INESC TEC

ACTIVITY PLAN 2025.

Editorial Notes

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

In 2025, INESC TEC will celebrate its 40th anniversary, commemorating the beginning of its operation in 1985. This celebration will be associated with the 40th anniversary of the signing of Portugal's Treaty of Accession to the former European Economic Community (now the European Union), reflecting a shared trajectory of growth and development.

In a year anticipated to be defined by the dynamic interplay of geopolitical shifts, climate urgency, technological innovation, and social transformation – driven by polarisation, populism, automation, and AI disruption – resilience and collaboration emerge as critical themes for addressing the complexities of a rapidly evolving world.

INESC TEC will implement a series of strategic initiatives to enhance its impact at both national and international levels, reinforcing its mission to benefit society. These initiatives are designed to strengthen the institution's academic excellence, innovation capabilities, operational sustainability, and its role in addressing societal challenges, shaped by the context described above.

In 2025, INESC TEC will strive to successfully execute its key initiatives while achieving significant growth, with total revenue projected to reach 44.5 M€, resulting in a substantial 18% increase in activity when compared to 2024 Activity Plan. The 14% increase in national programmes stands out and is mainly related to the large number of PRR (Portuguese Recovery and Resilience Plan) projects in which the institution is involved, namely 22 mobilising agendas, overall corresponding to a total funding of 18 M€. Also quite relevant is the 22% increase in EU Framework Programmes (Horizon Europe and H2020) with 80 active projects, 11 of which are coordinated by INESC TEC.

One major milestone in 2025 will be the launch of INESCTEC.OCEAN, a Centre of Excellence in Ocean Research and Engineering designed to address key areas such as marine structures, marine robotics, ocean energy, and ocean data. Funded by the Teaming for Excellence programme under Horizon Europe's Widening initiative, the project will be implemented from 2025 to 2031 and its key partners include Fórum Oceano, Cluster do Mar Português, APDL (Administração dos Portos do Douro, Leixões, and Viana do Castelo, Portugal), and the Norwegian R&D Centre SINTEF.OCEAN.

The institution will enhance its research team by recruiting researchers in key strategic areas aligned with its scientific strategy, supported by the implementation of the FCT Tenure programme for promising talent, encompassing roles both in higher education institutions and within INESC TEC itself. A substantial 17% growth in the number of R&D employees is projected, driven primarily by increased activity levels related to the execution of projects approved under the Portuguese Recovery and Resilience Plan (PRR) and EU programmes.

The institution will also aim to enhance its research impact by increasing high-quality publications, fostering active participation in prestigious academic roles and events, and supporting exploratory R&D through internal seed projects. In 2025, scientific production in terms of articles in indexed journals and conferences will grow slightly while INESC TEC's R&D Centres also increasingly emphasise outlet quality, focusing on high-impact journals in line with the significance and influence ambitioned for their work.

Additionally, the institute will adopt innovative research assessment practices, strengthen international recognition of its researchers, expand support for European Research Council grants, and advance Open Science initiatives, namely contributing to a national network that supports research data management and sharing, while promoting FAIR Data principles.

Efforts to boost technology commercialisation include establishing an Entrepreneurship and Spin-offs Office and maintaining a strong focus on patent filings. In 2025, the number of new patented inventions is expected to remain consistent, reinforcing INESC TEC's status as a leading patent applicant both nationally and across Europe. Additionally, three spin-offs are set to be established, while some others are advancing into their development phases. These initiatives include ventures in bioengineering and robotics applications, underscoring a steadfast commitment to translating research into impactful market solutions.

To provide innovative learning experiences, INESC TEC will continue its involvement in postgraduate programmes, establish a dedicated Research Student Office, and offer advanced training initiatives. Internationalisation will be supported through expanded mobility programmes, cultural training, and the International Visiting Researcher Programme. Aligned with industry needs, INESC TEC will launch the TEC4COMMUNICATIONS initiative to develop advanced communication systems and support industry-led roadmaps for technology and innovation.

Complementing the intensity of its research and innovation endeavours, INESC TEC's efforts to engage with society and promote science will remain unwavering. To enhance societal engagement, INESC TEC will restructure its Foresight and Public Policy Office, host the 10th edition of the Autumn Forum for public policy debates, and publish multimedia content to highlight research impact. The 40th anniversary will be a centrepiece of the year's activities, commemorating four decades of contributions to research and innovation. The celebration will feature technological demonstrations, academic debates, the publication of a commemorative book, and mini-documentaries broadcast on national television. Furthermore, INESC TEC will host prominent international conferences like ECML-PKDD 2025 and OFS 29 while organising or co-organising more than 50 Conferences, workshops and scientific sessions and participate in more than 80 fairs to showcase its achievements.

Amidst the challenges and uncertainties that lie ahead, INESC TEC approaches the future with confidence, guided by its steadfast commitment to knowledge production and science-based innovation. By embracing change, acting collaboratively, and fostering resilience, we aim to create meaningful impact and shape a fulfilling and sustainable future.

1 STRATEGIC PRIORITIES FOR 2025

1.1 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 the third quarter of 2024, INESC TEC's 13 R&D Centres hosted 956 integrated researchers (405 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.

1.2 High-level view of science and innovation

INESC TEC's operational and management model implements the concept of an end-to-end knowledge value chain, driving knowledge from its generation in research activities to its valorisation through different technology transfer instruments (Figure 1.1).

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, and innovation focused on main technology market drivers expressed internally through the TEC4 initiatives, currently TEC4AGRO-FOOD, TEC4COMMUNICATIONS, TEC4ENERGY, TEC4HEALTH, TEC4INDUSTRY and TEC4SEA.

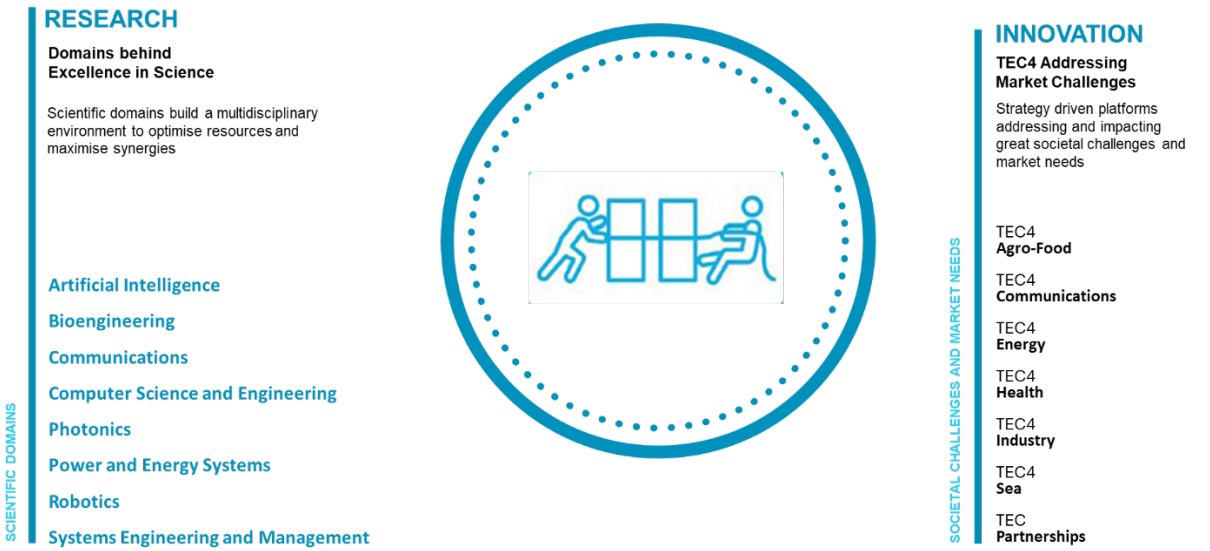


Figure 1.1 - High-level view of science and innovation at INESC TEC

1.3 Organisational structure

The institution's organisational structure (Figure 1.2) 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.

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

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

The TEC4 initiatives articulate INESC TEC's activity towards major economic sectors while also addressing 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, disseminating the research results and bringing major challenges and opportunities back to multiple Centres.

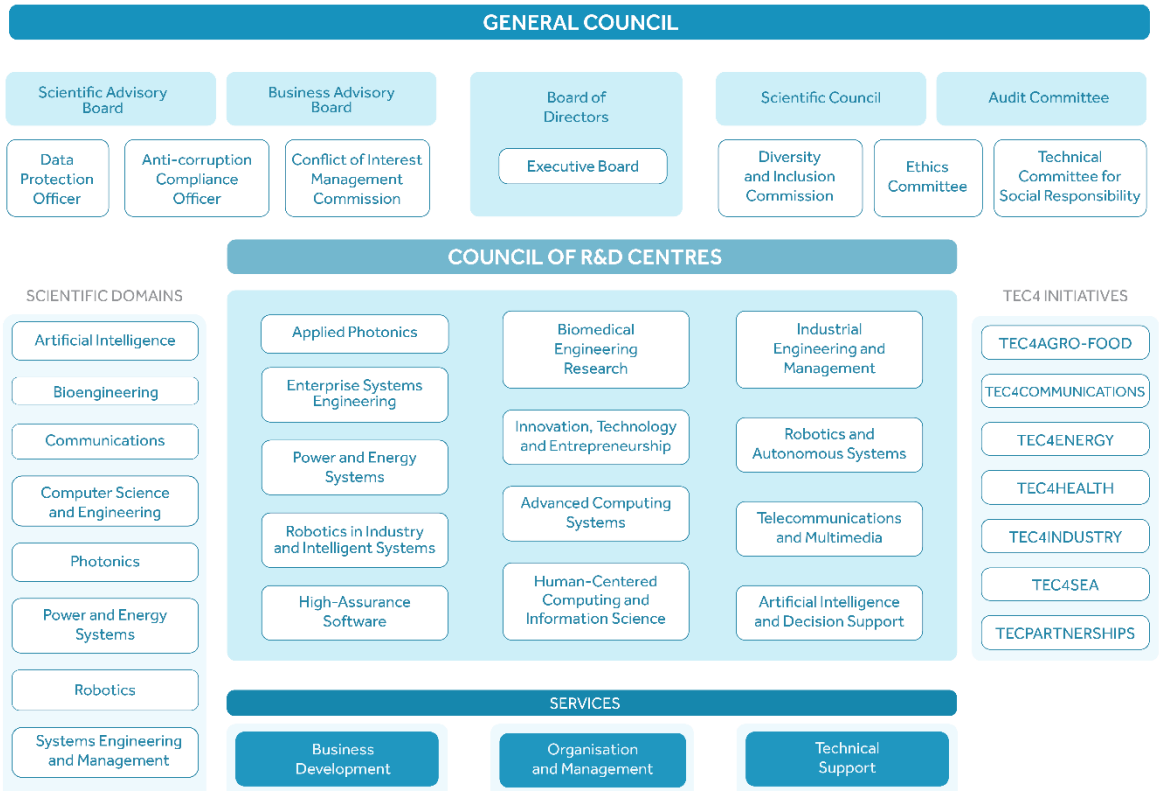


Figure 1.2 - INESC TEC organisational structure

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 Conflict 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. A new office has been set up to promote and articulate the institution's contributions to public policies.

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.

1.4 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.

1.4.1 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.

1.4.2 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.

1.4.3 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.

1.4.4 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.

1.4.5 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.

1.5 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 multidisciplinarity.

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.

1.6 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.

1.7 2025 external context outlook

Five external factors have been highlighted as potentially influencing the institution's activity significantly in the coming years.

First, **environmental concerns** may lead to increased emphasis on sustainable technologies and solutions, influencing the research focus of INESC TEC and causing scenarios of scarcity in raw materials and energy supply/demand, urging more efficient and alternative resources, processes, and solutions.

Sociodemographic trends can affect talent attraction and retention of the institution, taking into consideration lowering birth rates, ageing, and increased migration, as well as the low proportion of women studying STEM or the static condition of research and academic careers.

Regarding **global and regional politics**, the geopolitical repositioning of the EU, US and China can threaten broader international cooperation and progress on global challenges. At the same time, the domestic market for innovation remains fragile.

As for the **increasingly pervasive technology**, rapid technological advancements can create new opportunities or challenges for INESC TEC. These transitions will face skilled workforce gaps, deskilling processes, and delays in enacting appropriate legal and ethical frameworks. A shift in priorities towards non-economic and societal values will favour new organisational and social behaviours, namely, responsible innovation, ethical awareness, and related training.

Finally, the **national science, technology, and innovation policy** can directly impact the financial resources of the institute. Due to a fragmented science and technology system, where the effectiveness of public RDI funding is partly frustrated by its susceptibility to political cycles, unpredictable and severe oscillations, and heavy administrative burden, INESC TEC's resilience is only possible through a diverse funding portfolio.

The year 2025 is expected to be shaped by a dynamic interplay of geopolitical shifts, climate imperatives, technological advancements, and social transformations, fuelled by factors such as polarisation, populism, automation, and the disruptive impact of artificial intelligence.

The projections of the Portuguese Ministry of Finance, underlying the preparation of the state budget for 2025, forecast 2.1% of economic growth and 3.5% of investment growth in 2025, under a still moderately high inflation rate of 2.3%, estimating that the national public accounts surplus should reach 0.3% of the Gross Domestic Product (GDP), and predicting that the Portuguese unemployment rate would decrease to 6.5%.

Within this context, four major programmes - PRR (Portuguese Recovery and Resilience Plan), PT2030, Horizon Europe, and InvestEU 21-27 - will play a pivotal role in driving the development of INESC TEC's activities in the coming year, with a strong focus on fostering resilience and collaboration with the most innovative sectors of the economy.

1.8 Main initiatives for 2025

To fulfil its strategic commitments and achieve its objectives, INESC TEC defined a set of institutional initiatives that will be the focus of the institute's activity in 2025. They will enable the institution to strengthen its intervention in the national and international arenas, as well as its ability to better carry out its mission for the benefit of society.

In this section, these institutional initiatives are summarised, according to the respective commitments. However, institutional action in achieving INESC TEC's goals and commitments is not exhausted by these activities. There are other cross-cutting efforts, to which the several centres, services, and commissions make additional vital contributions and that are disclosed in other Sections of the plan.

One of the major highlights of 2025 will be the celebration of INESC TEC's 40th anniversary. This milestone acknowledges the establishment, in 1985, of an R&D institution in engineering based in Porto, as well as the signing of Portugal's Treaty of Accession to the former European Economic Community (now the European Union). To mark this occasion, a series of national and international initiatives are planned, including technological demonstrations, academic debates, and projects such as the publication of a commemorative book and the broadcast of mini-documentaries on national television. INESC TEC will also build on its existing activities, such as thematic magazines and podcasts, strengthening its role in serving society as part of the commemorative programme. These efforts aim to reflect the institution's contributions to research, innovation, and societal engagement over four decades.

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**
    - Launch and coordinate INESCTEC.OCEAN, a Centre of Excellence in Ocean Research and Engineering in Portugal, designed to address key areas such as marine structures, marine robotics, ocean energy, and ocean data. The initiative will foster R&D excellence spanning deep-sea exploration to interactions between the ocean, Earth, and space, promoting a culture of knowledge transfer and pushing the boundaries of innovation. Building on a successful application to the Teaming for Excellence program under Horizon Europe's Widening initiative, the project will be implemented from 2025 to 2031. Key partners include Fórum Oceano, Cluster do Mar Português, APDL (Administração dos Portos do Douro, Leixões, and Viana do Castelo, Portugal), and the Norwegian R&D Centre SINTEF.OCEAN, as outlined in Section 8;
    - Reinforce INESC TEC's research team with the recruitment of researchers for key strategic areas, in line with the institute's scientific strategy and namely through the implementation of the FCT Tenure programme for promising researchers, both in positions at the Associate HEIs and in internal INESC TEC positions;
    - Increase the volume of publications in high-impact journals and top-tier conferences by progressively implementing curated lists of recommended journals and conferences to guide INESC TEC researchers;
    - Encourage and support researchers in actively participating in prestigious academic activities, such as serving on editorial boards of leading journals, organizing or co-organising international scientific events, and contributing to committee boards or chairing technical committees.
    - Launch a new call for Internal Seed Projects, aiming at supporting internal exploratory R&D projects (in the categories of inter-centre research, junior researcher development and commercialisation proof-of-concept) that can be a starting point for jumpstarting new research and innovation areas;

- Conclude the FCT R&D Unit Evaluation process, incorporating a comprehensive review and in-depth reflection and discussion of the institute's results with the guidance of the newly appointed Scientific Advisory Board;
- Engage in international initiatives focused on new ways to assess research, namely CoARA – Coalition for Advancing Research Assessment, that aims to facilitate systemic reform in research evaluation by adhering to a shared set of principles and commitments;
- Reinforce the international recognition of researchers, through the encouragement of high-quality publication profiles, and the implementation of a new policy to support individual memberships in International scientific societies and communities relevant to the institution's activities;
- Expand the support to an institutional programme to support applications of INESC TEC researchers to high-impact European Research Council (ERC) grants;
- Enhance the adoption of Open Science practices, namely as a recognised National Centre for Research Data Management, leading a consortium with BIOPOLIS and CIIMAR, and contributing to a national network that supports research data management and sharing, while promoting FAIR Data principles.

