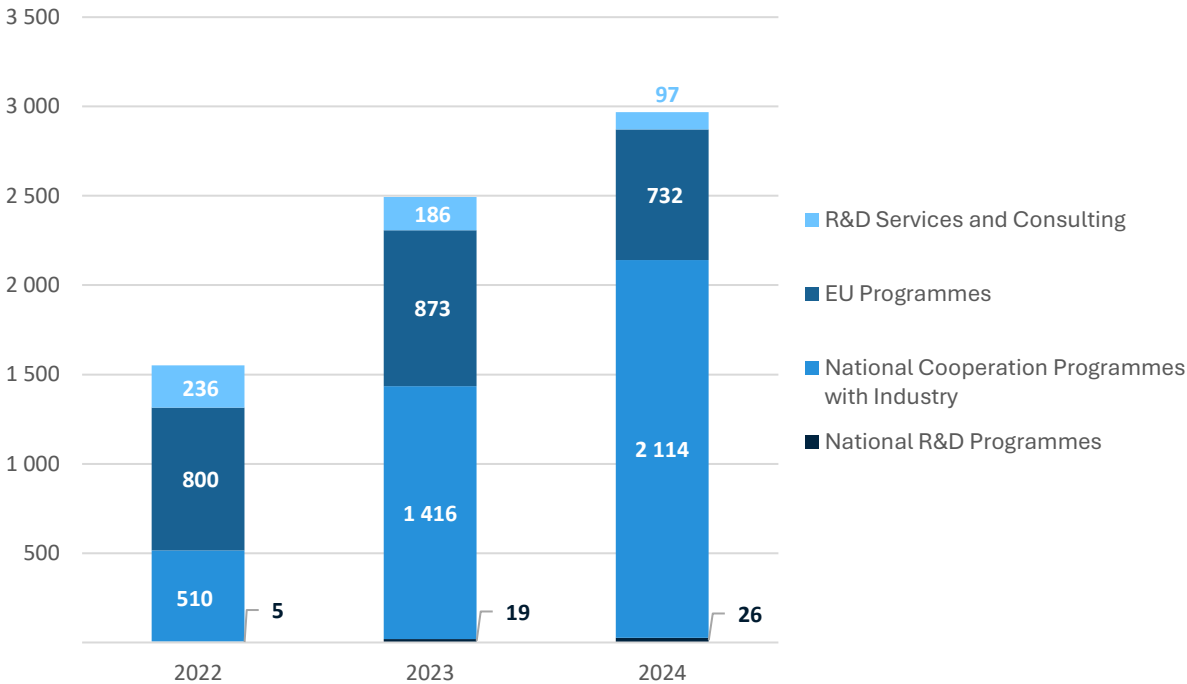


Figure 6.21 - CRIIS - Project funding evolution (k€)

6.8 CEGI - CENTRE FOR INDUSTRIAL ENGINEERING AND MANAGEMENT

Coordinators: Maria Antónia Carravilla and António Almeida

Presentation

The Centre for Engineering and Industrial Management (CEGI) at INESC TEC is a multidisciplinary research centre that aims to be a reference in Systems Engineering and Management, advancing research in Management Science and Service Science. Positioned at the intersection of industrial engineering and management, CEGI integrates scientific rigour and practical innovation to address dynamic, uncertain, and complex challenges. By integrating cutting-edge AI techniques with traditional methodologies, CEGI ensures its research delivers robust, ethical, and impactful solutions across diverse sectors.

Through close collaboration with academia, industry, and policymakers, CEGI drives impactful research and development that enhances operational efficiency, customer experience, and organisational resilience. By integrating cutting-edge technology, robust management practices, and a commitment to societal impact, CEGI empowers industries and communities to thrive in a rapidly evolving global landscape.

Research outcomes in 2024

In 2024, CEGI successfully completed several national projects and made substantial progress in ongoing initiatives, with a particular focus on EU projects and those funded by FCT and PRR. These efforts resulted in significant research outcomes and the publication of 52 articles in high-impact journals, 2 book chapters and 20 papers published in proceedings from peer-reviewed conferences.

Operations Research & Operations Management

Development of an innovative multidisciplinary approach for advanced mobility demand modelling, integrating comprehensive real-world data on user preferences and mode choices with economic choice models, data analytics, and demand learning techniques. The findings from this exploratory research were published in the Journal of Business Economics and Transportation Research Part E: Logistics and Transportation Review.

Development of a comprehensive mapping methodology for food subproducts in Portugal and a facility location optimisation model for insect production. This research initiative supported the completion of 3 MSc dissertations and is currently contributing to 1 ongoing MSc and 1 PhD project.

Development of a framework for last-mile routing based on the tacit knowledge of the truck drivers through a combination of machine learning with classical optimisation techniques. This research generated one paper in an international conference and two articles submitted in international journals.

Deep Control Learning Algorithm was adapted and applied to order allocation in online retail. The algorithm proved to be competitive (or superior) to the state-of-the-art, balancing better multiple objectives (cost, customer service and vendor satisfaction), and being more effective in short planning horizons, as in the case of fashion retail.

Periodic and real-time dispatching rule selection systems, based on supervised and reinforcement learning algorithms, for the job shop scheduling problem. The systems have shown +10% improvement over the best dispatching rules. This study was submitted to Computers and Industrial Engineering.

AI & Business Analytics

Development of a data classification methodology to detect genomic mutations in antibiotic-resistant bacteria. The real-world applicability of Graphene electrolyte gate field-effect transistors is assessed in bacterial detection scenarios by employing a proposed data classification methodology utilising the "V"-shaped transfer curves under different concentrations of mutated DNA. This research initiative is currently contributing to one ongoing PhD project.

Development of an Artificial Intelligence (AI) algorithm for bacterial classification. Fingerprint curves were acquired from real-time lamp-based Photoionization detectors and transformed into image representations, capturing their distinct patterns, to achieve bacterial classification. This is the first study

reporting a four-lamp-based PID for bacterial detection and discrimination, aided by an image-based AI tool. This work is going to be submitted to the Journal “Biosensors and Bioelectronics” (Q1 journal).

Development of an optimisation framework to guide the decisions regarding the sizing of hybrid renewable energy systems. It integrates operational factors, reflecting practical conditions where equipment downtime can significantly impact system performance, profitability, and the final optimal configuration. This work is going to be submitted to the Journal “Applied Energy” (Q1 journal).

Development of a benchmarking tool to evaluate different operational points where the equipment health indicators represent wear and tear. It brings innovation by applying Data Envelopment Analysis in asset management to indicate the best dispatching rules with maximum power production and minimum wear and tear. This work was published in Utilities Policy (Q1 journal).

Development of a robust conditional approach to evaluate the performance of the Education Systems of European NUTS-level regions. This approach considers strategic goals for Education and Training specified by the European Union to define a-priori the direction for improvement that each European region should follow. This research initiative contributed to 1 master thesis and is submitted to the Journal “Annals of Operations Research” (Q1 journal).

Service Science

Citizen engagement with Sustainable Energy Solutions (SES) is considered essential for the current energy transition. To address this opportunity, this study examines how different forms of the perceived value of SES (utilitarian, social, and environmental) influence different types of citizen engagement behaviours (information seeking, proactive managing, sharing feedback, helping other users, and advocating). This research was published in the Energy Policy Journal.

Innovation outcomes in 2024

A new markdown policy for products nearing their sell-by date was proposed, emphasising the importance of considering substitution effects, which significantly influence the outcomes of such policies. This outcome was disseminated in key international events dedicated to food waste reduction, including the First Workshop on Food Waste Reduction, engaging with experts from academia and retail, as well as the Food Waste Summit organised by ECR Retail Loss. Building on feedback from industry practitioners, new research directions are being explored, focusing on assortment and product display strategies.

Development of an optimisation model to enhance the operational efficiency of fuel management activities in forests surrounding linear infrastructure, effectively addressing the mismatch between equipment capabilities and site-specific conditions. The project’s outcome, the OPTIVEG platform, integrates these models to support strategic planning decisions while accounting for environmental factors, such as emissions. This research initiative facilitated the completion of one MSc dissertation in 2024 and initiated one PhD project the same year.

Development of several applications within packaging problems for automatic truck loading and building pallets for regular and irregular shape items, applying both classical optimisation approaches, machine learning and physics engine models. These solutions are being integrated with already existing technologies from national technology companies in the intralogistics domain.

The second version of TRUST was concluded. TRUST is a platform that supports human-guided learning of symbolic models. The platform allows connecting with any (symbolic) AI algorithm or library, visualising and interacting with the models and run post-hoc analysis (what-if, feature importance, and counterfactual explanations). TRUST was integrated with new state-of-the-art symbolic algorithms (GP-GOMEA and MSGP) and a novel (and improved) counterfactual algorithm (CoDiCE). These components can be called via UI or API and can be easily updated or replaced. TRUST is focused on tabular data, but it can be used to approach (and was already tested on) a variety of problems, including predictive and prescriptive tasks.

The development of a methodology for the creation and governance of Living Labs, initially explored at CEVE (Cooperativa Eléctrica do Vale d’Este) and currently being applied to other Living Labs in European projects, particularly in DECODIT, alongside the establishment of a social (community and governance) and technical infrastructure that enables the development and testing of new digital solutions for energy efficiency, which is presently being utilised in the AI-EFFECT project.

Activity Overview

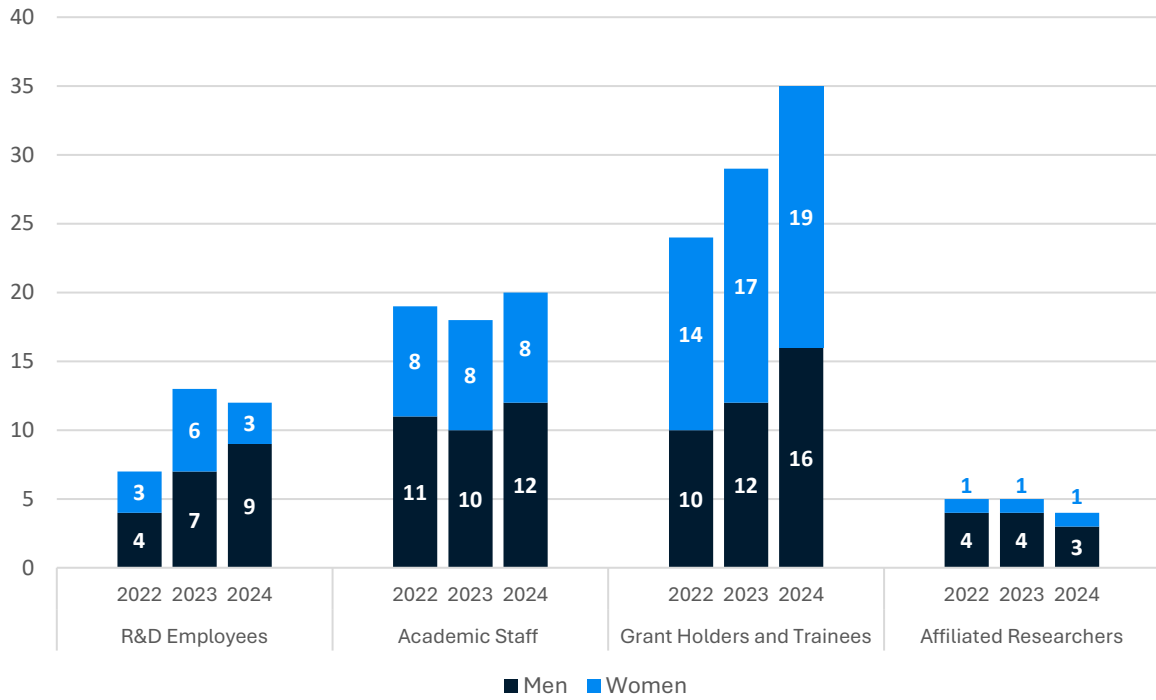


Figure 6.22 - CEGI - Research team evolution

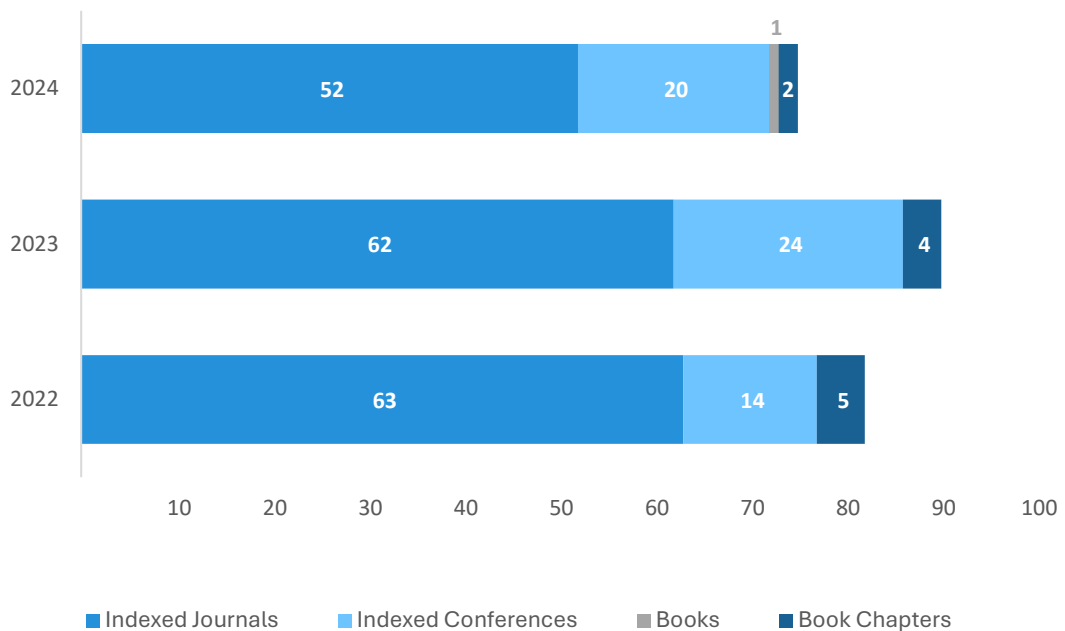


Figure 6.23 - CEGI - Evolution of publications by members of the Centre

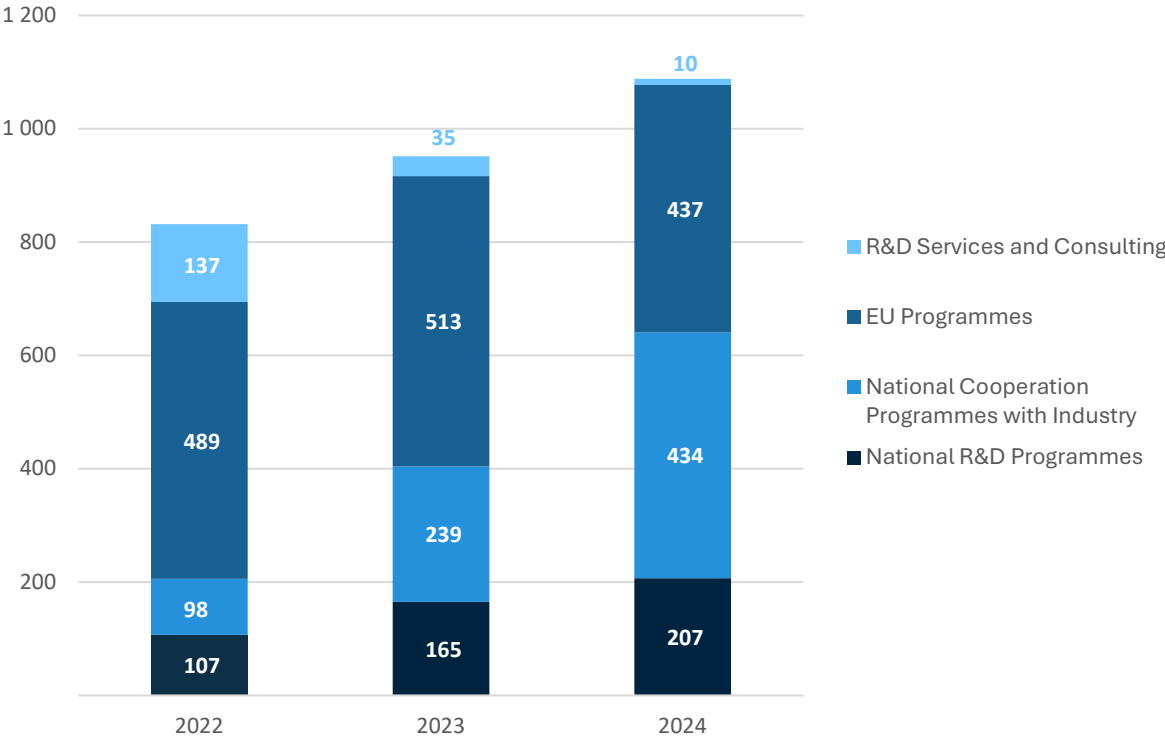


Figure 6.24 - CEGL - Project funding evolution (k€)

6.9 CITE - CENTRE FOR INNOVATION, TECHNOLOGY AND ENTREPRENEURSHIP

Coordinator: Alexandra Xavier

Presentation

CITE Vision is driving innovation, technology adoption, and entrepreneurial excellence towards a socially responsible and sustainable economy and society, empowering researchers and public and private organisations in the processes of Innovation, Technology Management, and Entrepreneurship.

By conducting multidisciplinary research on the following Research Lines (RL), CITE develops theories, methods, models, and tools to support sustainable innovations' design, exploitation, and adoption.

RL1. Innovation Management and Fuzzy Front-End of Innovation: Strengthening the conceptual and methodological foundations of Innovation Management and the Front-End of Innovation towards a responsible, ethical, and sustainable industry and society.

RL2. Technology Management and Policy: Study the challenges of implementing and adopting new technologies and how public policies can promote technology-enabled transformation.

RL3. Technology Entrepreneurship & Business Model Innovation: Delves into the symbiotic relationship between technology and entrepreneurship, exploring the dynamics of leveraging technological advancements to drive innovation in business models.

RL4. Research on Co-creation methods and open innovation strategies for user-centred design, empowering and nurturing entrepreneurship: research on collaborative co-creation methodologies and open innovation approaches within user-centred design to amplify sustainable solutions and cultivate innovation ecosystem where users and communities actively participate in shaping environmentally and socially conscious products and services.

In 2024, CITE participated in five **European R&D projects and five PRR projects**, driving research and innovation forward. CITE's efforts focused on four key areas: (i) developing methodologies and tools to maximise the impact of European and national projects (FIRE-RES, AI4REALNET, Every1, Insectera, ATE); (ii) supporting impactful open innovation campaigns (FIRE-RES, Sotecin Factory); (iii) researching novel business models (NEXUS, Every1, FIRE-RES); and (iv) promoting sustainability in innovation and technology management practices.

Through the OpenInnoTrain Programme, CITE strengthened strategic interactions for research and project collaboration on key topics such as energy transition, mission-oriented innovation policy, and maritime innovation in partnership with the University of Vaasa and Merinova Company in Finland.

Research outcomes in 2024

From R&D activities, CITE highlights the following outcomes:

- **Technical and Policy Recommendations for Energy Transition (RL1):** A technical deliverable from the ATE project, including the "Technology Adoption Mapping Tool" which examines key dimensions and challenges of technology adoption for energy transition, considering the entire ecosystem.
- 5G Maturity Study in Sines Port Community | RL4: A quantitative and qualitative study on innovation and digitalisation within the Sines Port community, focusing on advanced port activities and supportive digital technologies supported by 5G (NEXUS).
- Open-source Software strategy | RL3 & RL4: A research-driven approach to defining methodologies, governance models, and best practices for sustainable and impactful open-source software development (AI4REALNET).
- Cross-Industry Innovation Leveraging Technology and Collaboration | (RL3): The research focuses on the intersection between innovation, entrepreneurship, and Agri-Tech, showcasing how technology can create new market opportunities for startups and existing firms. The project

emphasises cross-industry collaboration to develop scalable business models. An article was submitted to an international conference in 2024 (InsectERA).

- Technology Exploitation Strategy Development Methodology | RL2: This exploratory methodology focuses on systematically identifying and assessing the potential for exploitation of research results. The approach emphasises self-reporting and self-assessment by guiding the results creators toward the identification of the value and potential exploitation routes to be considered (FIRE-RES).

Demonstrating CITE's dedication to Sustainable Innovation, three key publications stand out as significant research outcomes:

- Almeida, F.; Guimarães, C.M.; Amorim, V. (2024) Exploring the Differences and Similarities between Smart Cities and Sustainable Cities through an Integrative Review. Sustainability 2024, 16, 8890. <https://doi.org/10.3390/su16208890>;
- Guimarães, C., Santos D.S. and Almeida, F. (2024), Practical tools for measuring and monitoring sustainable innovation, Innovation, and Green Development, Vol 3, Issue 4, 100172 <https://doi.org/10.1016/j.igd.2024.100172>.
- Guimarães, C.M., Amorim, V. and Almeida, F., “**Responsible research and innovation (RRI) assessment: the path to a tool**”, IAMOT Conference, Porto, 8th – 10th July 2024.

Innovation outcomes in 2024

CITE strengthens research and development (R&D) efforts by developing advanced methodologies, models, and tools to tailor **entrepreneurship and innovation programs as well as advanced training materials**:

- A qualitative study identifying knowledge gaps in stakeholder engagement for the digital energy transition has been conducted. This led to the development of inclusive learning pathways and open educational resources. (Under Every 1 project).
- Four workshops were held on topics of value proposition validation, demonstrators, performance, and impact assessment to support 15 tech-innovation teams from the SoTeIn Factory open call.
- CITE coordinated one international accelerator program – EIT Jumpstarter 2024, providing expert training and mentorship to 10 early-stage entrepreneurial tech projects.
- CITE researchers conceived and implemented in collaboration with SAL, a customised technology exploitation acceleration activity for INESC TEC's Seed Projects: “Seed Project Accelerator Initiative”, with the goal of enhancing each project's potential exploitation routes and impact. Under the project “FIRE-RES”, a set of thematic webinars was developed and delivered to enhance the potential product-market fitness of over 50 participant teams in the Open Innovation Call for solutions in the field of wildfire management.

As part of **Dissemination activities**, CITE participated in the following activities:

- Collaboration in the IAMOT 24 Conference, serving as both chair and speaker in a panel.
- Keynote at the “**(In)Sustentável Congress**” showcasing the SoTeIn project and other INESC TEC sustainability projects under the theme “Natural Capital Valorization.”
- Participation in the roundtable panel 'A Boost for Financially Resilient Innovations in Wildfire Management' at the FIRE-RES International Event.
- Speaker at the “XXVI World Congress of the International Union of Forest Research Organizations (IUFRO)

- Organised and spoke at the “**AI, Data, Robotics Forum 2024 workshop**”: 'From Algorithms to Assurance: Designing Human-Centric AI for Collaboration, Trust, and Acceptance’, under the Ai4REALNET project.
- The open-access Journal of Innovation Management (JIM) is a multidisciplinary, peer-reviewed journal co-founded by a CITE researcher who currently serves as one of its co-editors-in-chief. Indexed in SCOPUS since January 2021, Q2 in Engineering, and Q2 in Management of Technology and Innovation. The journal reached 320 published articles in 2024.
- During 2024, CITE was active in three thematic groups from EEN: (i) Automotive, Transport and Mobility, (ii) Women Entrepreneurship, and (iii) Proximity and Social Economy.

Activity Overview

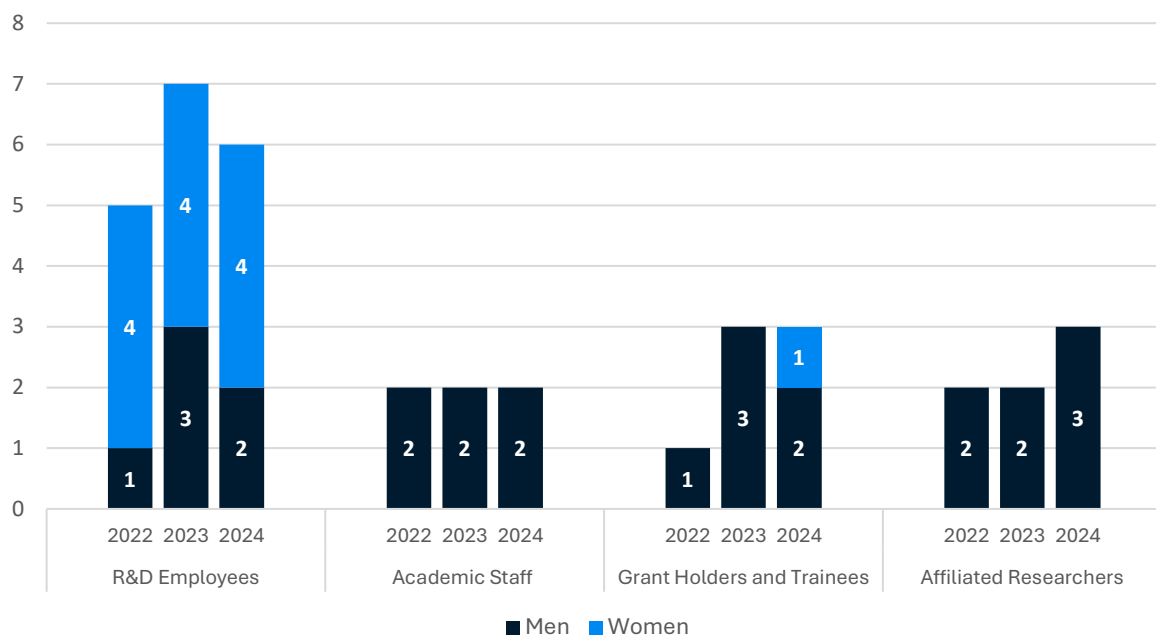


Figure 6.25 - CITE - Research team evolution

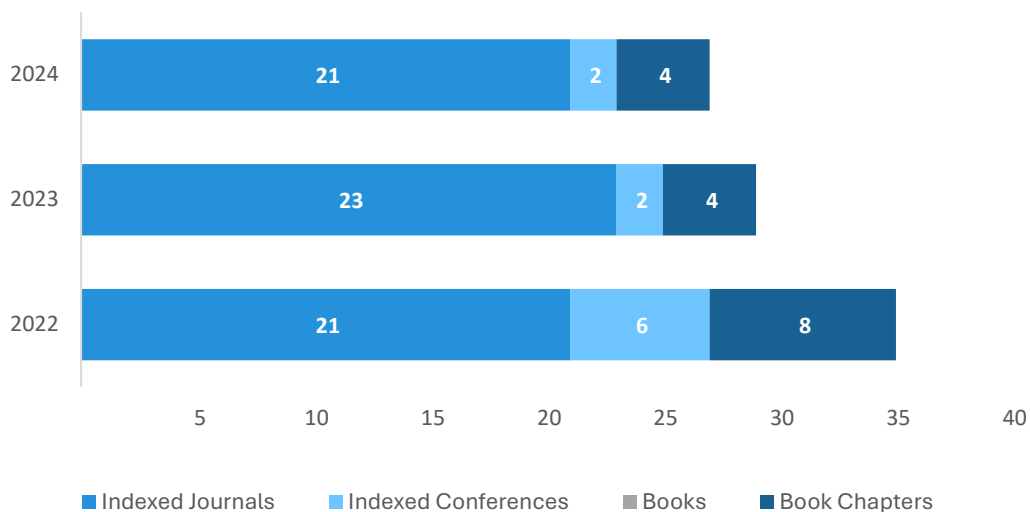


Figure 6.26 - CITE - Evolution of publications by members of the Centre

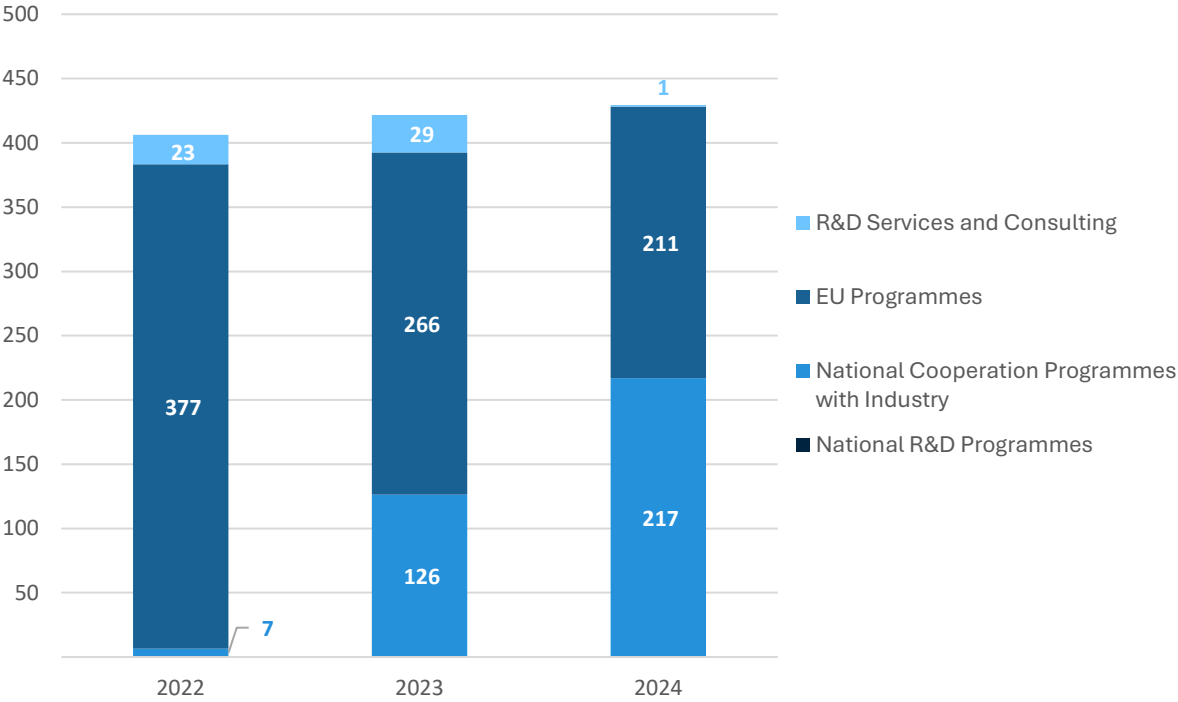


Figure 6.27 - CITE - Project funding evolution (k€)

6.10 HUMANISE - HUMAN-CENTRED COMPUTING AND INFORMATION SCIENCE

Coordinators: Ademar Aguiar, Artur Rocha and Hugo Paredes

Presentation

In 2024, the research centre continued to develop activities at the forefront of human-centred computing (HCC), computer science (CS), and information science (IS). This included researching and developing systems, methods, and tools for various types of software, such as applications, platforms, enterprise systems, digital twins, digital games, embedded software, and more. The main goal is to augment and leverage human abilities and practices within communities and environments.

In close collaboration with esteemed academic and industrial partners, the research centre pursued high-quality research, innovation, consultancy, and technology transfer. Our focus remained on the same six research areas and four innovation areas, encompassing state-of-the-art scientific and technological knowledge pertinent to all the typical layers of the complex software systems' stack.

In 2024, we implemented several initiatives to enhance the attractiveness and retention of both new senior and young researchers. These initiatives primarily focused on improving facilities, upgrading computational resources, and organising social-technical events. Additionally, we reaffirmed our commitment to training young researchers and professionals, with a particular emphasis on supervising master's and PhD students. Our research community comprises individuals originally from the Universidade do Porto (UP), Instituto Politécnico do Porto (P.Porto), Universidade de Trás-os-Montes e Alto Douro (UTAD), and Universidade Aberta (UAb).

Research outcomes in 2024

Information Management and Information Systems (IMIS). In 2024, we continued to be actively engaged in multiple projects and collaborations within information systems, research data management, data infrastructures, and information visualisation and interaction. We have maintained active involvement in narrative extraction, visualisation, and exploration through participation in LIAAD StorySense FCT project. Our commitment to health information systems remained strong through our involvement in the RECONNECTED EU project, which focuses on mental health literacy and social participation, as well as the Health from Portugal PRR project, which emphasises clinical data integration, sharing, and AI-driven decision support. In connection with these initiatives, we joined the “YouthDMH - Digital Mental Health for Young People” and “GOBLIN - Global Network on Large-Scale, Cross-domain, and Multilingual Open Knowledge Graphs” COST projects. Additionally, we continued our active participation in the EUGAIN COST project, addressing gender balance in informatics, and joined the Diversity and Inclusion Working Group of Informatics Europe. As a member of the iSchools organisation, we also began participating in regional meetings.