- **C1.2. Increase our involvement in the leadership of scientific initiatives**
  - Continued involvement in the leadership of national initiatives and European collaboration on HPC, Quantum Computing, AI and Chips Act;
  - Secure active membership with the Linux Foundation (LF) for Energy through formal registration.

C1.3. Improve the base conditions for technology commercialisation

- Launch the Entrepreneurship and Spin-offs Office aiming at fostering innovation and entrepreneurship within the INESC TEC research community, empowering researchers to create impactful solutions that address global challenges, as detailed in Section 1.11.5;
- Launch the second edition of the Seed Projects Bootcamp to support seed and early-stage entrepreneurial projects;
- Increase the number of new patent filings while ensuring quality and international impact;
- Actively participate in international tech fairs and contribution to leading organisations in the areas of knowledge valorisation and transfer such as the TTO Circle, EARTO, and PATLIB.

- **C1.4. Develop closer and deeper relationships with our innovation partners and the broader community**
  - Continue working towards the establishment of a steady portfolio of flagship industry-funded strategic research programmes;
  - Organise workshops and establish regular contact with technology-based companies.

- **C1.5. Provide innovative learning experiences**
  - Maintain INESC TEC’s involvement in PhD and Masters Programmes, essential to its ability to attract and involve young talent in conducting and disseminating excellent research while leveraging the intervention of Higher Education Institutions (in recent years, typically assisting more than 20 PhD programmes, and involving over 300 PhD students and 600 Master’s students);
  - Enhance the recruitment and retention of MSc and PhD students by establishing a dedicated Research Student Office at INESC TEC. This office will aim to enrich the research journey of hosted students, as outlined in Section 1.11.3;
  - New initiatives will namely include advanced training, including flagship programs like the INVICTA Spring School and the joint SLICES-Converge Summer School. These initiatives will also include advanced training for technical staff of key energy market players, focusing on critical

topics in the energy sector, such as the application of knowledge-based tools and AI for energy system management, the deployment of energy storage-based solutions, and planning for offshore wind energy projects. A new edition of the Executive Master in Cybersecurity, in collaboration with Porto Business School is also planned.

- **C1.6. Increase the international embedment of our community**
    - Increase participation in international mobility programmes and funding schemes supporting inbound and outbound mobility to improve the organisation's exposure to internationalisation and support researchers in their efforts to participate in such programmes;
    - Propose training programs to equip staff with skills for navigating cultural differences in negotiations and interactions with foreign partners or colleagues. Include training on policy influence, project preparation, and Horizon Europe frameworks. Collaboratively develop strategic plans that align research strengths with EU priorities and funding opportunities;
    - Launch new editions of the INESC TEC International Visiting Researcher Programme, which provides researchers from institutions abroad the opportunity to conduct research activities at INESC TEC for up to three months while maintaining their affiliation with their home institutions.
- **C1.7. Reinforce strategic alignment and close collaboration with HEI**
    - Continued work on the protocols with INESC TEC's Associate HEIs, framing the assignment and sharing of human and material resources;
    - Continued collaboration in the Advanced Studies Programmes running in several Associate HEIs, to offer post-graduate training within the scope of R&D projects, both through hands-on learning of transferable skills (innovation, entrepreneurship, leadership, and time management, among others) and through the specialisation in technological areas;
    - Support 22 professorships at higher education institutions, covering one third of their costs under the "FCT-Tenure" initiative. These positions will be closely aligned with the 14 permanent researcher positions at INESC TEC, enhancing expertise in strategic fields such as Artificial Intelligence, Quantum Computing, Bioengineering, Robotics, and Energy Systems. This initiative aligns with European priorities, strengthening INESC TEC's specialised research domains and fostering synergy between academia and the institute's long-term research objectives;
    - Further collaboration and sharing of good practices between INESC TEC and ISPUP – Institute of Public Health of the University of Porto in the area of data protection;
    - Advance the strategic cooperation initiative between INESC TEC and i3S – Institute for Research and Innovation in Health;
    - Foster the automation of the reporting channels between INESC TEC and its associates.

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**
    - Prepare plans, reports, and analyses of INESC TEC research considering the alignment with SDG, namely by the implementation of new internal points of collection of this information and steps to ascertain and disseminate the institution's positioning;
    - Establish the baseline for ESG (Environmental, Social, and Governance) performance, develop a roadmap for implementing the ESG strategy, and integrate ESG into the organisation's operations.
- **C2.2. Increase our contribution to regional and national R&I-based sustainable growth**
    - Actively contribute to the definition of European, FP10, national and regional R&I policies and strategies (namely Smart Specialisation), programmes and instruments (including the

mechanism to promote and support synergies with European programmes) and public initiatives;

- Promote the creation and support of the development and operation of innovation eco-systems, including Clusters and CoLABs (Collaborative Laboratories) with academic and business partners, in order to exploit knowledge created in research institutions and address major societal challenges.

- **C2.3. Better align and deliver R&I with industry's needs**
  - Launch the TEC4COMMUNICATIONS initiative, focused on developing next-generation communication systems that are highly configurable, virtualised, and integrated with sensing capabilities to meet the digitalisation needs of various sectors, as outlined in Section 5.6;
  - Promote and support the development of industry-led Technology/Innovation Roadmaps, both sectorial and thematic, at European and/or national level;
  - Develop and implement more strategic and stable relations with leading companies and industrial associations, namely via mid to long-term collaboration agreements;
  - Deepen discussions with the Business Advisory Board and act on its guidance to better align strategies and initiatives with industry needs;
  - Promote internal multidisciplinary collaboration to develop new services in the industrial and energy sectors using emerging technologies such as artificial intelligence, cybersecurity and optics.
- **C2.4. Contribute to the digitalisation of public administration**
  - Collaborate with PlanAPP - Centro de Competências de Planeamento, de Políticas e de Prospetiva da Administração Pública to identify opportunities for digitalisation and develop the related roadmaps and supporting initiatives, taking full advantage of INESC TEC neutral positioning regarding market solutions and providers;
  - Actively pursue the development and showcasing of demonstrators illustrating the potential of digital technologies to improve/transform public administration, in collaboration with relevant partners (namely technology providers and public administration entities).
- **C2.5. Raise our contribution to inform debates on issues that matter to society**
  - Restructure the Foresight and Public Policy Office, the organisational structure to advance the involvement of the institute's community with public policies, promoting the effective use of scientific evidence resulting from INESC TEC research by public bodies and policy makers, as detailed in Section 1.11.1;
  - As a keystone event of INESC TEC's 40th anniversary celebrations, organise the 10th edition of the Autumn Forum, INESC TEC's major annual event seeking to actively contribute to the public policy debate, by inviting relevant actors to present and discuss their views on topics of relevance for the country;
  - Launch new issues of the magazine "INESC TEC Science & Society", as well as videocasts and podcasts aimed at citizens interested in general knowledge about research, its possible applications and impact on society, as well as informed opinions on the public policies most influenced by technology.
- **C2.6. Engage in direct dialogue with the public**
  - As part of INESC TEC's 40th anniversary celebrations in 2025, undertake a series of initiatives, including technological demonstration events, debates, the publication of a commemorative book, and the broadcast of mini-documentaries on television. These activities will strengthen INESC TEC's societal impact, with an emphasis on enhancing initiatives such as thematic magazines, podcasts, and other projects integrated into the anniversary celebration programme;

- Launch of the new institutional website, focused on enhancing public engagement through improved accessibility and communication;
- Increase the number of new projects and initiatives explicitly including activities for dialogue and engagement with the public.

- **C2.7. Communicate scientific and technological achievements and their impact**
  - Host the ECML-PKDD 2025 Conference, one of the largest and most prestigious events in Machine Learning, expected to attract over 1,000 participants to Porto. The conference will feature a Main Scientific Track, Workshops, Tutorials, an Applied Data Science Track, Special Industrial Sessions, and a Journal Track in collaboration with two leading journals in the field: Machine Learning Journal and Data Mining and Knowledge Discovery Journal;
  - Organise and co-organise several other high-profile international conferences, including the OFS29 - Optical Fiber Sensors Conference, the 12th EurOMA Sustainable Operations and Supply Chains Forum, and the 26th IFIP Working Conference on Virtual Enterprises (PRO-VE25);
  - Promote talks and open days hosted by INESC TEC's R&D Centres to engage society, academia, industry, and media. These events will provide opportunities to explore the institute's key contributions to science and innovation, reinforcing its tradition of openness and accountability. Initiatives such as the Power & Energy Webinars series, the "Shape of Energy to Come" event, the Energy Technology Open Day, INTHEBLACK, and SOE will be central to this effort;
  - Strengthen the institution's global visibility by participating in prestigious international expositions and fairs to showcase cutting-edge research, innovations, and technological advancements to a worldwide audience and potential technology adopters. Key events include SUSEW, Lisbon Energy Summit, ENLIT 2025, euRobotics and Adra forums, AIM-NET and AIOTI working groups, as well as the Hannover and FIRA trade fairs;
  - Launch a new institutional website to revitalise the institution's online presence and serve as a critical platform for communication, outreach, and engagement with diverse stakeholders, including the scientific community, industry partners, policymakers, and the general public;
  - Develop a comprehensive digital communication strategy that integrates the new INESC TEC website, social media channels, and other digital platforms to enhance outreach, engagement, and visibility among key stakeholders.

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**
  - Strongly contribute to the Clusters and CoLABs' public policy objective through the active engagement in the eleven institutions that INESC TEC participates in;
  - Engage in projects and activities of the European Knowledge and Innovation Community (KICs) EIT Manufacturing;
  - Actively participate in several research associations, at national and international levels, namely EARTO, and EFFRA;
  - Leverage existing work on engaging multiple ecosystem actors and creating living labs as spaces for transformative innovation, to develop and implement approaches for orchestrating innovation ecosystems, particularly in the ocean, energy and manufacturing areas.

- **C3.2. Develop better linkages between knowledge production, development, and market uptake**
  - Reinforce the initiative of strategic scouting of R&D results, leveraging PRR and other competitive innovation projects, and develop efforts towards knowledge valorisation;
  - Continue the efforts to simplify ways for researchers to disclose new R&D results;
  - Launch of the Entrepreneurship and Spin-offs Office to stimulate and support technological entrepreneurship;

- Establishment of spin-offs under development;
- Encourage an active search for new partnerships with companies for diversifying and improving technology transfer channels and creating, at least one, long-term programme contract.

- **C3.3. Increase strategic integration in national and international tech-intensive value-chains**
  - Active participation in POEMS - Portuguese Competence Centre in Semiconductors, a cutting-edge initiative under the Chips for Europe Initiative, focusing on the strategic areas of chip design, advanced packaging, and emerging semiconductor technologies. This strategic alignment aims to bring Portugal to the forefront of semiconductor innovation and production, specifically focusing on microelectronics and semiconductors, pivotal for elevating the existing industrial and technological capacities to meet the key global challenges.
- **C3.4. Promote our pro-active participation in R&I agenda-setting at regional, national and EU level**
  - Actively engage in the update of the regional and national Smart Specialisation Strategies in the institute's areas of expertise as well as in the FP10 preparatory discussions.
- **C3.5. Increase our international networking, leadership and competitiveness**
  - Full operation of INESC Brussels Hub, the Brussels representation of INESC TEC, INESC Coimbra, INESC ID, INOV INESC and INESC MN, set up to reinforce the institutes' positions in European programmes, increase their visibility and credibility in key areas, represent them in European platforms, groups and structures, and provide their researchers a permanent physical space for support and representation. The activity of the Hub is detailed in Section 1.11.2;
  - Celebrate INESC TEC's 40th anniversary in alignment with four decades of European integration through a series of events, publications, and enhanced outreach initiatives;
  - Actively engage as a member in international organisations (15+), in broadened geographies, and in collaboration with international partners (Memoranda of Understanding, R&D contracts, researchers exchange programmes, etc);
  - The new phase of the UT Austin Portugal Program will begin in 2025. INESC TEC, the host organisation of this international Partnership for the past years, will remain committed to working with FCT on the possible directions to ensure the continuation of this long-standing relationship between Portugal and The University of Texas at Austin. 2025 will be a transition year for the Program, and the management contract FCT will sign with INESC TEC will determine the set of activities to be coordinated and organised by our institution on behalf of the Foundation.

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

- **C4.1. Improve attraction and retention of world-class talent**
  - Continue the implementation of the new model for Human Resources Management, with special focus on the areas of recruitment and selection, training, performance appraisal, career development and employee life cycle;
  - Strengthen talent attraction and retention by supporting 22 professorships under the "FCT-Tenure" initiative, aligned with INESC TEC's 14 research positions targeting priorities in AI, Quantum Computing, Bioengineering, Robotics, and Energy Systems;
  - Maintain a hybrid work model where co-workers can alternate between telework and face-to-face activity.
- **C4.2. Ensure opportunities and recognition for career achievements**
  - Reinforce the reorganisation of research careers, advancing the implementation of an explicit career development support policy.
- **C4.3. Expand the diversity of our community**

- Design and launch an upgraded version of INESC TEC International Visiting Researcher Programme, potentially more focused (on prioritised scientific domains and/or application areas) and related to challenges where European and international scientific cooperation is particularly needed;
- Seek initiatives and funding schemes that facilitate both inbound and outbound staff mobility to enhance the organisation's international exposure, strengthen its strategy for attracting and retaining human capital, and create opportunities for research staff to advance their scientific careers;
- Support the initiatives of the Diversity and Inclusion Commission focused on gender equality, interculturality, accessibility and age diversity as described in greater detail in Section 1.10.3.

- **C4.4. Provide a more dynamic and fulfilling working environment**
  - Develop regular activities to address issues raised by remote work and promote a sense of cohesion and community. Moreover, external visibility of such initiatives will be promoted to further increase INESC TEC's appeal;
  - Foster a sense of cohesion and community by celebrating INESC TEC's 40th anniversary with initiatives that reflect shared achievements and strengthen connections across society, academia, and industry;
  - Improve the working conditions in several labs.
- **C4.5. Strengthen our commitment to independence and compliance of research with ethical principles**
  - Continuously support and empower the internal Commissions and Committees dedicated to ethics, conflict of interest management, social responsibility, data protection and anti-corruption compliance. The detailed plans for their activities in 2025 are presented in Sections 1.9 and 1.10;
  - Ensure awareness of safe research in international cooperation/responsible internationalisation among our community.

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

- **C5.1. Strengthen the sustainability and resilience of our economic model**
  - Monitor and adjust INESC TEC's strategy for effective participation in European funding calls, particularly within the Horizon Europe program and the execution of mobilizing agendas, which constitute a significant portion of INESC TEC's projected 2025 budget;
  - Promote research and innovation services to national and international companies and public organisations.
- **C5.2. Promote and contribute to environmental sustainability**
  - Enhance energy efficiency and sustainability by expanding renewable energy generation capacity, upgrading lighting systems, and optimizing building heating and cooling infrastructure;
  - Promote environmental sustainability as a cross-organisational theme, namely by developing and publishing sustainability plans and reports.
- **C5.3. Improve quality, management and usage of our infrastructures**
  - Enhance and modernise research infrastructures across various domains, including energy systems, communication technologies, manufacturing, and robotics. Key initiatives include improving 5G/6G testing facilities, advancing microfabrication capabilities, expanding iiLab infrastructure, and optimising laboratory working conditions and equipment. These efforts aim to support cutting-edge R&D, foster innovation, and ensure alignment with national and European strategic goals;

- Development of new testing and training services to SME and other technology-based companies, taking advantage of research infrastructures and of the IN-DATA living lab.

- **C5.4. Strengthen the distinctive aspects of our institutional model**
  - Expand and formally launch of a Projects Office to establish and operate a centralised Project Management Office (PMO) to standardise processes, develop tools, train project managers, and manage project portfolios, ensuring efficiency, compliance, and enhanced outcomes. Additionally, it will provide advanced management tools to support project oversight, financial control, and institutional planning activities, as detailed in Section 1.11.4;
  - Launch initiatives to strengthen the contributions of advisory boards and councils to strategic options;
  - Implement and operationalise strategic management initiatives to ensure effective deployment and alignment across the organisation at all levels;
  - Launch strategic initiatives in organisational change, including comprehensive restructuring and enhancement of administrative areas;
  - Develop and implement a digital transformation strategy for INESC TEC within the international research and innovation landscape, emphasising AI as a key enabler for organisational processes, starting with a focus on open science;
  - Support strategic convergence in scientific goals and operational integration between some R&D Centres;
  - Initiate a Working Group in early 2025 to develop an institutional policy on INESC TEC's participation in defence projects and dual-use research.