Computing for Embedded and Cyber-Physical Systems (C4E&CPS). In 2024, particular focus was given to the participation in several international collaborations, in the scope of the Chips JU, particularly addressing RISC-V processors in embedded systems, and advanced computing platforms for cyber-physical systems. This led to the submission of several European projects, and one doctoral network proposal. The area also participated actively in European working groups on cyber-physical systems within the HiPEAC network, the importance of software in the scope of EMSIG activities, and the closing of the CERCIRAS COST Action. Area researchers participated in the steering and programme committees of conferences and workshops such as AEiC, ETFA, WFCS, ISORC, DeCPS, and the Portuguese Inforum symposium. As a transversal activity to several INESC TEC centres, the area was involved in setting up the proposal for the Portuguese competence centre on semiconductors and microelectronics, as well as several national and international proposals in this domain.

Human-Computer Interaction (HCI). Considered an umbrella research area, in 2024, the main activities were focused on sharing knowledge on UX and User-centric design methodologies, techniques, and principles. VR2Care project's major contributions were recognised in the EU Innovation Radar. The last year of development of the H2020/PAFSE project contributed to the consolidation of the communication and dissemination strategy, planned and implemented specific 3D Modelling, animation, and printing

educational scenarios in Northern Portuguese schools. Human-Centred AI (HCAI) is a flagship topic of the HCI research area with major contributions on cognitive personalisation and computational methods for users' motivation in the scope of several projects, including, NOUS, ILIAD, FRODDO and HfPT. Moreover, the HCI group worked on several research activities and projects, leading to multiple publications. These researchers were involved in the steering, organisation, and scientific committees of HCI international conferences: DSAI 2024 and HCII2024.

Software Engineering (ES). Software engineering researchers continued to contribute to various research topics and projects. In the Inno4Vac (IMI2/EU) project, the key contributions focused on the architecture, design, and implementation of novel architectures using federated repositories and privacy-preserving mechanisms to support federated machine learning. The researchers in this area were also involved in organising international conferences, including the top-ranked conference on the topic, the 46th International Conference on Software Engineering (ICSE 2024), the 29th European Conference on Pattern Languages of Programs (EuroPLoP 2024), the 26th International Conference on Agile Development (XP 2025) and the 17th International Conference on the Quality of Information and Communications Technology (QUATIC 2024). Research work on emerging topics such as Live Refactoring, Developer Experience, and Agile Methods for Aerospace conducted in collaboration with ProDEI doctoral students culminated in the submission of two doctoral theses, and another one is expected to be submitted soon in 2025.

Special Purpose Computing Systems/Embedded Systems (LASPeCS). During 2024 we continued work on two approved projects, related to state-of-the-art compilation technology and RISC-V processors. We were able to propose an innovative compilation approach capable of targeting arbitrary languages, based on a given grammar, and used this technology to generate MLIR code that supports an in-house dialect for streaming computation. We have also expanded the languages we support, and we are now able to analyse and modify Android binaries (i.e., APK files) using our framework. This new compiler was used to identify and correct resource leaks in Android applications. We have continued the work regarding memory-safety guarantees in C, our work now is able to detect, at compilation time, cases of dangling pointers, and we are working towards supporting idiomatic C constructs. There have been advances in adapting C/C++ code to improve hardware synthesizability, and we were able to compile a version of llama2 to hardware that is capable of sending the predicted words to an output stream without halting the hardware kernel after our automatic transformations. Finally, we have been migrating our compilation framework to a node.js based flow, which all previously mentioned works have benefited from.

Computer Graphics and Interactive Digital Media (CGIDM). The group is focused on fundamental research in Immersive Environments, XR, Multisensory VR, and 3D Multimodal Interaction, including Immersive Visualisation and Analytics, Immersive Learning, Procedural Content Generation, Haptic and Pseudo-haptic Devices, and DeskVR Interaction. The group concentrates applied research efforts also in training programmes for the industry, to provide immersive solutions with intuitive authoring tools. The participation in Advanced training programmes within the Industry 4.0 paradigm is maintained alongside a partnership with the iiLab. Some EU projects have been successfully concluded as is the case of INCLUDING (Innovative Cluster for Radiological and Nuclear Emergencies) and COST Action LITHME (Language In The Human-Machine Era). The group was involved in the organisation of international events. Some examples are the ICGI'2024 (International Conference on Graphics and Interaction), ICETC'2024 (16th International Conference on Education Technology and Computers), and International Workshop on CBRN Training Technologies. It also has high-ranking participation (at the board and steering committee levels) in the Immersive Learning Research Network (iLRN) and in the IEEE Education Society Technical Committee on Immersive Learning Environments.

Innovation outcomes in 2024

Geospatial Information Systems Engineering. The TEXPACT project, framed within the Recuperation and Resilience Plan, achieved significant innovation outcomes in 2024. Our team successfully implemented a comprehensive IoT architecture designed to monitor young athletes' performance metrics in near real time. This innovation integrated various sensor technologies with a user-friendly mobile application, allowing coaches and sports scientists to collect, analyse, and visualise crucial biometric data. The solution, which is a work in progress, provides valuable insights into training load, recovery status, and performance trends,

enabling more personalised training regimens. The FAIST project, also operating under the Recuperation and Resilience Plan framework, delivered groundbreaking outcomes in 2024 through the successful integration of artificial intelligence components into software solutions for the shoe industry. The project exemplifies how targeted AI implementation can continuously help transform traditional manufacturing sectors.

Earth, Ocean, and Space Science (EOSS). The Wavy Operations Bundle, a software ecosystem that results from the projects H2020 MELOA and EEA GRANTS WAVY-NOS, has been licensed to DEIMOS ENGENHARIA, SA for non-exclusive use of the software in the scope of their ULYSSES project. This software Bundle has been further extended in the scope of the H2020 ILIAD project. In the H2020 ILIAD, we have evolved the reference architecture to enable on-demand interoperable processing requests to the underlying models of the Digital Twin of the Ocean and improved the reference implementation of the Registry Component of this architecture, which instantiates a catalogue of models providing machine-readable descriptions for Digital Twins interoperability. It also continued to evolve the methods and tools to provide context and narrative to heterogeneous ocean data to facilitate the user's immersive exploration of data, behaviours, and patterns. Work has continued with DITTO - Digital Twins of The Ocean, a programme endorsed by the UN Decade of Ocean Science for Sustainable Development (2021-2030), and TURTLE, a project under the DITTO Programme, aims at establishing consensus on a meta-pattern for digital twins interoperability. The group has seen the IEEE (PAR) Project Authorisation Request for the definition of a Working Group that covers the development processes for new Digital Twins (DTs) of the Earth approved by the IEEE Oceanic Engineering Society/Standards Committee (OES/SC) as P3501 Digital Twins of the Earth Working Group (OES/SC/DTEWG). Within the NewSpace Portugal Project, operating under the Recuperation and Resilience Plan framework, the team has developed an AI model for SAR image segmentation of oil spills and has evolved in the implementation of a Minimum Viable Data Space to study the hypotheses to allow processes to be subscribed to generate, either operationally or on demand, data assets previously defined in the data space, even if they haven't been previously created.

Personalised Health Research (PHR). In the RECONNECTED project, a very large study – with a population of 3150 participants, from 9 different countries – was started, taking a complex systems approach to global societal challenges, mental health determinants, and mental health outcomes. The Moodbuster 2.0 (MB2) online intervention framework was extended in its capabilities as an EMA tool to accommodate this approach. In PHASE IV AI, a HEU project that aims to improve data privacy and data availability for AI developers in Health, new privacy-preserving processing methods have been studied. Inno4Vac/VAXPRED presented the first version of an in-silico platform to accelerate mRNA vaccine development and collected feedback from industry partners (GSK, Sclavo, Sanofi). A new HEU project – IMPROVE Preterm – was approved, aiming to optimise the discovery and use of cost-effective, affordable, and accessible interventions at birth and in early childhood to mitigate the adverse consequences of very preterm birth. This is a continuation of the H2020 RECAP Preterm project. Finally, in Health from Portugal, a project framed in the Recuperation and Resilience Plan, INESC TEC supported its partners in the design and development of new privacy-preserving tools covering several aspects of health data management.

Information Systems and Applied Computing (ISAC). ISAC develops research in three key areas: (i) Enterprise Computing; (ii) Data Management Systems and Applications; (iii) Digital Business and Learning. Bringing all those key areas together, Intelligent Organisational Ecosystems has been the main research line, supported by two major (multiannual) projects: (P1) Data4Bus, a project to define a Data Management process within a Portuguese Bank, from the Technological Architecture to the policies and procedures needed to support all activities in a highly regulated context; (P2) BankRoad2DataMgm, the establishment of a data governance practice and the capacity of a banking management solution to respond to the requirements relating to new financial and prudential reporting regulations issued by the European Central Bank, namely the BIRD (Banks' Integrated Reporting Dictionary) and the IRef (Integrated Reporting Framework).

Other projects in Requirements Engineering, Information Systems (Planning, Design, Management), and Enterprise Architecture have been developed, namely: (P3) BankDigitalTransf, a project in which the enterprise architecture of Banco Português de Fomento was defined, with a Future Architecture and a Transformation Plan being produced; (P4) involvement in two projects of the PRR's transForm agenda: P1.7, which consists of the development of a new digital platform for different entities in the forestry value chain;

P1.9, which aims to boost the digital transformation of Forest Producer Organizations. Connected to this research, ISAC has several active projects, with a mix of research and specialised consulting.

Activity Overview

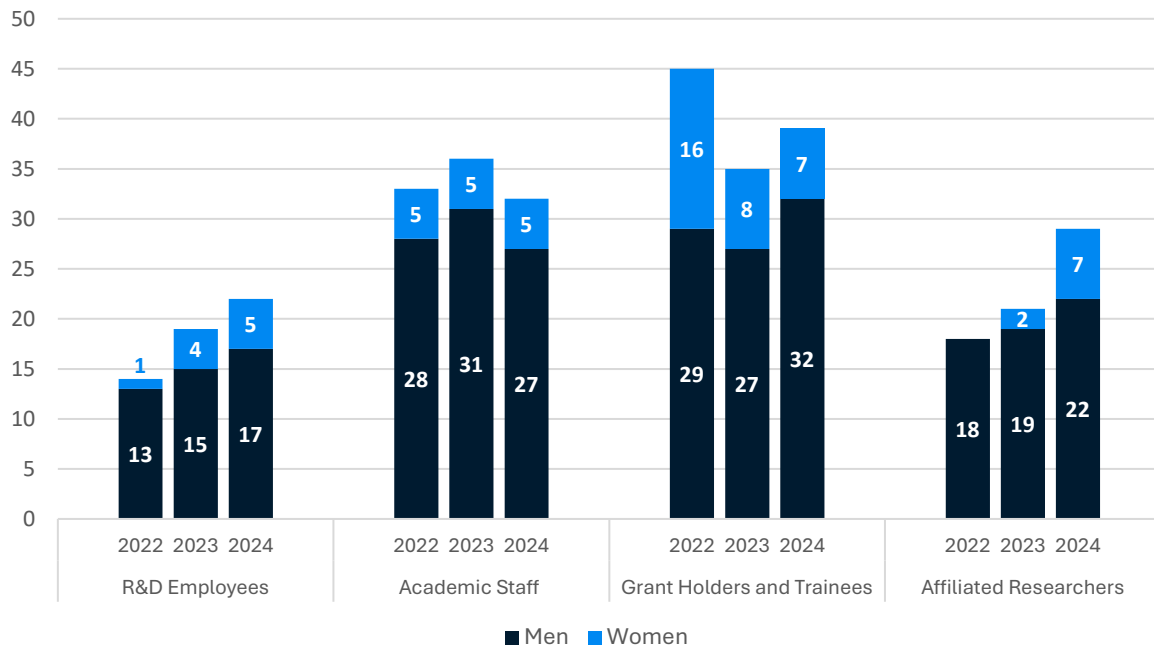


Figure 6.28 - HumanISE - Research team evolution

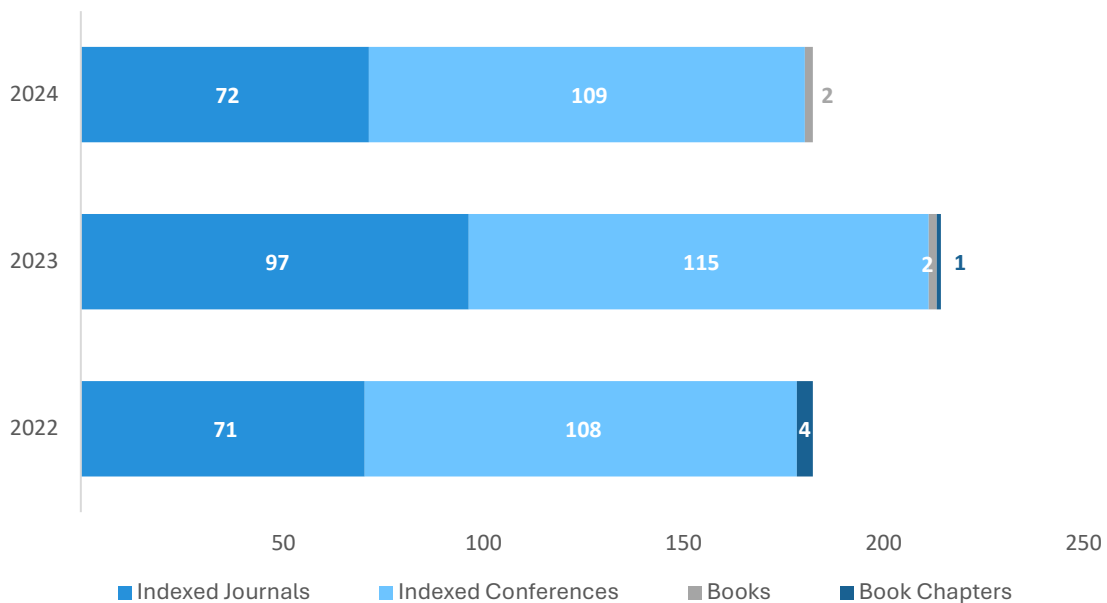


Figure 6.29 - HumanISE - Evolution of publications by members of the Centre

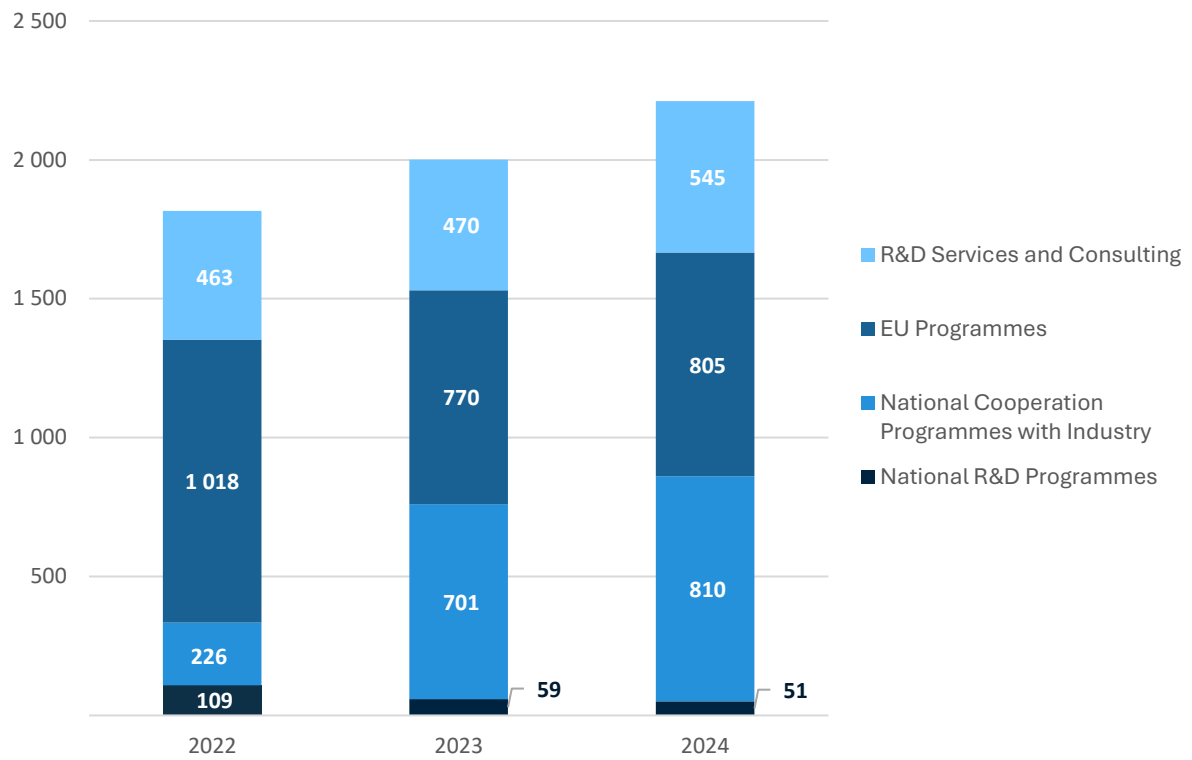


Figure 6.30 - HumanISE - Project funding evolution (k€)

6.11 LIAAD - ARTIFICIAL INTELLIGENCE AND DECISION SUPPORT LABORATORY

Coordinator: Alípio Jorge

Assistant to the Centre Coordinator: Joana Dumas

Presentation

The scientific foundations of LIAAD are machine learning, statistics, optimisation and mathematics, focusing on Intelligent and Adaptive Systems and Mathematical Modelling in Decision Support.

LIAAD produces high-quality, cutting-edge research at the international forefront of our research areas and promotes the transfer of knowledge and technology. The Centre has been working in Machine Learning and Data Science since 1991, later including Optimisation and Mathematical Modelling. The huge amounts of collected data and the ubiquity of devices with sensors and/or processing power offer opportunities and challenges to scientists and engineers. On the other hand, the demand for complex models for objective decision support is spreading in business, health, science and e-government, motivating our investment in different approaches to modelling. Currently, the growing impact of Artificial Intelligence (and of Machine Learning) in our lives demands a finer attention to bringing the human to the AI loop. Our overall strategy is to take advantage of the data flood, data diversification and existing resources to invest in research lines that will help shorten the gap between collected data and useful data, offering diverse modelling and methodological solutions, as well as bringing more transparency and meaning to Artificial Intelligence.

By the end of 2024, LIAAD had a total of 128 members (including external students and collaborations), with 44 core researchers and 48 grant holders and trainees. 24 of the researchers were Academic staff mostly from the University of Porto, but also from P. Porto, U. B. Interior, I. P. Viana do Castelo and I. P. Leiria.

Research outcomes in 2024

(C2.1) The paper *More (Enough) Is Better: Towards Few-Shot Illegal Landfill Waste Segmentation*, by Moline et al., on the exploitation of AI tools to support the detection of illegal landfill waste was awarded **Outstanding Paper at PAIS**, the Prestigious Applications of Intelligent Systems track at ECAI, the European Conference on Artificial Intelligence. In the domain of health, the paper by Almeida et al. *Physio*, an LLM-based Physiotherapy advisor won the **Best Demo Paper Award** at ECIR 2024 (Core A). The paper by Mendes-Neves et al. *Towards a foundation large events model for soccer* published at the Machine Learning Journal used transformers for sports data sequences. In another Machine Learning paper *Integration of multi-modal datasets to estimate human aging* Ribeiro et al. introduced tissue-specific regression models for age prediction by integrating epigenomic, transcriptomic, telomere length data, and histological images.

(C3.3) The **Network of Excellence Humane-AI-Net** finished in August and enabled scientific links with European partners. LIAAD was involved in the macro-project "**Metrics for ethics**". The projects PT-Pump-UP (seed), PTICOLA (google cloud platform) and StorySense (FCT) produced a number of **NLP resources for European Portuguese**, such as the ACE 2005 in Portuguese dataset published at the Linguistic Data Consortium (ACE-2005-PT: Corpus for Event Extraction in Portuguese at SIGIR 2024) and the Lusa dataset (*Text2Story Lusa: A Dataset for Narrative Analysis in European Portuguese News Articles* at LREC 2024). In June a workshop in Porto joined Computational Linguistics Researchers from Portugal, Galicia and Brazil. João Gama and Alípio Jorge were awarded the organisation of ECML-PKDD 2025, the main European Machine Learning conference. LIAAD researchers co-organised the CLEF Challenge - CheckThat! Lab Task 3 on Persuasion Techniques with colleagues from the Joint European Research Centre, the Polish Academy of Science and the University of Bologna, among others.

Innovation outcomes in 2024

(C1.4) The research on **Large Event Models** led to a spinoff in the build. LIAAD researchers were invited speakers or chairs in innovation and dissemination events such as the Applied XAI Track @ Applied Machine Learning Days 2024 – EPFL, Data Makers Fest, AI applied to soil protection at the IMPEL

conference in Alentejo, the Erasmus+ Blended Intensive Programme in Global Data Analytics Immersion: Theory and Practice for Tomorrow's Decision-Makers, and Women in Tech, among others.

(C2.1) A collaboration with C-BER resulted in a patent application of a method for **supporting automatic labelling in medical images**. A solution for **property value prediction** was developed and deployed at the company Confidencial Imobiliário.

Activity Overview

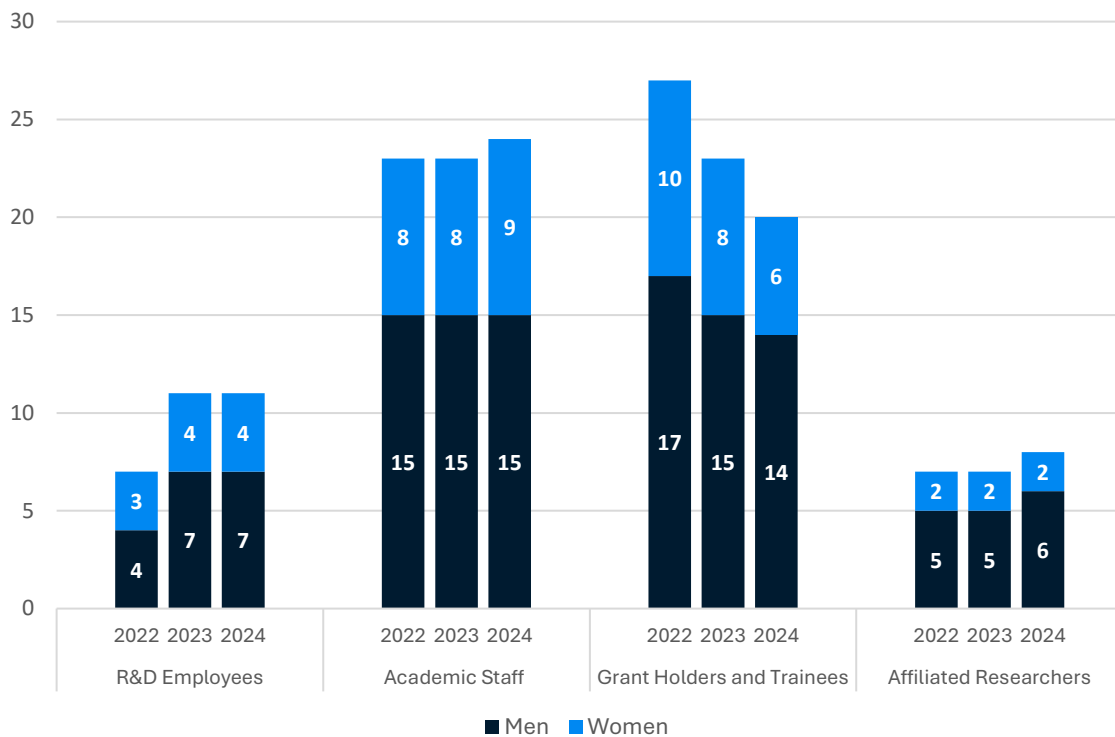


Figure 6.31 - LIAAD - Research team evolution

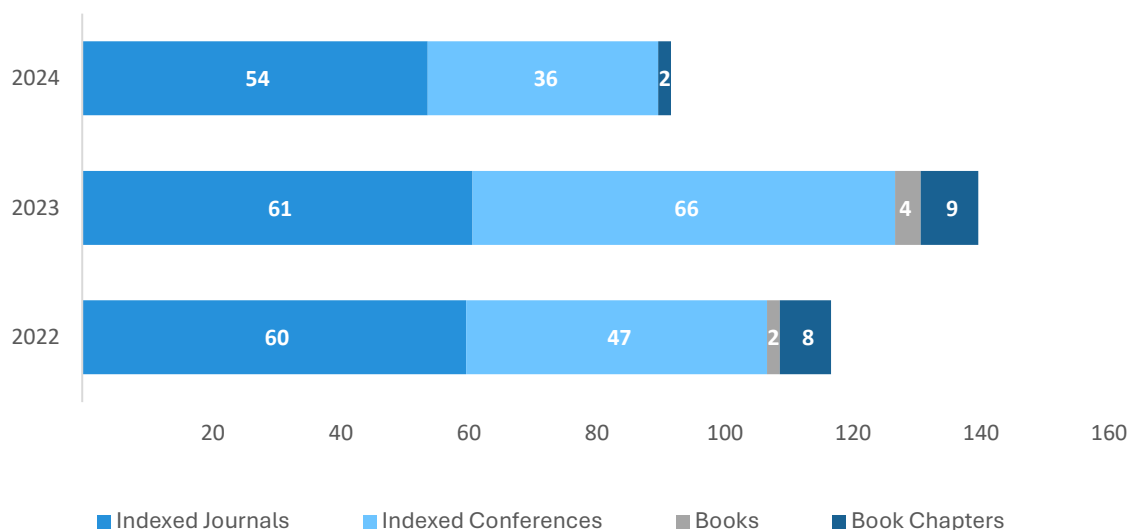


Figure 6.32 - LIAAD - Evolution of publications by members of the Centre

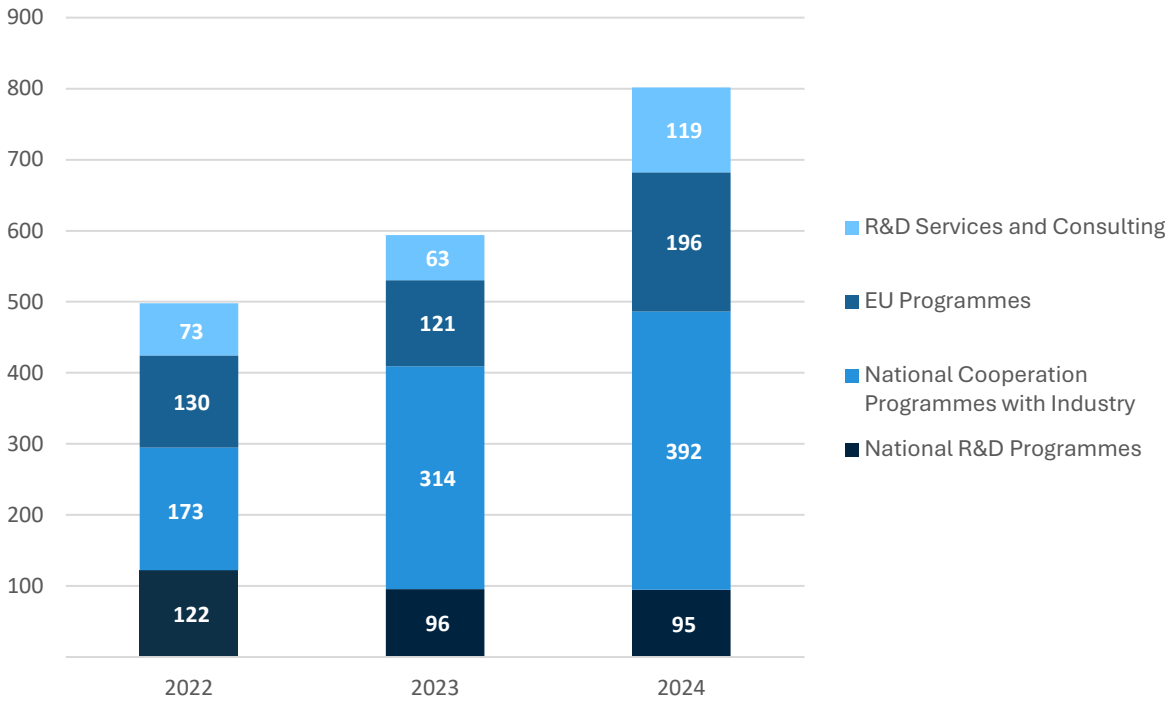


Figure 6.33 - LIAAD - Project funding evolution (k€)

6.12 CRACS – CENTRE FOR RESEARCH IN ADVANCED COMPUTING SYSTEMS

Coordinator: Ricardo Rocha

Presentation

CRACS pursues scientific excellence in the areas of programming languages, parallel and distributed computing, security and privacy, information mining, with a focus on scalable software systems for challenging multidisciplinary applications in Engineering, Life Sciences, Social Networks and the Internet of Things. The core research team includes mostly faculty members at the CS department at FCUP for a total of 17 PhD researchers in 2024 (the same as in 2023). The research environment is enriched with talented junior researchers (grant holders, trainees and employees) for a total of 29 core researchers that together build the necessary critical mass and scientific competences to fulfil our mission.

Research outcomes in 2024

A key goal for 2024 was to maintain CRACS's international visibility, notoriety and publication output, after the good results observed in recent years. In 2024, we achieved slightly worse output results for the number of participations as editor or associated editor in international journals, from 11 and 10 in 2022 and 2023, respectively, to 7 participations in 2024; for the number of participations in program committees of international events, from 42 and 34 in 2022 and 2023, respectively, to 31 events in 2024; and for the number of international events organised by CRACS members, from 11 and 15 in 2022 and 2023, respectively, to 5 events in 2024. Regarding the total number of publications in indexed journals, conferences and books, there was also a decrease from the 58 and 47 publications reached in 2022 and 2023, respectively, to 37 publications in 2024 (this number may increase due to later updates).

We would like to emphasise the publication 'Hardware Security for Internet of Things Identity Assurance' in the IEEE Communications Surveys & Tutorials, with an Impact Factor of 34; the Best Paper Award for the publication 'Blockchain-assisted Device as a Service (DaaS)' in the 6th International Congress on Blockchain and Applications; and the organization of the 14th ACM Conference on Data and Application Security and Privacy, with 80 participants from 16 countries. In what follows, we enumerate in more detail CRACS's main research outcomes in 2024.

- Heterogeneous parallel computing: development of a novel framework that uses CPUs and integrated GPUs in tandem to accelerate algebraic operations, such as the factorisation of a matrix into a product of three matrices used in the Singular Value Decomposition algorithm.
- Lock-freedom: redesign of a previous lock-free hash map to fully exploit the properties of the ERA theorem and to leverage the characteristics of multi-core cache-based architectures by minimising the number of cache misses. The new design achieves significant performance gains, is simpler, more reliable and more compatible to integrate with SMR methods.
- Quantitative types for pattern matching: we show how (well-established) type systems based on non-idempotent intersection types can be extended to characterise termination properties of functional programming languages with pattern matching features. To model such programming languages, we use a (weak and closed) lambda-calculus integrating a pattern matching mechanism on algebraic data types (ADTs). Remarkably, we also show that this language not only encodes Plotkin's CBV and CBN-calculus as well as other subsuming frameworks, such as the bang-calculus, but can also be used to interpret the semantics of effectful languages with exceptions.
- Graph mining: (i) a novel approach for efficiently finding subgraph patterns in hypergraphs; (ii) a novel deep learning architecture designed for efficient representation learning on continuous-time dynamic graphs with low-latency inference requirements; (iii) two new efficient approaches (online and offline) for computing natural visibility graphs from times series.
- Trust and security: in the context of project PRIVATEER, we have developed a solution and implemented a proof-of-concept prototype for the known single point of failure problem of

searchable encryption techniques. The solution uses multiple indexes in a round-robin approach, and it is currently being evaluated for functionality and performance.

- **Privacy:** proposal of a new Privacy-Aware Remapping mechanism that is able to improve the privacy level attained by Geo-Indistinguishability through a tailored pre-processing discretisation step. The proposed remapping technique is capable of reducing the re-identification risk of locations under Geo-Indistinguishability, with limited impact on quality loss.
- **Blockchain-based enhanced authentication:** we proposed a permissioned/private blockchain-based authentication framework that provides a solution to current security threats such as IoT device-level attacks, by achieving decentralised and distributed device authentication with negligible authentication latency.
- **Identity management and security:** new methods for hardware-based identity assurance in IoT devices, focusing on lightweight, energy-efficient authentication mechanisms that address the computational constraints of embedded systems while enhancing resistance to hardware and software attacks. We explored the integration of hardware trust anchors to mitigate identity-related vulnerabilities, evaluating candidate solutions such as Physically Unclonable Functions (PUFs) and Trusted Platform Modules (TPMs). These technologies are assessed for their effectiveness against known attack vectors and their adaptability across diverse IoT environments, aiming to support the development of robust identity frameworks for dynamic resource-constrained ecosystems.
- **Computer programming education** - in the context of project FGPE++, we are working on providing a framework for application of gamification to programming education, including the specifications, collection of gamified exercises and software. The expected impact is an improvement in efficiency of programming education and its student-perceived experience.
- **Automated assessment tools:** (i) development of the AsanasAssist system to create automatic and incremental feedback on programming exercises; (ii) improvement on the framework to assess the quality of synthetically-create table data.
- **Program code clustering:** new method for program code clustering (in an imperative paradigm) based on elements taken from the data flow and independently of the programming language.
- **Social media:** by performing automatic identification of publication strategies on Social Media by Higher Education Institutions, we can now predict 5 consecutive days with accuracy above 75%.

Innovation outcomes in 2024

In what follows, we enumerate CRACS's main innovation outcomes in 2024.

- **Privkit** - a privacy toolkit: we developed and publicly released the first version of Privkit, a privacy toolkit that provides methods for privacy analysis and anonymisation for heterogeneous data types. The current version is focused on privacy-preserving mechanisms for location data and facial data. Privkit is designed in a modular manner and can be easily extended to include new privacy-preserving mechanisms (PPMs) and accommodate novel data types according to the privacy requirements of ongoing and future projects. Available at <https://privkit.fc.up.pt>.
- **GAMAI** - an AI-powered exercise gamifier: leveraging large language models, GAMAI enables teachers to effortlessly apply storytelling to describe a gamified scenario, as GAMAI decorates natural language text with the sentences needed by OpenAI APIs to contextualise the prompt. Once a gamified scenario has been generated, GAMAI automatically produces exercise files.
- **Cybersecurity repository** - development of a cybersecurity repository to enable automatic document collection, filtering, and classification using various tools, including GPT-4o. This project uses an RSS Feed Consumer module and a PDF Crawler to efficiently gather documents from various sources.

Activity Overview

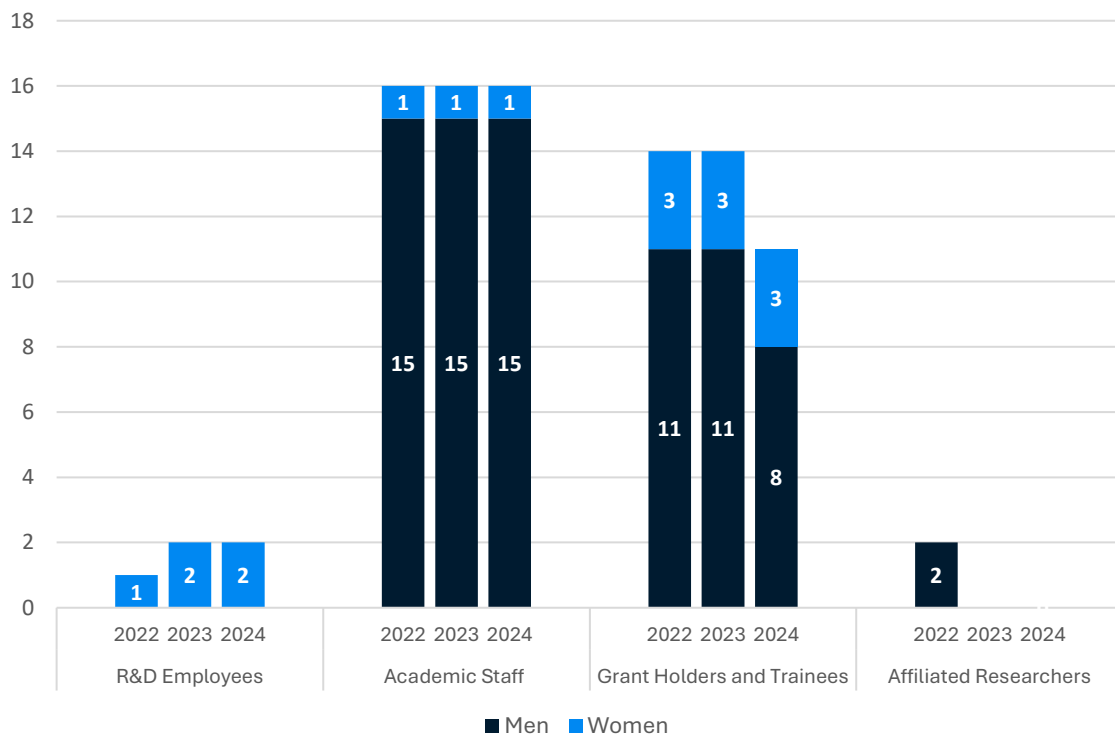


Figure 6.34 - CRACS - Research team evolution

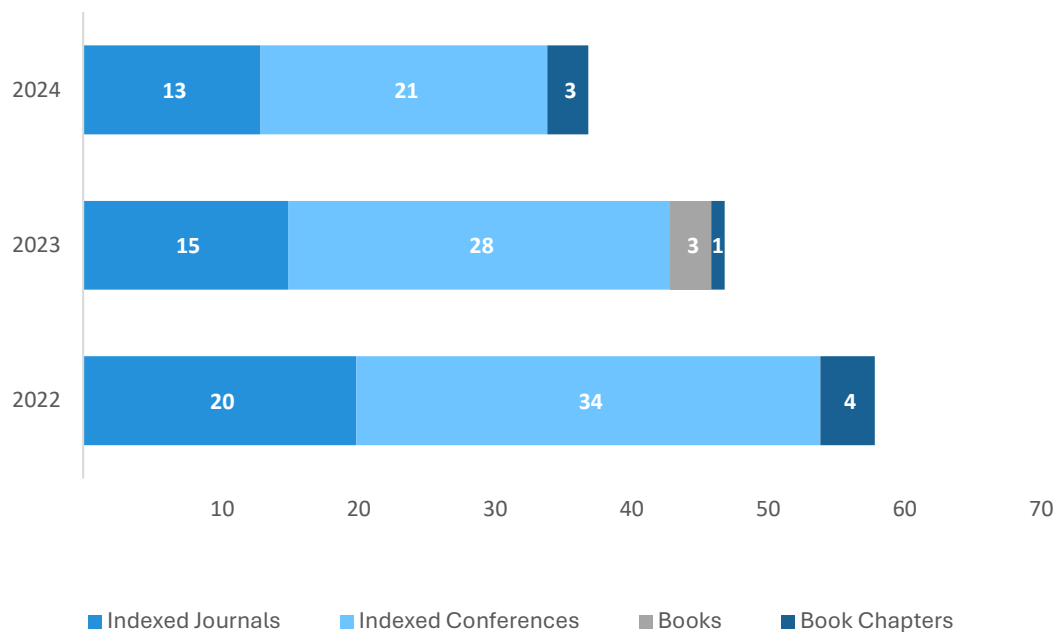


Figure 6.35 – CRACS - Evolution of publications by members of the Centre

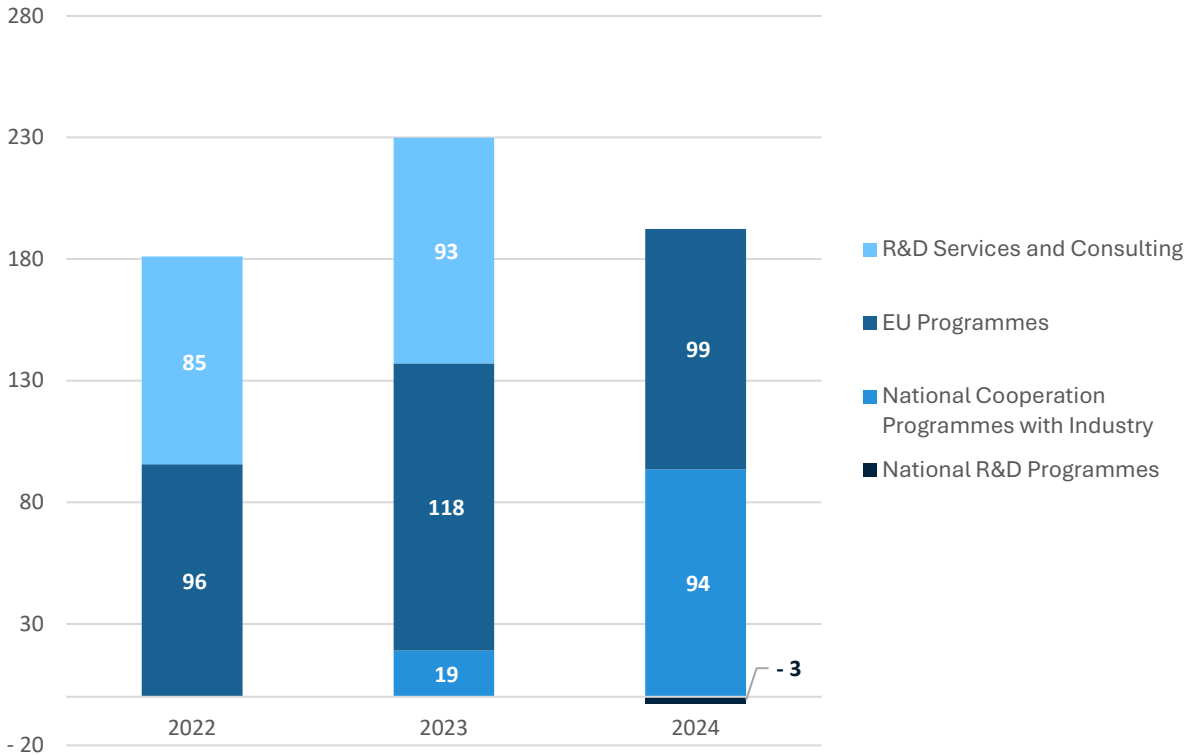


Figure 6.36 - CRACS - Project funding evolution (k€)

6.13 HASLAB - HIGH-ASSURANCE SOFTWARE LABORATORY

Coordinators: Alcino Cunha and António Luís Sousa

Assistant to the Centre Coordinator: Catarina Leones Fernandes

Presentation

HASLab is focused on the design and implementation of high-assurance software systems: software that is correct by design and resilient to environment faults and malicious attacks. To accomplish this mission, HASLab covers three main competencies within INESC TEC's Computer Science domain — Software Engineering, Distributed Systems, and Information Security — complemented by other competencies such as High-Performance Computing, Human-Computer Interaction, Programming Languages, Quantum Computing or the Theory of Computation. In particular, HASLab's research focuses on three main competencies:

- **Software Engineering:** methods, techniques, and tools for rigorous software development that can be applied to both classical and novel quantum computing architectures;
- **Distributed Systems:** improving the reliability and scalability of software by exploring properties inherent to the distribution and replication of computer systems;
- **Information Security:** minimising the vulnerability of software components to hostile attacks by deploying structures and cryptographic protocols whose security properties are formally proven.

Concerning innovation, HASLab aims to provide solutions — combining theory, methods, languages, and tools — to develop complete ICT systems that provide strong, high-assurance guarantees to their owners and users.

Research outcomes in 2024

In 2024, HASLab continued producing high-quality research with renowned international partners, including academia and IT companies. Compared to last year, the number of publications is slightly lower, but they were published in higher-quality venues. The team published 52 scientific publications, of which 31 were conference papers (including 6 CORE A* and 4 CORE A) and 21 journal articles (including 15 Q1 and 4 Q2). Among the publications in top venues, we highlight the following:

- The paper “When Amnesia Strikes: Understanding and Reproducing Data Loss Bugs with Fault Injection” published at VLDB, the top database conference, that presents LazyFS, a tool that simplifies the injection of database faults to reproduce data loss bugs.
- The article “Databases in Edge and Fog Environments: A Survey” published in ACM Computing Surveys, that surveys the current state of the art in the edge databases area, discussing topics such as the used hardware, latency performance, energy consumption, or privacy.
- The article “Quantum advantage in temporally flat measurement-based quantum computation” published in the Quantum Journal, which evaluates the ability to execute any Boolean function on quantum computers designed according to a measurement-based quantum computation model.
- The paper “X-Wing: The Hybrid KEM You've Been Looking For” published at the IACR Communications in Cryptology, describing a hybrid key-encapsulation mechanism (KEM) capable of addressing the demands of the dynamics of hybrid models that combine pre-quantum and post-quantum algorithms.
- The paper “Formally verifying Kyber Episode V: Machine-checked IND-CCA security and correctness of ML-KEM in EasyCrypt” published at CRYPTO, that describes a formally verified proof of the correctness of the NIST standard KEM.

In terms of prizes, we highlight the Atlantic Security Award won by Alexandra Mendes with a work that aims to use a large language model – trained with data retrieved from the dark web – in decision-making processes, namely in the design of defense policies and strategies.

Concerning projects, we kicked-off two new European projects in the area of high-performance computing: HANAMI, aimed at bringing Europe and Japan closer together in supercomputing, and EPICURE, which brings together the supercomputers of the European EuroHPC Joint Undertaking (EuroHPC JU) network to support its users. We also successfully concluded the InterConnect project, where we co-led the development of the main key exploitable result of the project, the Semantic Interoperability Framework, which is currently being explored in other HEU projects by entities such as the Linux Foundation for Energy, or the Big Data Value Association.

Concerning internalisation, we highlight the 2 PhD grants obtained by our students in the context of the Carnegie Mellon Portugal and the visit of 5 researchers from Brazil and Holand as part of the 2nd edition of the INESC TEC International Visiting Researcher Programme. HASLab also strengthened its partnership with the CENTRA network, focusing on the areas of edge-cloud computing and artificial intelligence.

In the past year, 6 students concluded their PhD (two were hired as Assistant Researcher) and we had 4 new PhD students. Finally, we also highlight the 1st “PhD Bytes” initiative, where PhD students had the opportunity to compete by presenting the best five-minute pitch describing their work to the broad community. In this 1st edition, Beatriz Cepa won with a pitch describing her research on Neuroimaging in HPC.

Innovation outcomes in 2024

Regarding innovation, the main highlight of 2024 was the PETALL (PeT) project, which won the second place in the 4th edition of the IN3+ Award, receiving €250k to develop techniques to ensure transparency and privacy in digital services.

In terms of impact in the community, we highlight the work on the project “Linha de Saúde 24h”, where we helped deploying advanced technologies and optimised services in a free healthcare telephone service for the population of Guinea-Bissau.

In the context of the collaboration with the Power and Energy Centre of INESC TEC, HASLab was also involved in the Grid Data and Business Network (GDBN), which is currently being developed within the framework of the BeFlexible project and that will be part of the Edge IoT project. This digital platform will allow consumers, aggregators, flexibility service providers and system operators to streamline their participation in local energy flexibility markets. As part of this work, HASLab participated in the Enlit Europe event, an annual conference and exhibition that unifies two major events in the power and energy sector, where we disseminated the concept and the development of the GDBN platform.

HASLab also participated in different industrial conferences in the area of HPC, such as the International Conference for High-Performance Computing, Networking, Storage, and Analysis (SC 2024) and the High-Performance Computing, AI, Data Analytics & Quantum Computing (ISC 2024), where our researchers also presented the paper “Can Current SDS Controllers Scale To Modern HPC Infrastructures”, written in collaboration with the Texas Advanced Computing Center (TACC), in the U.S.A., and the National Institute of Advanced Industrial Science and Technology (AIST), in Japan.

As part of the ATTRACT DIH we helped organise an event which brought together several experts on the HPC and AI subjects and that featured several debate sessions discussing why and how companies must join forces to find solutions and explore the financing opportunities within the project.

Finally, in 2024 we also registered two pre-disclosures related to the SmartKey mobile app, which provides easy and secure access to HASLab's open spaces, and the “Linha de Saúde 24h” project described above.

Activity Overview

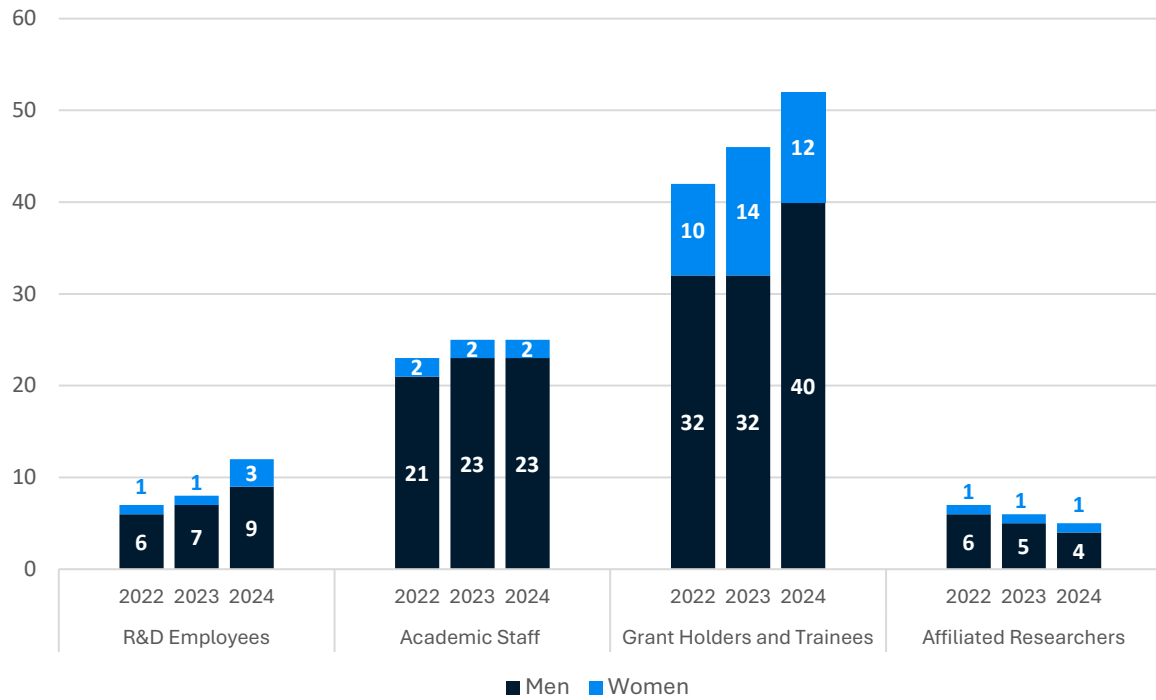


Figure 6.37 - HASLab - Research team evolution

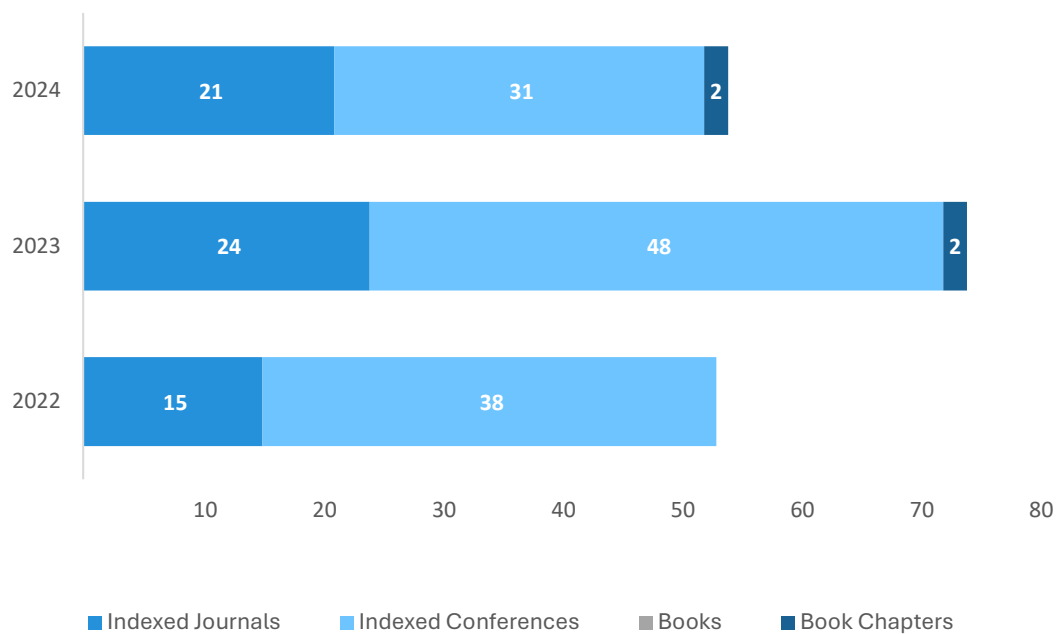


Figure 6.38 - HASLab - Evolution of publications by members of the Centre

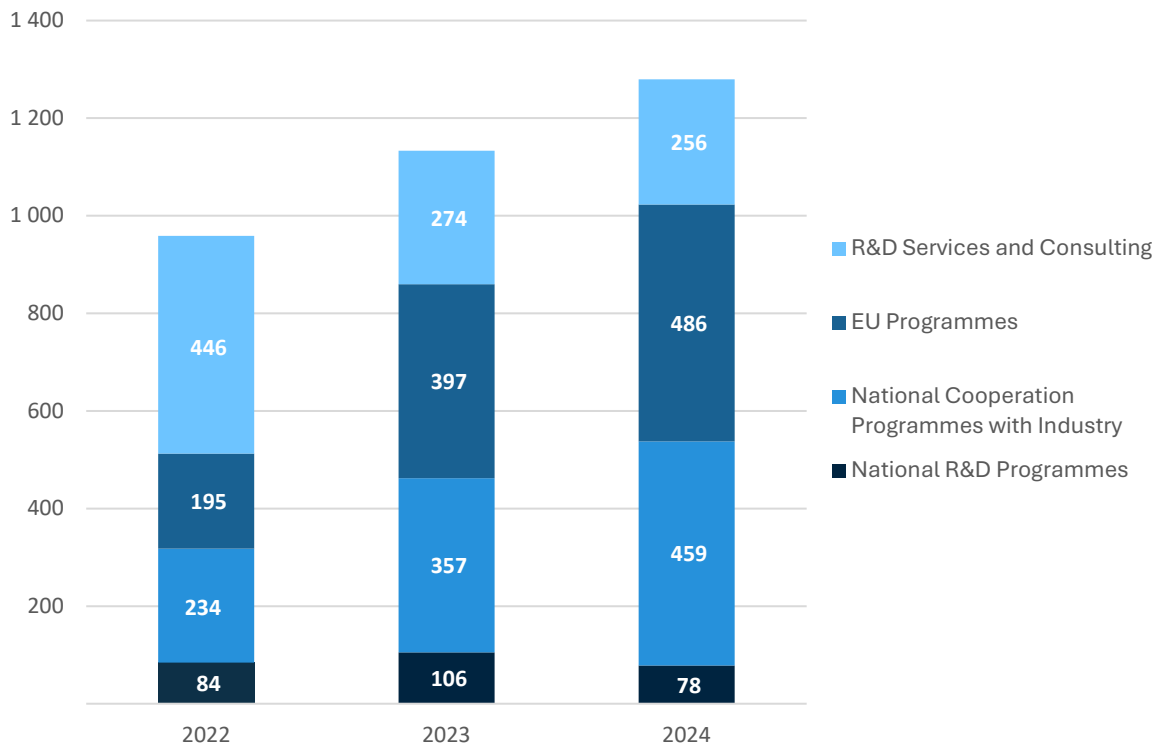


Figure 6.39 - HASLab - Project funding evolution (k€)

7 Research Infrastructures

7.1 Tec4Sea - Technologies for the Sea

Mission and positioning

The TEChnology for Sea infrastructure (TEC4SEA; www.tec4sea.com), is a platform designed to support multidisciplinary research, development, and test of marine robotics, telecommunications, and sensing technologies for operation in oceanic environments. It is open to both the R&D community and the industrial sector, thus providing the equipment, expertise, and logistics needed to support those communities in developing, evaluating, and validating technological solutions designed for maritime environments, thus fostering and advancing the blue economy.

TEC4SEA has three main objectives: supporting the R&D community, supporting the industrial sector, and pushing the technological envelope in developing technology for maritime environments, by making available facilities, resources, and know-how to economic agents and researchers.

TEC4SEA is a vertically integrated infrastructure; its expertise and resources range from pure conceptual research to field deployment missions, with strong industrial and logistic competences in prototype production and an eclectic set of laboratories, testbeds, equipment, and support facilities for experiments in controlled and real environments. It can thus support researchers in all phases of technology development, from conception and theoretical analysis to prototype development, field deployment, and technology validation.

Its geographic location (allowing fast access to deep sea), multidisciplinary nature, and vertically integrated structure are vital assets in supporting the development, evaluation, and validation of technological solutions designed for the ocean environment, allowing researchers to evolve from simulation/lab experiment to deployment and field trials. Its focus on ocean technology development—not on the ocean itself—and structural characteristics define it as a unique research infrastructure in Europe. TEC4SEA has poles in Porto and Faro, two major coastal cities in Portugal. Its first implementation phase had finished in the end of 2022 and was coordinated by Paulo Mónica as Principal Investigator. The implementation management team also had included Eduardo Silva, António Silva, Aníbal Matos, José Almeida, Nuno Cruz, Carlos Pinho, Diana Viegas, Luís Pessoa, Bruno Ferreira, Maria Graça Barbosa, and Marta Barbas.

Main achievements in 2024

In supporting public and private organisations operating at sea, INESC TEC's research vessel Mar Profundo carried out six missions throughout 2024. These operations were successful in several areas, including the monitoring of marine fauna and habitats and the inspection and assessment of the state of conservation of submerged infrastructures. In addition, the Mar Profundo, along with several of INESC TEC's robotic platforms and unmanned vehicles, has supported various research projects, such as Trident, EU-SCORES, and EU-AIRSHIP, and collaborated with government entities. The ship also played an important role in the international joint robotics exercise REPMUS24, the largest event of its kind, bringing together around 2,000 participants from 30 countries to test and demonstrate innovations in drones.

At the end of the year, the Mar Profundo underwent an upgrade that gave it autonomous dynamic positioning capability, an essential feature for the complexity of the missions it carries out. This improvement also extended its autonomy, allowing it to expand its area of operation to the Azores Archipelago.

7.2 EMSO-PT - European Multidisciplinary Seafloor Observatory – Portugal

Mission and positioning

EMSO-PT is a research infrastructure led by IPMA (Instituto Português do Mar e da Atmosfera) and involving 15 other research institutions working on ocean science or technology, including INESC TEC.

The ultimate goal of EMSO-PT is to organise the Portuguese contribution to the EMSO-ERIC network, a large-scale European Research Infrastructure, networking fixed point, deep sea multidisciplinary observatories, with the scientific objective of real-time, long-term monitoring of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere. It is a geographically distributed infrastructure at key sites in European waters, spanning the Arctic, the Atlantic, and the Mediterranean, up to the Black Sea. It will be in place by the end of the decade.

EMSO identifies eight main scientific questions where advances are foreseen: 1) Dynamics of tectonic plates and magmatic systems; 2) Climate and greenhouse gas cycling; 3) Ocean productivity and ocean dynamics; 4) Marine mammal and fish stocks; 5) Non-renewable marine resources; 6) Episodes, events and catastrophes; 7) Origins and limits of life; 8) Marine ecosystems dynamics. All these topics are dependent on long-term, continuous observations, able to capture significant episodes as they occur.

So far, the Portuguese participation in EMSO has been focused on the Azores and Cadiz nodes, in cooperation with France (Azores) and Italy (Cadiz) using two of the few available technological solutions for long term seafloor monitoring (ASSEM and GEOSTAR). Within the scope of EMSO-PT two sites will be considered close to the mainland: a deep water one, located in the Gulf of Cadiz, and another shallow water, located off North Portugal. The later one will also be a test bench for emerging monitoring strategies.

EMSO-PT observatories will merge “off-the-shelf” technology, which will ensure that they will meet the international standards, with novel approaches (based on networked, autonomous observation platforms) that will contribute to more sustainable monitoring operations and will create the basis for the development of new marine products and services, creating value and qualified jobs.

INESC TEC involvement in EMSO-PT addresses the establishment of long-term non-fixed observatories. Such work is organised along two complementary lines: relocatable nodes and long-endurance mobile platforms. In the first case, INESC TEC is building an EGIM (EMSO Generic Instrument Module) for integration and use in a Turtle relocatable node. In the second one, INESC TEC is implementing a network of underwater gliders for collection of oceanographic data.

While the goal of the EMSO-PT infrastructure is the implementation of a network of ocean observatories for data gathering, the underlying activities are aligned with CRAS research line associated with long term deployments.

INESC TEC core research team associated with this infrastructure includes Eduardo Silva, Aníbal Matos, José Almeida, Alfredo Martins, Hugo Ferreira, Nuno Cruz and Nuno Abreu.

Main achievements in 2024

EMSO-PT finished its first implementation phase in 2023. In 2024, there was continued participation in the international EMSO-ERIC activity, where the infrastructure strategy was discussed, and further work was planned for the following years.

Funding is waited for 2025 to implement the strategy to continue developing the infrastructure.

7.3 Robotics and Autonomous Systems Laboratory

Mission and positioning

The Robotics and Autonomous Systems Laboratory has two physical locations within the ISEP and FEUP campuses. These dedicated facilities support R&D activities, technical training of human resources as well as advanced education programs. In fact, as a research lab in an academic environment it fosters undergraduate research and supports multiple engineering courses and academic activities.

The mission of the laboratory is to support research of excellence in Autonomous Systems enabling observation and operations in complex, unstructured, and harsh environments. The multiple-purpose robotic operations include data gathering, inspection, mapping, surveillance, and/or intervention. The impact on the economic and social fabric development is also part of the objectives - by contributing to the performance, competitiveness, and internationalization of Portuguese companies and institutions.

The total area of the laboratory exceeds 1000m², distributed in two campuses: ISEP and FEUP. The overall facilities include two test tanks, the largest of which is 10mx6m and 5m deep, and a prototyping workshop. The laboratory's infrastructure includes a large set of robotic platforms (underwater, surface, aerial, and terrestrial), most of which are ready to operate in real environments. It also includes many sensors and auxiliary equipment that can be operated independently or integrated into larger systems. These assets contribute to great operability and have been key to establishing national and international partnerships.

Main achievements in 2024

The main achievement of the Robotics and Autonomous Systems Laboratory in 2024 addressed 3 areas:

1. Lab space and infrastructure

- Work has begun on reorganising the physical space on the ISEP campus, creating a mezzanine in a part of the open space, creating more work areas for staff and students and more storage space for equipment. This will provide better conditions, with work expected to be completed by the first half of 2025.
- Reorganisation of the storage space at ISEP, with a modular rack system and electric retrieval platform.

2. Human Resources

- At the end of the year, a group of researchers began a basic training course in safety and survival techniques at sea. This training will allow access to offshore platforms to test prototypes in operational environments.
- Following the growing participation in security/defence projects, essential security accreditation process started for handling classified and restricted information within the scope of European projects.

3. Lab prototypes and subsystem

- Development of a multi-modal sensing, positioning, and mapping system for docking of autonomous surface vessels. The approach combines complementary and redundant sensors for robustness against performance degradation of sensing devices. It includes RTK GNSS, RF ranging tags, artificial vision, IMU and LiDAR, whose data is fused by an Extended Kalman Filter. A companion dock was developed and instrumented to enable relative measurements.
- Development of a control strategy for autonomous surface vessel (ASV) docking. A Model Predictive Controller was developed, considering actuation, positional and other state constraints. The approach explicitly implements obstacle and collision avoidance, which are modelled as constraints.
- Integration of a new underwater stereo camera with depth extraction in the CRAB ROV.

- Ongoing upgrade of the scientific instruments available with new development equipment, navigation systems, LiDARS, Multibeam sonars, thermal cameras, and several underwater sensors.
- Continue the training of technicians to operate workshop facilities, help programming sensor drivers, and provide support to field operations.

7.4 Laboratory of Microfabrication

Mission and positioning

The Microfabrication laboratory explores non-traditional microfabrication techniques based on femtosecond laser direct writing processes. For example, microfluidics and optofluidic chips are produced to implement biosensors and micro and nanostructures. First order Bragg gratings are made by laser point-by-point direct writing leading to the development of better and more reliable sensing heads. Laser marking and surface treatment is also possible.