1.9 Compliance Officers

1.9.1 Data Protection Officer

Officer: Vasco Rosa Dias

Presentation

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

Main objectives and initiatives planned for 2025

Overall, the DPO role is aligned with several of INESC TEC's strategic plan objectives, namely and first of all, by strengthening our commitment to the independence and compliance of research with ethical principles, but also by indirectly contributing to a more impactful, socially responsible and multidisciplinary R&D, aligned with the SDG's, as well as to the resilience and sustainability of INESC TEC model.

Within the general tasks of the DPO we highlight in 2025 the following specific objectives:

- Strengthening of the internal awareness-raising initiatives, including as to the assignment of responsibilities within the organisation, thereby contributing to the dissemination of a data protection compliance culture across INESC TEC community;
- Strengthening of the training plan for staff members and researchers, including the addition of new resources in the existing online training courses;
- Particular emphasis shall be given, in the above-mentioned realm, to scientific research related topics and, in particular, the interplay between data protection and newly regulated fields such as AI systems use and development;
- Continuous implementation of the existing set of monitoring and auditing data protection tools available internally, following the activities conducted in the previous years;
- Continuous monitoring and assessment of the Institute's activities, including the R&D projects integrated or lead by INESC TEC; close cooperation with the Ethics Committee;
- Advise to the Board on Data Protection related issues; contributions to AI related task forces/ working groups;
- Continuous cooperation and coordination efforts with ISPUP under the Protocol established in the field of Data Protection;
- Follow up on relevant regulatory and standardisation/certification developments at the national, EU and international levels, including in what comes to the intersection between privacy and data protection and connected fields like digital markets, data governance, data spaces and AI;
- Contribution to external awareness-raising, seminars and policy making initiatives, in close cooperation with national partners or international or EU agencies and networks or associations like Metared, EARTO, including within the INESC's network and Brussels Hub.

1.9.2 Anti-corruption Compliance Officer

Officer: Ana Maria Mendonça

Presentation

At INESC TEC, the anti-corruption compliance officer (RCN) guarantees and controls the application of the Regulatory Compliance Programme for the Prevention of Corruption, as well as the implementation, control and adjustment of the Risk Prevention Plan (PPR), which is an integral part of the above-referred Programme.

All these duties are performed independently, permanently and with decision-making autonomy, with the necessary human and technical resources made available by the Institute.

Main objectives and initiatives planned for 2025

The main initiatives foreseen for 2025, although aligned with the strategic objective "Strengthen our commitment to independence and compliance of research with ethical principles", go beyond ethics in research, as stated below.

The RCN duties include some routine actions, such as:

- Answering of questions and doubts concerning the code of conduct and the risk prevention plan;
- Control of the reporting channel on corruption and breaches of EU law in certain domains, including the reception and follow-up on reports.

Other specific activities to be performed are:

- Elaboration of the interim and annual evaluation reports of the PPR and ensure the necessary interface with the competent entities in the field of prevention of corruption;
- Revision of the PPR whenever a change in the responsibilities or organisational structure of INESC TEC, or others directly relevant to the structure or management of the organisation justifies said review;
- Set up a record keeping of all information regarding the elaboration, implementation and review of prevention or risk management programmes - including reports of non-compliant practices - are stored and available.

During 2025, some of the Training Actions performed in 2024 aiming at the promotion of awareness-raising actions against corruption will be repeated, specially targeting the new members of INESC TEC Community. Based on the results of the 2024 annual evaluation of the PPR, other Training Actions, addressed to specific groups, will also be undertaken.

1.10 Internal Commissions and Committees

1.10.1 Conflict of Interest Management Commission

Chairperson: José Carlos Marques dos Santos

Presentation

The concern over the existence of conflicts of interest in organisations became more common due to the growing complexity of society, the number and diversity of relations between collaborators of organisations and external entities, and the growing sensitivity of society to these issues.

To ensure the independence and the integrity of the activities carried out, as well as to secure transparency regarding the interests of INESC TEC collaborators, that should be known by the institution, by its bodies and services, by other collaborators and by the entities with which it has relations, INESC TEC adopted in 2017 a conflict of interest management policy which includes CGCI to ensure compliance throughout the Institution.

Main objectives and initiatives planned for 2025

The work of CGCI is a continuous process that in 2025 will carry out a set of initiatives and actions that fall under the Strategic Objectives 4.5 “Strengthen our commitment to independence and compliance of research with ethical principles” of the Strategic Commitment n.º 4, “Cultivate an attractive, people-centred and talented community”, and 5.4 “Strengthen the distinctive aspects of our institutional model” of the INESC TEC’s Strategic plan 2023-2030.

Below is a list of the main initiatives and actions to be carried out by CGCI:

a) Regular contacts with INESC TEC community, namely through e-mails announcements and/or by answering questions and publishing information in the dedicated area in the intranet, ensuring that all INESC TEC collaborators are perfectly informed regarding the institution's Conflict of Interest Management Policy and its application;

b) Regular analysis of submitted declarations of interest (DI) and preparation of conflicts of interest management plans (PGCI), if justified, to be approved by the Board of Directors;

c) Supervise the process of monitoring each PGCI, by the designated monitor, to ensure that each one is complied with by the employee to whom it has been assigned;

d) Monitor compliance considering due dates for DI presentation, through a monthly report that reflects submission status of each collaborator;

e) Ensure the stabilisation and full operation of the process of semi-automation of the preparation of the monitor's report in order to facilitate the task of monitoring compliance with the PGCI;

f) Promote the implementation of the process that will make it possible to comply with article no. 5 (Offers, Gratuities and Advantages) of INESC TEC's Code of Conduct for the Prevention of Corruption, which the CGCI was tasked with;

g) promote training sessions on the application of the Policy for R&D centre coordinators and for monitors.

1.10.2 Technical Committee for Social Responsibility

Chairperson: António Baptista

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.

Main objectives and initiatives planned for 2025

Below we have listed the main initiatives and actions planned for 2025, developed aligned with the Strategic Objectives, listed in Section 9 of INESC TEC's Strategic Plan.

Provide a more dynamic and fulfilling working environment

- Organisation of initiatives such as Laughter Yoga workshop; healthy eating workshop; laboral gymnastics workshop and regular short walks, among others, aligned with the promotion of mental health and well-being with activities for the INESC TEC community;
- Continuous dissemination of information on Safety and Health at Work, revisitation of institutional signage related to this topic and organisation of different initiatives;

Communicate scientific and technological achievements and their impact

- Dissemination of scientific information about new occupational diseases, through several initiatives. Continuity of the partnership with EU-OSHA through the dissemination of the material of the "Safe and Healthy work in the digital age" campaign (2023-25), but also with new types of involvement with the community, namely the production and submission of articles and/or best practices to contribute to this European initiative.
- Creation of a network called "INESC TEC Social Ambassadors" to outreach the scientific, innovation and technological achievements of the institution in different areas (ex: schools – from pre-school to high-school) and with different objectives (promote INESC TEC's scientific domains and concepts, disseminate project's results that can be applied to these communities - ex: ECOVALE, INCoDe.2030, etc., encourage STEM in youngsters, namely female students). The objective is to create a network of different pivots, that – in the medium and long term -, have a multiplier effect on science-based impact from INESC TEC and pass the process to other people in the community that can perpetuate and disseminate the action over time.

Develop closer and deeper relationships with our innovation partners and the broader community

- 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;
- Promotion of volunteerism (*Dia do Voluntariado*) to encourage participation in community service or charitable activities;
- Promotion of blood donation campaigns, in line with the growing need in Hospitals;
- Organisation of a Christmas donation campaign;
- Collection of Plastic bottle caps, in a campaign called *Operação Tampinhas*, to be donated to institutions or individual families.

Promote and contribute to environmental sustainability.

- Keep supporting “The Earthshot Prize” initiative, a global environmental prize and platform for impact, dedicated to finding and growing solutions that will repair our planet this decade, as an Official Nominator;
- Develop action for the INESC TEC community and their families, such as Climate Change and Pollution mitigation efforts, such afforestation (planting autochthonous trees, namely that in parallel promote biodiversity), picking up rubbish, plastic waste on the beaches, riversides, etc. More than just offsetting complementary actions towards NetZero, organisations such as RTOs must act also in insetting across their community (business and collaborators).

Strengthen the sustainability and resilience of our economic model.

- Develop awareness campaigns about climate change impacts (economic, environmental and social), resilience threats and the need for adaptation planning/action, to promote overall sustainability for INESC TEC organisation and community, as a first-line action to address this topic.

1.10.3 Diversity and Inclusion Commission

Chairperson: Ana Filipa Sequeira

Presentation

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

In 2025, the D&IC will continue to focus on raising awareness, developing skills, monitoring the D&I landscape, and promoting initiatives in four priority areas: 1) **Gender Equality,** focusing on gender matters, monitoring and assessing the implementation of the Gender Equality Plan , whilst organizing events that touch on the relevance of gender parity; 2) **Interculturality,** working alongside INESC TEC's different services to promote an inclusive environment, helping to raise awareness to intercultural aspects of/at various institutional initiatives and processes; 3) **Accessibility,** fostering universal access in all INESC TEC activities, communications and platforms, as well as helping its collaborators and decision-making members to understand how to do so; 4) **Healthy Work Environments**, by conducting a specialized survey and working on its outcomes to help create positive, healthy conditions to all INESC TEC' members, with a special focus on mental health and work-life balance.

Main objectives and initiatives planned for 2025

The D&IC will continue to foster, empower, and counselling the INESC TEC community to put in place good practices towards the four priorities established above, as well as the INESC TEC strategic goals. This work will focus on monitoring INESC TEC's culture and environment, supporting and promoting diverse events and initiatives.

On the one hand, the Commission continues to set itself for a learning process, participating in events and training actions, promoted by relevant partners within the scientific community that allow for a better consultative posture within the INESC TEC community. On the other hand, the Commission will also continue the work developed through internal events and other projects, providing feedback towards greater inclusion, partnering with the Technical Commission for Social Responsibility, the International Relations Service, the Human Resources Service, among others.

In 2025, the D&I Commission aims to promote several initiatives, further engaging INESC TEC's community in matters of diversity and inclusion. These events include new editions of successful events that took place throughout previous years, as well as new initiatives. Aligned with some of the strategic objectives, the D&IC activities for 2025 comprise:

Commitment to gender equality promotion across INESC TEC's policies and culture

- Increase gender balance and representation through the Gender Equality Plan review and update.

Increase the international embedment of our community

- Encourage networking opportunities among national and foreign collaborators by providing a safe ground for learning and discussion.
- Promote initiatives to give visibility to foreign cultures.

Expand the diversity of our community / Promote a more dynamic and healthier working environment

- Monthly initiatives to promote a diverse workplace: i) organisation of events; ii) dissemination of information regarding specific dates and celebrations and their relevance to the work conducted by the Commission; and iii) sharing curated knowledge towards good practices of inclusion.
- Promote training on several topics related to D&I identified as concerns of our community.
- Organise and support talks to create awareness on unconscious bias and related prejudiced procedures, as well as to motivate reflection concerning moral and sexual harassment.
- Enforcing the accessibility of activities and the facilities at INESC TEC for everyone, including people with impairments.

1.10.4 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, Prof. Emeritus at the University of Porto, and integrates Susana Magalhães, who holds PhD in Bioethics and is the Coordinator of the Unit for Responsible Conduct in Research at I3S and professor at the 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, professor at the Faculty of Sciences, both of 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 ensuring the promotion of standards of integrity, honesty and responsibility in all the activities of INESC TEC's members, particularly in their research activities, through the observance of the institution's Code of Ethics.

Main objectives and initiatives planned for 2025

The main objectives for 2025 are not different from what was defined for 2024: to strengthen INESC TEC commitment to independence and compliance of research with ethical principles, the E.C. will pursue the support to INESC TEC researchers to ensure high ethical standards in their activities, both by assessing the questionnaires relating to ethical issues that may be raised by the projects, and interacting and responding to questions raised by PI's, concerning projects dealing with human beings and personal data as well as those involving artificial intelligence or autonomous systems.

There are aspects that will always be embraced in our regular activities:

- Keep a close cooperation with INESC TEC's DPO, Conflict of Interest Committee and Scientific Council, to provide clear guidelines regarding standards and principles that should govern research conduct concerning data collection, informed consent of participants, confidentiality, conflicts of Interest and publication practices;
- Make sure that all members of INESC TEC may report unethical behaviour or concerns without fear of reprisal;
- Promote awareness raising or training initiatives such as open talks, seminars or workshops, to strengthen a culture of ethics across INESC TEC community, and disseminate the institute's Code of Ethics and good practices.,
- Embrace initiatives that promote transparency, reproducibility, and sharing of research data, methods, and findings, having in mind that openness fosters accountability and encourages ethical behaviour;
- Improve the IT support for reporting and interaction between researchers and the Ethics Committee.

Some topics, however, require special attention and deserve specific actions:

- The international political situation, with open conflicts namely in Ukraine and the Middle East, has brought military applications of research to the forefront. Consequently, the E.C. has paid particular attention to the ethical issues arising, continuing a fruitful dialogue with the Board of Directors and planning new online conferences under the scope of the "INESC TEC Open Talks on Research Ethics and Defence."
- At the same time, it will continue to focus on the ethical issues raised by research in AI, following developments taking place both internationally and at the level of the European Commission (e.g. the ongoing drafting process of an EU General-Purpose AI Code of Practice, or the issuance of Guidelines on the responsible use of (generative) AI in research), and continuing to disseminate the relevant information and stimulate their discussion;
- Finally, to disseminate the European Code of Conduct for research Integrity and to reflect upon particular challenges that scientists are currently facing —namely open and reproducible science—, the E.C. will promote training sessions among the INESC TEC community.

1.11 Other Institutional Initiatives

1.11.1 Foresight and Public Policy Office

Team: José Manuel Mendonça and João Claro

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.

The office's activities are structured around four strategic action lines: (1) Identify and Disseminate, ensuring that INESC TEC's research and science-based innovation contributions reach policymakers and stakeholders effectively; (2) Connect and Raise Impact, building trusted relationships and fostering dialogue with public and private entities; (3) Support Collaborative Strategies for Impact, co-creating impactful research and innovation initiatives with policymakers and other stakeholders; and (4) Experiment and Innovate, piloting new approaches to policy engagement and foresight methodologies.

Main objectives and initiatives planned for 2025

Policy Impact and Engagement: The office will facilitate the production of high-quality policy briefs, impact reports, and case studies to inform policy frameworks at regional, national, and EU levels. A dedicated repository will be a key tool for disseminating INESC TEC's research contributions. Additionally, the office will promote monitoring and participation in policy processes, emphasizing evidence-based policymaking. *(Strategic objectives 2.5, 3.4, and 5.4; strategic lines 1 and 2.)*

Stakeholder Engagement: Workshops, roundtables, and high-level visits will facilitate dialogue between researchers, policymakers, and other stakeholders. Increased presence in the capital will strengthen engagement with national government and regulatory bodies, strengthening the positioning of INESC TEC as a trusted advisor. *(Strategic objectives 2.5, 3.1 and 3.4; strategic lines 2 and 3.)*

Capacity Building: Structured training and mentorship programs will equip INESC TEC researchers with skills in policy analysis, foresight, and strategic communication. Tailored resources will support effective engagement in policy contexts. *(Strategic objectives 2.1, 2.5, and 3.1; strategic lines 3 and 4.)*

Foresight and Strategic Planning: Lead studies on emerging trends and integrate scenario planning into INESC TEC's annual strategic reviews, ensuring adaptability to future challenges and opportunities. *(Strategic objectives 3.4 and 5.4; strategic line 4.)*

Integration of New Responsibilities: The office will encompass INESC TEC's Autumn Forum and Science & Society Magazine, leveraging these platforms for public dialogue and visibility. It will broaden engagement to include regional and municipal policy initiatives while maintaining national and EU focus. *(Strategic objectives 2.5, 3.4, and 5.4; strategic lines 1, 2, and 3.)*

Enhanced Policy Engagement Framework: The office will formalize processes for contributing to policy frameworks and deepen its collaboration with INESC Brussels HUB, focusing on Transformative Technologies and Framework Programme priorities. *(Strategic objectives 2.5, 3.1, 3.4, and 3.5; strategic lines 2 and 3.)*

Strategic Communication and Outreach: A dedicated website section and newsletter will highlight policy contributions and foresight insights, while impactful publications and strategic event participation will strengthen INESC TEC's visibility. *(Strategic objectives 1.1, 2.7, and 3.5; strategic lines 1 and 2.)*

Monitoring and Evaluation: The office will implement a comprehensive framework to track policy engagement effectiveness, publishing detailed annual reports to highlight achievements and lessons learned. *(Strategic objectives 1.1, 2.5, and 5.4; strategic line 4.)*

1.11.2 INESC Brussels Hub

Coordinator: Ricardo Miguéis

Presentation

The INESC Brussels HUB embodies the collective ambition of the five INESC institutes to position themselves as influential players in the European Union's research and innovation ecosystem. It serves as a bridge between the institutes and the EU, translating strategic priorities into tangible opportunities while representing a shared vision of excellence, collaboration, and global impact. As a central connection point, the HUB ensures active participation in key EU platforms and facilitates access to funding, partnerships, and policy discussions. It operates as both a practical enabler—helping researchers and administrators navigate the complexity of European frameworks—and a visionary catalyst, fostering a culture of international collaboration and thought leadership. Through this dual focus on operational excellence and aspirational goals, the HUB reinforces its role as a vital conduit for INESC TEC's long-term success in Europe.