Main achievements in 2024

The subjects where the lab had significant contributions were:

- Fabrication of microfluidic devices for 2D and 3D hydrodynamic flow focusing; demonstration of laser trapping and sorting within a microfluidic channel;
- Machining of Ultra Low Expansion (ULE) glasses; demonstration of high finesse Fabry-Perot cavities for temperature referencing;
- Optofluidic based on glass capillaries machining and incorporation of optical fibres (patent submitted);
- Fabrication of microfluidic and optofluidic devices using FLICE techniques for sensing applications;
- Fabrication of Bragg gratings in planar format;
- Fabrication of tunable integrated optics devices by the incorporation of surface heaters; the objective is to address the fabrication of complex chips to perform neuromorphic operations.

The Bragg and long period gratings fabrication set-up went through a renovation process, that included new drivers and air-bearing X-Y stages, re-written control software, and improved optical hardware. Since the laser was also sent to the suppliers for a major renovation, the development of this system, as well as all the other activities relying on the femtosecond laser, are stopped since the beginning of November.

The fabrication capabilities are complemented with equipment available at CEMUP – MNTEC. The cleanroom is a service providing laboratory managed by University of Porto that was supported since its creation by INESC TEC which made its micro/nanofabrication equipment available on this infrastructure for widespread use.

7.5 x-Energy Lab - Smart Grids and Electric Vehicles Laboratory

Mission and positioning

The x-Energy lab (formerly SGEVL – Smart Grids and Electric Vehicle Laboratory) is a multifunctional and multipurpose electric and digital infrastructure that offers a distinctive integrated capacity to simulate, prototype, and test solutions for the energy system of the future. The lab is an important research infrastructure (RI) that provides testing and validation capabilities to the research activities carried out within CPES scientific and innovation developments, as well as support and services to the scientific and industrial ecosystem.

Recognised by FCT as part of the National Roadmap for Research Infrastructures of Strategic Interest, the x-Energy lab has a professional management that guarantees the implementation of an action plan encompassing: an efficient and transparent management of resources; a clear, well-defined, and widely advertised policy defining the procedures to allow resident and visiting researchers to use the laboratory infrastructure; services to the scientific partners, educational entities, and business and industrial entities. The different projects within INESC TEC activity and services to business and industrial entities guarantee the short and long-term financial support that ensures the operation of the laboratory and its resources. Regular support for scientific and technical work (i.e., M.Sc. and Ph.D. theses) guarantees the availability of specialised and skilled human resources for ongoing and future research activities.

x-Energy has an advanced and fully configurable microgrid-based laboratory framework, integrating commercial technologies and prototypes and systems developed by the researchers (e.g., inverters, EV chargers), as well as supporting technologies (e.g., real-time digital simulators for power systems). It hosts a team of experienced researchers who carry out activities involving advanced modelling, prototyping, and testing, ensuring support for various projects (e.g., EU, national contracts with industry).

The x-Energy is currently led by Dr. Justino Rodrigues, who is responsible for the management activities and the implementation of the research and innovation plan set by CPES.

Main achievements in 2024

The main achievements of the RI for the year 2024 were the following:

- Continued development of a laboratory-scale validation facility, including hydrogen-producing electrolyzers (PRR H2DRIVEN). The PEM electrolyzer was commissioned and delivered, and the electronic power converter interface is currently under construction, with completion expected in 2025.
- Further improvement of the hybrid AC+DC microgrid, with two new high-power DC power sources and two new 1000V DC cable emulators purchased and already operational. The technical specifications for a DC electric panel to enable seamless integration and control of a DC grid are completed, and its procurement is underway. The development of the hybrid AC+DC microgrid is expected to continue through 2025, aiming to reach a high readiness level by the end of that year.
- Expansion of the EV charging testbed with new AC (prototypes and commercial) and DC (prototypes) EV chargers, as well as new charging locations, to implement and validate new control strategies using EV chargers deployed in the field (H2020 POCITYF, HE Green.Data.AI, PRR ATE projects).
- Continued development of a grid automation and protections testbed, considering digital protection units, under the PRR ATE project. The existing HIL/PHIL platform based on the OP5600 real-time digital simulator was updated with the newer OP5707XG model.
- Reinforcement of the x-Energy microgrid with the installation and successful testing of two additional controllable battery inverters.
- Reinforcement of x-Energy prototyping capabilities with the purchase of a new 3D printer and a reflow soldering oven machine.
- Development of a new roadmap for the x-Energy lab, aiming to define core guidelines for its scientific activities, services for industry, human resources capacitation, and infrastructure management. The roadmap is still under development, aiming to reach a high readiness level in 2025.

7.6 BRAIN Lab - Neuro-Engineering Lab

Mission and positioning

The Neuro-Engineering laboratory, a.k.a. BRAIN (Biomedical Research And INnovation) has a strong focus on researching new biomedical engineering methods for neurosciences & neurological diseases (e.g., Parkinson's, Alzheimer's, Autism or Epilepsy) and is divided in 5 main research lines: 1) Brain imaging (&signals); 2) Man-machine symbiosis with edge-AI (e.g. Brain-Computer Interfaces); 3) Multimodal Computer Vision Analysis for neurological diseases; 4) Neurosurgery Aiding Systems; and 5) Macro-to-nano bio(neuro)sensing.

Part of BRAIN-lab is the Stim-BRAIN Lab which is an advanced Brain Imaging infrastructure (that offers scientific services to third-parties, apart for our own research project) with an f-MRI simulator (mock scanner) fully equipped with synchronised 64ch video-Electroencephalogram(EEG) medical systems from Micromed, wearable EEG devices, video cameras, MRI compatible pads and audio system to simulate f-MRI experiences and prepare stimulation protocols to be deployed in MRI scanners at the CHUSJ or any other clinical centre. This infrastructure is used for fMRI and Video-EEG-fMRI paradigms development and testing for neuroscience projects with our clinical partners and students.

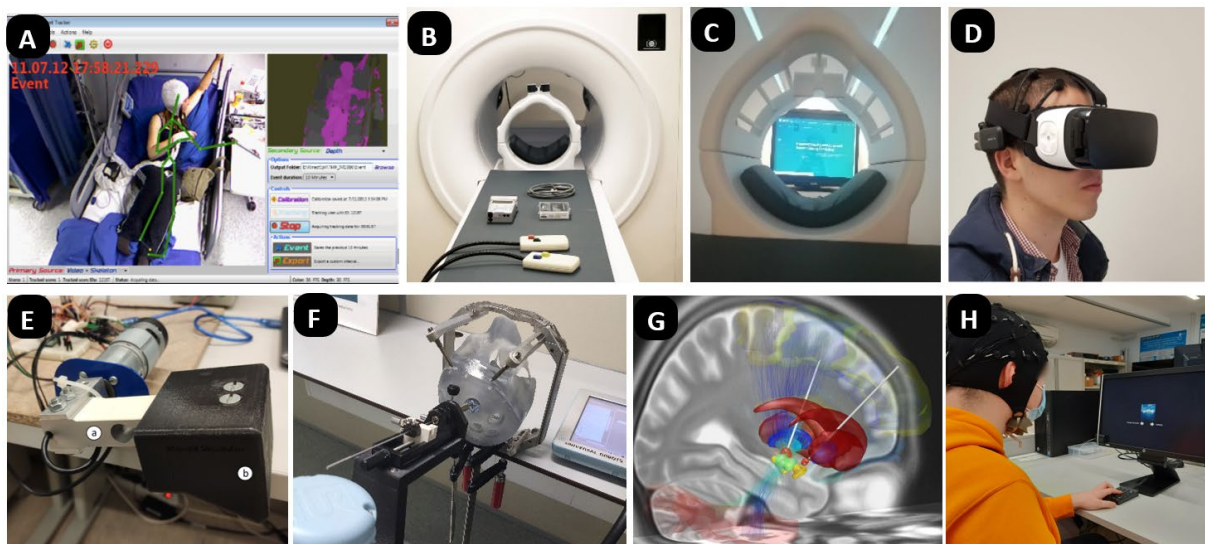


Figure 7.6: Some BRAINLab infrastructure and research projects examples. A- Neurokinect System interface; B/C- fMRI simulator for experimental design and training; D- Combination of EEG-wearable devices and Virtual reality to study psychophysiological states; E- Robotic wrist for wrist rigidity simulation; F- Surgical robot simulating automatic DBS electrodes precise adjustment based on real-time iHandU wrist rigidity quantification; G- 3Dmodel of brain structures and DBS stimulation electrodes position analysis to study electrodes position and brain stimulation connectivity; H- Experimental paradigm to correlate neuronal activity with memory recognition.

Main achievements in 2024

Breakthrough in biosensing: We published a paper in the scientific publication “Nature Communications Engineering” and launched a patent – iLoF 2.0 - introducing a new method for extracting “biosignal fingerprints” from backscattering photonic signals with high sensitivity and robustness. This new method is now patent pending.

New Startup (#4): The creation of the start-up #4 from the lab was a major achievement. SeedSight.io focus its activity on the developing an AI bio-photonic-sensing approach to detect different types of micron and nano-sized bio-components from laser backscattering “fingerprints” for the food market based on some of our prior work & patents. This start-up has raised its seed round to build the road to the food tech market. Seedsight.io has a contract with our lab for scientific assistance and equipment usage.

IEEE AI Research Hub Prize @GITEX Global 2024: Our UP-CMU PhD Student Tamás Karacsony won this prize promoted by IEEE at the largest tech and startup exhibition in the world held in Dubai with his work on AI for neurology video processing.

7.7 iiLAB - Industry and Innovation Lab

Mission and positioning

To disclose the state-of-the-art in advanced production technologies through the demonstration of research, experimentation, and advanced training results. iiLab fosters technology-driven innovation in public and private organisations, enhancing their capabilities in developing, adopting, and implementing advanced production technologies. This, in turn, promotes sustainable competitiveness within the circular economy.

- Development and demonstration of concepts and advanced technologies in the areas of robotics, automation, industrial cyber-physical systems (Internet of things) in the form of a show-room;
- Dissemination of INESC TEC's expertise for the industry and the community in general;
- Experimentation and prototyping space for technological companies;
- Tailor-made training for senior managers and senior executives of industrial companies.

Main achievements in 2024

In 2024, in line with what was established in the activity plan for that year, various activities were carried out in conjunction with other Centres, with the following being particularly noteworthy:

i) Use of iiLab by more than seven INESC TEC R&D projects that involved carrying out PhDs in cooperation with industry, contributing to the reception of eight doctoral students, the training of doctoral graduates and the publication of nine articles in prestigious scientific journals and international conferences.

ii) Development of closer and deeper relations with our innovation partners and the broader community by organising thirty-three promotion sessions and visits to iiLab by industrial companies and other stakeholders from the innovation ecosystem (IAMOT 2024 with twenty participants and 2024 EIT Manufacturing Portugal Conference with fifty participants). This has contributed to the establishment of new R&D contracts and the sale of services by INESC TEC.

iii) Implementation and deployment of a dedicated 5G infrastructure, coupled with Network Operating System (NOS). Within this initiative, we have developed and demonstrated seven pilot cases in the scope of the NOS 5G & Digital Transformation TestBed, in close collaboration with the following national SME technology companies: Flowbotic, Infinite Foundry, Neadvance, Azitek, FoodinTech, Azevedos, and SARKKIS.

iv) Design and implementation of a training roadmap to guide individuals and companies through the complexities of digital transition and empower the companies' workforce with the skills needed to thrive in the digital age. Two executive and senior training programmes ("Programa Avançado em Industry 4.0" and "Digitalização shopfloor"), with a strong practical component based on research results, were held, attended by twenty-four people from industry; in the scope of the EIT Winter School, Innovat ED project, a simulation workshop was held in the iiLab training room.

v) Development and implementation of a showcase for visitors and trainees by integrating into a real-world complex manufacturing process some research results in areas such as advanced planning model, planning and scheduling, simulation and optimisation, digital twin, automation, collaborative robotics, IoT platform, augmented reality, and quality control with AI, enabling seamless data exchange and interoperability. Sessions to present this showcase were held.

vi) Hosting eighteen R&D projects carried out in cooperation with industry, both at national and international level, contributing to a better alignment of the R&I carried out at INESC TEC with the needs and interests of industry.

vii) Support licensing to industry technology-based products and services.

vii) Organisation of a high-visibility international events like Hybrid Workshops on Mari4_YARD project.

x) Establishing of co-operation links with international Industry Laboratories, like for example the Siemens i-Experience Centre.

The advisory board has met and approved iiLab's strategic guidelines, which have subsequently been approved by the executive committee.

7.8 TRIBE LAB - Laboratory of Robotics and IoT for Smart Precision Agriculture and Forestry

Mission and positioning

The (TRIBE LAB) laboratory of Robotics and Internet-of-Things (IoT) for Smart Precision Agriculture and Forestry was conceptualised in 2013 with a clear mission: to pioneer robotics, automation, and IoT-based solutions. Our aim is to revolutionise smart precision agriculture and forestry, ensuring that operations are conducted at the "right time, right tool/product, right amount, right place" for optimal outcomes. We focus on enhancing profitability, sustainability, and automation across three primary environments: Permanent Crops, Forest biomass harvesting, and Protected Cultivation (Greenhouses and Controlled Environment Agriculture). Our research, development, and technology deployment activities are guided by a comprehensive ten-year roadmap (2020-2030), meticulously aligned with European agendas, FAO's agricultural priorities, and the TEC4AGRO-FOOD Innovation Area agenda. By addressing societal challenges and leveraging cutting-edge innovation, we strive to be at the forefront of transforming the agricultural landscape for a sustainable future. TRIBE LAB has a multi-disciplinary team and operates with dynamic flexibility, focused on research and developing cutting-edge physical prototypes. We have the capability to quickly create prototypes on demand, ready to address emerging societal challenges.

Research Team: Filipe Neves Santos (PhD), Tatiana Pinho (PhD), António Paulo Moreira (Prof. PhD), Mário Cunha (Prof. PhD), José Boaventura (Prof. PhD), António Valente (Prof. PhD), Manuel Silva (Prof. PhD), Héber Sobreira (PhD), André Aguiar (PhD), Luís Santos (PhD), Pedro Moura (MSc), Sandro Magalhães (PhD candidate), Daniel Silva (PhD candidate), Vítor Tinoco (PhD candidate), Francisco Terra (MSc), Ricardo Neves (MSc), Humberto Rocha (MSc), Isabel Pinheiro (PhD candidate), Miguel Marques (PhD candidate), José Sarmiento (PhD candidate), Mafalda Pereira (PhD candidate), Renan Tosin (PhD candidate), André Baltazar (PhD candidate), Domingos Bento (MSc), Francisco Oliveira (PhD candidate), Germano Moreira (PhD candidate), Igor Portis (PhD candidate), Leandro Rodrigues (PhD candidate), Rui Coutinho (PhD candidate).

Reference Centres: CRIIS (Leader), CAP, CESE, HumanISE, HASLAB, LIAAD, and CITE.

Main achievements in 2024

In 2024, INESC TEC gained significant recognition in agricultural robotics, securing prestigious awards and advancing research and innovation. The Modular-E robotic platform won the Silver Medal for Best World FIRA Robot 2024, ranking second globally at FIRA 2024, while the TRIBE LAB team placed 2nd in the Hackathon Grand Défi Robotique Agricole. Additionally, Modular-E was awarded first place in the Prémios Inovação Agricultura 2024 and showcased for dual-use applications at ARTEX 2024, demonstrating its adaptability beyond agriculture.

Throughout the year, 28 software and hardware prototypes were developed, reaching an average TRL of 7 and progressing toward real-world deployment. Notable projects included Orios and Modular-X, designed to simplify technology transfer and meet industry needs. These innovations contributed to major Horizon Europe, H2020, and PRR-funded projects, such as NOVATERRA, WATSON, Agenda transForm, Vine&Wine, InsectERA, and Blockchain.PT. TRIBE LAB also organised five public demonstration sessions, reinforcing the practical applications of its robotic solutions.

The laboratory made a strong impact in academia, with three PhD candidates defending their theses, alongside 27 peer-reviewed publications and five master's theses. Public engagement was also a priority, with 40+ media features and participation in key events like EPIA 2024, ROBOT 2024, IROS 2024, World FIRA 2024, and the European Robotics Forum 2024, where research developments and prototypes were showcased. TRIBE LAB was also represented at EuropaAmerica 2024, strengthening international collaborations.

In 2024, TRIBE LAB reaffirmed its role in advancing Robotics and IoT for agriculture and forestry, driving innovation, real-world deployment, and industry collaboration. Moving forward, it remains committed to expanding technology adoption and strengthening partnerships to shape the future of smart agriculture and forestry.

7.9 Computer Graphics and Virtual Environments Lab

Mission and positioning

The Computer Graphics and Interactive Digital Media Lab is an infrastructure composed by two physical labs located in two poles, Vila Real and Porto:

- MASSIVE Lab (Vila Real / UTAD)
- GIG Lab (Porto / FEUP)

Each laboratory promotes distinct contributions in the area of Immersive Media / XR.

Mission and positioning

Multisensory Virtual Reality Laboratory (MASSIVE)

MASSIVE (acronym for Multimodal Acknowledgeable multiSenSory Immersive Virtual Environments) is a laboratory devoted to the multidisciplinary study of the relationship between virtual reality technologies and the different dimensions of human performance.

Our mission is to use virtual reality technology to enhance human abilities to address global challenges and improve quality of life. We will achieve this goal by contributing to scientific advances in the field and having an active participation in the community, always with an ambition to innovate based on the ethical principles that guide research and life in general.

From the fundamental investigation of perceptual equivalence using virtual reality technologies to applied research in application fields with focus on training and education, the positioning of the lab is in the following research lines:

- Perceptual equivalence between real-world and multisensory virtual reality environments to enable effective real-world knowledge transfer using only digital tools;
- Immersive authoring tools to promote the democratisation of virtual reality applications development and overcome adoption barriers;
- Multisensory Immersive Virtual Reality Training Platforms to enable safer, more efficient and cost-effective training environments for the industry, contributing to industry innovation and competitiveness;
- Immersive learning environments to promote better quality education and reduce inequalities in access to education while promoting motivation and better learning outcomes.

Laboratory of Graphics, Interaction and Games (GIG)

The mission of the laboratory is to advance multidisciplinary scientific research in the fields of Computer Graphics, Human-Computer Interaction and Digital Games, with particular emphasis on Immersive Environments.

From the fundamental investigation of technologies and algorithms to support digital mediation in virtual environments, to user-centric authoring tools, the laboratory has developed several innovative computational tools. However, the focus is also on the study of human augmentation, with a view to improving the processes associated with the application areas of Industry 4.0, Health, Ocean and Earth, Tourism, Culture and Education.

The positioning of the lab is in the following research lines:

- Studies in human augmentation for enhanced performance in professional and personal activities;
- Immersive learning environments and authoring tools to enhance training and education;

- Serious Games and Gamification to promote increased motivation and efficacy in cultural heritage, training and behaviour change;
- Immersive 360° video tools to improve communication;
- Extended reality frameworks to deploy the most cost-effective solutions;
- 3D multimodal interaction in immersive environments, including haptics and pseudo-haptics;
- Virtual Choreographies interoperability standards to integrate in immersive environments;
- Immersive environments to support Decision Support and creating what-if scenarios.

Main achievements in 2024

- Core research and prototyping in immersive multisensory virtual reality, including:
 - Immersive VR authoring Tool for Training;
 - Collaborative Immersive VR Training Platform;
 - Adaptive haptic devices;
 - DeskVR interaction;
 - Immersive visualisation.
- Conclusion of projects:
 - INCLUDING Innovative Cluster for Radiological and Nuclear Emergencies;
 - COST Action “LITHME: Language In The Human-Machine Era”.
- Submission of proposals: 1 proposal IC&DT-FCT (waiting for results).
- Concluded PhD Theses: 2;
- Concluded MSc Theses: 27;
- Journal Publications: 23;
- Conference Publications: 12;
- Organisation of International Events:
 - VISIGRAPP 2024 - International Joint Conference on Computer Vision, Imaging and Computer Graphics;
 - ICGI'2024 - International Conference on Graphics and Interaction;
 - ICETC 2024 - International Conference on Education Technology and Computers;
 - INCLUDING Join Action @ Porto;
 - International Workshop on CBRN Training Technologies;
- Dissemination events for schools: 10;
- Dissemination events for industry partners: 21;

7.10 CLOUDinha Laboratory

Mission and positioning

The CLOUDinha laboratory provides computational support to research and development activities of INESC TEC and University of Minho. It offers bare-metal and virtualised environments, along security features such as trusted hardware. The cluster consists of 106 microATX servers spanning multiple hardware generations, including Haswell, Kaby Lake, Comet Lake, Coffee Lake, and Raptor Lake. These servers are built on Intel Core i3, i5, and i9 CPUs, with different memory configurations and heterogeneous storage, including HDDs, SSDs, and NVMe devices. They also feature programmable network cards from Intel and Netronome and are connected via 1 Gb or 10 Gb networks.

Additionally, the cluster includes four rack servers based on Intel Xeon hardware, supporting up to 192GB of memory and heterogeneous storage devices, including SSDs, NVMe, and persistent memory. These servers are connected through a 10 Gb network, with some of them featuring programmable network capabilities (DPDK). To enable accurate energy consumption analysis, the cluster is equipped with power metering devices.

The heterogeneous hardware nature of the cluster is fundamental for supporting different research projects that may require specific hardware features (e.g., different storage or network technologies, access to trusted hardware capabilities).

Main achievements in 2024

In 2024, the laboratory provided the computational infrastructure to develop, optimise, and test software prototypes created by HASLab researchers in various topics within the Computer Science and Engineering domain, including:

- Distributed systems and scalable data management;
- Storage systems, AI frameworks, and databases;
- Privacy and security;
- Emerging technologies such as blockchains, Internet of Things, and Digital Twins;
- Bioinformatics.

Additionally, the laboratory was upgraded with new hardware to support a new research line, namely “Energy efficiency and sustainability”.

These software prototypes were developed as part of HASLab’s research and innovation projects, as well as PhD and MSc theses. Notably, the CLOUDinha Laboratory supported, as the main computational infrastructure, the research of 12 ongoing and 2 completed PhD theses, 10 concluded and 23 ongoing MSc theses, and 1 research project within INESC TEC’s Visiting Researcher Programme. Overall, the work conducted at CLOUDinha led to the development of 21 software prototypes, collectively requiring thousands of hours of computation.

The research quality and scientific rigor of the work assessed by the CLOUDinha Laboratory can be demonstrated with the following publications: “When Amnesia Strikes: Understanding and Reproducing Data Loss Bugs with Fault Injection” published at the PVLDB journal and presented at the 50th International Conference on Very Large Databases (VLDB); “TADA: A Toolkit for Approximate Distributed Agreement” published at Science of Computer Programming journal; and “Can Current SDS Controllers Scale To Modern HPC Infrastructures?” presented at Workshops of the International Conference for High Performance Computing, Networking, Storage and Analysis (SC24-W).

Among the many developed prototypes, LazyFS, a fault injection tool for assessing consistency properties of critical data applications, has already seen adoption in production environments by leading data management companies. Specifically, it has been integrated with the Jepsen fault injection framework, as well as the etcd, MongoDB, PostgreSQL, and DuckDB database systems.

7.11 Communications Laboratory

Mission and positioning

The Communications Laboratory (CommsLab) was established in 2006 at INESC TEC's main building, following a successful proposal to FCT under the National Program for Scientific Hardware Renewal. The CommsLab, originally named "Optical Communications and Microwave Laboratory", has been constantly evolving over the years. In 2021, benefiting from funding from the National Roadmap for Scientific Infrastructures from FCT, the laboratory underwent a refurbishment, which significantly improved the comfort for researchers (in terms of illumination and air quality) as well as the conditions for carrying out experiments such as water supply, improved communications network infrastructure and uninterrupted power supply.

CommsLab is composed of optical and electronic test equipment for R&D in electronics, optical and RF communications, including modulation/demodulation of RF signals using custom modulation formats up to 6 GHz bandwidth, as well as low frequency characterisation equipment and a 3D printing machine. Also, it includes an electrically large anechoic chamber (1.2 m x 0.6 m x 0.6 m) designed for evaluating antennas from 67 GHz to 115 GHz. The laboratory is also equipped with a Low Earth Orbit (LEO) Satellite communications gateway, Software Defined Radio (SDR) hardware, companion computing nodes, robotic platforms (e.g., drones, balloons, and a robot dog), and acoustic modems, supporting networking research activities related to radio and acoustic communications targeting mobile air, land and waterborne scenarios. A small sized water tank supports the characterisation and validation of optical, acoustic and RF underwater communications solutions.

The main objective of the CommsLab is to support the experimental evaluation and testing of next generation communications and sensing solutions in a controlled environment, enabling the validation of simulation results and preparation for subsequent testing in real-world scenarios.

Main achievements in 2024

Aligned with the objectives of the CommsLab, the main achievements in 2024 were the following:

- Finalisation of an initial prototype of a reconfigurable intelligent surface at 6.5 GHz suitable for human activity sensing;
- Conduction of several experimental characterisation campaigns of memristor devices in both DC and RF domains, including the characterisation of switching behaviour;
- Establishment of improved workshop capabilities for SMT device soldering, de-soldering and re-work, including a thermal chamber with the capability for controlled temperature profiles;
- Long-term performance evaluation of a Low Earth Orbit (LEO) Satellite communications gateway in the laboratory, proving feasible the support for new Wi-Fi and 5G-based backup communications solutions for emergency/disaster management scenarios;
- Continuation of the extension of the laboratory facilities to a complementary room, including the finalisation of construction works, installation of an optical fibre cable between the INESC TEC main building and the complementary room, and installation of new equipment enabling research on beyond 5G and 6G solutions in cooperation with a telecom operator;
- Initial implementation of an Open Radio Access Network (O-RAN) prototype operating on FR1, giving support for multiple research activities in the context of ongoing projects and BSc, MSc and PhD works;
- Implementation of additional capabilities in the mobile 5G cell prototype, including new xApp implementing object-aware capabilities, useful for predictive Line-of-Sight blockage detection which then can trigger proactive mitigation actions such as positioning, link adaptation, RIS configuration or handovers;

- Development of a multimodal underwater wireless communications prototype, giving support for multiple ongoing research activities of the centre in this field;
- Establishment of an initial simulation-assisted prototype using Semantic Communications, tailored for enabling broadband-like user experience when acquiring images through long-range acoustic links;
- Contributions to training sessions and support of the ongoing works related to the CTM Summer Internships, B.Sc. curricular internships and MSc and PhD theses.

8 Special Projects

8.1 UT AUSTIN Portugal Program

Coordinators: José Manuel Mendonça and Rui Oliveira

Executive Director: Andreia Passos

Mission and Positioning

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.

Main Achievements in 2024

In 2024, FCT granted a no-cost extension to the three International Partnerships while an independent evaluation was conducted by Technopolis. Throughout the year, the Portuguese and U.S. leaderships of UT Austin Portugal collaborated closely with all stakeholders to ensure a thorough assessment of the Program's 17-year impact. Simultaneously, the Program worked with FCT and the Ministry of Education, Science and Technology (MECI) to develop a proposal for a new funding cycle (2025-2030), aligning with national and European priorities and strengthening the long-established transatlantic relationship in areas where this joint venture could potentially deliver unique value hardly replicated with other partners.

Despite being an extension year, 2024 was marked by key strategic events aimed at securing future funding. The UT Austin Portugal Colloquium: Charting Future Impact, held in Austin in September, convened over 90 delegates to address major societal challenges and resulted in a detailed report on the Program's future contributions. The Annual Conference in Oeiras, Taking Discovery to Market, further underscored the Program's role in fostering impactful science, and its value in bridging the gap between the lab and market. Additionally, MECI's visit to UT Austin in November provided an opportunity to gain deeper understanding of UT's research strengths and discuss the renewal of the Partnership. These events were the result of extensive stakeholder engagement, benefiting from previous input from the External Review Committee, Governing Board, and Area Directors.

In 2024, the program made significant progress in its research component. Following FCT's evaluation of the 2022 Exploratory Research Project Call, eight selected projects were approved to begin. In a groundbreaking move, UT Austin expanded the research portfolio by funding an additional eleven high-scoring projects that lacked Portuguese-side funding, covering areas such as healthcare, water desalination, and space debris mitigation. Furthermore, to support bidirectional research mobility within these projects, UT doubled its financial support for U.S. teams. This commitment continued in the 2024 ERP Call, with UT teams receiving up to €100K per project.

On the Education front, the Program funded research internships at UT Austin, ensuring selected candidates affiliated with research institutions received financial support, visa assistance, and onboarding guidance. Thirteen visiting students were accepted, with eleven completing research stays in Advanced Computing, Nanotechnologies, and Earth-Space Interactions. The Program also delivered online training in key areas:

- Medical Physics: a new edition of the Online Advanced Course on Biomedical Applications was set up under the auspices of the University of Coimbra and in collaboration with UT's MD Anderson Cancer Research Center. For the first time, most classes were conducted in English.

- Clean Energy: for the second year, the Program partnered with TxEEE – Texas Executive Engineering Education to deliver short courses in Energy Data Analytics (Focus on Portugal – Energy Data Analytics) and Hydrogen (Hydrogen’s Role in a Decarbonised Future: Recent Trends, Opportunities, and Considerations) tailored for Portuguese audiences.

- Technology Commercialisation and Entrepreneurship: Designed by Cam Houser, founder of Actionwork and with the participation of instructor Mitch Jacobson, Executive Director of Austin Technology incubator at The University of Texas, From Portugal to the World: Innovation-to-Business Journey was a hands-on learning course running from May to June on Zoom. The Program also launched a call for Expressions of Interest for the pilot program Techlaunch, modelled after the successful and long-running NSF’s I-Corps initiative, set to launch in 2025. These pilot programs were intended to reinstate, in the forthcoming phase of the Program, the Innovation strand, which was suspended between 2018 and 2023 after the sponsor decided to steer the Innovation funds to the Strategic Research Projects.

The Program remained committed to science communication, participating in major events such as the SOE Workshop at GLEX Summit in the Azores, featuring UT Austin’s Kirstin Schulz, and Ciência’24, which showcased the impact of FCT’s International Partnerships through former program beneficiaries.

Despite budget constraints, which led to a smaller executive team and limited communication resources, the Program maintained an active presence through its website, social media, and media coverage. Only the Affiliated Doctoral Program Call, intended to fund ten doctoral students, was put on hold due to FCT procedural setbacks, pushing its launch to the next funding phase.

As the host institution of this FCT Partnership, INESC TEC, through its Leadership and Executive teams, has consistently improved the management of the Program and made significant efforts to communicate its activities, outcomes and impact as broadly as possible.

In 2024, INESC TEC reaffirmed its role as an institution particularly well-suited to managing transnational S&T partnerships. In addition to responding promptly to FCT’s request to work with Technopolis and provide the consulting company with key background information and Phase III indicators for a robust evaluation of the Partnership, the Program’s Leadership at INESC TEC played a major role in the negotiation process between FCT, MECI, and UT Austin, ultimately leading to the Program’s renewal for a six-year funding period. The Leadership at INESC TEC was particularly involved in the design and delivery of the colloquium at UT Austin, which proved decisive for the presentation of the 4th phase proposal and technical annexes. Actually, much of the strategic and diplomatic work undertaken in 2024 by the Leadership, assisted by its Executive Team, extended well beyond the scope of the assignments outlined in the management contract between INESC TEC and FCT.

9 SUPPORT SERVICES

9.1 LEGAL SUPPORT SERVICE

Manager: Rita Barros



Presentation

The Legal Support function plays a pivotal role in advancing INESC TEC's mission to promote scientific innovation and technological development and transfer. This service is dedicated to safeguarding the institution's best interests by ensuring full compliance with applicable international, European, and national legal frameworks. It upholds exemplary practices across critical domains, including human resource management, institutional relations, contractual agreements, public procurement, and the protection of personal data. The team consistently strives to provide tailored, effective solutions to legal issues and comprehensive guidance in response to queries, maintaining a commitment to delivering the most appropriate advice in each circumstance.