Main objectives and initiatives planned for 2025

Aligned with the 2030 Strategic Plan, the HUB is prioritising the following strategic objectives and initiatives for 2025:

- **Strengthening INESC TEC's Presence and Visibility in the EU –** Active participation in Horizon Europe partnerships, ETIPs, EARTO working groups, and FP10 preparatory discussions; Forge alliances with RTOs, industry players, and Horizon Europe-associated countries to secure high-impact roles in consortia. *(Strategic Objectives 1.2, 3.4, and 3.5.)*
- **Promoting Thought Leadership through the Think Tank Dimension –** Publish Policy Briefs, Intelligence Reports, and Event Reports to influence EU policies; Lead strategic projects like CSAs and Tenders; Promote INESC TEC's strengths through targeted interventions in events and working groups; Deliver advanced training on policy influence, project preparation, and Horizon Europe frameworks. *(Strategic Objectives 1.2, 2.5, and 3.4.)*
- **Enhancing Internal Capacity for Sensing and Seizing – Sensing Opportunities**: Work with centres to align EU priorities with strategic plans and agendas; Facilitate foresight exercises to anticipate trends and opportunities; Jointly develop strategic plans aligning research strengths with EU goals and funding instruments. **Seizing Opportunities:** Leverage insights from sensing to develop impactful proposals aligned with Horizon Europe and FP10; Collaborate with centres to lead or join high-impact consortia in key domains; Facilitate multilevel alignment with EU priorities and embed foresight into project planning; Transform sensing intelligence into actionable steps for CSAs, Tenders, and mission-driven projects. *(Strategic Objectives 2.5, 3.4, and 3.5.)*
- **Celebrating INESC TEC's 40th Anniversary with Strategic Events –** Organise/contribute to an EU Roadshow to showcase INESC TEC's contributions; Host Winter and Summer Meetings integrating strategic reflections with EU R&I priorities; Organise satellite events during the Strategic Meeting to strengthen European collaboration. *(Strategic Objectives 1.1, 2.7, and 3.5.)*
- **Expanding the HUB's Infrastructure and Team –** Secure a larger, functional office in Brussels to support the HUB's goals and stakeholder engagement; Foster secondments and exchanges between the HUB and INESC TEC centres to deepen expertise and collaboration. *(Strategic Objectives 3.5, 4.1, and 5.4.*

1.11.3 Research Student Office

Team: Aníbal Matos, Sara Brandão

Presentation

The Research Student Office was established at the end of 2024. Its mission is to enrich the research journey of our students, leveraging our strong collaborations with academia and industry, and fostering a talented and cohesive network of students as integral members of our institute, preparing them to excel and succeed. Students are the backbone of any research institution, representing at INESC TEC nearly 40% of its human resources. Creating a centralised structure for students becomes essential to implement a strong, cohesive vision, and equipping them with the skills, knowledge, and connections needed to excel in research, drive innovation, and succeed in their future careers. A well-supported student population will produce world-class research, enhancing INESC TEC's global reputation.

Main objectives and initiatives planned for 2025

Student affairs and academic integration: Develop initiatives to improve student satisfaction, retention, and success by fostering a supportive and enriching environment. Oversee key aspects of student life, ensuring students are fully integrated into their research projects with access to mentorship and guidance throughout their research journey. **Recruitment and Talent Development:** Lead efforts to attract and retain top students, both locally and internationally. Improve recruitment procedures and develop a distinctive value proposition for students. **Partnership Collaborations:** Strengthen relationships with academic institutions, industry partners, and other research centres. Reassess INESC TEC's involvement in existing doctoral programs to enhance their impact. Explore joint initiatives with HEIs. Launch a pilot collaboration with industry to integrate doctoral students into companies. Contribute to the development of a long-term strategy for sustaining and enhancing these partnerships. **Student Development and Research Experience:** Create opportunities for student exchanges and mobility programs, allowing students to expand their networks, gain new perspectives, and engage in collaborative research with peers and experts globally. Support and manage the PhD Representatives Committee, ensuring that students have a platform to voice their concerns and provide support for organizing events and other initiatives that enhance their research experience, foster a sense of community and sharing of good practices. **Monitoring and Performance Metrics:** Develop and track student related indicators, including academic performance, research output, grant acquisition, and employment outcomes. Conduct regular student satisfaction surveys and use data-driven insights to continuously improve our services. **Financial Sustainability and Guidance:** Provide students with guidance on financing options, helping them secure financial support for their studies. Secure and manage funding from diverse sources, including FCT grants, other scholarships, and industry collaborations, to support graduate students.

Contribution to the INESC TEC's Strategic Objectives

Raise the contribution and visibility of our research: Expand INESC TEC's involvement in PhD and master's Programmes; Increase the enrolment of new PhD students; Promote publications in high-ranked journals.

Provide innovative learning experiences: Implement student-led initiatives promoting the sharing of best practices; Create new training programmes (soft skills, entrepreneurship, knowledge valorisation).

Increase international embedment and diversity: Create new opportunities for student exchanges and mobility programmes; Increase the proportion of foreign PhD students.

Improve attraction and retention of world-class talent: Increase recruitment of top students; Offer personalised support to students and provide career guidance; Improve the work environment and conditions offered to research students.

Strengthen economic and institutional model: Improve success rate on FCT´s PhD grants; Create new funding scheme for 1st Year PhD students; Develop and track student-related indicators; Create a student-centred section in our website.

1.11.4 Project Office

Team: Lígia Silva, Luís Carneiro and Mário Jorge Leitão

Presentation

- One is related with the implementation and operation of a Project Management Office (PMO) at INESC TEC. The PMO covers the definition of processes, standards and best practices for project management; design and development of related IT and methodological tools; training and capacitation of project managers; management of a portfolio of projects and the monitoring and reporting of projects performance. The PMO serves as a centralised support unit, with the aim of ensuring efficiency and effectiveness in the management of projects, both transversal and R&D centres projects; promoting customer and stakeholders' satisfaction; compliance with funding requirements; and maximising the project results.
- The other activity is related with the development and provision of tools to support the management and control of projects and the overall activity at INESC TEC (analytical accounting), enhancing the capabilities of the institutional ERP and other applications, especially in the areas of annual planning (initial and updates), budget control and management of compensation schemes for the participation of academic staff and grant holders in projects.

Main objectives and initiatives planned for 2025

The objectives and initiatives planned for the PMO in 2025 are the following:

- Conclude the development of set of support tools, including: a Project Management Manual a set of templates (project charter, meeting minutes, risk management, requirements collection, communication, among others);
- Specify improvements in INESC TEC IT tools that support project management, including IRIS and uOneConnect;
- Promote training activities ensuring the project managers capacitation in the selected methodologies, best practices and tools;
- In articulation with other structures, support the development of tools and training activities to promote the compliance with the rules and regulations of funded projects;
- Ensure the adoption of the defined processes and tools by the projects that will start during the year, with the necessary adaptations to the reality of each project. Gradually enlarge the adoption by more projects;
- Monitor the development of these projects and support the adoption of best practices;
- Define and implement a pilot with a set of selected projects managed by the PMO (project management team);
- Evaluate the adoption of the defined processes and tools and promote the continuous improvement.

The objectives and initiatives planned for general project support in 2025 are the following:

- Adapt all the existing tools and develop new ones to interact with the new ERP that will begin its operation in January 2025, enhancing present analytical accounting processes of the institution, aiming at greater accuracy and production of indicators both timely and with increased frequency (from quarterly to monthly);
- Adapt the existing processes do new requirements raised by internal users and by new financial models recently adopted in National and European R&D programmes.

1.11.5 Entrepreneurship and Spin-offs Office

Team: João Claro, Alexandra Xavier, Daniel Vasconcelos, Alípio Torre and Vasco Rosa Dias

Presentation

The Entrepreneurship and Spin-offs Office works to bridge the gap between research and the market, fostering innovation and strengthening INESC TEC's entrepreneurial ecosystem. By leveraging INESC TEC's deep tech R&D results, the office will help researchers transform ideas and innovations into viable market solutions and businesses, driving sustainable growth and creating societal impact. The vision for the office is to be a catalyst for innovation and entrepreneurship within the INESC TEC research community, empowering researchers to create impactful solutions that address global challenges and contribute to a sustainable future.

The office's mission is to: Cultivate a Culture of Innovation and Entrepreneurship – encourage creativity, risk-taking, and entrepreneurial thinking among the INESC TEC community; Support Spin-Off Creation – provide comprehensive support and resources for the development and growth of spin-off companies, from ideation to commercialisation; Foster Collaboration – build strong partnerships with industry, investors, and other stakeholders to enhance the entrepreneurial ecosystem; and Drive Impact – translate research innovations into marketable results with the potential to generate economic and social value.

Main objectives and initiatives planned for 2025

Aligned with the 2030 Strategic Plan, the office is prioritising the following strategic objectives and initiatives for 2025:

- **Establishment of foundations:** (i) Establishment of a governance and operations model including organisational aspects, standardised workflows and decision-making processes; (ii) Develop a communication strategy, including a brand, website area, intranet area and newsletter; (iii) Update INESC TEC's Spin-Off Policy: Revise and align INESC TEC's spin-off policy with international models and best practices to foster a robust entrepreneurial ecosystem. (Strategic Objectives 1.3, 3.1, and 5.4.)
- **Set up an entrepreneurship resource hub:** (i) Develop and map templates, frameworks and tools; (ii) Map funding opportunities and forge partnerships with investors and funding agencies. (Strategic Objectives 1.3, 2.3, and 3.5.)
- **Community building:** (i) Establish a robust network of advisors and mentors: a) create an advisory board of industry leaders and experienced venture builders and b) build a mentor network to provide guidance and support for venturing teams; (ii) Develop an alumni network engagement model for the office's activities; (iii) Stakeholder mapping for engagement. (Strategic Objectives 2.3, 3.1, and 4.1.)
- **Create awareness:** (i) Understand the entrepreneurship mindset of the INESC TEC community; (ii) Launch events highlighting innovation, entrepreneurship, spin-offs and startups to the INESC TEC community; (iii) Host networking and matchmaking events connecting entrepreneurs, investors, and industry partners. (Strategic Objectives 2.5, 3.1, and 4.1.)
- **Support programs:** (i) Expand existing program for tech to market (the Seed Project Acceleration Program - 2nd edition); (ii) Pilot program for hands-on venture-building and incubation support. (Strategic Objectives 1.3, 2.3, and 4.1.)
- **Spin-off Support:** (i) Review and update of the monitoring system; (ii) Establishment of a Spin-off support mechanism. (Strategic Objectives 1.3, 2.3, and 5.4.)

1.12 Articulation with the detailed plan

The strategic priorities outlined in Section 1 provide a high-level view of the more detailed plan that is presented in the remainder of the document.

Section 2 provides a quantitative aggregate perspective of the plan, bringing together the key activity indicators planned for 2025, namely regarding human resources, activity in projects, publications, intellectual property, and dissemination.

The high-level research and innovation goals are developed in greater detail for the Scientific Domains in Section 3, the Thematic Lines in Section 4, the TEC4 initiatives in Section 5, and the Research Centres in Section 6.

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 INESC TEC.OCEAN, a Centre of Excellence in Ocean Research and Engineering.

The plans for the Support Services, which also play a key role in many of the main initiatives foreseen for 2025, are presented in Sections 9.

2 MAIN INDICATORS FOR 2025

This section presents the main global indicators for INESC TEC, regarding human resources, activity in projects, scientific publications, IP protection, exploitation and technology transfer, and dissemination activities planned for 2025. The presentation of each R&D Centre and the detailed discussion of their objectives, activities and results are carried out in Section 6.

2.1 Human Resources

2.1.1 Global indicators

Table 2.1 and Figure 2.1 show the breakdown of INESC TEC's Human Resources by type of contractual link and the expected evolution for 2025. Table 2.1 also includes the number of PhDs (431 planned at the end of 2024).

Table 2.1 - Evolution of INESC TEC's Human Resources

Type of Human Resources			2023	2024 (Forecast)	2025 (Plan)	Δ 2024-25	
Integrated HR	Core Research Team	Employees	238	273	320	47	17%
		Academic Staff	187	197	197	0	
		Grant Holders and Trainees	400	467	505	38	8%
		Total Core Researchers	**825**	**937**	**1022**	**85**	**9%**
		Total Core PhD	**290**	**319**	**345**	**26**	**8%**
	Affiliated Researchers		66	67	61	-6	-9%
	Management, Administrative and Technical	Employees	126	138	153	15	11%
		Academic Staff	9	9	8	-1	-11%
		Grant Holders and Trainees	2	0	1	1	
		Total Manag, Admin and Tech	**137**	**147**	**162**	**15**	**10%**
		Total Integrated HR	**1028**	**1151**	**1245**	**94**	**8%**
		Total Integrated PhD	**381**	**409**	**431**	**22**	**5%**

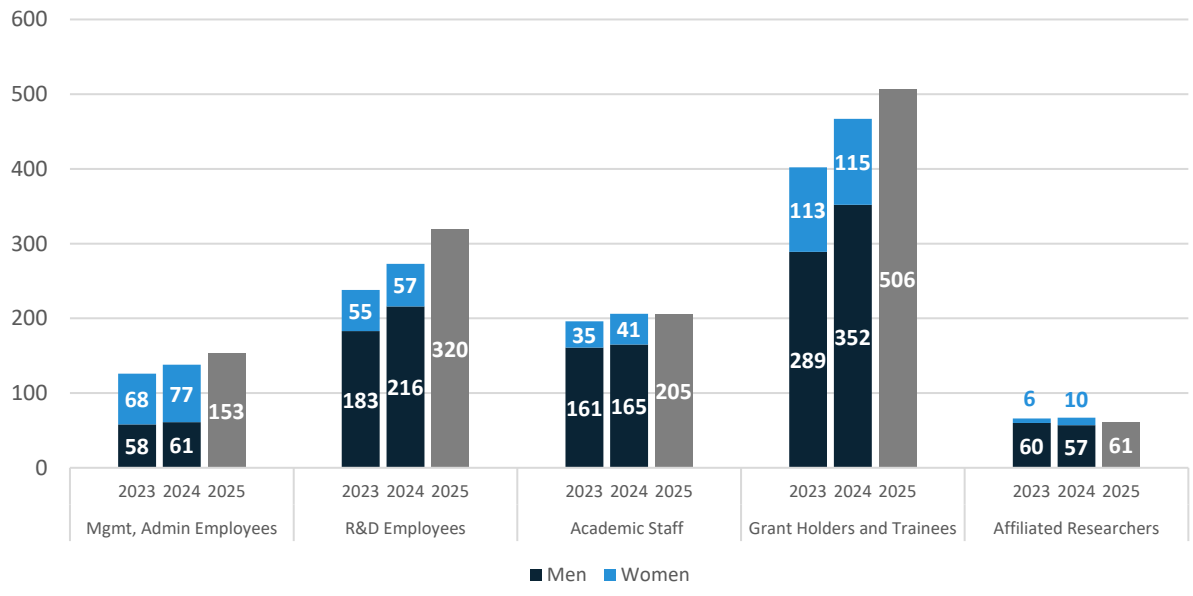


Figure 2.1 - Evolution of INESC TEC Human Resources

In Figure 2.2, the distribution of human resources planned for 2025 does not address gender distribution, which is not the object of planning in future hires. Nevertheless, INESC TEC is closely monitoring indicators related to dimensions of Diversity and Inclusion (D&I), namely those relating to gender balance, in practices such as recruitment, among several others.

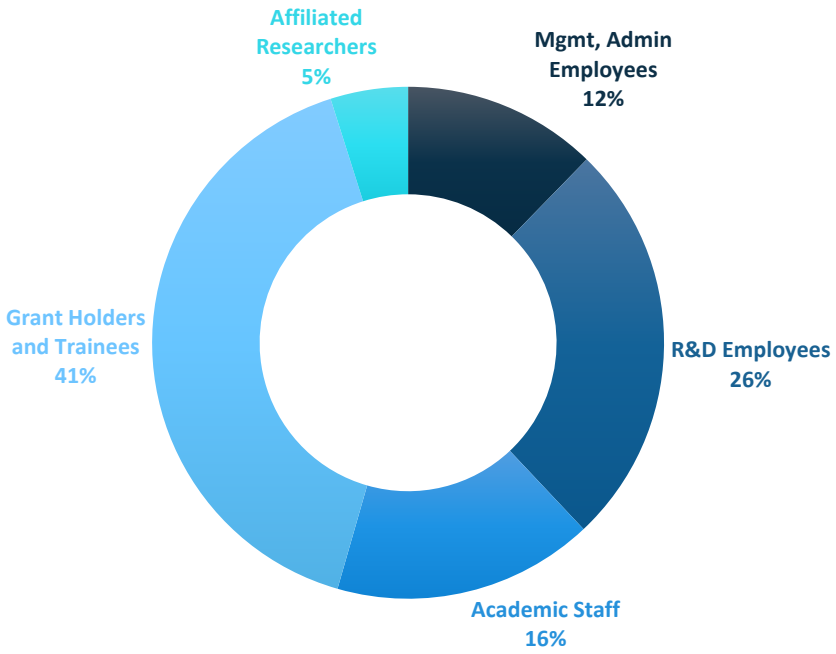


Figure 2.2 - Distribution of Human Resources (Plan 2025)

As highlighted in Figure 2.2, grant holders and trainees remain the largest human resources group (41%) at INESC TEC, showing a growth trend.