Highlights in 2024

The service continued to provide essential support to the Institution's activities across various domains, including research and development contractual activity, public procurement, intellectual property, and employment matters. It ensured compliance with the applicable legal frameworks while closely monitoring developments in International and European law across these areas. In this context, the Legal Support Service maintained a demanding work pace, broadening its scope of activities. The key contributions included:

- Assisting the human resources department by addressing the complexities arising from the diverse contractual arrangements within the Institution, along with their specific nuances;
- Ensuring the presence of a Legal Support representative within the Ethics Committee, fostering alignment across diverse issues while guaranteeing adherence to legal obligations;
- Supporting the management control department, particularly regarding the legal framework governing expenditures within funded projects, as well as interactions with funding bodies;
- Managing the growing volume of contractual engagements, both within the scope of funded initiatives and through direct agreements with national and international companies and institutions;
- Increasing the drafting and review of Confidentiality Agreements with domestic and foreign companies, enabling exploratory discussions for potential collaborations or the provision of services;
- Providing legal assistance in negotiating and drafting licensing agreements in close collaboration with SAL, while participating in a joint Task Force established to monitor critical projects involving intellectual property matters;
- Preparing and negotiating Consortium Agreements for European projects NUCLIM, AEROSUB, SEAGUARD and INESC TEC.OCEAN, where INESC TEC acted as the coordinating entity. Additionally, contractual negotiations were undertaken for numerous other European projects where INESC TEC participated as a partner;
- Offering legal support to the international relations department, including the negotiation and drafting of Memoranda of Understanding and the preparation of legal opinions on residence permit and visa applications;
- Offering comprehensive legal advice to facilitate informed decision-making at the executive level, including strategic assessments of institutional operations, governance matters, and compliance with evolving legal frameworks. This involved drafting and reviewing high-level agreements,

advising on risk mitigation strategies, and contributing to the legal oversight of administrative processes;

- Providing support and oversight to ensure compliance with the General Data Protection Regulation (GDPR) and complementary national legislation. This role encompassed the early identification and monitoring of research projects with potential data protection implications, the development of template documents, and the negotiation and drafting of data sharing and data processing agreements;
- Acting both as a contracting authority and as a tenderer in public procurement. As a contracting authority, the service played a vital role in supporting the execution of major infrastructure projects, ensuring compliance with procurement rules and procedures. As a tenderer, the service managed the legal complexities involved in preparing competitive bids, navigating procedural requirements, and safeguarding the institution's interests during competitive tenders.

9.2 ACCOUNTING AND FINANCE SERVICE

Manager: Paula Faria

Assistant Manager: Libânia Caetano



Presentation

The Finance and Accounting Service plays a crucial role in managing INESC TEC's financial operations. It is responsible for overseeing all accounting activities, ensuring compliance with fiscal obligations, and maintaining a stable cash flow to meet financial commitments.

Beyond its core financial functions, the service acts as a key intermediary between INESC TEC and external entities, operating in alignment with the Board's strategic guidelines. It also manages essential administrative tasks, including procurement, travel processes, insurance policies, and fixed assets, ensuring efficient financial and operational management across the institute.

Highlights in 2024

The **Finance and Accounting Service** is committed to improving efficiency and implementing innovative financial solutions for the **INESC TEC community**, in alignment with the **INESC TEC Strategic Plan 2023-2030**. In 2024, the service successfully focused on key initiatives that strengthened financial sustainability, optimised processes, and promoted environmental responsibility.

Strengthening the Sustainability and Resilience of Our Economic Model

- **Enhancing Operational Efficiency:** Continuous improvement activities and best practices were reinforced to streamline financial operations;
- **Optimising Procurement:** The digitisation of Dispatch Notes linked to the original purchase request enhanced transparency and agility of the Procurement Process;
- **Fixed Assets Management:** An analysis of the oldest fixed assets and subsequent disposal and write-off of several obsolete items contributed to a greater efficiency in tracking and maintaining the institute fixed assets;
- **ERP System Implementation:** The team participated in requirements' definition, selection, and implementation of a new ERP system to enhance financial and administrative integration.
- **Event Logistics Optimisation:** Logistics processes for organising events were improved to ensure cost-efficient and smooth execution;
- **Team Expansion:** Additional staff members were hired, to manage the increasing workload and maintain service excellence.

Promoting and Contributing to Environmental Sustainability

- **Digital Transformation:** The digital archive process was further consolidated and enhanced, reducing paper usage and improving accessibility.

By focusing on these strategic initiatives, the **Finance and Accounting Service** contributed to **greater financial resilience, process efficiency, and sustainable practices**, ensuring continued support for INESC TEC's long-term growth and success.

9.3 MANAGEMENT CONTROL SERVICE

Manager: Vanda Ferreira

Assistant Manager: Bárbara Maia



Presentation

The Management Control service is responsible for coordinating and executing the activities inherent to budgetary planning and control, and to produce, coordinate and disseminate management information in order to ensure that all resources are obtained and used effectively and efficiently so as to fulfil the purposes of the institution. The service is also responsible for continuous reporting to funding agencies of financial reports and the reimbursement of expenses, monitoring funded projects for compliance with funding agencies terms and conditions by working closely with researchers and providing training whenever necessary.

Highlights in 2024

During 2024, the service supported the financial management of 196 funded projects, having submitted 215 financial reports to the respective funding entities, which represents more than 28 million euros of expenses.

In addition to funded projects, the service monitored 106 projects providing direct services to companies, which in 2024 represented 2.8 million euros.

Among funded projects, 99 projects were funded by Horizon 2020 and Horizon Europe European Union framework programmes, 13 of which were coordinated by INESC TEC. The service also reported 16 projects funded by other European programs, such as INTERREG. The expenses reported throughout the year accounted for 11 million euros.

Regarding national projects, the largest volume of expenditure submitted concerns the PRR agendas, representing 8.5 million euros reported in financial reports, followed by FCT projects, with one million euros of expense.

There were also a set of large-scale strategic projects such as FCT's Multiannual funding, large infrastructures, and funding for Technology and Innovation Centres funded by ANI, and the funding for the new iilab building from CCDR-N. All these large strategic projects required a huge effort from the service (22 financial reports), representing more than 5.5 million euros of reported expense.

Regarding internal control, the service remained committed to improving the management information provided to its users and was heavily involved in defining the requirements and training for the new ERP.

9.4 HUMAN RESOURCES SERVICE

Manager: Luís Seca

Assistant Manager: Margarida Gonçalves



Presentation

The Human Resources service coordinates and executes all activities pertaining to human resources administrative management and the development of HR policies, according to applicable law, internal regulations, and Board guidelines.

Activities are divided into operations and compliance (payroll, benefits, recruitment, HR technology support, workplace safety) and development and culture (reconceiving HR management strategies, policies, and practices).

Highlights in 2024

Development and culture

(presented in the frame of the Strategic Objective listed in Section 9 of the INESC TEC Strategic Plan)

Improve attraction and retention of world-class talent; ensure opportunities and recognition of carer achievements; strengthen the distinctive aspects of our institutional model

- **Job descriptions and competencies policy:** Developed draft proposal for structured employee-job role allocation; Identified behavioural competencies for each position; Updated job role catalogue;
- **Career policy:** Design of a structured promotion mechanism for PhD researchers, defining the transition process from junior to auxiliary researcher roles; Simulation of career promotion/progression for R&D roles;
- **Compensation:** Drafted function-specific salary intervals based on current roles and market analysis;
- **Performance appraisal policy:** Drafting a goal-based management framework linked to variable compensation, ensuring alignment with performance-driven incentives. The document will be presented for the Executive Board validation and approval in order to be applied in the 2025 performance appraisal process;
- **Recruitment and selection policy:** Completion of final working group discussions on recruitment and selection guidelines. Formulation of the proposal for the new recruitment and selection policy, to be presented to the Executive Board for validation and approval.

Strategic objective – providing innovative learning experiences

- **Implement the training policy:** Implementation of several internal and external training initiatives; training needs assessment for 2025; INESC TEC's professional training report for the 1st semester of 2024 was presented at the Units Council in September 2024; proposal of strategic training initiatives for 2025 such as project management, team management, and languages.

Operations and compliance

Digital Transformation and Operational Efficiency

- **Dematerialisation of Employee Cards:** Implementation of an app for Android and iOS devices, eliminating the need for physical cards;
- **Optimisation of the Grant Contract Signing Workflow:** Reduction in processing time through workflow review and automated emails with detailed signing instructions;
- **Automation of Contractual Communication:** Automatic sending of the signed contract to the grant holder upon process completion.

Partnerships and Employee Well-being

- **Mental Health:** Establishment of various psychology partnerships to support employees;
- **Support for Remote Work and Energy:** Sharing this information in the admission email, onboarding session, and within the salary receipt email;
- **Insurance Negotiation:** Improvements in conditions offered to employees through renegotiation with the insurance company.

Recruitment and Integration

- **Recruitment and Selection Events:** Active participation in academic community events and job fairs;
- **Monthly Onboarding Session:** Structured integration of new hires and scholarship holder;
- **Summer Internship Programme:** Hosting of approximately 100 interns;
- **Creation of a Work Proposal Template:** Document presenting the institutional context, benefits, and salary package;
- **New Dissemination Channels:** Registration of INESC TEC in the TALENT Business Directory and LinkedIn.

Contract Management and Administrative Processes

- **Review of Funding Sources:** Adjustments to public notices, employment contracts, and internal processes (NC and ML);
- **HR Guide:** Development of a reference document on contract types and project allocation;
- **Curricular Internships:** Guidelines on the submission of internship and dissertation contracts, including mandatory fields and signature collection;
- **Creation of Standardised Emails:** Automatic messages for communicating quarterly closings and values to be included in salary receipts;
- **Access Monitoring:** Control of access for employees located at FEUP;
- **Availability of Retention Agreements:** Easy access via DRIVE for consultation by Centres and managers;
- **Mandatory Legislation Disclosure:** Inclusion of informational materials on parenting, equality, non-discrimination, and workers' rights on the intranet.

Improvement in Communication and Customer Service

- **Reduction in response time;**
- **Weekly Automated Emails:** Implementation of alerts on pending process (NC) closures;
- **Clarifications and Guidance:** Specialised assistance on topics such as IRS, Young IRS, vacation, health insurance, and more.

Strategic and Institutional Enhancements

- **Collaboration with KPMG:** Initiation of joint work;
- **Adherence to the "TechVisa" Programme:** Facilitation of hiring foreign professionals by expediting visas and residence permits;
- **Seeking Best Practices:** Research with organisations like Great Place to Work to identify, create, and maintain a positive work environment.
- **Payment of Fees and School Insurance:** Support for FCT grant holders in paying enrolment fees and school insurance.

This report reflects the actions carried out throughout 2024, demonstrating the Human Resources Service's commitment to innovation, efficiency, and employee well-being

9.5 MANAGEMENT SUPPORT SERVICE

Manager: Isabel Macedo



Presentation

The Management Support Service facilitates effective decision-making in several governing bodies of INESC TEC and assists the Board of Directors in streamlining internal strategic initiatives. With a cross-cutting perspective, it ensures institution-wide coordinated information management and seeks to improve current processes and procedures, by developing data-driven recommendations and solutions.

Highlights in 2024

In addition to its core operational activities, which have expanded significantly alongside the institution's growth, the Service's key highlights, aligned with the INESC TEC Strategic Plan 2023-2030, are outlined below:

Raise the contribution and visibility of our research

- Coordination and execution of INESC TEC's application in the FCT R&D Units Evaluation 2023/2024 process, ensuring a structured response across all phases and dimensions;
- Advancement of Open Science practices at INESC TEC by:
 - Submission and approval of the "FAIRWay - A Pathway to Promote Open Science Through Research Data Lifecycle Management" project, in collaboration with CIIMAR and BIOPOLIS and funded by FCT, to contribute to a support network for research data management and openness in Portugal, promoting the principles of FAIR Data.
 - Strengthening of INESC TEC's data management area - Encompassing a flash talk and poster presentation at the Portuguese Research Data Management Forum (Fórum GDI), presentations to invited institutions such as CITCEM, CiiEM, CIIMAR, and the elaboration of Data Management Plans (DMPs) for the AI4REALNET and NUCLIM projects, alongside ongoing DMP support for other projects.
- Institutional capacity building in R&D management by leveraging advanced insights through:
 - Bibliometric benchmarking analyses across INESC TEC's eight Research Domains;
 - Development of a Power BI Dashboard to provide data-driven insights, supporting R&D Centres in strategic decision-making;
- Support for the Board of Directors in International Research Assessment Initiatives, including involvement in EARTO Collective Studies and other efforts focused on advancing research evaluation methods;
- Mediation support for the B-On - Online Knowledge Library and assistance to internal users with issues related to the service.

Strengthen the distinctive aspects of our institutional model

- Enhancement of continuous improvement, namely through the comprehensive assessment of data quality across INESC TEC's platforms, fostering cross-service collaboration and knowledge sharing:
 - Curation of databases for theses and dissertations, projects and publications;
 - Curation of the newly developed information database for entities;
 - Development of a patent database, to be released in early 2025.

9.6 SECRETARIAL COORDINATION

Managers: Ana Isabel Oliveira and Grasiela Almeida



Presentation

The Secretarial team is responsible for effectively executing the tasks required for the development of the activities of the Board of Directors, Research Centres and Services they support in accordance with INESC TEC's internal rules and processes.

In 2024, the team was composed of 20 employees, developing their work directly under the responsibility of a coordinator within a structure, being also coordinated by one of the managers: Ana Isabel Oliveira, managing the team of Executive Assistants of the Board of Directors, and Grasiela Almeida managing the team of Assistants that support Research Centres and Services.

Each manager supervises its corresponding team (conducting regular meetings, assuring procedure compliance, providing training, giving feedback on performance, providing information on established partnerships and anticipating needs) while combining efforts to develop both teams and the institution, focusing on continuous improvement.

Highlights in 2024

Apart from the regular operational activities mentioned above, the main highlights in 2024 were:

- **Team Expansion & Training:** Recruitment and training of three new Assistants — two for CPES (Centre for Power and Energy Systems) and TEC4, and one Executive Assistant for the Board of Directors;
- **Administrative Support Reorganisation:** Restructuring part of the administrative support team by service type (Organisation & Management, Business Development, and Technical Support) to optimise resources and enhance efficiency;
- **Executive Support Enhancement:** Strengthening support for the Board of Directors, organisational structures, associative bodies, and intervention areas, contributing to more effective decision-making and strategic alignment;
- **Upskilling & Digital Transformation:** Delivery of an Advanced Microsoft Excel Training for the Secretariat Team to enhance data-driven decision-making and digital proficiency, supporting INESC TEC's focus on digital transformation and internal capacity building;
- **Onboarding Process Development:** Collaboration in the development of a new onboarding framework for interns, reinforcing the institute's commitment to attracting and integrating young talent;
- **HR Policy Contribution:** Participation in the R&S GTE - Recruitment and Selection Working Group, contributing to the development of the "Guidelines for the New R&S Policy";
- **Vendor & Contract Oversight:** Systematic monitoring of contracts with travel agencies, catering providers, and printing services, ensuring operational efficiency and cost-effectiveness, supporting the institute's goal of sustainable management;
- **Institutional Knowledge Management:** Ongoing maintenance and optimisation of CRM as the institutional contacts database, reinforcing the institute's focus on structured knowledge management and digital tools.

9.7 FUNDING OPPORTUNITIES OFFICE

Manager: Marta Barbas



Employees

1 Men

1 Women

Presentation

The Funding Opportunities Office aims at identifying the relevant funding opportunities to support INESC TEC Research, Development and Innovation activities, always aligned with the mission and objectives of the Institute.

This service also supports and supervises the development and submission of proposals to different funding programmes, always in collaboration with the R&D Centres and with the other Business Development Services.

Highlights in 2024

From all the activities developed we shall highlight, for its relevance, the maintenance and update of Funding Opportunities pages on the Intranet available for everyone to access information regarding the different Funding Programmes (funding rates, rules of participation, call calendars, etc.), the survey carried out on intranet pages for continuous improvement, and finally the support provided to the high volume of submissions of FCT Programmes, Portugal 2030 and Horizon Europe.

We also maintained several meetings with Horizon Europe National Contact Points and principal researchers of coordinated proposals. We also held information sessions for the most competitive national calls.

Some facts and figures related to the submitted proposals monitored by the service:

- Business R&D - Co-promoted Operations P2030: 30 proposals;
- Demonstrator R&D - Co-promoted Operations P2030: 3 proposals;
- R&D Projects Internationalization on a European Scale P2030: 3 proposals;
- Intellectual and Industrial Property Protection Projects P2030: 3 proposals;
- Business R&D - Contractual Investment Scheme - P2030: 1 proposal;
- R&D Projects Health Research La Caixa Foundation/FCT: 1 proposal;
- Exploratory Projects in All Scientific Domains FCT: 19 proposals;
- IC&DT Projects in All Scientific Domains FCT: 71 proposals;
- RESTART Programme FCT: 2 proposals;
- IC&DT Projects Data Science and Artificial Intelligence in Public Administration FCT: 9 proposals;
- FCT R&D Projects - International Partnerships: 9 proposals;
- Science4Policy 2024 (S4P-24) FCT: 1 proposal;
- BIP Proof Call UP: 1 proposal;
- Support to Meetings TdP/ATPNP: 2 proposals;
- European Tenders: 2 proposals;
- HORIZON Europe: 109 proposals;
- Digital Europe Programme: 3 proposals;
- European Defence Fund: 8 proposals;
- ERASMUS 2027: 1 proposal;
- LIFE Programme: 4 proposals;
- Single Market Programme: 1 Proposal (EEN) ;
- Interregional Innovation Investments Instrument (I3): 2 proposals;
- European Urban Initiative (EUI): 3 proposals;

- European Space Agency (ESA): 3 proposals;
- EIT Manufacturing: 2 proposals;
- EIT Food: 1 proposal;
- COST Actions: 2 proposals;
- Cascade Funding: 5 proposals.

9.8 TECHNOLOGY LICENSING OFFICE

Manager: Daniel Marques de Vasconcelos



Presentation

The Technology Licensing Office (TLO) at INESC TEC aims to maximise the societal impact of the research and development (R&D) results produced at the institution. In 2024, the TLO further consolidated its position as a reference player in intellectual property (IP) strategy and knowledge transfer at the European level, actively contributing to enhancing INESC TEC's reputation and fostering partnerships.

Highlights in 2024

The year 2024 was marked by significant achievements in IP protection and valorisation. The office secured a **new maximum of five licence agreements**, three of which were international and two involved spin-offs. These results underscore the strategic importance of IP and spin-offs in maximising the impact of INESC TEC's R&D. The TLO also managed a **record number of active patent families (42)**, including **nine newly created** in 2024. INESC TEC **ranked 4th ex aequo in the Portuguese European Patent Office (EPO) Patent Index 2024**, demonstrating a consistent presence in the Top 10 since 2017. Marine robotics, energy, and smart communications were emerging technological fields in patent protection, while instrumentation and medical devices showed a solid performance in line with previous years. Additionally, **11 patents were granted in key international markets, including Europe, China, US, Japan, and Australia**. In scouting, **42 new R&D results** were mapped with an emerging contribution from industrial engineering.

In 2024, the TLO reinforced its intellectual property management practices by **adopting the OKR (Objectives and Key Results) framework** to improve goal setting and result quantification, increasing the team's efficiency and transparency and enabling the pursuit of more ambitious objectives. Additionally, the **recruitment of a new technology manager specialised in robotics** and industrial management enabled an expanded engagement with researchers in this field, promoting the impact of their technological solutions.

Several innovative solutions developed at INESC TEC in various sectors were recognised for their impact. The transformative potential of five key technologies - iLoF, BB-Spectral, Modular-E, DeepEpi-2, and EVFlex - was recognised at national and international levels. For most, the TLO played an active role in their valorisation, supporting the development, IP protection, and promotion of these innovations to maximise their impact. Among these, two technologies received prestigious **first-place awards for their societal and industry impact: "Intelligent Lab-on-a-Fiber" (iLoF) won the EARTO Innovation Awards 2024 ("Impact Expected" category)** and is currently being used by the INESC TEC spin-off of the same name; **Pocket-Vet, based on BB-Spectral technology, was recognised in the 11th Agricultural Credit Entrepreneurship and Innovation Awards** in the Food Safety and Nutrition category. The TLO played a crucial role in preparing these applications, ensuring their success in competitive award programmes and further demonstrating **INESC TEC's ability to convert scientific knowledge into technological solutions with meaningful societal benefits**.

At the international level, the **TLO reinforced its presence and level of participation in the European Commission's prestigious TTO Circle**. The office is an active member of the benchmarking group and leads the working group on open-source software, in collaboration with CERN, IMEC, and ESA, compiling and disclosing best practices and contributing to the enhancement of the European innovation ecosystem. Through the TLO, INESC TEC also integrated both national (GAPI) and European (PATLIB) networks to promote and disseminate the importance of IP as a success factor for companies of all sizes.

The office also focused on raising awareness about IP in the INESC TEC community and, in December 2024, held a **pilot webinar based on a case study from the EPO about the Austrian SME Marinomed**.

In 2024, the TLO successfully achieved all the planned objectives, in alignment with the Strategic Objectives of INESC TEC's Strategic Plan 2023-2030:

1. **Raise the contribution and visibility of our research.** To enhance the identification of new R&D results and improve their valorisation in future projects and business opportunities, the office

strengthened the relationships between tech managers, research centre coordinators and PIs in their respective domains. This approach was particularly relevant in the case of CESE, which disclosed 16 novel results in 2024, compared to only 21 between 2020 and 2023, and had two spin-offs in development. In this context, the office also redesigned the pre-disclosure form, making it digital, to accommodate feedback received.

2. **Improve the base conditions for technology commercialisation.** The TLO pursued three main strategies: i) expanding our contact network for need and commercial validation; ii) consolidating existing successful partnerships; and iii) creating and enhancing opportunities to showcase our technologies to industrial partners or relevant stakeholders.
 - a. 57 meetings, 63% with relevant international industry stakeholders in different fields.
 - b. Licensing of the KEPSoft software and incorporation of the KEPSoft spin-off, bringing together organisations from Portugal, Scotland, and Hungary, to address a market gap in the field of kidney transplantation. At the national level, the licensing of Recreation to Capwatt is contributing to decentralising energy systems and supporting EU energy transition goals.
 - c. Promotion of the visit of Galp’s innovation team to INESC TEC’s facilities and visits to some of the institute’s labs, namely x-Energy and BRAIN, and organisation of an open session, “Demystifying Entrepreneurship and Venture Capital,” in partnership with Armilar Ventures.
3. **Increase our international networking, leadership, and competitiveness.** The team succeeded in advancing INESC TEC’s position in relevant European associations devoted to Research and Technology and Technology Transfer, such as EARTO and the TTO circle, with the 1st place in EARTO’s Innovation Awards in the “Impact Expected” category, and integrating two workgroups of the TTO Circle, as well as presenting INESC TEC at the annual TTO meeting in Madrid. Additionally, members of the TLO took part in important technology fairs, such as TechInnov and Les Rendez-vous Carnot 2024, in collaboration with TEC4Partnerships, and in the policy event “Deep Tech: Europe’s new wave of innovation?” organised by Science|Business in April in Brussels. Active participation in these international events and networks brings knowledge and capacity and unlocks opportunities to boost the influence and impact delivered by INESC TEC to a European level.
4. **Improve attraction and retention of world-class talent.** The office’s team grew to three tech managers in a total of four FTEs, which highly contributed to improving performance.
5. **Develop closer and deeper relationships with innovation partners and the broader community.** The TLO addressed this goal in two ways:
 - a. A pilot webinar titled “Succeed Using IP” showcased best practices and promoted engagement with other members of the ecosystem, aiming to facilitate future IP protection and technology transfer processes between partners. The event gathered around 50 participants from both academia and industry.
 - b. Regular strategic meetings at CRAS (LSA), and initial steps with CRIIS (iiLAB), CESE, and CBER. These efforts strengthened internal outreach, fostered mutual understanding of institutional goals, and streamlined IP-related processes. Given the positive outcomes, the Technology Licensing Office (TLO) plans to expand this approach to additional Centres.
6. **Build stronger knowledge-based and multidisciplinary R&I ecosystems** by fine-tuning the new spin-off committee for active spin-offs and entrepreneurial projects and consolidating the technical support to seed projects in the commercial proof-of-concept category. This work has contributed to 10 spin-offs in development and led to the appointment at the end of 2024 of a new office that will directly take on responsibility for this area.

9.9 INTERNATIONAL RELATIONS OFFICE

Manager: Andreia Passos



Presentation

Since its establishment, the International Relations Service (SRI) has played a pivotal role in strengthening INESC TEC’s international engagement. Key achievements include but are not limited to professional support for the onboarding of foreign staff and visitors, the design and launch of the INESC TEC International Visiting Researcher Programme (IIVRP), the organisation of training activities to enhance intercultural literacy, or the development of tools and procedures to assist researchers in entering into international agreements, most notably Memoranda of Understanding (MoUs). Since 2018, the Service has also been responsible for managing the UT Austin Portugal Program, earning recognition from both the Program Leadership and the External Review Committee for the work undertaken. Despite these achievements, the SRI continues to face challenges, particularly regarding its size and place within the organisational chart.

Highlights in 2024

In 2024, the Service made significant strides in achieving the goals set at the end of 2023, despite coming across (new and old) challenges. The most pressing challenge was the underfunding of human resources within the UT Austin Portugal Program, which hindered the hiring of new staff in 2025. With a core team of only 2.5 full-time equivalents (FTEs), the Service experienced an increased workload on the side of the Program, particularly due to the need to accelerate the negotiations for the Partnership’s renewal for 2025-2030. While it is undeniably true that hosting this partnership has significantly enhanced the Service’s international visibility and network and strengthened its managerial and operational capabilities, it might have limited, to some extent, its ability to engage in strategic activities directly related to INESC TEC. This issue is especially critical if team size is reduced and no new personnel are introduced. Furthermore, with the SRI acting sometimes more as an extension of HR — when it comes to assisting foreign staff - the team has at times diverted focus from more business development priorities. In 2024, the team assisted over 90 foreign newcomers (excluding visiting researchers managed under the IIVRP Programme or the UT Austin Portugal Program).

Nonetheless, the Service successfully achieved most of the goals outlined in the 2024 Activity Plan. One of the most notable accomplishments was the coordination, launch, and implementation of the 2024 edition of the INESC TEC International Visiting Researcher Programme (IIVRP). This edition saw the highest number of research topics submitted (over 60) and the highest number of applications received (over 90) since the Programme’s inception. Managing this process - particularly the evaluation phase - proved to be challenging and time-consuming due to the absence of an IT tool for automation, but the team, with the support of the Scientific Evaluation Panel, was able to notify applicants before the Summer holidays. Also, recognising that the impact of such programmes is long-term, the Service continued tracking joint outcomes associated with previous editions of the IIVRP in order to inform the Board of Directors of the IIVRP’s payoff to the institution’s investment. Equally important, the SRI kept managing third parties’ international mobility programmes at INESC TEC, namely the ERCIM Alan Bensoussan Fellowship Programme, which allows international fellows to visit INESC TEC for twelve months and the NII’s International Internships Programme, a long-standing initiative that has been giving Master’s and PhD students affiliated with INESC TEC the chance to visit the Japanese partner for up to six-month stays. In April 2024, the SRI hosted a visit from NII’s Global Liaison Office Director, Dr Emmanuel Planas. Dr. Planas met with several centre coordinators and senior researchers to identify collaboration opportunities between INESC TEC and NII that could be leveraged by NII’s international mobility programs or other EU and Japanese funding frameworks. Another milestone was the launch of the joint call for exploratory research projects, a significant step in INESC TEC’s partnership with NARLabs. The SRI collaborated closely with the Taiwanese counterpart to develop a proposal approved by both institutions’ top management. The Service drafted supporting documentation, organised preliminary meetings between NARLabs and INESC TEC researchers to identify potential research consortia, managed applications, answered queries, and facilitated connections.

As mentioned before, the SRI played a crucial role in supporting the UT Austin Portugal Leadership in negotiating a new funding cycle for FCT's partnership with UT Austin. Although the Program primarily serves the Portuguese research and innovation community, managing it on behalf of FCT enhances INESC TEC's international visibility and recognition not only from a managerial point of view but also from a scientific standpoint. Beyond implementing the approved Activity Plan, the team worked closely with the Portuguese and U.S. leaderships of the Program to draft a proposal for a new funding cycle aligned with national and European priorities. A key event leading up to this proposal was the **UT Austin Portugal Colloquium: Charting Future Impact**, held in Austin in early September. This gathering brought together over ninety delegates from UT Austin and Portuguese institutions - including academia, research institutions, and businesses - to discuss major societal challenges requiring coordinated scientific collaboration. Focus areas included earth and space interactions, advanced computing, nanotechnologies, and clean energy, many of which align with INESC TEC's strategic scientific and application areas. Later on, the team helped organise a high-level mission to UT Austin, headed by the Ministry of Science, Technology and Innovation, to further discuss the partnership's future.

Beyond S&T Programme management, the SRI continued supporting the negotiation of international agreements (e.g.: Semiconductors: Instituto de Pesquisas Eldorado, Brazil; Advanced Computing, AI, Green Energy and Ocean Robotics: National Applied Research Laboratories, Taiwan) while providing a set of guidelines and recommendations for the responsible and effective use of MoU frameworks to start and develop partnerships ("Towards an Effective Use of MoUs | Guidelines). It coordinated over 15 high-level international visits from companies and business organisations (e.g.: Chubu Electric Power, Japan; SG Innovate, Singapore; TalTech, Estonia); diplomatic bodies (U.S. Ambassador in Portugal); universities and research institutions (e.g.: NII, Japan; University of Santiago de Compostela, Spain; UT Austin, USA; ICHEC, Ireland; KRISO, South Korea) and government authorities (Controlaria General de la Republica, Colombia) while reinforcing its collaboration with AICEP. Such visits facilitated meaningful connections between international visitors and INESC TEC research centres and TEC4s, allowing our institution to showcase its competencies and research and innovation portfolio beyond borders. Also, in 2024, a staff member of the team was invited to the Operations Committee of CENTRA, where INESC TEC has had a seat for some years now. This position gives the SRI privileged access to several research centres, institutes and laboratories in Asia and North America engaged in research on cyberinfrastructure and its applications.

Also, as part of its ongoing commitment to supporting INESC TEC's foreign community, the Service continued to provide regular updates and guidance on relocation-related matters. In 2024, the SRI launched an updated version of the Quick Mobility Guide, reflecting recent changes in immigration regulations. Additionally, the SRI Welcome Appointment established itself as an essential resource for foreign newcomers holding fellowship or employment contracts with INESC TEC, helping to ensure smooth transitions and institutional onboarding (in 2024, the Service conducted 21 appointments). Lastly, the SRI took on a leading role in building awareness of research security and integrity matters in international scientific cooperation. At the invitation of the U.S. Embassy in Portugal, the Service hosted the visit of Hoover Institution's expert, Dr Glenn Tiffert, who gave a talk at INESC TEC on Strengthening Knowledge Security for a More Challenging World. The SRI also drafted an internal document, "Guidelines for Safe International Research", which - although not yet published - has positioned SRI as a trusted consulting stakeholder within the organisation on matters of safe research in the international arena.

Despite resource limitations, the International Relations Service advanced INESC TEC's internationalisation efforts in 2024. Through strategic partnerships, program management, support for foreign staff, and research security initiatives, SRI continues to strengthen the institution's global engagement. However, sustaining this momentum will require adequate resourcing and a clear strategic focus to balance administrative responsibilities with long-term strategic international goals.

9.10 COMMUNICATION SERVICE

Manager: Joana Desport Coelho

Assistant Manager: Sofia Maciel



Presentation

The Communication Service (SCOM) works closely with the Board of Directors to define and implement INESC TEC's communication strategy, strengthening its reputation and positioning as a leading R&D institution. The activities cover internal communication - promoting knowledge sharing and engagement within the INESC TEC community - and external communication, enhancing the institution's visibility and supporting the dissemination of scientific and innovation activities. Following an integrated marketing communication approach, SCOM operates across five key areas: content production, design and multimedia, event organisation, leadership and support in R&D project communication, and translation. These competencies drive strategies in science communication (podcasts, videocasts, editorials), digital marketing (social media, website, newsletters), public relations (national and international media, events), and advertising (annual reports, institutional materials).