A significant increase in the number of R&D employees is planned, with a foreseen growth of 17%, explained mainly by the substantial rise in activity level related to the execution of the projects approved in PRR (the Portuguese Recovery and Resilience Plan) and in the EU programmes.

In 2025, the number of employees in the Support Services is planned to increase by 11%, due to the need to support the continued growth of the institute's activity and the deployment of new strategic objectives. Due to the transitional nature of the growth in activity related to PRR projects, the related hiring is also following a transitional employment policy, linked to the execution of those projects.

2.1.2 R&D Centres indicators

The detailed Human Resources figures expected for the end of 2025 are given in Table 2.2 for each R&D Centre.

Table 2.2 - Human Resources by type and R&D Centre (Plan 2025)

Type of Human Resources			Total R&D Centres	R&D Centres													Special Projects
				CTM	CAP	CRAS	CBER	CPES	CESE	CRIIS	CEGI	CITE	HUMANISE	LIAAD	CRACS	HASLAB	
Integrated HR	Core Research Team	Employees	**320**	18	17	45	12	87	32	30	11	10	24	14	1	14	5
		Academic Staff	**197**	16	7	11	5	10	7	14	20	2	41	23	16	25	
		Grant Holders and Trainees	**505**	104	45	72	40	82	13	45	18	2	26	17	7	31	3
		Total Core Researchers	**1 022**	**138**	**69**	**128**	**57**	**179**	**52**	**89**	**49**	**14**	**91**	**54**	**24**	**70**	**8**
		Total Core PhD	**345**	**29**	**21**	**24**	**12**	**48**	**18**	**26**	**27**	**6**	**50**	**32**	**16**	**31**	**5**
	Affiliated Researchers		**61**	8	2		2	2	6	1	4	2	21	8		5	
	Administrative and Technical	Employees	**30**	1	1	6	1	3	2	3	1		1	1		4	6
		Total Admin and Tech	**30**	1	1	6	1	3	2	3	1		1	1		4	6
	Total Integrated HR		**1 113**	**147**	**72**	**134**	**60**	**184**	**60**	**93**	**54**	**16**	**113**	**63**	**24**	**79**	**14**
	Total Integrated PhD		**405**	**37**	**23**	**24**	**13**	**50**	**24**	**27**	**31**	**8**	**71**	**40**	**16**	**36**	**5**

2.1.3 Support Services indicators

The Human Resources figures expected for the end of 2025 for the Board of Directors, the TEC4 teams, and the Support Services are provided in Table 2.3.

Table 2.3 - Human Resources by type and Service (Plan 2025)

Type of Human Resources		Total	Board and Advisors	Support Services															
						Organisation and Management Services					Business Development Services				Technical Support Services			
				TEC4	DPO	AG	AJ	CF	CG	RH	SAAF	SAL	SRI	SCOM	SRC	SIG	SAS	SGI
Integrated HR	Employees	123	21	10	2	4	4	11	14	7	4	5	7	10	5	7	5	7
	Academic Staff	8	4	4														
	Grant Holders and Trainees	1	1															
	Affiliated Researchers																	
	Total Integrated HR	**132**	**26**	**14**	**2**	**4**	**4**	**11**	**14**	**7**	**4**	**5**	**7**	**10**	**5**	**7**	**5**	**7**
	Total Integrated PhD	**26**	**12**	**6**		**1**	**1**	**1**				**4**	**1**					

2.2 Activity in projects

2.2.1 Global indicators

Table 2.4 shows the breakdown of INESC TEC's funding sources and the expected evolution from the 2024 plan to the 2025 plan with an overall growth in activity of 18%.

Table 2.4 - Funding sources and planned evolution

Sources	2024	2025	Δ (k€ / %) 2024-25	
National Programmes	24 360	27 878	3 518	14%
European Programmes	10 501	13 157	2 655	25%
R&D Services and Consulting	2 420	2 447	27	1%
Other Funding Sources	359	982	622	173%
Total Revenues	**37 641**	**44 463**	**6 823**	**18%**

Figure 2.3 illustrates the funding distribution planned for 2025, and its comparison with the plan for 2024. The total revenue planned for 2025 grows 18% in comparison with 2024, with variations per funding source, as explained below.

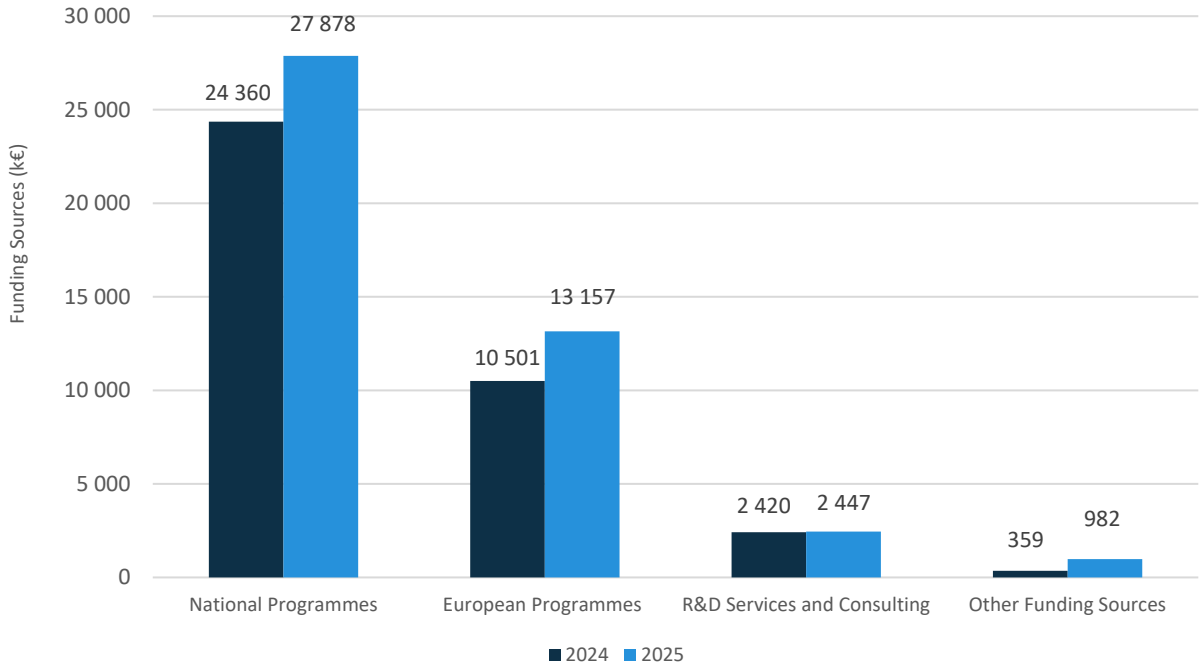


Figure 2.3 - Evolution of funding by source (k€)

Figure 2.4 shows the funding distribution by source in comparison with that of the previous plan.

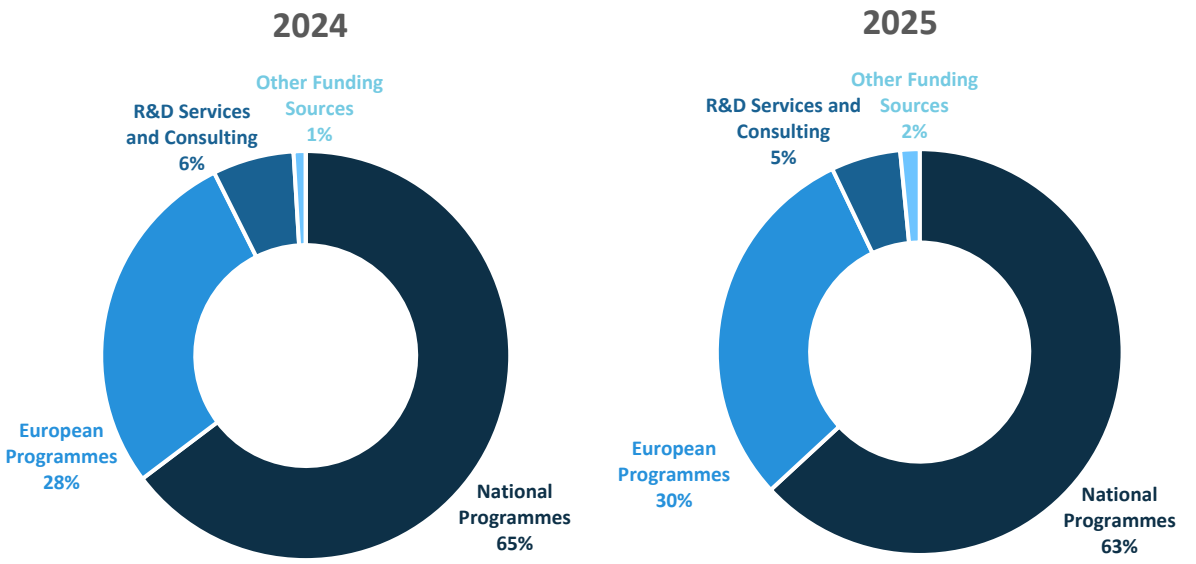


Figure 2.4 - Distribution of project funding by source - Plan 2024 (left) and Plan 2025 (right)

The number of active projects and the average funding per project by source is also of interest, as shown in Table 2.5.

Table 2.5 - Number of active projects and average funding by source (Plan 2025)

Type of Project		Number of Active Projects		Δ (%)	Average Funding (k€)	
		2024	2025	2024-25	2024	2025
PN-FCT	National R&D Programmes - FCT	25	24	-1	63	52
PN-COOP	National Cooperation Programmes with Industry	32	32	0	438	554
PUE-FP	EU Framework Programmes	73	80	7	138	154
PUE-DIV	EU Cooperation Programmes - Other	9	12	3	36	68
SERV-NAC	R&D Services and Consulting - National	34	39	5	44	34
SERV-INT	R&D Services and Consulting - International	4	7	3	75	65
OP	Other Funding Programmes	7	8	1	200	110
	Total	**184**	**202**	**18**	**159**	**172**

The main observations arising from the global indicators summarised in the previous tables and figures are the following:

- The total revenue planned for 2025 grows to 44.5 M€, a value 18% higher than in the 2024 activity plan;
- The 14% increase in national programmes stands out and it is mainly related to the large number of PRR projects (Portuguese Recovery and Resilience Plan) in which the institution is involved, namely 22 mobilising agendas, overall corresponding to a total funding of 18 M€. This means that national programmes now represent 63% of the institution's total funding, compared to the 65% foreseen in the 2024 plan. Furthermore, due to the large size of PRR projects, the average funding per project in national cooperation programme with industry increases from 438k€ to 554k€;

- Still referring to projects in national cooperation programmes with industry, the reduction in their number is related to the end of the P2020 programme and the late start of the P2030 programme. The activity in the P2030 programme is expected to start in late 2024 and grow in 2025 and 2026. Finally, it is assumed that in 2026, P2030 projects will partially replace the activity in the PRR programme, thus reducing the impact of the end of this sizeable programme;
- Particularly noteworthy is the 25% increase in European Programmes, primarily within EU Framework Programmes (Horizon Europe and H2020), which now include 80 active projects. Among these, 11 are coordinated by INESC TEC, with special recognition given to INESCTEC.OCEAN;
- Regarding R&D services and consulting, this plan foresees the maintenance of this activity, representing 5% of the institution total revenue. This essentially results from the high involvement of companies in the PRR agendas and the delayed start of the P2030 programme, which has led companies to postpone new R&D contracts.

2.2.2 R&D Centres indicators

A detailed view of the total funding by source per R&D Centre is given in Table 2.6 and Figure 2.5. In comparison with the plan for 2024, some changes can be highlighted:

- The most relevant variation is the already referred increase in National Cooperation Programmes with Industry (14%), resulting from the projects approved in the PRR (the Portuguese Recovery and Resilience Plan) programme, reflected across all the R&D Centres;
- In terms of European projects, the planned increase (25%) is mainly led by CRAS and the initiative "INESCTEC.OCEAN" - categorised in Table 2.6 as "Special Project" -, while CPES, CTM and HumanISE maintain high levels of activity in this type of funding;
- Activity in national contract research and consulting projects within the Centres is expected to experience a modest slowdown, while a minor increase is anticipated in international projects.

Table 2.6 - Project Funding (k€) and Uncertainty Analysis (Plan 2025)

			R&D Centres													
		Total (k€)	CTM	CAP	CRAS	CBER	CPES	CESE	CRIIS	CEGI	CITE	HUMANISE	LIAAD	CRACS	HASLAB	Special Projects
Projects	PN-FCT	**1 238**	115	72	560	38	73	0	41	117	0	26	105	26	65	0
	PN-PICT	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PN-COOP	**17 720**	2 164	1 301	1 159	496	4 652	1 566	2 681	594	499	1 395	488	140	587	0
	PUE-FP	**12 347**	1 957	243	3 397	376	2 469	468	447	369	359	863	239	88	181	891
	PUE-DIV	**819**	7	4	387	0	17	5	0	0	36	22	0	38	256	49
	SERV-NAC	**1 322**	40	0	246	40	467	293	16	0	0	120	0	0	100	0
	SERV-INT	**454**	0	0	0	40	387	14	12	0	0	0	0	0	0	0
	OP	**877**	0	315	95	3	0	0	0	0	0	0	30	0	109	325
	Total Projects	**34 777**	**4 283**	**1 934**	**5 845**	**993**	**8 066**	**2 346**	**3 197**	**1 079**	**893**	**2 425**	**862**	**292**	**1 297**	**1 266**
Uncertain Projects		**1 226**	**102**	**83**	**59**	**92**	**45**	**15**	**95**	**0**	**8**	**196**	**133**	**0**	**318**	**82**
Total Funding		**36 003**	**4 385**	**2 017**	**5 903**	**1 085**	**8 111**	**2 361**	**3 291**	**1 079**	**901**	**2 621**	**995**	**292**	**1 614**	**1 348**
Uncertain Projects		**3%**	2%	4%	1%	8%	1%	1%	3%	0%	1%	7%	13%	0%	20%	6%

Table 2.6 also shows that uncertain projects represent 3% of the total funding from projects, although the relative weight between uncertain and firm projects is quite variable across R&D Centres, as shown in Figure 2.5

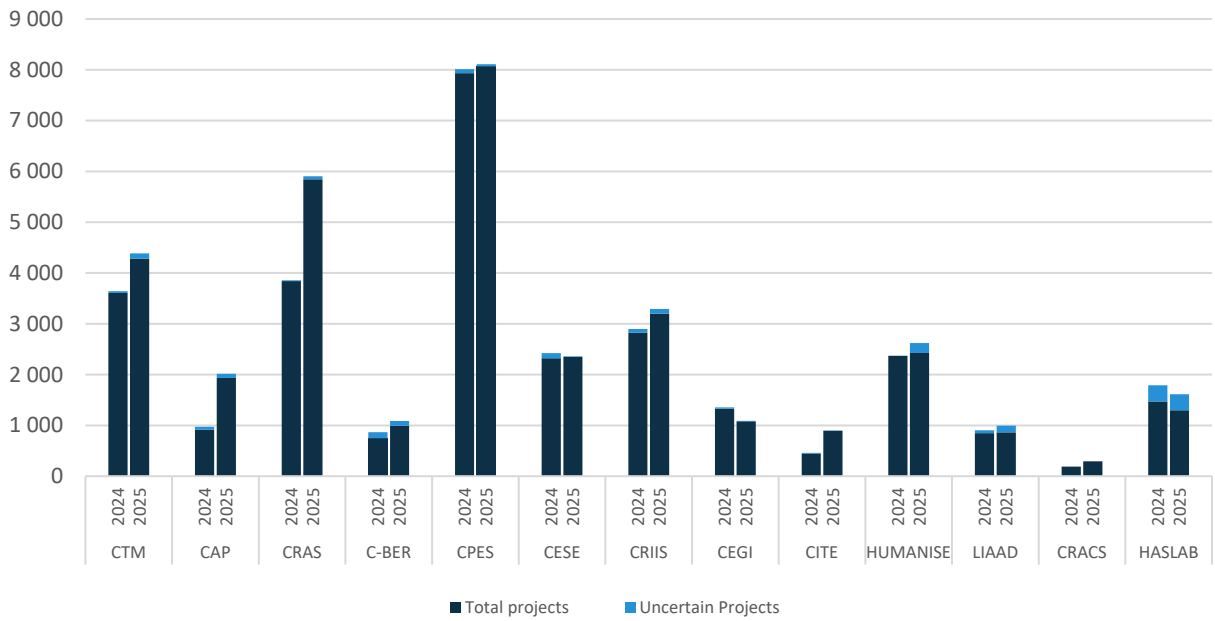


Figure 2.5 - Project funding and uncertainty analysis (k€) per R&D Centre (Plan 2024 vs Plan 2025)

2.3 Publications

2.3.1 Global indicators

Table 2.7 and Figure 2.6 show the number of INESC TEC publications in 2021, 2022 and 2023 and the planned figures from 2021 to 2025.