Highlights in 2024

External Communication

Science communication

- **“INESC TEC Ciência e Sociedade” Podcast and Videocast** – The second season, focusing on high value-added industry, was launched in 2024. Episodes were broadcast on YouTube (videocast) and disseminated via a podcast distribution company (Blubrry) that places the episodes across multiple platforms (e.g., Spotify). The second season reached over 1 200 YouTube views and more than 150 streams on Blubrry, with 46% impactful listens. On social media, the second season reached over 12 500 views (LinkedIn, Instagram, Twitter and Facebook). (Content in Portuguese.)
- **Science Bits podcast** – 11 new episodes were produced, with almost 4 000 streams. Distributed via Engenharia Radio and the BIP newsletter, the podcast gathered more than 1 500 page visits. (Content in Portuguese.)
- **Spotlight** – Six new editions were published in the BIP magazine, aiming at highlighting the connection between INESC TEC's science and innovation and current global social challenges. Total page views exceeded 1 600.
- **INESC TECWatch** – A new science communication format introduced at the end of 2024, explaining and providing accurate information on current topics relevant to our scientific domains. Four editions were published via BIP newsletter, Substack and Medium, generating more than 780 interactions.
- **FCT R&D Units Evaluation** – The preparation was a collaborative effort involving multiple INESC TEC teams, including the Communication Service. SCOM's key contributions included the development of content for a dedicated website (<https://eval2024.inesctec.pt/>), which centralised all core information. Additionally, for the remote interviews and the day of the visit, SCOM produced and shared various multimedia materials, including remote visits to INESC TEC's infrastructures located outside the headquarters.

Public Relations

- **National Press Relations** – Over 30 stories were promoted in national media, using diverse formats such as press releases, interviews, and opinion pieces. This resulted in 640 news pieces, equivalent to an Automatic Advertising Value of more than €13.5M.
- **International Press Relations** – Eight press releases were disseminated through the Alpha Galileo platform, leading to over 7 200 engagements from journalists worldwide (a 38% increase from

2023) and more than four thousand alerts generated, which resulted in more than 60 news pieces identified in international media. A clear effort was made to pursue international positioning, which was reflected not only in the results achieved in terms of international press relations, but also throughout other channels, such as an increase in terms of presence in Medium or an account on Substack, as already stated before.

- **Events** – The communication team was involved in the organisation of almost 50 events targeted to external audiences – this support includes not only events organised by INESC TEC, but also by other entities featuring INESC TEC. The annual event “Fórum do Outono” increased the number of participants, reaching nearly 300 in-person and 300 online participants.

Digital Marketing

- **Website** – Visits to the INESC TEC website increased nearly 10%, surpassing 60 000 interactions. Unique page views also increased (1,2%), totalling over 139 500. The launch of a new website is expected in the first half of 2025 and 2024 represented a big advancement in terms of work conducted to achieve this objective.
- **BIP Magazine** – Subscribers increased to nearly 1 500, with visits rising to over 22 300 (+1%). The news section remained the most popular, gaining around 500 additional visits compared to 2023.
- Social media channels – Overall growth in followers across all channels, except X (former Twitter). [Facebook](#) ended with 9 057 followers (+84), [Instagram](#) 3 290 (+370), [LinkedIn](#) 26 571 (+5 121), [X](#) 9 428 (-40) and [YouTube](#) 1 491 (+93).

Advertising

- **Design and Multimedia** – Activities divided into institutional communication (supporting materials for INESC TEC Science & Society Magazine, Spotlight, podcasts, videocasts, social media channels), visual identities and other multidisciplinary visual works for events, and updating existing visual identities through flyers, videos, stands, and related materials. The rebranding of the INESC TEC brand initiated in 2024 will be fully implemented in 2025.

Internal Communication

- We strengthened our commitment to a collaborative, diverse, international, and inclusive environment, fostering active community engagement and a sense of belonging. We revamped internal communication initiatives, launching new channels and content that highlight the social impact of our science and technology, recognise internal talent, and encourage collaboration.
- We also invested in improving internal events, enhancing networking, idea-sharing, and social interactions, with higher attendance than in 2023. Notably, our community contributed to shaping the celebrations for INESC TEC’s 40th anniversary.
- In partnership with Human Resources, we updated the welcome guide, enhancing the onboarding experience and reinforcing our commitment to valuing and retaining talent.
- Nine internal events were organised, three of which were within the scope of the Technical Committee for Social Responsibility: Laughter Yoga Workshop, INESC TEC Anniversary, INESC TEC on foot, INESC TEC on the Move, Strategic Meeting, World Mental Health Day, Roasted Chestnuts Party, Volunteer Day and INESC TEC Season Party. In 2024, the Season Party reached a record attendance of over 400 participants. Other internal events also saw increased participation, notably Team Building and the Strategic Meeting.
- To maintain internal community engagement, 242 posts were made on Mattermost channels (“News and Events”, “Town Square”, “Kit Kat time”), resulting in over 670 interactions.
- An internal TV network was launched to communicate news, events, projects and other updates.
- Merchandise production was aligned with the rebranding strategy, which included the distribution of branded kits during key internal events such as the Strategic Meeting.
- Continuous support was provided for the translation and proofreading of institutional documents.

9.11 NETWORKS AND COMMUNICATIONS SERVICE

Manager: Gil Coutinho



Presentation

The Networks and Communications Service is responsible for the operation and maintenance of INESC TEC's voice and data infrastructures, the implementation of network-based services, and for providing users the respective support.

Besides daily operation and support in the utilization of resources (e.g., network access, telephony, hybrid events, printing, etc.), permanent activities of the service include the continuous monitoring of the infrastructure, namely to allow for corrective and preventive measures. Strategic modernisation and improvements (concerning e.g. performance, scale, security) is also conducted, for example in the provisioning of datacentre resources, network equipment, videoconferencing solutions, etc.

Highlights in 2024

- Planning of the new NetDB platform;
- Implementation of DMARC for email services, enhancing security and deliverability;
- Completion of the Auditorium A multimedia infrastructure upgrade;
- Finalization of links between core switches and datacentre switches;
- Activation of "Penalty Box" in the Firewall, a security mechanism that blocks IPs violating defined policies;
- Migration to new datacentre management software (MMS);
- Implementation of IPsec tunnel for the "CESE Testbeds" project, connecting our pfSense to a 5G router with NOS SIM card acquired by CESE, enabling secure communication between devices and internal servers;
- Firmware updates on datacentre switches;
- Implementation of Netdisco for collecting data about MAC and IP addresses on the network;
- Housekeeping and standardization of VLANs across all switches;
- Renewal of the printer fleet;
- Implementation of DNSSEC (Domain Name System Security Extensions), reinforcing DNS authentication using digital signatures based on public key encryption;
- Implementation of DNS RPZ (DNS Firewall), a method that allows a name server to override customised information in the global DNS to provide alternative responses to queries;
- Increased cooling capacity of datacentre A with the installation of new air conditioning equipment;
- Restructuring of the CPES lab network, installation of new switch, and creation of project support networks:
 - smart_building
 - scale
 - sgevl EV
 - scada
- Direct connection of CRAS at FEUP to INESC TEC;
- Initiation of the SUBMERSE project;

- Commencement of the electrical panel change project;
- Upgrade of the Graylog cluster (open-source log analysis and management platform);
- Major upgrade of firewalls (headquarters and DR);
- Virtualisation of the last physical server for VOIP;
- Implementation of security measures for all SRC servers:
 - Two-factor authentication (2FA);
 - Use of fail2ban tool to block IPs with anomalous behaviour on each server;
 - Mandatory password use for privileged account access;
- Initiation of testing process for VOIP phones purchase and renewal.

9.12 MANAGEMENT INFORMATION SYSTEMS SERVICE

Managers: Fábio Alves and João Miguel Silva



Presentation

The Management Information Systems Service is responsible for coordinating and executing all activities related to the development and maintenance of INESC TEC's management information system.

The primary goal of the service is to provide technology-based solutions to support a wide range of processes, helping the organization to work more efficiently.

The key systems under SIG's supervision include the Human Resources system, the Intranet (which supports automated workflow processes and facilitates internal institutional communication), the INESC TEC Research Information System (IRIS), the Institutional Repository, the official website, uONEConnect (a project management platform for European projects) and CRM. In addition, SIG offers support to various departments in their interactions with the financial SAP system.

Highlights in 2024

INESC TEC Mobile App

Launch of the INESC TEC mobile application, which provides a set of services that facilitate daily activities for the entire community.

Main features:

- Clocking in/out via the application with NFCs and QR Codes reading integration
- Vacations and holidays records
- Space and room reservation including physical access management
- Resources to facilitate the integration of new employees

IRIS - NetDB

This new module is designed to register the connections within INESC TEC's internal infrastructure, enabling efficient maintenance and monitoring by the team responsible. To achieve this, several key functionalities were implemented, including:

- Registration of equipment, interfaces, IPs, and their associated components;
- Listing and searching tools for all records to facilitate streamlined monitoring and maintenance;
- Various editing methods were incorporated, allowing for detailed modification of each connection property as needed.

IRIS - Projects Module

- Improvements in the user experience within the team management component, optimising the interface and workflow.

IRIS - Entity Management Module

- Implementation of new features to facilitate the efficient management of entities within the system.

IRIS - Scientific Domains Management Module, which includes essential features such as:

- **People Management:** Organising and controlling information about collaborators and researchers.
- **Project Management:** Tracking and managing scientific projects;

- **Publication Management:** Integration and monitoring of scientific publications;
- **Theses Management:** A system for tracking and managing ongoing academic theses.

IRIS - Application Management Tool for internship and PhD programmes, providing:

- **Decentralised Selection Process:** Allows the submission of applications to the respective juries, categorised by thematic area, ensuring more efficient and specialised evaluations.

uONEConnect

The development of a new dashboard that provides a 360° view of all project data, offering a real-time snapshot of the current project status and allowing external project reviewers to access all this information in a single location.

9.13 SYSTEM ADMINISTRATION SERVICE

Manager: Jaime Dias



Presentation

The System Administration Service (SAS) is responsible for managing INESC TEC's computing and storage infrastructures, both on-premises and cloud-based. SAS maintains critical collaboration platforms and authentication systems, manages end-user devices, and oversees institutional software deployment and licensing. The service provides helpdesk support and technical assistance to end-users, administrative staff, and research teams. SAS also contributes to organisational data protection efforts through technical assessments and consultation.

Highlights in 2024

In addition to regular maintenance and improvements of the infrastructures and services, SAS increased its efforts on cybersecurity and resiliency at the system administration level to address the increase in number and complexity of cyberattack attempts.

In 2024, SAS enhanced procedures for supporting end users and their computers to maintain service quality, despite an increased number of support requests.

With the increased R&D activity related to Machine Learning and Artificial Intelligence, SAS continued expanding and improving its computing and storage infrastructures. It also continued its work on setting up an MLOps (Machine Learning Operations) platform, which, due to staffing limitations, is expected to be completed only in 2025.

Key highlights of 2024 include:

Computing infrastructures

- Five new servers were acquired and integrated into the CCloud computing cluster, two of which are equipped with high-performance, LLM-capable GPUs—Nvidia L40S (48 GB VRAM) and H200 (141 GB VRAM). These new servers are dedicated to HPC workloads, including machine learning, deep learning, and AI research and development;
- The overall computing capacity, encompassing both VMware and CCloud clusters, has expanded to 2,600 physical CPU cores, 25 TB of RAM, and 64 GPUs. Of these, 35 are LLM-capable, providing a total of 617,000 CUDA cores, 2.6 TB of VRAM, and 17,000 Tensor cores.

Storage infrastructures

- A 2.8 PB high-throughput object storage system (S3), composed of two clusters, was deployed to support large-scale data storage and AI-optimised workloads. The system was designed and built in-house using open-source software and enterprise-grade server hardware, interconnected via a 100 Gbit/s Ethernet switching network. This approach enabled significantly more storage capacity and better performance than what would have been obtainable with a turnkey solution at the same cost.

Multi-factor authentication

- SAS enabled multi-factor authentication on all applications, both on-premises and in the cloud, that support it, paving the way for its enforcement in 2025.

Data protection

- As a member of the institutional Data Protection Team, SAS contributed to compliance efforts through technical assessments, infrastructure analysis, and consultation on research projects with data privacy implications.

9.14 INFRASTRUCTURE MANAGEMENT SERVICE

Manager: Jorge Couto



Presentation

The Infrastructure Management Service assures the support services necessary for the adequate management and maintenance of INESC TEC buildings infrastructures.

Highlights in 2024

Increase energy efficiency of buildings:

- Energy certification of the two buildings in Asprela;
- Installation of a dishwasher to reduce water usage and provide greater support to the cleaning service;
- Design and construction of a dedicated electrical panel for the Datacentre to handle the significant power increase of the computational cluster.

Security

- Preventive and corrective maintenance of the various fire control devices installed in all the buildings.

Workspace improvement

- Renovation of the cafeteria in Building A;
- Installation of an internal TV for dissemination of scientific results and other relevant information for collaborators and visitors;
- Installation of an acoustic booth to support web meetings;
- Creation of a meeting room at the INESC TEC centre at UTAD;
- Renovation of the videoconference system in the meeting rooms on the 4th floor;
- Installation of a videoconference system in Auditorium A;
- Improvement works at the University of Minho centre in Braga;
- Renovation works in room J2023 at FEUP.

Team Development

- Training of team members in workplace safety, electricity, and English language skills.

Other activities

- Continued maintenance of building infrastructure and systems.

10 Annex I

10.1 CTM – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CTM research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.1 – CTM – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	9	13	14	1
	Academic Staff	14	15	16	1
	Grant Holders and Trainees	49	65	78	13
	Total Core Researchers	72	93	108	15
	Total Core PhD	22	24	27	3
	Affiliated Researchers	10	10	8	-2
	Administrative and Technical Employees	1	1	1	
	Total Integrated HR	83	104	117	13
	Total Integrated PhD	32	34	35	1

Table 10.2 – CTM – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	113	103	169	66
PN-PICT	National R&D Programmes - S&T Integrated Projects	77	32	3	-30
PN-COOP	National Cooperation Programmes with Industry	277	671	939	269
PUE-FP	EU Framework Programmes	244	983	1 256	273
PUE-DIV	EU Cooperation Programmes - Other	11	9	13	3
SERV-NAC	R&D Services and Consulting - National	625	235	30	-205
SERV-INT	R&D Services and Consulting - International	21			
OP	Other Funding Programmes	74	5	23	18
Total Funding		1 443	2 037	2 432	395

Table 10.3 – CTM – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	45	57	27
Indexed Conferences	39	56	46
Books			
Book Chapters	1		1
Concluded PhD Theses – Members	5	2	4
Concluded PhD Theses - Supervised	6	3	5

Table 10.4 – CTM – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	4	7	1
Technology Disclosures (TDF)	1	2	1
First Priority Patent Applications (New Inventions)	1	2	1
First Patents Internationalisation			1
First Patent Granted	1	1	
Commercial Contracts (Licences, Options, Assignments)			
Spin-offs established			
Spin-offs in development			

Table 10.5 – CTM – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	13	8	6
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	6	5	5
International events in which INESC TEC members participate in the program committees	37	35	23
Participation in events such as fairs, exhibitions or similar	5	20	16
Conferences, workshops and scientific sessions organised by the Centre	11	7	11
Participants in the conferences, workshops and scientific sessions organised by the Centre	800	900	475
Advanced training courses organised by the Centre	2	2	2

Table 10.6 – CTM – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	GROW	Rui Lopes Campos	01/10/2018	30/09/2021
PN-FCT	MATinMOL	Maria Inês Carvalho	01/03/2021	28/02/2025
PN-FCT	CIRCUMSTANCE	Hélder Filipe Oliveira	01/01/2022	30/06/2025
PN-FCT	UNIFY	Nuno Miguel Paulino	10/03/2023	09/03/2026
PN-FCT	TORIS	Luís Manuel Pessoa	01/03/2023	28/02/2025
PN-FCT	CAGING	Luís Filipe Teixeira	01/02/2023	31/12/2024
PN-FCT	LUCCA	Tânia Pereira	01/03/2023	28/02/2025
PN-FCT	CELLO	Hélder Filipe Oliveira	06/03/2023	05/03/2026
PN-PICT	DECARBONIZE-1	Hélder Martins Fontes	01/01/2021	30/06/2023
PN-COOP	FLY_PT-1	Hélder Martins Fontes	01/07/2020	30/06/2023
PN-COOP	Produtech_R3-3	Rui Lopes Campos	01/09/2022	31/12/2025
PN-COOP	HfPT-3	Hélder Filipe Oliveira	01/10/2021	31/12/2025
PN-COOP	NewSpacePortugal-3	Ana Filipa Sequeira	01/10/2022	31/12/2025
PN-COOP	NEXUS-2	Filipe André Ribeiro	01/10/2022	31/12/2025
PN-COOP	SUSTAINABLE PLASTICS	Pedro Miguel Carvalho	01/09/2022	31/12/2025
PN-COOP	A-MoVeR	Luís Manuel Pessoa	01/12/2022	01/12/2025
PUE-DIV	OpenMinds	Gilberto Bernardes Almeida	30/12/2021	29/12/2023
PUE-DIV	AEROGANP-1	Hélder Martins Fontes	01/01/2023	30/06/2026
PUE-FP	InterConnect-1	Filipe André Ribeiro	01/10/2019	31/03/2024
PUE-FP	CINDERELLA	Jaime Cardoso	01/06/2022	31/05/2026
PUE-FP	WATSON	Pedro Miguel Carvalho	01/03/2023	28/02/2026
PUE-FP	EADIGIFOLK	Gilberto Bernardes Almeida	01/01/2023	31/12/2026
PUE-FP	OVERWATCH-1	Hélder Martins Fontes	01/11/2022	31/10/2025
PUE-FP	CONVERGE	Luís Manuel Pessoa	01/02/2023	31/01/2026
PUE-FP	A-IQ Ready	João Canas Ferreira	01/01/2023	31/12/2025
PUE-FP	SuperIoT	Hélder Martins Fontes	01/01/2023	31/12/2025
PUE-FP	TERRAMETA	Luís Manuel Pessoa	01/01/2023	31/12/2025
PUE-FP	PHASE IV AI	Hélder Filipe Oliveira	01/10/2023	30/09/2026
PUE-FP	AI4LUNGS	Hélder Filipe Oliveira	01/01/2024	30/06/2027
PUE-FP	REPLICA	Hélder Martins Fontes	15/06/2024	15/03/2025
SERV-NAC	OPITDEV	Filipe André Ribeiro	01/01/2024	31/12/2024
SERV-NAC	RFIDCORK-1	Rui Lopes Campos	07/06/2024	06/08/2024
SERV-NAC	TestBed5G_1	Rui Lopes Campos	01/02/2024	30/08/2025
OP	Inphinit	Paula Viana	01/12/2019	01/12/2022
OP	INVICTA	Ana Filipa Sequeira	01/02/2023	31/07/2024

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

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Books

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Chapter/Paper in Books

1. Kruczkowski, M, Drabik-Kruczkowska, A, Wesolowski, R, Kloska, A, Pinheiro, MR, Fernandes, L, Galan, SG, "Precise Identification of Different Cervical Intraepithelial Neoplasia (CIN) Stages, Using Biomedical Engineering Combined with Data Mining and Machine Learning", Interdisciplinary Cancer Research, 2024

Publications (Editor)

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Concluded Theses (PhD)

1. Albuquerque, T., “Multimodal Cervical Cancer Diagnosis: Deep Learning for Automatic Decision Support”
2. Aly, L., “Emotion-driven Physiological Actor Dynamics For Interactive Theatre Sound”
3. Costa, T., “Enhanced multiview experiences through remote content selection and dynamic quality adaptation”
4. Silva, H., “Mitigating Information Asymmetry in the 5G Era: unveiling practices that restrict users' Internet access”

10.2 CAP – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CAP research team composition and evolution and the main indicators of its activity carried out in 2024 participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.7 – CAP – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	15	15	14	-1
	Academic Staff	8	7	7	
	Grant Holders and Trainees	19	16	20	4
	Total Core Researchers	42	38	41	3
	Total Core PhD	19	19	18	-1
	Affiliated Researchers	3	2	2	
	Administrative and Technical Employees	1	1	2	1
	Total Integrated HR	46	41	45	4
Total Integrated PhD	22	21	20	-1	

Table 10.8 – CAP – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	120	113	40	-73
PN-PICT	National R&D Programmes - S&T Integrated Projects			-5	-5
PN-COOP	National Cooperation Programmes with Industry	201	287	469	182
PUE-FP	EU Framework Programmes	206	169	382	214
PUE-DIV	EU Cooperation Programmes - Other	5	4	4	
SERV-NAC	R&D Services and Consulting - National	43	5	72	67
SERV-INT	R&D Services and Consulting - International	64	14		-14
OP	Other Funding Programmes	21	89	109	21
Total Funding		659	680	1 071	391

Table 10.9 – CAP – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	27	34	25
Indexed Conferences	14	9	27
Books			
Book Chapters			
Concluded PhD Theses – Members	1	2	3
Concluded PhD Theses - Supervised	1	2	3

Table 10.10 – CAP – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	1	1	6
Technology Disclosures (TDF)	2	3	2
First Priority Patent Applications (New Inventions)	1	2	1
First Patents Internationalisation	2	2	1
First Patent Granted		4	
Commercial Contracts (Licences, Options, Assignments)	1	1	1
Spin-offs established			1
Spin-offs in development	1	1	1

Table 10.11 – CAP – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	4	7	13
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	3	3	5
International events in which INESC TEC members participate in the program committees	1	8	1
Participation in events such as fairs, exhibitions or similar		2	3
Conferences, workshops and scientific sessions organised by the Centre	1	2	7
Participants in the conferences, workshops and scientific sessions organised by the Centre	20	200	160
Advanced training courses organised by the Centre		1	

Table 10.12 – CAP – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	SolSensors	Luís Carlos Coelho	01/05/2018	31/12/2021
PN-FCT	MYTAG	Pedro Jorge	01/01/2022	31/12/2024
PN-FCT	MODAS	Orlando Frazão	01/03/2023	28/02/2026
PN-COOP	CorkSurf	Pedro Jorge	01/07/2020	30/06/2023
PN-COOP	AgendaTransform-1	Diana Filipa Guimarães	01/10/2022	31/12/2025
PN-COOP	ATE-1	Luís Carlos Coelho	01/01/2023	31/12/2025
PUE-FP	EUSCORES-1	Luís Carlos Coelho	01/09/2021	31/08/2025
PUE-FP	SUBMERSE	Orlando Frazão	01/05/2023	30/04/2026
PUE-FP	INNOAQUA-1	Luís Carlos Coelho	01/06/2023	31/05/2027
SERV-NAC	DFOSREN	Ireneu Dias	30/06/2021	31/12/2024
SERV-NAC	Glass_ID	Pedro Jorge	02/01/2024	31/12/2024
SERV-NAC	NovaLente	Manuel Joaquim Marques	19/12/2024	18/07/2025
SERV-NAC	Corksurf2	Nuno Azevedo Silva	01/06/2024	30/11/2024
OP	SMARTCAP	Orlando Frazão	01/02/2022	31/01/2026
OP	OFS29	Paulo Vicente Marques	01/02/2023	31/01/2026
OP	EMSLIBS2023	Ireneu Dias	10/02/2023	31/03/2024
OP	BIPSKD	Nuno Azevedo Silva	15/11/2023	14/11/2024

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

List of Publications

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15. Maia, JM, Marques, PVS, "Study on fs-laser machining of optical waveguides and cavities in ULE® glass", JOURNAL OF OPTICS, vol.26, no.6, pp.065802, 2024
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21. Robalinho, P, Rodrigues, AV, Novais, S, Ribeiro, AL, Silva, S, Frazao, O, "Novel Digital Signal Processing Method for Data Acquired From Low Coherence Interferometry", *IEEE SENSORS JOURNAL*, vol.24, no.24, pp.40896-40903, 2024
22. Silva, NA, "Harnessing the Distributed Computing Paradigm for Laser-Induced Breakdown Spectroscopy", *BIG DATA AND COGNITIVE COMPUTING*, vol.8, no.11, pp.154, NOV, 2024
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4. Capela, D, Lopesa, T, Ferreira, MFS, Magalhaes, P, Jorge, PAS, Silva, NA, Guimaraes, D, "Analysing Heavy Metal Contaminants in Wood Wastes using Laser-Induced Breakdown Spectroscopy (LIBS)", *OPTICAL SENSING AND DETECTION VIII*, vol.12999, pp.108, 2024
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6. Cavaco, R, Lopes, T, Jorge, PAS, Silva, NA, "Augmented Reality for Spectral Imaging Applications", *UNCONVENTIONAL OPTICAL IMAGING IV*, vol.12996, pp.79, 2024
7. Cunha, C, Monteiro, C, Martins, HF, Silva, S, Frazao, O, "Environmental Monitoring of Submarine Cable in Madeira Island", *EOS ANNUAL MEETING, EOSAM 2024*, vol.309, pp.10013, 2024
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11. Ferreira, MFS, Oliveira, R, Capela, D, Lopes, T, Marrafa, J, Meneses, P, Oliveira, A, Baptista, C, Gomes, T, Moutinho, S, Coelho, J, da Silva, RN, Guimaraes, D, Silva, NA, Jorge, PAD, "LIBS imaging as a process control tool in the cork industry", OPTICAL SENSING AND DETECTION VIII, vol.12999, pp.47, 2024
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13. Guimaraes, D, Capela, D, Lones, T, Magalhaes, P, Pessanha, S, Jorge, PAS, Silva, NA, "Screening Chromium Contamination in Wood Samples using Laser-Induced Breakdown Spectroscopy Imaging", 2024 IEEE SENSORS APPLICATIONS SYMPOSIUM, SAS 2024, pp.1-5, 2024
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18. Monteiro, CS, Perez-Herrera, RA, Silva, NA, Silva, SO, Frazao, O, "Optimizing Graphene Oxide Saturable Absorbers for Short Pulse Generation in Fiber Lasers: Characterization and Aging Assessment", FIBER LASERS AND GLASS PHOTONICS: MATERIALS THROUGH APPLICATIONS IV, vol.13003, pp.3, 2024
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20. Robalinho, P, Rodrigues, A, Novais, S, Ribeiro, ABL, Silva, S, Frazao, O, "Low Coherence Interferometry Measurement: An Algorithm for fast processing with low noise and phase linearisation", EOS ANNUAL MEETING, EOSAM 2024, vol.309, pp.10022, 2024
21. Rocha, V, Ferreira, TD, Silva, NA, "All-optical output layer in photonic extreme learning machines", MACHINE LEARNING IN PHOTONICS, vol.13017, 2024
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23. Silva, NA, Rocha, VV, Ferreira, TD, "Enabling optical extreme learning machines with nonlinear optics", MACHINE LEARNING IN PHOTONICS, vol.13017, 2024
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26. Teixeira, J, Ribeiro, A, Jorge, AS, Silva, A, "Probing molecular affinity with optical tweezers", Proceedings of SPIE - The International Society for Optical Engineering, vol.12991, 2024
27. Teixeira, J, Ribeiro, J, Silva, N, Jorge, P, "Automated Optical Tweezers for Enhanced Bioparticle Analysis via Combined Scattering and Raman Spectroscopy", 2024 IEEE SENSORS APPLICATIONS SYMPOSIUM, SAS 2024, vol.36, pp.1-6, 2024

Books

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Chapter/paper in Books

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Publications (Editor)

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Concluded Theses (PhD)

1. Ferreira, M., "Development of Laser-Induced Breakdown Spectroscopy Systems for Industrial Applications"
2. Ferreira, T., "Advances in Paraxial Fluids of Light with Photorefractive Media"
3. Santos, P., "Development of optical fiber sensors with plasmonic nanostructures"

10.3 CRAS – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CRAS research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.13 – CRAS – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	24	28	31	3
	Academic Staff	12	11	11	
	Grant Holders and Trainees	35	40	46	6
	Total Core Researchers	71	79	88	9
	Total Core PhD	17	17	19	2
	Affiliated Researchers	1			
	Administrative and Technical Employees	3	5	6	1
	Total Integrated HR	75	84	94	10
	Total Integrated PhD	17	17	19	2

Table 10.14 – CRAS – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	543	566	570	4
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	469	843	664	-179
PUE-FP	EU Framework Programmes	1 791	1 769	1 892	123
PUE-DIV	EU Cooperation Programmes - Other	149	276	317	41
SERV-NAC	R&D Services and Consulting - National	89	68	184	117
SERV-INT	R&D Services and Consulting - International	128	124	65	-60
OP	Other Funding Programmes			3	3
Total Funding		3 169	3 646	3 695	49

Table 10.15 – CRAS – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	22	25	23
Indexed Conferences	29	31	32
Books	1		
Book Chapters	4	3	5
Concluded PhD Theses – Members		1	5
Concluded PhD Theses - Supervised		1	5

Table 10.16 – CRAS – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	1	2	
Technology Disclosures (TDF)	1	1	3
First Priority Patent Applications (New Inventions)	1	1	2
First Patents Internationalisation		1	1
First Patent Granted	1	1	
Commercial Contracts (Licences, Options, Assignments)			
Spin-offs established			
Spin-offs in development			

Table 10.17 – CRAS – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	15	7	8
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	2	2	5
International events in which INESC TEC members participate in the program committees	16	4	11
Participation in events such as fairs, exhibitions or similar	14	25	19
Conferences, workshops and scientific sessions organised by the Centre	10	12	24
Participants in the conferences, workshops and scientific sessions organised by the Centre	370	400	1 855
Advanced training courses organised by the Centre		3	4

Table 10.18 – CRAS – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	Connect2Oceans	Alfredo Martins	20/03/2021	31/07/2024
PN-FCT	NMicroARTIC	Alfredo Martins	12/03/2023	11/03/2026
PN-FCT	SENTINEL	Ana Cristina Pires	01/01/2024	31/03/2025
PN-COOP	Drivolution	André Dias	01/09/2022	01/09/2025
PN-COOP	StoneByPortugal	Ana Cristina Pires	01/07/2022	30/06/2025
PUE-DIV	Prince	Hugo Miguel Silva	01/01/2019	31/12/2022
PUE-DIV	FLYPASS	Bruno Miguel Ferreira	06/06/2022	30/04/2024
PUE-DIV	SEAWINGS	José Miguel Almeida	01/12/2022	31/05/2026
PUE-DIV	AOWINDE	Ana Paula Lima	01/01/2023	31/12/2025
PUE-FP	SPRING	Aníbal Matos	01/08/2019	31/07/2024
PUE-FP	DEEPFIELD	Hugo Miguel Silva	01/10/2019	30/09/2023
PUE-FP	ATLANTIS	Andry Maykol Pinto	01/01/2020	31/12/2023
PUE-FP	MAGPIE-2	Diana Viegas	01/10/2021	01/10/2026
PUE-FP	FIRELOGUE	Hugo Miguel Silva	01/11/2021	31/10/2025
PUE-FP	TIMREX	Ana Cristina Pires	01/01/2022	31/12/2024
PUE-FP	TRIDENT	José Miguel Almeida	01/01/2023	31/12/2027
PUE-FP	MineIO	José Miguel Almeida	01/01/2023	30/06/2026
PUE-FP	AIRSHIP	José Miguel Almeida	01/01/2023	31/12/2026
PUE-FP	TALOS	Andry Maykol Pinto	01/10/2023	30/09/2026
PUE-FP	NETTAGPlus	Diana Viegas	01/05/2023	30/04/2026
PUE-FP	NauticalSunrise	Alfredo Martins	01/12/2023	30/11/2027
PUE-FP	BioProtect	Alfredo Martins	01/05/2024	30/04/2028
PUE-FP	SEAGUARD	Bruno Miguel Ferreira	01/10/2024	31/03/2027
PUE-FP	NuClim	José Miguel Almeida	01/09/2024	31/08/2028
SERV-NAC	UWRoboticEMFInspect	José Miguel Almeida	01/01/2024	31/12/2025
SERV-NAC	MAR_PreExpTunel4	José Miguel Almeida	29/01/2024	31/12/2024
SERV-INT	ILVO2_eBAR	José Miguel Almeida	01/10/2023	30/11/2024
SERV-INT	DiveTrack	Nuno Cruz	02/01/2024	31/05/2024
OP	SOE22	Ana Cristina Pires	07/07/2022	31/10/2024
INT	SUMO_Mar_Profundo	Paulo Mónica Oliveira	01/01/2022	
INT	SUMO_Semi_Rig	Nuno Cruz	01/01/2022	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

List of Publications

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Books

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Publications (Editor)

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Concluded Theses (PhD)