The numbers for past publications have been obtained from different indexing sources (ISI, SCOPUS and DBLP) gathered by the Authenticus platform. Publications with authors from different Centres are counted individually in each Centre, but the institutional total removes repetitions of the same publication.

Values for 2024 and 2025 have been estimated using a bottom-up approach and must be considered cautiously. Since it was impossible to remove potential duplicates, the totals obtained summing the values provided by each Centre were reduced by the same factor derived from 2023 publications (about 8% of the publications are authored by researchers from more than one Centre).

Table 2.7 - Number of INESC TEC Publications

Publication Type	2021 (Closed)	2022 (Closed)	2023 (Closed)	2024 (Forecast)	2025 (Plan)
Indexed Journals	451	539	524	389	394
Indexed Conferences	471	446	538	339	373
Books	4	4	11	0	3
Book Chapters	33	40	31	21	22
PhD Theses - Supervised	58	43	38	48	54

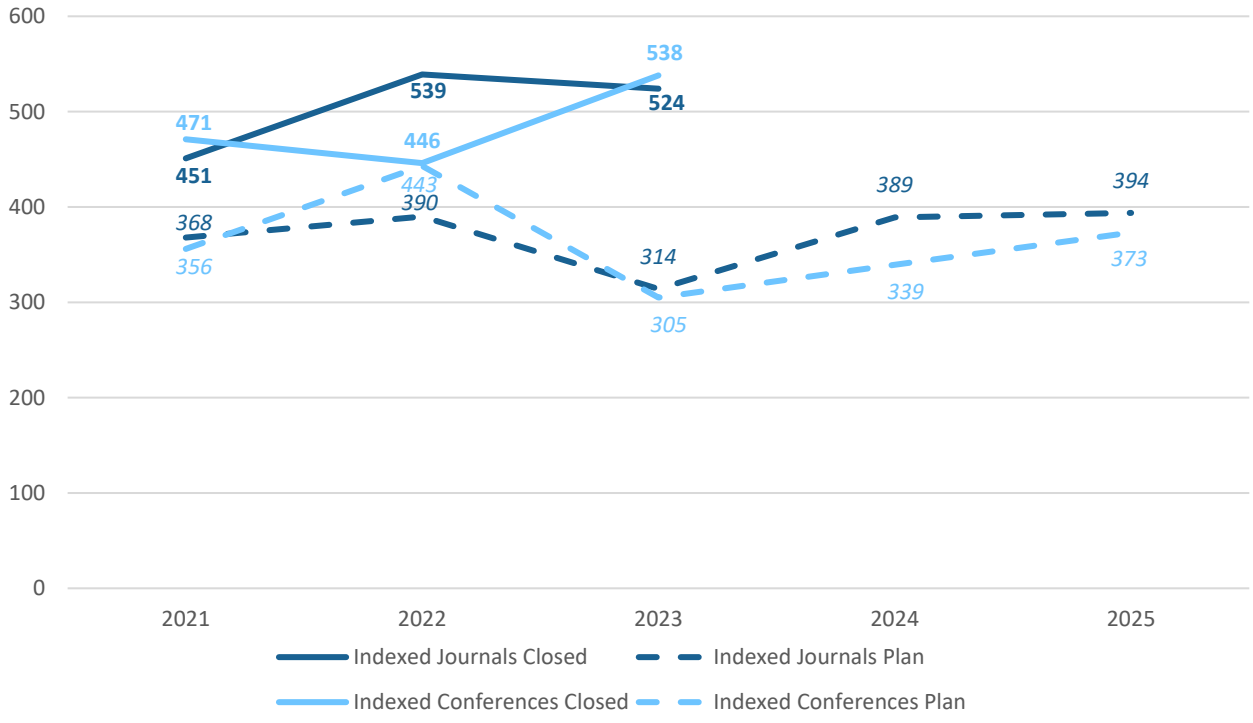


Figure 2.6 - Evolution of INESC TEC Publications

In 2025, scientific production in terms of articles in indexed journals will grow slightly while INESC TEC's R&D Centres also increasingly emphasise outlet quality, focusing on high-impact journals in line with the significance and influence ambitioned for their work.

As in previous plans, estimates are very conservative, as evidenced in Figure 2.6 by the consistent trend where actual values for both indexed journals and conferences significantly exceed the planned figures upon execution.

Similarly, INESC TEC researchers increasingly prioritise publication in high-ranked conferences, often considered more prestigious and competitive, submitting their high-quality work to appraisal according to the standards of the top researchers in their fields.

2.3.2 R&D Centres indicators

Figure 2.7 presents the number of indexed publications in journals and conferences per R&D Centre.

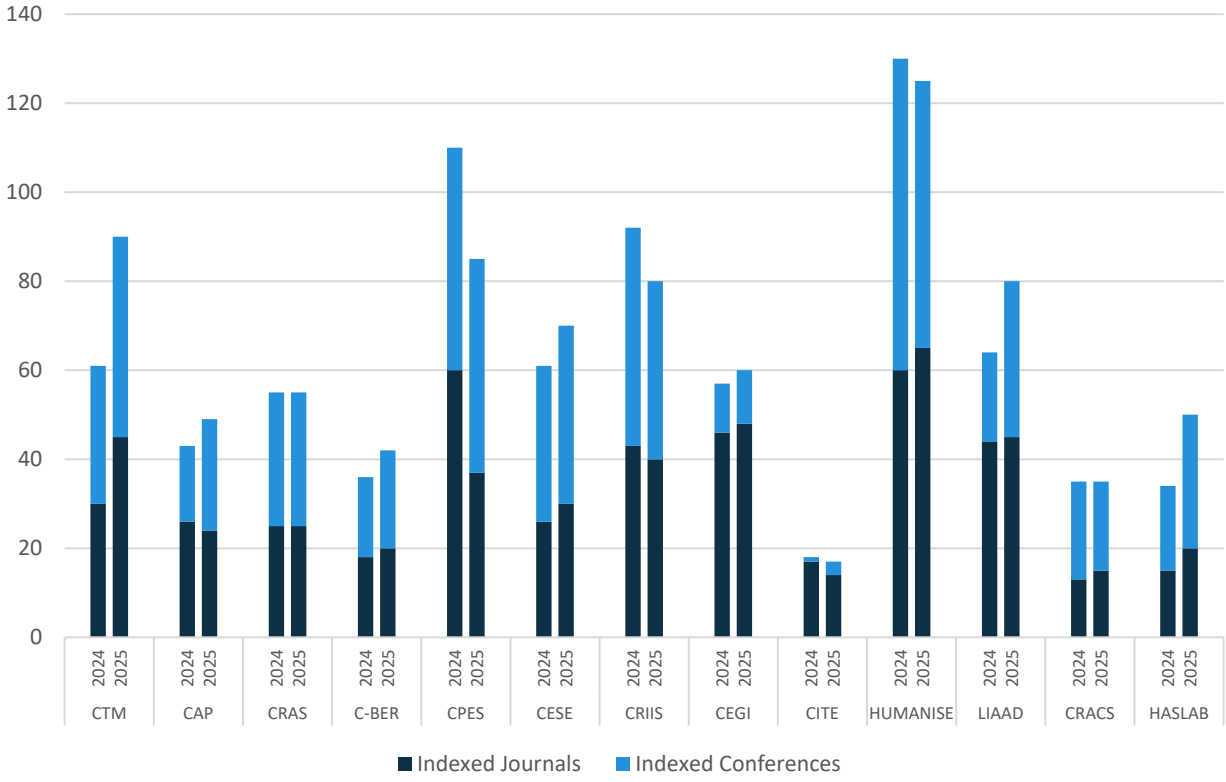


Figure 2.7 - Indexed Publications in Journals and Conferences (Forecast 2024 vs Plan 2025)

2.4 Knowledge transfer

Table 2.8 presents the number of INESC TEC's knowledge transfer (KT) results and the expected evolution for 2025.

Table 2.8 - Results related with Knowledge Transfer

Type of Result	2023	2024 (Forecast)	2025 (Plan)
Pre-disclosures	31	34	36
Invention disclosures	23	15	24
First Priority Patent Applications (New inventions)	8	7	8
First Patents Internationalisation	5	3	4
Commercial Contracts (Licences, Options, Assignments) of direct IP exploitation	3	3	7
Spin-offs established	1	2	3

In 2025, the number of new patented inventions is expected to remain steady, solidifying INESC TEC's position as a leading patent applicant both domestically and across Europe. The institute's IP portfolio strategy continues to emphasise market-driven or high-quality high-risk inventions, prioritising quality over quantity. The number of international patents and grants in upcoming years is expected to reflect this lean approach.

The number of newly documented R&D results, including pre-disclosures and technology disclosures, is projected to align with figures from previous years, maintaining a consistent innovation output.

As for commercial contracts, the Technology Licensing Office foresees an increase due to the ongoing progress in specific-market networking, pricing and negotiation tools, identification of suitable channels and maturity of specific intangible assets.

Finally, three spin-offs are set to be established, while some others are advancing into their development phases. These initiatives include ventures in bioengineering and robotics applications, underscoring a steadfast commitment to translating research into impactful market solutions.

2.5 Dissemination activities

Table 2.9 illustrates the expected activity of INESC TEC members and R&D Centres in various categories of dissemination activities.

Table 2.9 - Results related with dissemination activity – Plan 2024 vs Plan 2025

Type of Activity	2024	2025
Participation as principal editor, editor or associated editor in journals	77	79
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	49	60
International events in which INESC TEC members participate in the program committees	189	188
Participation in events such as fairs, exhibitions or similar	161	81
Conferences, workshops and scientific sessions organised by the R&D Centres	60	54
Participants in the conferences, workshops and scientific sessions organised by the R&D Centres	3 180	4460
Advanced training courses organised by the R&D Centres	29	23

INESC TEC's researchers plan to maintain a dynamic activity in scientific dissemination through events and other formats, in line with the institute's strategic objectives. The list of conferences and other events to be organised or co-organised by INESC TEC researchers is presented in detail in Section 6, for each R&D Centre.

The increase in the number of participants in conferences, workshops and scientific sessions is partly explained by the organisation of 2 high-profile Scientific Conferences in 2025: 1) the ECML-PKDD 2025 Conference, one of the largest and most prestigious events in Machine Learning, expected to attract over 1,000 participants to Porto. The conference will feature a Main Scientific Track, Workshops, Tutorials, an Applied Data Science Track, Special Industrial Sessions, and a Journal Track in collaboration with two leading journals in the field: Machine Learning Journal and Data Mining and Knowledge Discovery Journal; 2) the OFS29 - Optical Fiber Sensors Conference, a premier international forum dedicated to advancements in optical fibre sensor technology, bringing together researchers, industry leaders, and innovators to exchange knowledge, showcase breakthroughs, and explore applications across diverse fields.

While maintaining a commitment to participating in scientific events, the strategy for engagement in fairs and exhibitions has been refined, explaining a reduction in the related indicator. This evolution marks a move from an exploratory approach—where attendance was used to assess the relevance of various events—to a more targeted and strategic focus. Now, the emphasis is on participating in high-impact international technology fairs and exhibitions, such as ENLIT 2025, Hannover, or FIRA trade fairs, which offer significant opportunities for building a global network, fostering strategic collaborations, and presenting the institution's achievements to a well-defined and influential audience. Furthermore, substantial efforts will be directed towards initiatives celebrating the institution's 40th anniversary, highlighting milestone accomplishments and reinforcing its legacy. This refined approach ensures efficient resource allocation, maximising visibility and impact by prioritising events and initiatives that align with the institution's long-term objectives.

3 INESC TEC SCIENTIFIC DOMAINS

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) - presented in the following sections.

3.1 Artificial Intelligence

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

3.1.1 Scope and vision

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. In the 21st century, AI has made major advances, particularly in areas dominated by machine learning and more specifically deep learning. These include natural language processing, computer vision, content generation and recommender systems. Artificial Intelligence is already having a significant impact on many industries, including healthcare, energy, finance, transportation, and manufacturing, 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 also very significant with roots in mathematical logic, linguistics, and psychology. Currently, symbolic approaches open avenues for explainability and transparency in AI systems.

Besides the fundamental need for large amounts of high-quality data (for the correct application), the growing influence of Artificial Intelligence calls for a human-centric approach with advances in the trustworthiness of the delivered tools, chiefly the interpretability of predictions and decisions, generalisation to unseen and even unpredictable situations, and robustness to biased data or unethical results.

Nowadays, Artificial Intelligence has powerful algorithms that can approach very difficult tasks, only doable by humans until little more than five or ten years ago, with astounding quality. Although the success of current neural and statistical approaches is almost blinding, there is a very important legacy of symbolic methods. They matter not only to the human dimension of AI, but also to the possibility of powering non-symbolic solutions with new cognitive layers that can be engineered and designed.

The growing dissemination of AI solutions and AI agents as enhancers of human capabilities, artificial co-workers or artificial experts, boosts the importance of human-AI interaction and of the trustworthiness of AI counterparts. 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 visualisation 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. The ongoing and foreseen transformation of human tasks and jobs requires anticipation and reflection by all the players.

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. At the same time, they can capture refined patterns due to highly powerful estimations and are highly reusable. 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.

3.1.2 Research Challenges

A) Build highly valuable and reusable AI resources

- Algorithms are the central piece in AI development. The combination and modification of classical and modern AI approaches in their symbolic and subsymbolic flavours is the essence of the answer to every current AI challenge. Dealing with different types of inputs and combining them in different regimes, from static to streaming, is very important.
- More than simply processing information, AI algorithms and systems use and produce models that represent knowledge. Models are increasingly an important output of AI. Producing reusable, expandable and refinable models poses a number of important challenges. Developing live and responsive models such as digital twins is a challenge not only for AI but for other domains as well.
- Models become complex and mutable, raising hard questions of how to continuously evaluate and manage them, using human centred and automated approaches. AutoML approaches enable the automatic selection and assessment of models and algorithms.
- Data is a highly valuable asset. Producing, collecting, curating, managing, disseminating, accessing and learning from datasets or data sources are transversal challenges essential to AI development. Data augmentation and the production of artificial data 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. Such pipelines can be made reusable and are an important asset.

Aligned with this research challenge, the following actions are planned for 2025:

- Design of specialised AI agents to tackle complex real-world problems and support decision-making processes. Seamlessly integration of such agents into flexible and scalable decision support systems powered by Large Language Models.
- Advance work in following initiatives: (i) automatically generated courses can create reusable, modular educational content tailored to specific AI resources, promoting scalability and accessibility for diverse audiences; (ii) educational Chatbots can act as repositories and interactive tutors, providing explanations, examples, and real-time feedback, which enhances resource value and reusability; (iii) domain-specific and context-aware approaches to entity extraction aim to produce NLP frameworks that adapt to dynamic lexicons and domain drifts, which can be repurposed across various industries like healthcare, finance, or technology; (iv) disinformation detection involves integrating multilabeling techniques to create an adaptable system that can evolve with changing disinformation patterns, such a system could be reused or extended in other contexts for content moderation or information verification.
- Development and management of research datasets and data workflows through institutional data repositories and data curation practices aimed at improving data FAIRness and reusability.
- Development of reusable resources such as pipelines, packages, services for different purposes from prediction to information extraction.

B) Exploit models and algorithms for advanced tasks

- Pre-trained large models have the ability to solve problems they haven't been trained for. They can be exploited as is, in a zero-shot manner, or with some further training, as in few-shot, 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, instead of artificially coded programs.
- Exploiting models as complex entities, and almost natural phenomena, represents a number of challenges which themselves lead to the understanding of the models, their algorithms, and 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, when communication with humans is important. The exploitation of neuro-symbolic approaches or the use of symbolic methods per se for more than optimising prediction error are important research paths.
- The development and validation of AI systems or of information systems with AI components.

Aligned with this research challenge, the following actions are planned for 2025:

- Advancement of hybrid optimisation methods to address increasingly complex problems in health, manufacturing, logistics and supply chains. These efforts will target dynamic production planning, asset management and inventory routing in environments characterised by uncertainty and rapid change. By integrating optimisation with machine learning, these methodologies will provide robust, real-time decision-support systems, enabling faster and more effective responses to disruptions. Applications will span diverse sectors, including manufacturing, transportation, and energy, contributing to greater operational efficiency and resource utilisation.
- Application of AI models for accounting organisation, software configuration and validation of clinical records.