1. Campos, D., “Multi-domain Contextual Awareness using Unmanned Surface Vehicles for Offshore Wind Farms Inspection”
2. Claro, R., “Robust Perception System for Autonomous Precise Landing of UAVs in Offshore Wind Farms”
3. Gaspar, A., “Close-Range Localisation for Inspection of Underwater Structures”
4. Matos, T., “Sediment circulation and accumulation sensors for in situ continuous monitoring”
5. Nunes, A., “Underwater Reconstruction and Object Recognition”

10.4 C-BER – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present C-BER research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.19 – C-BER – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	4	4	8	4
	Academic Staff	6	6	4	-2
	Grant Holders and Trainees	15	25	19	-6
	Total Core Researchers	25	35	31	-4
	Total Core PhD	8	8	9	1
	Affiliated Researchers	1	1	2	1
	Administrative and Technical Employees	1	1	1	
	Total Integrated HR	27	37	34	-3
	Total Integrated PhD	9	9	10	1

Table 10.20 – C-BER – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	76	99	61	-38
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	80	83	261	178
PUE-FP	EU Framework Programmes	38	98	152	54
PUE-DIV	EU Cooperation Programmes - Other				
SERV-NAC	R&D Services and Consulting - National	23	10	62	52
SERV-INT	R&D Services and Consulting - International	21	163	38	-125
OP	Other Funding Programmes	6	7	12	5
Total Funding		244	460	586	126

Table 10.21 – C-BER – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	31	30	24
Indexed Conferences	25	46	32
Books		1	
Book Chapters	1	1	1
Concluded PhD Theses – Members	1		2
Concluded PhD Theses - Supervised	1	2	2

Table 10.22 – C-BER – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	3	1	8
Technology Disclosures (TDF)	5	1	1
First Priority Patent Applications (New Inventions)	2	1	2
First Patents Internationalisation		2	1
First Patent Granted		1	1
Commercial Contracts (Licences, Options, Assignments)		1	1
Spin-offs established		1	1
Spin-offs in development	2	1	

Table 10.23 – C-BER – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	5	6	2
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)		7	3
International events in which INESC TEC members participate in the program committees	14	25	18
Participation in events such as fairs, exhibitions or similar		5	4
Conferences, workshops and scientific sessions organised by the Centre	1	3	3
Participants in the conferences, workshops and scientific sessions organised by the Centre	50	160	150
Advanced training courses organised by the Centre			1

Table 10.24 – C-BER – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	THOR	Miguel Coimbra	01/03/2021	28/02/2025
PN-FCT	CAGED	Miguel Coimbra	01/03/2021	28/02/2025
PN-COOP	TEXPACT-1	Miguel Velhote Correia	01/07/2022	31/12/2025
PN-COOP	Vine&Wine_PT-2	Duarte Filipe Dias	11/10/2022	10/10/2025
PUE-FP	FIRE_RES-1	Duarte Filipe Dias	01/12/2021	01/12/2025
PUE-FP	CARE-IN-HEALTH	João Paulo Cunha	01/01/2023	31/12/2027
PUE-FP	AI4REALNET-1	Duarte Filipe Dias	01/10/2023	31/03/2027
SERV-NAC	PD_MultiCentre	João Paulo Cunha	01/04/2023	30/07/2024
SERV-NAC	CardioLife_Support	Duarte Filipe Dias	20/04/2024	19/05/2024
SERV-NAC	EndoGastricAI	Miguel Coimbra	01/04/2024	31/03/2026
SERV-NAC	CropsHealthPilot	Duarte Filipe Dias	15/05/2024	31/10/2024
SERV-INT	RAISE	Duarte Filipe Dias	01/10/2022	31/12/2024
OP	smartDBS	João Paulo Cunha	01/12/2022	30/11/2025

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

List of Publications

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10. Ferreira, ICA, Venkadesh, KV, Jacobs, C, Coimbra, M, Campilho, A, "Towards automatic forecasting of lung nodule diameter with tabular data and CT imaging", BIOMEDICAL SIGNAL PROCESSING AND CONTROL, vol.96, pp.106625, OCT, 2024
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12. Fontes, M, De Almeida, JDS, Cunha, A, "Application of Example-Based Explainable Artificial Intelligence (XAI) for Analysis and Interpretation of Medical Imaging: A Systematic Review", IEEE ACCESS, vol.12, pp.26419-26427, JUL, 2024
13. Karácsony, T, Jeni, LA, de la Torre, F, Cunha, JPS, "Deep learning methods for single camera based clinical in-bed movement action recognition", IMAGE AND VISION COMPUTING, vol.143, pp.104928, 2024
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2. Arrais, A, Vieira, RD, Dias, D, Soares, C, Massano, J, Cunha, JPS, "A Wearable Quantified Approach to Parkinson's Disease Gait Motor Symptoms", 2024 IEEE 22ND MEDITERRANEAN ELECTROTECHNICAL CONFERENCE, MELECON 2024, pp.791-796, 2024
3. Aslani, R, Dias, D, Cunha, JPS, "PPG-Based Real-Time Blood Pressure Monitoring using Reflective Pulse Transit Time: Rest vs. Exercise Evaluation", 2024 IEEE 22ND MEDITERRANEAN ELECTROTECHNICAL CONFERENCE, MELECON 2024, pp.1084-1088, 2024
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Books

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Chapter/Paper in Books

1. Silva, AS, Correia, MV, Plácido da Silva, H, "Invisibles: A New Frontier in Vital Signs Monitoring", NATO Science for Peace and Security Series - D: Information and Communication Security - Modern Technologies Enabling Innovative Methods for Maritime Monitoring and Strengthening Resilience in Maritime Critical Infrastructures, 2024

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1. Melo, T., "Computer-aided diagnosis and follow-up of prevalent eye diseases using OCT/OCTA images"
2. Pereira, S., "Artificial Intelligence-based Decision Support Models for COVID-19 Detection"

10.5 CPES – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CPES research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.25 – CPES – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	50	63	83	20
	Academic Staff	10	9	10	1
	Grant Holders and Trainees	39	47	64	17
	Total Core Researchers	99	119	157	38
	Total Core PhD	29	31	37	6
	Affiliated Researchers	5	2	2	
	Administrative and Technical Employees	3	2	3	1
	Total Integrated HR	107	123	162	39
Total Integrated PhD	34	33	39	6	

Table 10.26 – CPES – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	117	84	77	-7
PN-PICT	National R&D Programmes - S&T Integrated Projects	77	70	7	-63
PN-COOP	National Cooperation Programmes with Industry	527	1 083	3 176	2 092
PUE-FP	EU Framework Programmes	2 034	2 831	2 111	-720
PUE-DIV	EU Cooperation Programmes - Other	60	2	-1	-2
SERV-NAC	R&D Services and Consulting - National	956	1 044	1 075	32
SERV-INT	R&D Services and Consulting - International	27	168	243	75
OP	Other Funding Programmes	180	11		-11
Total Funding		3 978	5 293	6 688	1 395

Table 10.27 – CPES – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	128	56	66
Indexed Conferences	40	58	53
Books			
Book Chapters	3	3	1
Concluded PhD Theses – Members	3	4	1
Concluded PhD Theses - Supervised	4	4	5

Table 10.28 – CPES – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	2	9	3
Technology Disclosures (TDF)		8	3
First Priority Patent Applications (New Inventions)		1	2
First Patents Internationalisation			
First Patent Granted			
Commercial Contracts (Licences, Options, Assignments)			2
Spin-offs established			
Spin-offs in development		1	

Table 10.29 – CPES – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	9	8	13
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	5	1	2
International events in which INESC TEC members participate in the program committees	6	3	4
Participation in events such as fairs, exhibitions or similar	3	3	13
Conferences, workshops and scientific sessions organised by the Centre	10	13	22
Participants in the conferences, workshops and scientific sessions organised by the Centre	1 156	745	2 187
Advanced training courses organised by the Centre	2	3	2

Table 10.30 – CPES – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-COOP	BATERIAS2030	Clara Sofia Gouveia	01/07/2020	30/06/2023
PN-COOP	CITYCATALIST	Filipe Joel Soares	01/07/2020	30/06/2023
PN-COOP	SCALE	Clara Sofia Gouveia	01/01/2021	30/06/2023
PN-COOP	DIGITALCER	Clara Sofia Gouveia	01/01/2021	30/06/2023
PN-COOP	RN21	Zenaida Mourão	01/07/2022	31/12/2025
PN-COOP	BioShoes4All-1	Ricardo Jorge Bessa	01/07/2022	31/12/2025
PN-COOP	H2DRIVEN	Rui Esteves Araujo	01/10/2022	01/10/2025
PN-COOP	NGS	Clara Sofia Gouveia	01/01/2023	31/12/2025
PN-COOP	Tools4AgriEnergy-LA11.1	José Villar	01/04/2023	30/09/2025
PUE-FP	XFLEX_HIDRO	Carlos Moreira	01/09/2019	29/02/2024
PUE-FP	POCITYF	Justino Miguel Rodrigues	01/10/2019	30/09/2026
PUE-FP	ATTEST	Filipe Joel Soares	01/03/2020	31/08/2023
PUE-FP	OneNet	Alexandre Lucas	01/10/2020	31/03/2024
PUE-FP	OpenInnoTrain	Luís Seca	01/01/2019	30/06/2024
PUE-FP	GREENH2ATLANTIC	João Peças Lopes	01/12/2021	19/06/2023
PUE-FP	ENERSHARE	Ricardo Jorge Bessa	01/07/2022	30/06/2025
PUE-FP	BeFlexible	Ricardo Jorge Bessa	01/09/2022	31/08/2026
PUE-FP	iSTENTORE	Filipe Joel Soares	01/01/2023	31/12/2025
PUE-FP	Green_Dat_AI	Gil Silva Sampaio	01/01/2023	31/12/2025
PUE-FP	SINNOGENES	Ricardo Silva	01/01/2023	31/12/2026
PUE-FP	Every1	Alexandre Lucas	01/11/2022	30/04/2026
PUE-FP	InterStore	Alexandre Lucas	01/01/2023	31/12/2025
PUE-FP	ENFIELD	Ricardo Jorge Bessa	01/09/2023	31/08/2026
PUE-FP	ENPOWER	José Villar	01/09/2023	31/08/2026
PUE-FP	TwinEU	Ricardo Jorge Bessa	01/01/2024	31/12/2026
PUE-FP	SMHYLES	Helena Vasconcelos	01/01/2024	31/12/2027
PUE-FP	CRETE_VALLEY	Filipe Joel Soares	01/12/2023	30/11/2028
PUE-FP	EULAC ENERGYTRAN	Ignacio Gil	01/01/2024	31/12/2025
PUE-FP	HEDGE_IoT	Vasco Manuel Campos	01/01/2024	30/06/2027
PUE-FP	ORION	Tatiana Guedes	01/09/2024	31/08/2027
PUE-FP	AI_EFFECT	Ricardo Jorge Bessa	01/10/2024	30/09/2027
PUE-FP	HYNET	Justino Miguel Rodrigues	01/10/2024	30/09/2027
PUE-FP	EnerTEF	Alexandre Lucas	01/11/2024	31/10/2027
PUE-FP	STORHY	Bernardo Silva	01/10/2024	30/09/2028
SERV-NAC	MORADIST	Manuel Matos	01/02/2021	31/12/2025
SERV-NAC	Fin_Losses	Filipe Joel Soares	01/10/2021	31/12/2025

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
SERV-NAC	TechMeter	David Emanuel Rua	18/04/2022	30/06/2024
SERV-NAC	ECOVALE	Zenaida Mourão	01/09/2022	31/03/2025
SERV-NAC	Eolica_offshorePT	João Peças Lopes	01/06/2023	31/03/2025
SERV-NAC	ELFOS_evolved	José Ricardo Andrade	01/06/2023	29/07/2024
SERV-NAC	ENS_Pico	Carlos Moreira	01/07/2023	31/03/2024
SERV-NAC	SmartAmmonia	Filipe Joel Soares	12/06/2023	31/03/2025
SERV-NAC	PV_Ferreira3	Bernardo Silva	01/09/2023	31/03/2024
SERV-NAC	RAM_PLAN_GREEN_PORT	João Peças Lopes	01/10/2023	31/12/2024
SERV-NAC	PV_Alcacer	João Peças Lopes	15/09/2023	30/09/2024
SERV-NAC	BIOMASS	Bernardo Silva	01/10/2023	31/01/2024
SERV-NAC	SolarPVSMiguel_EstC	João Peças Lopes	15/10/2023	30/06/2024
SERV-NAC	PVTerceira_EstComp	João Peças Lopes	22/11/2023	30/09/2024
SERV-NAC	PV_Pico_EstComp	João Peças Lopes	22/11/2023	30/06/2024
SERV-NAC	CampusREN2024	João Peças Lopes	15/05/2024	30/06/2024
SERV-NAC	PV_Morno	Carlos Moreira	15/12/2023	31/03/2024
SERV-NAC	SolarPV_Faial_EstCom	João Peças Lopes	22/11/2023	30/09/2024
SERV-NAC	R3EA	José Villar	01/11/2023	31/12/2024
SERV-NAC	ENS_Pico_TA	Carlos Moreira	15/11/2023	14/01/2024
SERV-NAC	Madeira_UA	Carlos Moreira	01/03/2024	30/11/2024
SERV-NAC	PQ_Industrial_UPACs	João Peças Lopes	15/01/2024	31/12/2024
SERV-NAC	PQ_Industrial_Bate	João Peças Lopes	02/01/2024	31/12/2024
SERV-NAC	PV_SJorge_Est	João Peças Lopes	27/12/2023	30/09/2024
SERV-NAC	PV_SantaMaria_Est	João Peças Lopes	27/12/2023	30/06/2024
SERV-NAC	Evol_HidroPT	João Peças Lopes	15/12/2023	31/12/2024
SERV-NAC	GridSupportStorage	Clara Sofia Gouveia	01/03/2024	30/09/2024
SERV-NAC	DesCFoodScenarios	Zenaida Mourão	02/01/2024	02/01/2025
SERV-NAC	DesCFoodRoteiro2050	Zenaida Mourão	02/01/2024	02/01/2025
SERV-NAC	biomass_freq	João Azeredo Aguiar	15/01/2024	14/03/2024
SERV-NAC	MASS_GRID_2	João Azeredo Aguiar	01/04/2024	31/07/2024
SERV-NAC	DesCFoodTec2050	Zenaida Mourão	01/02/2024	31/12/2024
SERV-NAC	PVonMASS	Bernardo Silva	01/01/2024	31/05/2024
SERV-NAC	PS_MORA_TRAINING	Leonel Magalhães Carvalho	15/05/2024	30/09/2024
SERV-NAC	PV_Ferreira_Malhada	Bernardo Silva	01/05/2024	31/12/2024
SERV-NAC	Perfis_Perdas_2025	José Nuno Fidalgo	20/05/2024	19/12/2024
SERV-NAC	EDALCOEGeotermicas	João Tomé Saraiva	01/07/2024	31/12/2024
SERV-NAC	I2P2024	José Nuno Fidalgo	15/05/2024	14/11/2024

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
SERV-NAC	EDALCOERenovaveis	João Tomé Saraiva	01/07/2024	30/11/2024
SERV-NAC	Wind_Curtail_Soft_5	Leonel Magalhães Carvalho	01/09/2024	31/10/2024
SERV-NAC	RECreation	José Villar	11/06/2024	10/06/2027
SERV-NAC	PROBONO	Zenaida Mourão	01/06/2024	30/09/2026
SERV-NAC	ELFOS_resampled	José Ricardo Andrade	01/09/2024	28/02/2025
SERV-NAC	HybridStorage	Ricardo Silva	01/09/2024	31/01/2025
SERV-NAC	SERVSIS_VE	Leonel Magalhães Carvalho	01/10/2024	01/05/2025
SERV-NAC	CapRecep4NewRES	João Peças Lopes	01/10/2024	29/06/2025
SERV-NAC	AltoLindoso	João Tomé Saraiva	11/11/2024	10/12/2024
SERV-NAC	Impacto_Invest	José Nuno Fidalgo	02/12/2024	01/05/2025
SERV-INT	CleanEnergy4EUIslands2	João Peças Lopes	15/04/2023	14/04/2027
SERV-INT	ColabForecast	José Ricardo Andrade	08/04/2024	30/11/2024
SERV-INT	DynaMarket	José Villar	01/09/2024	31/08/2026
SERV-INT	PredicoSupport	José Ricardo Andrade	08/11/2024	07/04/2025
SERV-INT	GridNode	Clara Sofia Gouveia	26/06/2023	31/12/2024
SERV-INT	VRE_MZ	João Peças Lopes	02/01/2024	01/11/2024
INT	Lab_redes_eletricas	Justino Miguel Rodrigues	01/01/2014	

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

List of publications

International Journals with Scientific Referees

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3. Ahmadipour, M, Othman, MM, Bo, R, Javadi, MS, Ridha, HM, Alrifayy, M, "Optimal power flow using a hybridization algorithm of arithmetic optimization and aquila optimizer", EXPERT SYSTEMS WITH APPLICATIONS, vol.235, pp.121212, 2024

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5. Azimi, M, Salami, A, Javadi, MS, Catalao, JPS, "Optimal and distributed energy management in interconnected energy hubs", APPLIED ENERGY, vol.365, pp.123282, 2024
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10.6 CESE – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CESE research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.31 – CESE – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	27	30	31	1
	Academic Staff	6	6	7	1
	Grant Holders and Trainees	11	16	12	-4
	Total Core Researchers	44	52	50	-2
	Total Core PhD	16	16	19	3
	Affiliated Researchers	9	9	7	-2
	Administrative and Technical Employees	2	2	2	
	Total Integrated HR	55	63	59	-4
	Total Integrated PhD	24	25	26	1

Table 10.32 – CESE – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	130	21	-1	-22
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	918	1 367	1 315	-53
PUE-FP	EU Framework Programmes	533	550	618	69
PUE-DIV	EU Cooperation Programmes - Other	1	-1	4	5
SERV-NAC	R&D Services and Consulting - National	347	225	139	-86
SERV-INT	R&D Services and Consulting - International	37	64	20	-44
OP	Other Funding Programmes		2	68	67
Total Funding		1 967	2 227	2 163	-64

Table 10.33 – CESE – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	24	37	33
Indexed Conferences	37	40	35
Books		1	1
Book Chapters	2	1	4
Concluded PhD Theses – Members		2	
Concluded PhD Theses - Supervised		2	

Table 10.34 – CESE – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	1	2	14
Technology Disclosures (TDF)	8	3	2
First Priority Patent Applications (New Inventions)			
First Patents Internationalisation			
First Patent Granted			
Commercial Contracts (Licences, Options, Assignments)			
Spin-offs established			
Spin-offs in development			2

Table 10.35 – CESE – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	3	3	8
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	3	1	3
International events in which INESC TEC members participate in the program committees	8	8	11
Participation in events such as fairs, exhibitions or similar	4	5	14
Conferences, workshops and scientific sessions organised by the Centre	8	8	5
Participants in the conferences, workshops and scientific sessions organised by the Centre	200	190	289
Advanced training courses organised by the Centre	1	1	3

Table 10.36 – CESE – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-COOP	BE@T-1	César Toscano	01/07/2022	31/12/2025
PN-COOP	Hi_reV-1	Rui Diogo Rebelo	01/01/2022	30/09/2025
PN-COOP	GIATEX	Rui Correia Dias	01/10/2022	01/09/2025
PN-COOP	Blue_Bioeconomy	Rui Correia Dias	01/01/2023	31/12/2025
PN-COOP	BLOCKCHAINPT	Luís Guardão	01/01/2023	31/12/2025
PUE-DIV	PRODUTECH_DIH	Carla Pereira	01/10/2022	31/03/2026
PUE-FP	BetterFactory-1	César Toscano	01/10/2020	30/09/2024
PUE-FP	CircThread	António Lucas Soares	01/06/2021	31/05/2025
PUE-FP	SoTeclnFactory	Gustavo Dalmarco	01/06/2022	31/05/2025
PUE-FP	ReSChape	Ricardo Augusto Zimmermann	01/10/2022	30/09/2025
PUE-FP	tExtended	César Toscano	01/12/2022	30/11/2026
PUE-FP	Confacts2	Ana Cristina Simões	01/01/2023	31/12/2024
PUE-FP	EITM_RIS_Hub_2023	Vasco Bernardo Teles	01/01/2023	31/12/2023
PUE-FP	RISESME	Ricardo Augusto Zimmermann	01/01/2024	31/12/2026
PUE-FP	RENEE-1	António Baptista	01/01/2024	31/12/2027
PUE-FP	EITM_RIS_Hubs_2024	Vasco Bernardo Teles	01/01/2024	31/12/2024
PUE-FP	InnovatED	Ana Cristina Simões	01/01/2024	31/12/2024
PUE-FP	TTAccelerator	Vasco Bernardo Teles	01/01/2024	31/12/2025
SERV-NAC	MESPARTNERSHIP	Luís Guardão	25/11/2020	25/01/2026
SERV-NAC	APSPARTNERSHIP	Luís Guardão	15/11/2020	15/01/2026
SERV-NAC	ECOSSISTEMA	Rui Diogo Rebelo	28/02/2022	31/12/2024
SERV-NAC	Estaleiro40	Reinaldo Silva Gomes	01/05/2023	31/12/2024
SERV-NAC	DTNARR3AUTO	Filipe David Ferreira	25/09/2023	31/12/2024
SERV-NAC	OutsourcingIT_Fase1	Hugo Miguel Ferreira	16/09/2024	15/01/2025
SERV-NAC	PFAI4_5eD	Américo Azevedo	01/04/2024	30/06/2024
SERV-NAC	PFA_DIG_SHOPFLOOR_1a	Américo Azevedo	10/10/2024	09/11/2024
SERV-INT	BeamAutoLogSim	Romão Filipe Santos	01/11/2023	31/12/2024
OP	IAMOT 2024	Ana Cristina Simões	15/05/2023	14/09/2024

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

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10.7 CRIIS – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CRIIS research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.37 – CRIIS – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	19	25	30	5
	Academic Staff	13	13	14	1
	Grant Holders and Trainees	33	41	55	14
	Total Core Researchers	65	79	99	20
	Total Core PhD	20	22	26	4
	Affiliated Researchers	3	1	1	
	Administrative and Technical Employees	2	3	3	
	Total Integrated HR	70	83	103	20
	Total Integrated PhD	22	23	27	4

Table 10.38 – CRIIS – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	5	19	26	7
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	510	1 416	2 114	698
PUE-FP	EU Framework Programmes	780	875	732	-143
PUE-DIV	EU Cooperation Programmes - Other	19	-1		1
SERV-NAC	R&D Services and Consulting - National	236	177	81	-96
SERV-INT	R&D Services and Consulting - International		9	16	7
OP	Other Funding Programmes	4	6	11	5
Total Funding		1 554	2 500	2 979	479

Table 10.39 – CRIIS – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	52	48	57
Indexed Conferences	63	70	70
Books	1		
Book Chapters	5	4	5
Concluded PhD Theses – Members		2	4
Concluded PhD Theses - Supervised	3	2	11

Table 10.40 – CRIIS – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	1	4	5
Technology Disclosures (TDF)		2	
First Priority Patent Applications (New Inventions)		1	
First Patents Internationalisation	1		1
First Patent Granted		1	
Commercial Contracts (Licences, Options, Assignments)			
Spin-offs established			
Spin-offs in development		1	3

Table 10.41 – CRIIS – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	7	2	7
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	4	3	4
International events in which INESC TEC members participate in the program committees	8	11	14
Participation in events such as fairs, exhibitions or similar	5	10	11
Conferences, workshops and scientific sessions organised by the Centre	7	2	4
Participants in the conferences, workshops and scientific sessions organised by the Centre	250	250	90
Advanced training courses organised by the Centre			

Table 10.42 – CRIIS – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	OmicBots	Mário Cunha	16/01/2022	15/01/2026
PN-COOP	Continental FoF-2	António Paulo Moreira	01/07/2020	30/06/2023
PN-COOP	InsectERA	Filipe Neves Santos	01/01/2023	31/12/2025
PN-COOP	GreenAuto	Manuel Santos Silva	03/10/2022	31/12/2025
PN-COOP	PhenoBot-LA8.1-1	Filipe Neves Santos	01/10/2022	30/09/2025
PN-COOP	Wine4Cast-LA8.1	Filipe Neves Santos	01/10/2022	30/09/2025
PN-COOP	SFT-EDIH	Filipe Neves Santos	01/09/2022	31/08/2025
PUE-FP	NOVATERRA	Filipe Neves Santos	01/10/2020	31/03/2025
PUE-FP	SCORPION	Filipe Neves Santos	01/01/2021	31/12/2023
PUE-FP	MARI4_YARD	Germano Veiga	01/12/2020	30/11/2024
PUE-FP	Waste2BioComp	Germano Veiga	01/06/2022	31/05/2025
PUE-FP	MomaFlex	Luís Freitas Rocha	01/01/2023	31/12/2024
PUE-FP	PEER-1	Luís Freitas Rocha	01/10/2023	30/09/2027
PUE-FP	AI4ENGINE	Rafael Lírio Arrais	01/01/2023	31/12/2023
SERV-NAC	ROBOCARE	Filipe Neves Santos	01/03/2020	30/09/2024
SERV-NAC	VINCI7D	Manuel Santos Silva	01/09/2020	31/03/2024
SERV-NAC	ARTURO	Marcelo Petry	01/09/2023	31/12/2024
SERV-NAC	RLSENSEDEMO	Filipe Neves Santos	01/06/2024	30/11/2024
OP	ModularE_Exp	Filipe Neves Santos	01/09/2024	31/08/2024

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

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10.8 CEGI – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CEGI research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.43 – CEGI – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	7	13	12	-1
	Academic Staff	19	18	20	2
	Grant Holders and Trainees	24	29	35	6
	Total Core Researchers	50	60	67	7
	Total Core PhD	26	29	29	
	Affiliated Researchers	5	5	4	-1
	Administrative and Technical Employees	1	1	1	
	Total Integrated HR	56	66	72	6
	Total Integrated PhD	31	34	33	-1

Table 10.44 – CEGI – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	107	165	207	42
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	98	239	434	195
PUE-FP	EU Framework Programmes	478	512	441	-71
PUE-DIV	EU Cooperation Programmes - Other	11		-4	-4
SERV-NAC	R&D Services and Consulting - National	137	35	10	-25
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes		-2		2
Total Funding		832	949	1 088	139

Table 10.45 – CEGI – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	63	62	52
Indexed Conferences	14	24	20
Books			1
Book Chapters	5	4	2
Concluded PhD Theses – Members	7	1	6
Concluded PhD Theses - Supervised	10	2	6

Table 10.46 – CEGI – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	2		1
Technology Disclosures (TDF)	1	1	1
First Priority Patent Applications (New Inventions)			1
First Patents Internationalisation			
First Patent Granted			
Commercial Contracts (Licences, Options, Assignments)			2
Spin-offs established			
Spin-offs in development		2	3

Table 10.47 – CEGI – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	27	27	18
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	1	5	1
International events in which INESC TEC members participate in the program committees	9	12	14
Participation in events such as fairs, exhibitions or similar	0	1	6
Conferences, workshops and scientific sessions organised by the Centre	2	0	3
Participants in the conferences, workshops and scientific sessions organised by the Centre	28	0	100
Advanced training courses organised by the Centre	3	0	1

Table 10.48 – CEGI – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	BeFresh	Pedro Amorim	01/01/2022	30/09/2025
PN-FCT	CIBELE	José Fernando Oliveira	01/03/2023	28/02/2025
PN-FCT	MOSH	Beatriz Brito Oliveira	01/01/2023	31/12/2024
PN-FCT	TacitRouting	António Galvão Ramos	01/03/2023	25/02/2025
PN-FCT	eduBEST	Ana Camanho	01/02/2023	31/01/2026
PN-COOP	SMARTgNOSTICS	Luís Guimarães	01/01/2023	31/12/2025
PUE-FP	TRUSTAI	Gonçalo Reis Figueira	01/10/2020	31/03/2025
PUE-FP	DECODIT	Lia Patrício	01/06/2024	30/11/2027
SERV-NAC	CAREVIEW	Mário Amorim Lopes	01/06/2023	31/12/2024

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

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1. Ali, S, Ramos, AG, Carravilla, MA, Oliveira, JF, "Heuristics for online three-dimensional packing problems and algorithm selection framework for semi-online with full look-ahead", *APPLIED SOFT COMPUTING*, vol.151, pp.111168, 2024
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3. Amorim, P, Dehoratius, N, Eng Larsson, F, Martins, S, "Customer Preferences for Delivery Service Attributes in Attended Home Delivery", *MANAGEMENT SCIENCE*, vol.70, no.11, pp.7559-7578, 2024
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5. Banica, B, Patrício, L, Miguéis, V, "Citizen engagement with sustainable energy solutions- understanding the influence of perceived value on engagement behaviors", *ENERGY POLICY*, vol.184, pp.113895, 2024
6. Barbosa, F, Casacio, L, Bacalhau, ET, Leitao, A, Guimaraes, L, "Performance evaluation and benchmarking to inform dispatching rules for hydropower plants", *UTILITIES POLICY*, vol.90, pp.101780, OCT, 2024
7. Bôto, JM, Neto, B, Miguéis, V, Rocha, A, "Development of the Dietary Pattern Sustainability Index (DIPASI): A novel multidimensional approach for assessing the sustainability of an individual's diet", *SUSTAINABLE PRODUCTION AND CONSUMPTION*, vol.50, pp.139-154, OCT, 2024

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9. Carvalho, F, Tavares, JMRS, Ferreira, MC, "A Machine Learning Approach for Predicting and Mitigating Pallet Collapse during Transport: The Case of the Glass Industry", APPLIED SCIENCES-BASEL, vol.14, no.18, pp.8256, SEP, 2024
10. Carvalho, T, Simoes, AC, Teles, V, Almeida, AH, "Empowering SMEs for the digital future: unveiling training needs and nurturing ecosystem support", EUROPEAN JOURNAL OF ENGINEERING EDUCATION, vol.49, no.6, pp.1158-1178, 2024
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12. César, I, Pereira, I, Rodrigues, F, Miguéis, VL, Nicola, S, Madureira, A, Reis, JL, Dos Santos, JPM, De Oliveira, DA, "A Systematic Review on Responsible Multimodal Sentiment Analysis in Marketing Applications", IEEE ACCESS, vol.12, pp.111943-111961, 2024
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15. D'Inverno, G, Santos, JV, Camanho, AS, "An innovative benefit-of-the-doubt approach for health system effectiveness: a global case study on amenable mortality", INTERNATIONAL TRANSACTIONS IN OPERATIONAL RESEARCH, 2024
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23. Gonçalves, T, Almada Lobo, B, "Enhancing robustness to forecast errors in availability control for airline revenue management", *Journal of Revenue and Pricing Management*, 2024
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30. Morim, A, Campuzano, G, Amorim, P, Mes, M, Lalla-Ruiz, E, "The drone-assisted vehicle routing problem with robot stations", *EXPERT SYSTEMS WITH APPLICATIONS*, vol.238, pp.121741, 2024
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47. Torres, G, Fontes, T, Rodrigues, AM, Rocha, P, Ribeiro, J, Ferreira, JS, "Many-objective sectorization for last-mile delivery optimization: A decision support system", EXPERT SYSTEMS WITH APPLICATIONS, vol.255, pp.124559, 2024
48. Vanhoucke, M, Coelho, J, "Reducing the feasible solution space of resource-constrained project instances", COMPUTERS & OPERATIONS RESEARCH, vol.165, pp.106567, 2024
49. Vaz T.G., Oliveira B.B., Brandão L., "Optimisation for operational decision-making in a watershed system with interconnected dams", Applied Energy, vol.367, pp.123385, 2024
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2. Azevedo, A, Almeida, AH, "Smart Factories - design and results of a new course in a MSc curriculum of engineering", 2024 IEEE GLOBAL ENGINEERING EDUCATION CONFERENCE, EDUCON 2024, 2024
3. Costa, L, Almeida, A, Reis, L, "Methodology for Implementing a Manufacturing Execution System in the Machinery and Equipment Industry", 5TH INTERNATIONAL CONFERENCE ON INDUSTRY 4.0 AND SMART MANUFACTURING, ISM 2023, vol.232, pp.2028-2037, 2024
4. Dauer A., Dias T.G., de Sousa J.P., de Athayde Prata B., "Configurations and features of demand responsive transports", Transportation Research Procedia, vol.78, pp.71-78, 2024