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. The development of effective collaboration between AI systems and humans requires sophisticated modeling, trustworthiness and explainability.
- Enabling humans to inspect AI algorithms, pipelines and models is important for avoiding and correcting errors, increasing safety and trust. Verification of systems and programs becomes more complex than with ordinary algorithms. Visualisation becomes a very important tool.
- It is important to anticipate and mitigate the risks and the impact of AI systems in society and in individuals. Privacy, safety, freedom, employment and general wellbeing must be taken into account in every step of AI development, starting from conception and continuously in deployment.

Aligned with this research challenge, the following actions are planned for 2025:

- Contribution to the enhancement of the interpretability of predictions and decisions of the models in different scenarios focusing on the societal impact, methods and metrics. Consolidate the proposed methods for privacy-preserving visual case-based explanations. Investigate from correlations to causality using the causal interpretation for improving the model's outcomes for a variety of applications.
- Identification of architectural patterns to ensure Human Centered AI approaches, ensuring Trustworthy AI systems by design.
- Enhancement of explainability and causality for Machine Learning and on natural language interaction.

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. To face these challenges it is important to 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, such as photonics, that combine the paradigms of extreme learning machines, reservoir computing and diffractive neural networks towards the deployment of all-optical processors and A.I. platforms, with advantages in processing speed, scalability, and energy efficiency.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of classifiers for real-time application to run on the edge, on-board of autonomous systems with limited or no communications with control systems.
- Development of innovative toolchains and architectures for RISC-V based SoCs extended with custom accelerators and instructions, in the context of AI-edge devices.
- Work on Federated Learning, model quantisation and distillation, generation of synthetic data and data stream mining (online learning).

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

- The work on the development of intelligent decision support systems combines 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.
- 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.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of techniques for entity extraction and disinformation detection.
- Development of new sensor fusion methods and algorithms for multi-modal perception systems, addressing dynamic in multiple scenarios from underwater, airborne or other GNSS-denied environment.
- Development of new approached for automatic audiovisual content creation that explores the coherence of the content created in terms of multimodality, the emotion transmitted and the artistic quality of the overall content.
- Enhancement of semantic scene understanding and completion by Investigating approaches for multimodal knowledge extraction and fusion, towards the creation of linked concepts with temporal relevance to create Spatio-Temporal-Scene-Graphs. The aim is to explore how the usage of various sensors and modalities can decrease the bias an increase the performance of models in the scope of several tasks, namely captioning, retrieval (converted in a graph matching problem) or visual questioning answering (answers can be found directly on the graph).
- Development of methods that are robust and able to generalise to unseen and even unpredictable situations. Enhance the multi-task learning frameworks to efficiently and accurately perform multiple interconnected tasks.
- Development of novel methodologies for grounding language with images and for information fusion.

3.2 Bioengineering

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

3.2.1 Scope and vision

The field of Bioengineering addresses fundamental engineering principles, practices and technologies for medicine, biology, environmental and health sciences to provide effective solutions to problems in these fields. This field includes (but is not limited to) the development of mathematical theories & models, physical, biological and chemical principles, computational models and algorithms, devices and systems for clinical, industrial and educational applications in these domains.

We envision the next generation of advances and high impact of research on bioengineering for prevention, early detection and diagnosis of different types of diseases, ageing-related impairments, rehabilitation, occupational health and wellness, environmental-biology interactions, among others.

- Development of bioengineering novel methods and tools for the prevention, early detection and diagnosis of different types of diseases, ageing-related impairments, rehabilitation, occupational health and wellness, environmental-biology interactions, among others.
- Development of advanced technologies at the frontier of engineering, medicine, biology and other health & environmental sciences and transfer them to the future world market;

3.2.2 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 micro & nano sensing in different disease models 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

Nowadays we are collecting ever larger amounts of health information and having more and more computer power but we are not using this availability to its full potential for promoting personalised and precision solutions to todays' health challenges such as cardiovascular diseases, diabetes or Alzheimer's disease.

Genomics is generating data at an unprecedented scale by assaying molecular data from a large set of individuals in a time and cost-effective way. While this opens new avenues for research and treatments, it also poses many challenges in order to handle the volume of data and speed of analysis that is required. To tackle some of these problems, we expect to apply cutting-edge genomic data science including AI and machine learning techniques, but also develop novel data analysis strategies. Different omics data will be combined with other multi-modal data, including wearable and health sensors and clinical data, to obtain an integrative view of the physiological state of the individuals. Data will be analysed at different levels of granularity, to understand the mechanisms that lead to complex phenotypes and diseases. We expect to understand unmet clinical needs and apply the acquired knowledge for patient benefit.

Methods and tools to integrate and harmonise knowledge will be brought together with computational models to produce digital platforms leveraging personalised health research. The goal is to empower medical research with the necessary computational framework to determine treatment pathways adapted to each individual.

In this RC we aim to combine large-scale data collection (from electronic patient records to genetics and proteomics) with human-centred technology design to contribute to new approaches to these health challenges and help patients better manage their health and humans live healthier & happier lives. Several competencies of INESC TEC are and will be involved in this RC, from Health informatics & Computational Biology to Bionics, Wearable and Implantable technologies.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of techniques for gene expression and integration of multi-omics datasets.
- Development of new occupational health methodologies based on psychophysiology measures. Some of these results are key to promoting well-being in the workplace.
- Creation of tools for real-time feedback and educational initiatives to improve sleep literacy across populations as well as the development of automatic individualised sleep recommendations and interventions.

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.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of new image analysis and deep learning approaches to support clinicians in the classification of endoscopic lesions. These new methods will use one of the largest datasets at the European level to enhance their performance.

  Development of hybrid in silico/physics-informed machine learning approach for multimodal data fusion, resulting in cutting-edge, high-fidelity digital breast models with breast magnetic resonance imaging pose transformation from prone to supine, to predict tumour location.

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.

Aligned with this research challenge, the following action is planned for 2025:

- Design and implementation of a “symbiotic engine” and test it in a virtual environment and possibly in real life.

3.3 Communications

Steering Committee: Manuel Ricardo and Rui Campos

3.3.1 Scope and vision

Context-aware, on-demand communications systems using and providing ubiquitous sensing

Communications technologies, mainly those that are wireless and aligned with the vision for next-generation, are essential for the development of other research areas. Current visions in fields such as industry, energy, smart cities, mobility, health, sea, and agriculture demand well-engineered communications solutions. The current and next generations of communications systems are substantially different from the previous generations. The next generation of mobile and wireless communications will use and provide ubiquitous sensing and localisation capabilities, service-oriented software architectures, autonomous systems for supporting communications equipment such as high-altitude platforms and drones, ubiquitous artificial intelligence, and edge and cloud computing for creating on-demand virtual networks.

Motivated by this vision, the new emerging bandwidth-intensive, latency-sensitive applications, and the need to connect the unconnected, this scientific domain sees as its major challenge the design of communications systems that are more context-aware and deployable on-demand. This means communications systems that can dynamically adapt their characteristics according to the communications context, including the physical environment, energy constraints, the communicating peers, and the users or machines involved in the communication.

3.3.2 Research Challenges

A) Autonomous Communications Systems

Communications networks are the nervous system of the digital world in which we are and will be immersed. Next-generation communications systems need to be self-manageable, self-controllable, and self-adaptable towards fully autonomous communications networks operating similarly to other autonomous systems such as autonomous cars.

The ever-increasing complexity of the underlying technologies, including an ever-increasing number of parameters that can be controlled and whose optimisation according to the context is yet to be explored, is not compatible with the human-in-the-loop anymore. Also, there is a need to make communications efficient and scalable from multiple perspectives including performance, energy consumption and privacy.

This complexity leads to an increasing need for novel solutions that take advantage of advanced optimisation techniques and the computational capacity available, either in the cloud or in the edge, as the means to self-manage, self-control, and self-optimise the network operation dynamically and in real-time.

In this research challenge, we aim to investigate new fundamental communications solutions that support the digital world of the future in a sustainable and secure manner. This will be achieved by means of:

- Developing mobile, adaptive networking infrastructures for agile and flexible network coverage and capacity reinforcement using robotic platforms.
- Creating wireless network digital twins enabling fast, flexible, and energy-efficient evaluation of “what if” scenarios and the training and validation of novel AI/ML-based communications algorithms without the burden and resource-inefficient training and testing in real testbeds.
- Developing new security mechanisms, algorithms and protocols providing increased levels of communication confidentiality, integrity, and availability from PHY layer to APP layer, considering an increasing amount of input data, the physical environment where the communication is taking place, the wireless medium over which the communicating is being accomplished, as well as the challenges of increasingly decentralised/distributed communication scenarios.
- Developing machine learning models for intrusion detection of encrypted malicious traffic against a backdrop of human- and machine-generated legitimate traffic in the context of zero-trust networks, via training with legitimate traffic only or with both legitimate and malicious traffic.

- Developing mechanisms to exploit the advances in distributed renewable energy sources and energy flexibility to integrate communications infrastructure and power distribution systems towards energy-aware networking.
- Novel approaches for learning to adapt baseband processing to the communication context and environment, including multi-standard, multi-mode support (e.g., radio, optical), free frequency bands, interference patterns, spectrum sharing, and the state of the hardware platform (e.g., power supply availability, computational power) towards a more energy efficient computing at the edge.
- Photonic integrated circuit design and programmable photonics for mmWave fibre/wireless communications towards a seamless integration of optical and wireless networks and Quantum Key Distribution (QKD) for truly secure communications.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of new AI models to automatically detect the dynamic QoS requirements of a given emergency scenario, producing a Service Level Agreement (SLA). Our algorithms will, then, optimise the placement of the UAVs and radio resources allocation to comply with such SLA. Finally, Large Language Models will be used to automatically create the flight plans for the UAVs, and the necessary code to interface with the APIs of possible different auto-pilot solutions from different vendors.

B) Communications for Extreme Environments

Airborne, underwater, underground, and industrial communications have been attracting growing interest in the research community. Underwater wireless networks have been considered for military and commercial applications including ocean data collection, disaster prevention, border surveillance, and environmental monitoring. Unmanned aerial systems can assist humans in extreme or difficult-to-reach environments as well as provide cost-effective wireless coverage and capacity for devices without infrastructure coverage. Underground wireless networks can enable applications such as precision agriculture, pipeline leakage detection, mine disaster rescue, and concealed border patrol. Satellites can improve communications, namely in remote areas (e.g., offshore) and ongoing monitoring of Earth phenomena ranging from weather and climate to disaster management. Industrial communications have been relevant for communicating with the users and devices on the shop floor and more recently with the robotic platforms such as Autonomous Ground Vehicles (AGVs) operating there as well, where wireless communications become crucial.

Underwater, aerial, underground, space, and industrial wireless networks share common core research challenges that arise from the harsh nature of the propagation medium (absorption, reflection, diffraction, and scattering), the inaccessible nature of the environment, and the tight Quality of Service (QoS) requirements in the case of industrial wireless communications, in many cases used to replace wired solutions. As a result, conventional communications and networking techniques cannot be applied in extreme communication environments like these mainly due to the unavoidable impairments suffered by using traditional wireless technologies and the limitations of operating far from the power grid.

In this research challenge, we target the development of communications solutions for extreme environments such as the ocean, industry, natural and manmade disaster scenarios, and space. This will be accomplished by means of:

- Developing multi-tier communications approaches for extreme environments, including integrated communications across multiple media such as space, air, underwater, and underground.
- Investigating robotic-borne wireless networks enabling mobile, adaptive networking infrastructures in extreme environments such as air, water surface, underwater and underground by taking advantage of robotic platforms for carrying the communications nodes (e.g., AUVs, ASVs, UAVs).
- Creating network digital twins enabling fast, flexible, and energy-efficient evaluation and training and validation of novel AI/ML-based algorithms without the time-consuming, highly costly, and resource-inefficient training and testing in real testbeds and environments.
- Developing robust and high data rate underwater communications taking advantage of short-range acoustics and multimodal approaches combining acoustics, optical and radio simultaneously and considering multiple input parameters such as water salinity, water turbidity and background acoustic noise.

- Developing communications solutions for industrial environments, including cabled, hybrid and full wireless using multi-technology and multimodal approaches (e.g., radio, optical).
- Using geometric and probabilistic constellation shaping techniques for more resilient, energy-efficient, and adaptive optical wireless underwater.
- Developing free-space quantum communications solutions for high-security wireless communications.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of semantic encoders and decoders fine-tuned for underwater maritime scenarios, allowing for long-range broadband-like quality of experience through very bandwidth constrained acoustic links.
- Development of fallback Internet communications solution for emergency and maritime scenarios, deployed on-board platforms. Such solutions will create a local communications "bubble" with Internet access capabilities using a LEO-based backhaul link.

C) Obstacle-aware Communications

Communications and sensing have evolved as separate scientific fields. This is envisioned to change with the advent of wireless communications in the millimetre-wave frequencies and up to the sub-THz and visible light frequencies, characterised by line-of-sight operating ranges, which could benefit from visual data to accurately predict the wireless channel dynamics such as anticipating future received power and blockages as well as constructing high-definition 3D maps for positioning.

Computer vision applications will become more robust against occlusion and low luminosity if helped by radio-based imaging, such as the high frequency radio signals generated by large reconfigurable intelligent surfaces that can also provide high-resolution sensing.

This new and emerging joint research challenge relies on a range of technologies in the fields of wireless communications, computer vision, sensing, computing, and machine learning, and is aligned with the research trend on Joint Communications and Sensing (JCAS) towards mobile perceptive networks.

We aim at developing novel communications solutions that incorporate network and environment sensing by design, towards perceptive networks. This will be carried out by means of:

- Designing reconfigurable electronics transceiver architectures and signal processing algorithms for large antenna arrays up to 110 GHz, enabling accurate beamforming and spatial noise-shaping, towards real-time digital control of antenna array radiation patterns suitable for environment sensing, localisation and obstacle-aware communications.
- Photonics-enabled communications and sensing devices: novel algorithms and hardware architectures based on radio-over-fibre and optical-wireless interfaces enabling wireless communications and RF sensing and localisation with large antenna arrays up to the sub-THz.
- Designing obstacle-aware robotic-borne networking solutions ensuring line-of-sight communications for agile and flexible coverage and capacity reinforcement in urban scenarios and indoor environments, using computer vision and sensing techniques for environment-aware positioning of the airborne infrastructure nodes.

Aligned with this research challenge, the following action is planned for 2025:

- Establishment of a novel research platform. The basis of this infrastructure is an experimental Chamber, which enables the collection of synchronised experimental data from radio communications, radio sensing, and vision sensing, and features a 10 Kg capable robotic arm holding a vision-assisted 5G mm-wave Base-station running Open Air Interface (OAI), allowing for the realisation of experiments mimicking a fully mobile base-station, as well as an obstacle with controlled mobility. This platform will also integrate a vision-aided reconfigurable intelligent surface (RIS), a vision-radio simulator and 3D environment modeller, and machine learning (ML) algorithms accessible through a web-based dashboard. This platform will be integrated with the SLICES-RI Metadata Registry System, which will allow for the storage of annotated vision-radio datasets.

3.4 Computer Science and Engineering

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

3.4.1 Scope and vision

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

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

The incredible progress being made towards the widespread use of digital sensing and instrumentation technologies along with the sheer computing power at our disposal reinforces our resolve to effectively and efficiently collect, filter, curate, store, process, visualise and analyse the massive volumes of data generated.

As our reliance on information systems grows, there is a rising need for these systems to be trustworthy, fast, always available, and ethically responsible. Software development, verification, and testing have become crucial aspects in the critical path of any digital system, underlining the paramount importance of ensuring quality throughout the entire process.

The whole computing pipeline is becoming more complex, which poses additional challenges in ensuring reliability and performance. Therefore, research on computing architectures and non-functional aspects of software is essential for achieving the scalability, interoperability, and efficiency required for sustainable digital systems.

3.4.2 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. In this context, 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:

- Designing tools and techniques to evaluate and improve the interaction between developers and software development tools in next-generation development environments.
- Creating new approaches, techniques and tools to improve the developer experience, along the software development life cycle by providing quicker, better and more informative feedback about the several quality aspects of the software being built; easy integration with traditional development and quality assessment tools; and suggestions, recommendations, and guidance on how to improve those quality aspects (e.g. liveness, smart-assistance, AI-based co-piloting tools, immersive environments).
- Develop new techniques and tools to support and ease the maintenance phase of software systems. This can be achieved by automatically generating new test cases to exercise novel system parts and using traceability information to calculate the subset of existing test cases that are impacted by changes.
- Improve the education of future software engineers, with didactic approaches and learning-supporting tools, targeting all phases of the software development process, from formal requirement specification to programming and testing.
- Empowering more people with simpler software development approaches and tools to enable them to design and build their own applications addressing their 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 the increasingly complex software systems that are being developed nowadays, namely large-scale concurrent and distributed systems and cyber-physical systems that operate in uncertain and hostile environments. We will also target emerging computing paradigms where future software systems will be developed, particularly quantum computing platforms. This is to be achieved as follows:

- Designing scalable rigorous methods, calculi, and logic to ensure and verify program correctness at all levels of the software development process.
- Improving structured and formal requirements specification languages to diminish ambiguity and enable research on the automation of the software development process, namely on the deployment of synthesis procedures to repair incorrect programs or automatically generate invariants to support program verification.
- Designing techniques and tools to increase the effectiveness and efficiency of software testing where traditional testing techniques are difficult to apply (for example, distributed or AI/ML driven systems) and taking advantage of HPC environments.
- Contributing to innovative concurrent high-level and domain-specific programming languages, APIs and compilers targeting the whole spectrum of parallel and distributed computing, by raising the abstraction level of current approaches.
- Improving the scalability and usability of formal design techniques and tools, to enable the verification of complex distributed and cryptographic protocols directly by the domain experts, without the need to resort to (scarce) formal methods experts.
- Integrating rigorous formal analysis and user-centred design practices in software design techniques and tools to enable both formally proving user-centred requirements during early design stages and prototype evaluation.
- Creating foundations and rigorous mathematical methods for emerging computing paradigms, including Quantum Computer Science, Quantum Software Engineering, Post-Quantum Secure Systems and Cyber-Physical Systems.