5. de Oliveira, JF, Campos, J, Martins, T, Fernandes, CS, Ferreira, MC, "Innovating in Nursing Education: A Game Prototype for Bridging the Gap in Family-Centered Care", Lecture Notes in Networks and Systems, vol.1212 LNNS, pp.183-193, 2024
6. Ferreira P., Pardal A., Martins S., "Allocation and Sequencing of Missions on Autonomous Vehicles", Communications in Computer and Information Science, vol.2281 CCIS, pp.184-197, 2024
7. Ferreira, MC, Gouveia, D, Dias, TG, "Gamification in Mobile Ticketing Systems: A Review", INFORMATION SYSTEMS AND TECHNOLOGIES, VOL 4, WORLDCIST 2023, vol.802, pp.143-152, 2024
8. Ferreira, MC, Peralo, G, Dias, TG, Tavares, JMRS, "Analyzing Quality of Service and Defining Marketing Strategies for Public Transport: The Case of Metropolitan Area of Porto", INFORMATION SYSTEMS AND TECHNOLOGIES, VOL 4, WORLDCIST 2023, vol.802, pp.153-161, 2024
9. Ferreira, MC, Veloso, M, Tavares, JMRS, "A Comprehensive Examination of User Experience in AI-Based Symptom Checker Chatbots", DECISION SUPPORT SYSTEMS XIV: HUMAN-CENTRIC GROUP DECISION, NEGOTIATION AND DECISION SUPPORT SYSTEMS FOR SOCIETAL TRANSITIONS, ICDSST 2024, vol.506, pp.98-108, 2024
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11. Gharahbagh, AA, Hajhashemi, V, Ferreira, MC, Machado, JJM, Tavares, JMRS, "Abnormal Action Recognition in Social Media Clips Using Deep Learning to Analyze Behavioral Change", GOOD PRACTICES AND NEW PERSPECTIVES IN INFORMATION SYSTEMS AND TECHNOLOGIES, VOL 6, WORLDCIST 2024, vol.990, pp.359-370, 2024
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15. Oliveira, MA, Guimaraes, L, Borges, JL, Almada-Lobo, B, "A Data-Driven Monitoring Approach for Diagnosing Quality Degradation in a Glass Container Process", MACHINE LEARNING, OPTIMIZATION, AND DATA SCIENCE, LOD 2023, PT I, vol.14505, pp.288-302, 2024
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17. Ramalho F.R., Moreno T., Soares A.L., Almeida A.H., Oliveira M., "Application of Augmented Reality to Support Manufacturing Resilience", Lecture Notes in Mechanical Engineering, pp.654-662, 2024
18. Silva, DM, Ferreira, MC, Tavares, JMRS, "Understanding Customer Experience with Healthcare Mobile Applications", Proceedings of the International Conference on Ubiquitous Computing and Ambient Intelligence (UCAI 2024), Belfast, UK, 27-29 November 2024., vol.1212, pp.217-226, 2024
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Books

1. Zimmermann, R, Rodrigues, JC, Simoes, A, Dalmarco, G, "Human-Centred Technology Management for a Sustainable Future", Springer Proceedings in Business and Economics, 2024

Chapter/Paper in Books

1. Torres, AI, Beirão, G, "Artificial intelligence technologies: Benefits, risks, and challenges for sustainable business models", Artificial Intelligence Approaches to Sustainable Accounting, pp.229-248, 2024
2. Silva, JR, Ramos, AG, Salimi, F. "Districting in Last Mile Delivery: Route Creation Using SHPP-Based Algorithms", Communications in Computer and Information Science - Optimization, Learning Algorithms and Applications, 2024

Publications (Editor)

Blank

Concluded Theses (PhD)

1. Ali, S., "Practical approaches for online and semi-online 3D packing problems"
2. Golalikhani, M., "An integrated decision-support framework towards incorporating practical pricing decisions into carsharing systems"
3. Gomes, R., "The role of flexibility in forest-to-bioenergy supply chain risk management"
4. Loureiro, AL., "A multi-disciplinary approach to leverage the sustainability of the taxi industry"
5. Rodrigues, M., "Minimizing Municipal Solid Waste through Food Waste Prevention: Comprehensive Analysis and Practical Tool"
6. Silva, C., "Retail and Humanitarian Operations in Urban Slums: Driving Social Impact at the Base-of-the-Pyramid"

10.9 CITE – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CITE research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.49 – CITE – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	5	7	6	-1
	Academic Staff	2	2	2	
	Grant Holders and Trainees	1	3	3	
	Total Core Researchers	8	12	11	-1
	Total Core PhD	5	6	5	-1
	Affiliated Researchers	2	2	3	1
	Administrative and Technical Employees				
	Total Integrated HR	10	14	14	
Total Integrated PhD	7	8	8		

Table 10.50 – CITE – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT				
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	7	126	217	91
PUE-FP	EU Framework Programmes	331	212	192	-21
PUE-DIV	EU Cooperation Programmes - Other	45	54	19	-35
SERV-NAC	R&D Services and Consulting - National	23	2	1	
SERV-INT	R&D Services and Consulting - International		28		-28
OP	Other Funding Programmes			-4	-4
Total Funding		406	422	425	3

Table 10.51 – CITE – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	21	23	21
Indexed Conferences	6	2	2
Books			
Book Chapters	8	4	4
Concluded PhD Theses – Members			
Concluded PhD Theses - Supervised			

Table 10.52 – CITE – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)			
Technology Disclosures (TDF)			
First Priority Patent Applications (New Inventions)			
First Patents Internationalisation			
First Patent Granted			
Commercial Contracts (Licences, Options, Assignments)			
Spin-offs established			
Spin-offs in development			

Table 10.53 – CITE – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	3	1	1
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	1	2	3
International events in which INESC TEC members participate in the program committees	2	2	4
Participation in events such as fairs, exhibitions or similar	2	4	3
Conferences, workshops and scientific sessions organised by the Centre	3	12	7
Participants in the conferences, workshops and scientific sessions organised by the Centre	70	120	80
Advanced training courses organised by the Centre	2		

Table 10.54 – CITE – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PUE-DIV	EEN2022	Alexandra Xavier	15/01/2022	15/07/2025
PUE-FP	VR2Care-1	Cristina Machado Guimarães	01/01/2022	30/09/2024
PUE-FP	EITJumpstarter23	Alexandra Xavier	01/01/2023	31/12/2025
PUE-FP	MANTRA	Alexandra Xavier	01/11/2024	30/04/2028
SERV-NAC	SGIDI_AUDIT_NELO	Alexandra Xavier	15/01/2024	31/03/2024

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

List of publications

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- Almeida, F, "Causes of Failure of Open Innovation Practices in Small- and Medium-Sized Enterprises", ADMINISTRATIVE SCIENCES, vol.14, no.3, pp.50, MAR, 2024
- Almeida, F, "Contributions of Municipal Initiatives to Digital Health Equity", WORLD, vol.5, no.4, pp.1165-1180, DEC, 2024
- Almeida, F, "Entrepreneurs' decision-making in sustainable open innovation practices", The International Journal of Entrepreneurship and Innovation, 2024
- Almeida, F, "Implementation of a chatbot in a unified communication channel", Journal of Systems and Information Technology, 2024
- Almeida, F, "The role of partnerships in municipal sustainable development in Portugal", International Journal of Urban Sustainable Development, 2024
- Almeida, F, Bálint, B, "Approaches for Hybrid Scaling of Agile in the IT Industry: A Systematic Literature Review and Research Agenda", Information, 2024
- Almeida, F, Buzady, Z, "FLIGBY for graduates' employability enhancement in Computer Engineering", COMPUTER APPLICATIONS IN ENGINEERING EDUCATION, vol.32, no.6, 2024
- Almeida, F, Buzady, Z, "The Contribution of FLIGBY to the Entrepreneurial Learning Outcomes", TECHNOLOGY KNOWLEDGE AND LEARNING, vol.29, no.3, pp.1663-1683, 2024
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- Almeida, F, Morais, J, "Non-formal education as a response to social problems in developing countries", E-Learning and Digital Media, 2024
- Almeida, F, Ocon, E, "Achieving sustainable development goals through digitalization in ports", BUSINESS STRATEGY AND THE ENVIRONMENT, vol.33, no.7, pp.6737-6747, 2024

12. Almeida, F, Simões, J, "Practical approaches for the implementation of distributed scrum teams", International Journal of Applied Systemic Studies, vol.11, no.1, pp.52-67, 2024
13. Alvarelha, A, Resende, J, Carneiro, A, "EMPLOYMENT AND WAGE DYNAMICS IN THE ELECTRICITY SECTOR: EVIDENCE FROM PORTUGAL 2002–2020", Energy Economics, 2024
14. Ascençao, C, Teixeira, H, Gonçalves, J, Almeida, F, "Large-scale agile security practices in software engineering", INFORMATION AND COMPUTER SECURITY, 2024
15. Ferreira, J, Franca, M, Rei, M, Peixoto, R, Larsen, SA, Bernini, A, Lopes, L, Conde, C, Claro, J, "Towards user-centered design of medical devices for SUDEP prediction and prevention: Insights from persons with epilepsy and caregivers", EPILEPSY & BEHAVIOR, vol.161, pp.110034, DEC, 2024
16. Ferro, A, Buzady, Z, Almeida, F, "Developing Entrepreneurial Competencies among Tourism Students using FLIGBY", JOURNAL OF HOSPITALITY & TOURISM EDUCATION, vol.36, no.1, pp.36-50, 2024
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18. Moura, B, Santos, I, Barros, N, Almeida, FL, "D4SP – decision support system based on the use of the AHP method for science park selection", International Journal of Information and Decision Sciences, vol.16, no.1, pp.1-18, 2024
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10.10 HUMANISE – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present HumanISE research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.55 – HumanISE – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	14	19	22	3
	Academic Staff	33	36	32	-4
	Grant Holders and Trainees	45	35	39	4
	Total Core Researchers	92	90	93	3
	Total Core PhD	38	41	40	-1
	Affiliated Researchers	18	21	29	8
	Administrative and Technical Employees	1	1	1	
	Total Integrated HR	111	112	123	11
Total Integrated PhD	56	62	69	7	

Table 10.56 – HumanISE – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	109	59	51	-8
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	226	701	810	109
PUE-FP	EU Framework Programmes	943	623	716	93
PUE-DIV	EU Cooperation Programmes - Other	76	147	89	-59
SERV-NAC	R&D Services and Consulting - National	450	470	545	75
SERV-INT	R&D Services and Consulting - International	12			
OP	Other Funding Programmes	1			
Total Funding		1 816	2 001	2 211	210

Table 10.57 – HumanISE – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	71	97	72
Indexed Conferences	108	115	109
Books		2	2
Book Chapters	4	1	
Concluded PhD Theses – Members	7	4	10
Concluded PhD Theses - Supervised	11	8	26

Table 10.58 – HumanISE – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	5	4	
Technology Disclosures (TDF)	1		
First Priority Patent Applications (New Inventions)			
First Patents Internationalisation			
First Patent Granted		1	
Commercial Contracts (Licences, Options, Assignments)		1	
Spin-offs established			
Spin-offs in development			

Table 10.59 – HumanISE – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	1	3	1
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	12	12	6
International events in which INESC TEC members participate in the program committees	32	37	29
Participation in events such as fairs, exhibitions or similar	3	7	
Conferences, workshops and scientific sessions organised by the Centre	4		
Participants in the conferences, workshops and scientific sessions organised by the Centre	140		
Advanced training courses organised by the Centre			

Table 10.60 – HumanISE - List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	FronTowns	Leonel Morgado	20/03/2021	19/03/2025
PN-FCT	DBoidS	João Barroso	01/01/2022	30/06/2025
PN-FCT	Osler	Nuno Feixa Rodrigues	01/03/2023	30/11/2024
PN-COOP	FAIST-1	Lino Oliveira	01/06/2022	31/12/2025
PUE-DIV	TRIO	Maria van Zeller	28/02/2022	27/07/2024
PUE-DIV	WavyNOS	Artur Rocha	06/06/2022	30/04/2024
PUE-DIV	CAPTA	Lino Oliveira	01/07/2023	31/12/2026
PUE-FP	TIPES	Susana Alexandra Barbosa	01/09/2019	29/02/2024
PUE-FP	INCLUDING	Miguel Correia Melo	01/08/2019	30/09/2024
PUE-FP	Inno4Vac	Artur Rocha	01/09/2021	28/02/2027
PUE-FP	PAFSE	Paulo Martins	01/09/2021	31/08/2024
PUE-FP	ILIAD	Artur Rocha	01/02/2022	31/07/2025
PUE-FP	RECONNECTED	Gonçalo Campos Gonçalves	01/06/2023	30/11/2027
PUE-FP	BLUE-X	Marco Amaro Oliveira	01/12/2023	31/05/2026
PUE-FP	NOUS	Hugo Paredes	01/01/2024	31/12/2026
PUE-FP	FRODDO	Hugo Paredes	01/06/2024	31/05/2027
SERV-NAC	SEPIA	Gonçalo Campos Gonçalves	01/02/2021	31/12/2024
SERV-NAC	Data4Bus	José Correia	17/12/2021	31/12/2024
SERV-NAC	MAP3	José Correia	15/09/2022	31/12/2024
SERV-NAC	SIGMAIA3	Ricardo Henriques	01/09/2022	30/11/2024
SERV-NAC	BankRoad2DataCtlg	José Correia	02/01/2023	30/04/2024
SERV-NAC	BankDigitalTransf	José Correia	01/09/2023	31/12/2024
SERV-NAC	TutorIA	João Barroso	28/11/2023	27/11/2024
SERV-NAC	EYEFRYBluetooth	José Correia	02/09/2024	01/01/2025
SERV-NAC	FJB	Sérgio Nunes	19/03/2024	31/12/2024
SERV-NAC	BankTransf24	José Correia	21/06/2024	20/02/2025
SERV-NAC	BankRoad2DataMgm	José Correia	29/07/2024	28/01/2026
SERV-NAC	AMIDA	Ângelo Martins	25/07/2024	24/11/2024

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

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10.11 LIAAD – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present LIAAD research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.61 – LIAAD – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	7	11	11	
	Academic Staff	23	23	24	1
	Grant Holders and Trainees	27	23	20	-3
	Total Core Researchers	57	57	55	-2
	Total Core PhD	28	31	31	0
	Affiliated Researchers	7	7	8	1
	Administrative and Technical Employees	1	1	1	
	Total Integrated HR	65	65	64	-1
Total Integrated PhD	35	38	39	1	

Table 10.62 – LIAAD – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	122	96	95	-1
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	173	314	392	78
PUE-FP	EU Framework Programmes	69	106	257	152
PUE-DIV	EU Cooperation Programmes - Other	61	16	-61	-77
SERV-NAC	R&D Services and Consulting - National	73	63	54	-9
SERV-INT	R&D Services and Consulting - International			65	65
OP	Other Funding Programmes		14		-14
Total Funding		498	608	802	194

Table 10.63 – LIAAD – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	60	61	54
Indexed Conferences	47	66	36
Books	2	4	
Book Chapters	8	9	2
Concluded PhD Theses – Members	2	2	4
Concluded PhD Theses - Supervised	2	7	6

Table 10.64 – LIAAD – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	1	1	
Technology Disclosures (TDF)	1	1	2
First Priority Patent Applications (New Inventions)		1	1
First Patents Internationalisation			1
First Patent Granted			
Commercial Contracts (Licences, Options, Assignments)		1	
Spin-offs established			
Spin-offs in development			1

Table 10.65 – LIAAD – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	48	20	20
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	3	8	9
International events in which INESC TEC members participate in the program committees	34	45	36
Participation in events such as fairs, exhibitions or similar	3	4	10
Conferences, workshops and scientific sessions organised by the Centre	12	6	4
Participants in the conferences, workshops and scientific sessions organised by the Centre	300	300	100
Advanced training courses organised by the Centre			1

Table 10.66 – LIAAD – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	ADANET	Alípio Jorge	17/05/2022	16/05/2025
PN-FCT	StorySense	Alípio Jorge	01/03/2023	28/02/2026
PN-COOP	AgWearCare-1	João Vinagre	01/08/2021	30/06/2023
PN-COOP	OnlineAIOps-1	João Mendes Moreira	18/01/2021	30/06/2023
PUE-DIV	ATTRACT_DIH	Ricardo Teixeira Sousa	01/10/2022	30/09/2025
PUE-FP	HumanE-AI-Net	João Gama	01/09/2020	31/08/2024
PUE-FP	EMERITUS	João Gama	01/09/2022	31/08/2025
PUE-FP	AIBOOST	João Gama	01/09/2023	28/02/2027
SERV-NAC	PAPVI2	Ricardo Teixeira Sousa	01/06/2023	31/12/2024
SERV-NAC	Easy4ALL	Evelin Freire Amorim	01/09/2024	31/08/2026
SERV-INT	HALM	Ricardo Teixeira Sousa	31/01/2024	30/07/2024
OP	ECML_PKDD2025	João Gama	01/10/2023	30/09/2026

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

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1. Campos, R, Jorge, AM, Jatowt, A, Bhatia, S, Litvak, M, "Proceedings of Text2Story - Seventh Workshop on Narrative Extraction From Texts held in conjunction with the 46th European Conference on Information Retrieval (ECIR 2024), Glasgow, Scotland, UK, March 24, 2024", Text2Story@ECIR, vol.3671, 2024

Concluded Theses (PhD)

1. Baghoussi, Y., "Enhancing Forecasting using Read & Write Recurrent Neural Networks"
2. Moreno, M., "Omics-based prediction of human phenotypes using scalable machine learning approaches"
3. Pedroto, M., "Time-To-Event Prediction"
4. Silva, T., "Mobility Patterns From Data"

10.12 CRACS – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present CRACS research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.67 – CRACS – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	1	2	2	
	Academic Staff	16	16	16	
	Grant Holders and Trainees	14	14	11	-3
	Total Core Researchers	31	32	29	-3
	Total Core PhD	16	17	17	
	Affiliated Researchers	2			
	Administrative and Technical Employees				
	Total Integrated HR	33	32	29	-3
Total Integrated PhD	18	17	17		

Table 10.68 – CRACS – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT			-3	-3
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry		19	94	75
PUE-FP	EU Framework Programmes		84	79	-5
PUE-DIV	EU Cooperation Programmes - Other	96	34	20	-15
SERV-NAC	R&D Services and Consulting - National	85	93		-93
SERV-INT	R&D Services and Consulting - International				
OP	Other Funding Programmes	5		20	20
Total Funding		186	230	210	-20

Table 10.69 – CRACS – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	20	15	13
Indexed Conferences	34	28	21
Books		3	
Book Chapters	4	1	3
Concluded PhD Theses – Members	2	3	1
Concluded PhD Theses - Supervised	2	4	2

Table 10.70 – CRACS – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)			
Technology Disclosures (TDF)			
First Priority Patent Applications (New Inventions)			
First Patents Internationalisation			
First Patent Granted		1	
Commercial Contracts (Licences, Options, Assignments)			
Spin-offs established			
Spin-offs in development			

Table 10.71 – CRACS – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	11	10	7
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	11	15	5
International events in which INESC TEC members participate in the program committees	42	34	31
Participation in events such as fairs, exhibitions or similar		2	2
Conferences, workshops and scientific sessions organised by the Centre	1		1
Participants in the conferences, workshops and scientific sessions organised by the Centre	25		80
Advanced training courses organised by the Centre			4

Table 10.72 – CRACS – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PUE-DIV	PANDORA	António Pinto	01/12/2020	30/11/2022
PUE-DIV	FGPEPlusPlus	Ricardo Queirós	01/10/2023	30/09/2025
PUE-FP	PRIVATEER	António Pinto	01/01/2023	31/12/2025
OP	ACM_CODASPY	João Paulo Vilela	01/04/2024	15/07/2024

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

List of publications

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11. Lopes, J, Pinto, P, Partida, A, Pinto, A, "Use of Visibility Graphs for the Early Detection of DoS Attacks", 2024 IEEE INTERNATIONAL CONFERENCE ON CYBER SECURITY AND RESILIENCE, CSR, pp.101-106, 2024

12. Martins, O, Vilela, JP, Gomes, M, "WiFi-based Person Identification Through Motion Analysis", 2024 IEEE INTERNATIONAL MEDITERRANEAN CONFERENCE ON COMMUNICATIONS AND NETWORKING, MEDITCOM 2024, pp.209-214, 2024
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18. Queirós, R, "GERF - Gamified Educational Virtual Escape Room Framework for Innovative Micro-Learning and Adaptive Learning Experiences", Communications in Computer and Information Science, vol.1937 CCIS, pp.140-148, 2024
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20. Queirós, R, Pinto, CMA, Cruz, M, "Work in progress: Leveraging Virtual Escape Rooms for Innovative Computer Programming Learning Environments", VIII IEEE WORLD ENGINEERING EDUCATION CONFERENCE, EDUNINE 2024, 2024
21. Resende, JS, "TORKAMELEON: Improving Tor's Censorship Resistance with K-Anonymization and Media-Based Covert Channels", INTERNATIONAL CONFERENCE ON TRUST, SECURITY AND PRIVACY IN COMPUTING AND COMMUNICATIONS, 2024

Books

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Chapter/Paper in Books

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3. Alves, S, Cockx, J, "Proceedings of the 9th ACM SIGPLAN International Workshop on Type-Driven Development, TyDe 2024, Milan, Italy, 6 September 2024", TyDe@ICFP, 2024

Concluded Theses (PhD)

1. Moreno, P., “Generic Lock-Free Memory Reclamation”

10.13 HASLAB – ACTIVITY RESULTS IN 2024

Activity indicators

The following tables present HASLab research team composition and evolution and the main indicators of its activity carried out in 2024 - participation in projects under contract, scientific production, IP valorisation and knowledge dissemination. The information on publications for 2024 has been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform and from CORE (Computing Research and Education Association of Australasia).

Table 10.73 – HASLab – Research team composition

Type of Human Resources		2022	2023	2024	Δ 2023-24
Integrated HR	Employees	7	8	12	4
	Academic Staff	23	25	25	
	Grant Holders and Trainees	42	46	52	6
	Total Core Researchers	72	79	89	10
	Total Core PhD	28	29	31	2
	Affiliated Researchers	7	6	5	-1
	Administrative and Technical Employees	3	5	4	-1
	Total Integrated HR	82	90	98	8
	Total Integrated PhD	34	35	35	

Table 10.74 – HASLab – Project funding

Funding Source		Total Income (k€)			Δ (k€)
		2022	2023	2024	2023-24
PN-FCT	National R&D Programmes - FCT	84	106	78	-27
PN-PICT	National R&D Programmes - S&T Integrated Projects				
PN-COOP	National Cooperation Programmes with Industry	234	357	459	103
PUE-FP	EU Framework Programmes	195	370	367	-3
PUE-DIV	EU Cooperation Programmes - Other		27	119	91
SERV-NAC	R&D Services and Consulting - National	431	269	256	-13
SERV-INT	R&D Services and Consulting - International	15	5		-5
OP	Other Funding Programmes	25	193	257	64
Total Funding		984	1 326	1 537	210

Table 10.75 – HASLab – Summary of publications by members of the Centre

Publication Type	2022	2023	2024
Indexed Journals	15	24	21
Indexed Conferences	38	48	31
Books			
Book Chapters		2	2
Concluded PhD Theses – Members	3	2	6
Concluded PhD Theses - Supervised	3	2	6

Table 10.76 – HASLab – Summary of IP protection, exploitation and technology transfer

Type of Result	2022	2023	2024
Pre-Disclosures (PDF)	3		2
Technology Disclosures (TDF)	2	2	
First Priority Patent Applications (New Inventions)			
First Patents Internationalisation			
First Patent Granted			
Commercial Contracts (Licences, Options, Assignments)			
Spin-offs established			
Spin-offs in development			

Table 10.77 – HASLab – Summary of dissemination activities

Type of Result	2022	2023	2024
Participation as principal editor, editor or associated editor in journals	5	3	5
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	12	8	8
International events in which INESC TEC members participate in the program committees	19	34	26
Participation in events such as fairs, exhibitions or similar	4	4	3
Conferences, workshops and scientific sessions organised by the Centre	6	1	1
Participants in the conferences, workshops and scientific sessions organised by the Centre	140	82	30
Advanced training courses organised by the Centre		1	1

Table 10.78 – HASLab – List of projects

Type of Project	Short Name	Leader	Starting date	Ending date (planned)
PN-FCT	IBEX	Renato Jorge Neves	01/01/2022	31/08/2025
PN-FCT	SpecRep	Nuno Moreira Macedo	01/01/2022	31/12/2023
PN-FCT	FLEXCOMM	João Marco	01/01/2022	30/12/2023
PN-COOP	BCDSM	João Tiago Paulo	01/02/2024	30/01/2027
PUE-DIV	EuroCC2	Rui Carlos Oliveira	01/01/2023	31/12/2025
PUE-DIV	EPICURE	António Luís Sousa	01/02/2024	31/01/2028
PUE-FP	HANAMI	Paula Cristina Rodrigues	01/01/2024	31/12/2026
PUE-FP	exaSIMPLE	André Martins Pereira	01/03/2024	31/01/2025
SERV-NAC	IDINA	João Marco	20/10/2021	31/01/2025
SERV-NAC	ENSCOMP3	José Nuno Oliveira	15/11/2023	31/03/2024
SERV-NAC	Saude24GB	João Marco	01/02/2024	31/10/2024
SERV-NAC	PeT	José Orlando Pereira	01/06/2024	31/05/2028
OP	Sustainable HPC-1	António Luís Sousa	01/07/2021	31/12/2025
OP	Deucalion	António Luís Sousa	01/01/2023	31/12/2025

Type of Project:

PN-FCT	National R&D Programmes - FCT
PN-PICT	National R&D Programmes - S&T Integrated Projects
PN-COOP	National Cooperation Programmes with Industry
PUE-FP	EU Framework Programme
PUE-DIV	EU Cooperation Programmes - Other
SERV-NAC	National R&D Services and Consulting
SERV-INT	International R&D Services and Consulting
OP	Other Funding Programmes

List of publications

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2. Broy, M, Brucker, AD, Fantechi, A, Gleirscher, M, Havelund, K, Kuppe, MA, Mendes, A, Platzer, A, Ringert, JO, Sullivan, A, " Does Every Computer Scientist Need to Know Formal Methods?", FORMAL ASPECTS OF COMPUTING, vol.37, no.1, pp.1-6, 2024
3. Coelho, R, Sequeira, A, Santos, LP, "VQC-based reinforcement learning with data re-uploading: performance and trainability", QUANTUM MACHINE INTELLIGENCE, vol.6, no.2, DEC, 2024
4. Cunha, A, Macedo, N, Liu, C, "Validating multiple variants of an automotive light system with Alloy 6", INTERNATIONAL JOURNAL ON SOFTWARE TOOLS FOR TECHNOLOGY TRANSFER, vol.26, no.3, pp.365-377, 2024
5. de Oliveira, M, Barbosa, LS, Galvao, EF, "Quantum advantage in temporally flat measurement-based quantum computation", QUANTUM, vol.8, pp.1-62, 2024
6. Ferreira, LMM, Coelho, F, Pereira, J, "Databases in Edge and Fog Environments: A Survey", ACM COMPUTING SURVEYS, vol.56, no.11, pp.285:1-285:40, 2024

7. Gordillo, A, Calero, C, Moraga, MA, García, F, Fernandes, JP, Abreu, R, Saraiva, J, "Programming languages ranking based on energy measurements", SOFTWARE QUALITY JOURNAL, vol.32, no.4, pp.1539-1580, 2024
8. Guimaraes, JD, Vasilevskiy, MI, Barbosa, LS, "Digital quantum simulation of non-perturbative dynamics of open systems with orthogonal polynomials", QUANTUM, vol.8, pp.1242, 2024
9. Hill, RK, Baquero, C, "Pondering the Ugly Underbelly, and Whether Images Are Real", Commun. ACM, vol.67, no.3, pp.8-10, 2024
10. Lima, R, Ferreira, JF, Mendes, A, Carreira, C, "DiffuzzAR: automatic repair of timing side-channel vulnerabilities via refactoring", AUTOMATED SOFTWARE ENGINEERING, vol.31, no.1, pp.1, JUN, 2024
11. Lucas, W, Carvalho, F, Nunes, RC, Bonifácio, R, Saraiva, J, Accioly, P, "Embracing modern C plus plus features: An empirical assessment on the KDE community", JOURNAL OF SOFTWARE-EVOLUTION AND PROCESS, vol.36, no.5, 2024
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15. Rua, R, Saraiva, J, "A large-scale empirical study on mobile performance: energy, run-time and memory", EMPIRICAL SOFTWARE ENGINEERING, vol.29, no.1, pp.31, 2024
16. Rufino, J, Ramírez, JM, Aguilar, J, Baquero, C, Champati, J, Frey, D, Lillo, RE, Fernández Anta, A, "Performance and explainability of feature selection-boosted tree-based classifiers for COVID-19 detection", HELIYON, vol.10, no.1, pp.e23219, 2024
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21. Silva, CAM, Bessa, RJ, Andrade, JR, Coelho, FA, Costa, RB, Silva, CD, Vlachodimitropoulos, G, Stavropoulos, D, Chadoulos, S, Rua, DE, "Enhancing the European power system resilience with a recommendation system for voluntary demand response", ISCIENCE, vol.27, no.12, pp.111430, 2024

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2. Arriaga, A, Barbosa, M, Jarecki, S, Skrobot, M, "C'est Très CHIC: A Compact Password-Authenticated Key Exchange from Lattice-Based KEM", Advances in Cryptology - ASIACRYPT 2024 - 30th International Conference on the Theory and Application of Cryptology and Information Security, Kolkata, India, December 9-13, 2024, Proceedings, Part V, vol.15488, pp.3-33, 2024

3. Barbosa, LS, "Paraconsistency for the Working Software Engineer (Extended Abstract)", Software Engineering and Formal Methods - 22nd International Conference, SEFM 2024, Aveiro, Portugal, November 6-8, 2024, Proceedings, vol.15280, pp.22-30, 2024
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5. Barbosa, M, Gellert, K, Hesse, J, Jarecki, S, "Bare PAKE: Universally Composable Key Exchange from Just Passwords", ADVANCES IN CRYPTOLOGY - CRYPTO 2024, PT II, vol.14921, pp.183-217, 2024
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8. Cardoso, WR, Ribeiro, ADL, da Silva, JMC, "Expert Systems in Information Security: A Comprehensive Exploration of Awareness Strategies Against Social Engineering Attacks", GOOD PRACTICES AND NEW PERSPECTIVES IN INFORMATION SYSTEMS AND TECHNOLOGIES, VOL 2, WORLDCIST 2024, vol.986, pp.34-43, 2024
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17. Maia, L, Sá, M, Ferreira, I, Cunha, S, Silva, L, Azevedo, P, Saraiva, J, "On the Impact of PowerCap in Haskell, Java, and Python", Proceedings of the 3rd International Workshop on Resource Awareness of Systems and Society, Maribor, Slovenia, July 2nd - 5th, 2024., vol.3867, pp.34-43, 2024
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31. Viera, M, Pardo, A, Saraiva, J, "Tabulation with Zippers", FUNCTIONAL AND LOGIC PROGRAMMING, FLOPS 2024, vol.14659, pp.83-98, 2024

Books

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1. Oliveira, N, "On the Relational Basis of Early R/G Work", Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), vol.LNCS 14781, pp.56-76, 2024
2. Busquim e Silva, RA, Arai, NN, Burgareli, LA, Parente de Oliveira, JM, Sousa Pinto, J, "Exploring Frama-C Resources by Verifying Space Software", Computer Science Foundations and Applied Logic, pp.583-615, 2024

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1. Nebeling, M, Spano, LD, Campos, JC, "Companion Proceedings of the 16th ACM SIGCHI Symposium on Engineering Interactive Computing Systems, EICS Companion 2024, Cagliari, Italy, June 24-28, 2024", EICS (Companion), 2024

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1. Brito, C., "Towards a Privacy-Preserving Distributed Machine Learning Framework"
2. Esteves, T., "End-to-End Software-Defined Security for Big Data Ecosystem"
3. Kassam, Z., "Beyond Distributed Transactions through Exactly-once Exchanges"
4. Moreno, M., "Omics-based prediction of human phenotypes using scalable machine learning approaches"
5. Ribeiro, F., "Explaining Software Faults in Source Code"
6. Rua, R., "Green Software in the Large: Energy-driven Techniques, Tools and Repositories"

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