Aligned with this research challenge, the following actions are planned for 2025:

- Design of novel tools for testing the reliability of data-centric applications to ensure data durability under faults.
- Development of a lightweight formal methods tool for the design and analysis of transactional consistency criteria in database management systems.
- Development of a tool-supported approach to generating natural language explanations of model checking counterexamples.
- Production of a formally verified implementation of the upcoming standard for a post-quantum secure signature scheme (Dilithium) and obtain verified implementations for the ARM architecture.

C) Managing the Increasing Complexity of Critical Information Systems

The way information is produced and consumed has a profound impact on society, both in personal and professional contexts. Two central problems arise from this information abundance: managing complexity and managing information quality and relevance.

Managing complexity is a challenge that arises from both the infrastructure and access points of view. With so much information available, it can be difficult to manage the underlying infrastructure that supports it, including storage, processing, and distribution. Ensuring that these systems can handle large volumes of data while still operating efficiently and effectively is crucial.

At the infrastructure level, where complexity results from factors such as its size, diversity of software and services, multiple data sources, differences in administrative domains, compliance with laws and regulations, and other challenges related to functionality and application domains, non-functional system characteristics play a critical role in ensuring the trustworthiness and sustainability of these systems. Non-functional system characteristics refer to aspects of computing systems that are not directly related to their core functionality, but rather to how well they perform in terms of scalability, performance, interoperability, dependability, security, energy efficiency, as well as quality, quantity, and confidentiality of information they process.

The second central problem arising from information abundance is accessing and managing the quality and relevance of the information organisations and individuals use and are exposed to. With so much information available, it can be challenging to find the specific data or content that one needs, and this is crucial for maximising productivity and efficiency. Even more difficult, is to ensure that the information being used is of high quality and relevance. This is particularly true in the era of fake news and misinformation, where it can be challenging to distinguish between accurate and inaccurate information.

The overarching challenge when dealing with multi-objective solutions and often conflicting requirements lies in being able to provide the best balance for each specific application or service at hand, which requires a deep understanding of the many variables at play, and composable multidisciplinary approaches and solutions. To this end, we envision the continued need to focus on improving:

The non-functional aspect 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 organisations 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.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of data management solutions to improve the efficiency and sustainability of AI workloads running on HPC centers by designing novel energy-efficient and carbon-aware systems, namely, at the storage layer.

- Improvement of the security and privacy of data-centric applications/services and corresponding infrastructures by designing privacy-preserving data management solutions and ransomware-proof systems.
- Development of techniques to foster adaptable computing in the edge-cloud computing continuum with privacy-centric processing to be done at edge, namely, by exploiting application-specific accelerators, the memory hierarchy, and weak consistency replication.
- Redesign of decades-old storage and operating systems' building blocks to improve the performance, dependability, and resource efficiency of modern computing infrastructures, namely supercomputers and cloud data centers, by leveraging emerging hardware and technologies.
- Production of reliable software solutions that can deal with large amounts of data in a privacy-preserving manner to assist researchers from social and life sciences in designing and investigating novel personalised treatments in application areas ranging from mental health to epidemiology and immunology. Such large-scale software ecosystems, assist researchers in structuring and extracting knowledge, applying a variety of data analysis tools and ML models in a trustworthy and privacy-preserving computational environment. Solutions sought are in-line with interoperability and data sovereignty guidelines as envisaged for the European Health Data Spaces (EHDS), as well as with the enforcement of responsible AI principles.

D) Designing and Deploying Heterogeneous Computing Architectures

Processor architectures moved from single-core to multi and many-core including heterogeneous accelerator devices such as ASICs or FPGAs, with many of the dimensions of flexibility offered in the past by software to be shifted to hardware components. However, the future is looking towards new applications on the edge and IoT applications, including the use of AI and ML algorithms, stricter time constraints, and more power-efficient computation to address economical and sustainability concerns.

Therefore, as the performance requirements of these modern applications continue to increase, heterogeneous systems offer a way to achieve the required performance while minimizing power consumption and cost. Heterogeneous systems will provide a way to tailor hardware to specific applications, where the hardware meets the application demands, and where the software effectively utilises the hardware.

The design of these novel computing systems needs to consider the holistic vertical continuum of hardware and software, to cope with these emergent applications. The increase in the complexity of systems, the requirements on high performance of autonomous systems, and the dependability and cybersecurity requirements. This comprises a challenge that spans from the digital component, through the instruction sets and compilers, and up to the 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 optimisation.
- 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.

Aligned with this research challenge, the following actions are planned for 2025:

- Integration of multiprocessor architectures for AI. The integration of various processing units and hardware accelerators for artificial intelligence enables the utilisation of devices tailored to specific tasks or workloads, thereby optimizing performance through some level of specialisation. However, two

primary challenges arise: determining the appropriate types of diverse hardware or accelerators to employ and effectively partitioning the workload among the different devices. Solutions are being pursuit using standard instruction set RISC-V architectures and ASIC devices.

- Establishment of new hardware architectures in CMOS technology that exploit the inherent parallel computing properties of analog signal processing and its power efficiency for AI applications. Take advantage of ever-smaller digital circuits to build digitally assisted analog computation for improved accuracy. Improve efficiency by encoding information in sparse, pulse-based signaling with very low duty cycle for real-time, event-based operations where the system consumes energy only during the event.
- Design novel mechanisms and scheduling schemes to improve the energy efficiency of HPC clusters by leveraging the heterogeneity of modern infrastructures and the programmability of emerging hardware solutions.
- Development of innovative toolchains and architectures for RISC-V based SoCs extended with custom accelerators and instructions, in the context of AI-edge devices. Moreover, the improvement of safety of the C languages, with work such as the application of Rust-like safety rules over the C language, or new approaches to standards like MISRA-C.

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

Human-technology symbiosis is a close and mutually beneficial relationship between humans and machines, mutually enhancing their capabilities. Humans and machines are increasingly collaborating, by sharing information, goals, and tasks, fostering a symbiotic relationship to empower and complement each other.

Digital environments, combining immersion/presence, collaboration, interaction, and narrative, provide rich and engaging experiences for users, in the context of learning, entertainment, workplaces, and industry, raising challenges for their integration with everyday information systems and processes.

This research challenge aims to improve computational systems to enable a better relationship between humans and machines, 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.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of responsive interfaces.
- Development of 3D environments and tangible interfaces and in multisensory systems.
- Development of information retrieval and information access methods to support better integration between users and computational systems.

3.5 Power and Energy Systems

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

3.5.1 Scope and vision

Support to the Sustainable Energy Transition

This Scientific Domain supports the energy transition leading to a reduction of GHG emissions, via the decarbonisation of the energy system, large-scale RES integration, electrification of the society and increased energy efficiency.

This involves the combination of physical representations and data-driven methods for modelling and optimising energy systems, leveraging from emerging technologies like AI, blockchain and interoperability.

Results include concepts, models, methodologies and tools useful for addressing the decision problems of citizens, communities, multi-utilities, system operators, regulators, policymakers and government bodies.

3.5.2 Research Challenges

A) Cost-effective decarbonisation and digitalisation 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 à critical to decarbonise other economy sectors:

- H2 utilisation in fuel cells (e.g., mobility);
- NH3 utilisation in chemical industry (e.g., fertilisers);
- H2/NH3 utilisation as renewables storage (to generate carbon-free electricity again).

Digital technologies should be integrated in energy systems operation and planning to further increase the integration of clean energy sources.

Main challenges

- New mathematical models for emerging technologies like electrolysers and thermal storage
- Novel methods must be developed to optimise the integrated management of multiple energy networks and vectors
- Managing advanced digital infrastructure for power systems
- Designing 100% renewable systems

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

- Optimise the operation of electrolysers to maximise the use of renewables and provide system services.
- Develop advanced control solutions to manage natural gas networks when incorporating renewable gases (biogas and H2).
- Enable the implementation of P2P solutions associated with seasonal energy storage to guarantee security of supply.
- 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).
- Aggregate multi-vector resources' flexibility for optimal participation in electricity, gas and carbon markets.
- Design and operate 100% renewable systems for green hydrogen and ammonia production.
- Implement reference architectures to facilitate secure data sharing in the energy sector – energy data spaces.

- 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.

Aligned with this research challenge, the following actions are planned for 2025:

- Conduct research on the co-location of different energy sources within offshore power plants to reduce overall project costs by maximising the use of existing infrastructure, increasing electricity generation, and achieving a lower levelised cost of electricity (LCOE). This integrated approach will enhance the economic viability of offshore energy projects while supporting the transition to a sustainable energy system.
- To address the significant challenges for power system operation and control introduced by the large-scale adoption of hydrogen (H_2) electrolysers, innovative control schemes will be developed to enable H_2 electrolysers to actively participate in system support services, both in onshore and offshore environments. These schemes aim to enhance grid stability, flexibility, and resilience while integrating green hydrogen production.
- Advancement on the concept of the Data Space Connector as a service to incentivise prosumers and consumers to share their energy data. By incorporating a reward mechanism, this approach will drive the adoption of digital energy services. The connector-as-a-service model simplifies the deployment of data spaces, reducing complexity and associated costs, thereby enabling broader access to innovative digital solutions across the energy sector.

B) Evolving and de-centralizing 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.
- Provide appropriate economic signals to consumers and producers to induce them to adapt their short- and long-term behaviors to existing and expected demand and supply.

In the past - these markets were based on large, centralised conventional generation plants producing and adjusting their schedules to follow inelastic and unaware energy demand, together with the provision of the necessary reserves to the system.

Now - we are now facing a shift towards a distributed and decentralised energy system, characterised by:

- mass electrification
- the increase of distributed generation from clean and hard-to-dispatch renewable primary sources
- the development of new distributed energy resources

This rapid evolving environment is posing new technical and market challenges for their efficient integration.

The main challenges are:

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.

Aligned with this research challenge, the following actions are planned for 2025:

- Address the enhancement of market access for small-scale customers by developing multi-energy aggregators to foster a more inclusive and decentralised energy ecosystem. These aggregators will integrate and optimise multi-vector resources—electricity, heat, and gas networks—to unlock their

flexibility and enable effective participation across various energy markets. This approach aims to empower small-scale and distributed energy participants, supporting their engagement in local and wholesale energy systems.

- Development of innovative business models and algorithms tailored to diverse stakeholders, including renewable energy project promoters, shared asset managers, vulnerable consumers, and hierarchical energy-sharing schemes. These models will incorporate new flexible assets while addressing the challenges of flexibility provision to support the establishment and operation of local energy communities. This will enable energy communities to develop further and balance local needs with broader system requirements.
- Design of local energy and flexibility markets while ensuring their seamless coordination with wholesale energy and system service markets. These market frameworks will enable decentralised decision-making, promote efficient resource use, and foster resilience in a dynamic and evolving energy landscape.
- Adoption of foundational models for time series such as Chronos and large language models (LLMs) like LLaMA to support end-consumers in interpreting energy data, improve data quality by addressing missing data issues, and providing actionable recommendations to end-users in a trustworthy way.

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.

- Severe weather events such as extreme heat, cold waves, storms, and dust clouds can reduce thermal and hydro power, make photovoltaic power unavailable for extended periods, and lead to a lack of wind power.
- The progressive electrification of consumptions can also cause significant sudden surges in demand.

Conversely, digitalisation 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.

- Investing in infrastructure that can withstand severe weather events is essential to ensure the resilience of power systems.
- Flexible and responsive power systems are essential for ensuring the security of electricity supply, e.g., demand response, local energy islands.
- Another critical element of a flexible and resilient power system is the use of energy storage technologies.

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. To 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. To develop methodologies for establishing reliable and resilient expansion plans for coupled energy networks (electricity and gas) in converter-dominated systems.
3. To analyse the ability of the existing flexibilities in local energy grids for improving the continuity of supply during contingency events.
4. To leverage data-driven models to monitor the asset condition and to define optimal maintenance plans.

Aligned with this research challenge, the following actions are planned for 2025:

- Definition of hybridisation strategies for hydro-pumped power plants, emphasising their potential to enhance power system resilience. These plants will be critical in providing power regulation services by

improving system flexibility. Additionally, the anticipated reduction in wear and tear will minimise maintenance-related outages, thereby increasing overall plant reliability.

- Development of advanced tools for islanding, service restoration, and network protection in hybrid AC/DC grids. These innovations aim to reinforce energy system resilience by introducing new protection schemes, enabling the formation of stable islanded systems, and significantly reducing system restoration times following major disruptions. The goal is to propose new operations strategies leveraging the flexibility of DER and hybrid AC/DC grid topologies towards a more reliable and resilient operation. Research into the optimal fitting and sizing of grid-forming converters will address multi-class stability challenges, ensuring robust and reliable operation across diverse grid configurations. These converters play a pivotal role in maintaining system stability by emulating the behaviour of traditional synchronous generators, providing inertia, and regulating voltage and frequency in power systems dominated by renewable energy sources.
- Optimisation of multi-vector flexibility and hybrid energy solutions will be prioritised, focusing on innovative thermal storage technologies. This work will lead to developing risk mitigation strategies to enhance system robustness by leveraging the interconnection of electricity, gas, and heat/cooling networks. Such integration will reduce vulnerabilities and ensure seamless operation across various scenarios, including extreme weather conditions.

D) Smart control architectures and centres of the future

Electrical networks are under transformation as the ongoing decarbonisation and digitalisation 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 networks, 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.

Grids ageing infrastructure combined with the proliferation of DER in MV and LV networks, and cybersecurity risks, also motivates the development of new control architectures.

The main challenges to address are:

- More numerous, complex, and coordinated decisions to make;
- More uncertainty to consider and more anticipation needed;
- Human operator cognitive load would continue to increase and might saturate.

The envisioned research challenges are:

1. Promote coordinated operation between electricity markets, TSO and DSO, within an increasingly complex network and market operation context:
    a. Dealing with both long-term and short-term operation restrictions imposed by future flexibility services;
    b. Considering automatic and decentralised control and human assisted operation.
2. Assist human operators via a proactive collaboration in robustly operating the flows over a power grid, avoiding blackouts because of overloads, while minimizing 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 virtualisation and distributed computation at the edge. Namely:

a. Protections adaptive to network operating conditions and to the distributed energy resources connected;

b. Dynamic control area definition could help improve the efficiency of network control strategies.

Aligned with this research challenge, the following actions are planned for 2025:

- Development of advanced AI-based decision-making systems to enhance real-time control of power systems with high levels of renewable generation and flexible resources. Key scientific challenges include accurately estimating aleatoric and epistemic uncertainty and incorporating symbolic knowledge representation to improve system reliability and interpretability. These tools will extend to multi-energy networks, focusing on the dynamic integration and coordination of electricity, heat, and gas networks for a more resilient and sustainable energy system.
- Development of adaptive protection systems for smart distribution substations that seamlessly integrate model-based and data-driven methodologies, aiming to provide more effective control of inverter-dominated networks. New optimal TSO-DSO distributed control strategies will be developed considering Phasor Measurement Units (PMU) measurements and Wide Area Monitoring (WAM) and control tools. Leveraging advanced power-hardware-in-the-loop (PHIL) capabilities, the proposed solutions will enable rigorous testing and validation under real-world operating conditions, while exploring the latest virtualisation and distributed edge computing architectures. Additionally, the systems will incorporate self-learning mechanisms to adapt to evolving grid configurations, fostering a more resilient distribution infrastructure.

3.6 Photonics

Steering Committee: Diana Viegas, Nuno Silva and Pedro Jorge

3.6.1 Scope and vision

The vision for Photonics research at INESC TEC is to explore the potential of photonic-based science in the development of innovative enabling technologies contributing to a smarter, sustainable, and more efficient operation of complex systems such as the human body, the environment or critical infrastructures.

This activity of discovery and innovation subscribes to Optica's core values and is built on accepted scientific methods and engineering practice. It involves:

1. Advancing fundamental understanding of the fundamental physics of light-matter interactions, as well as explore new materials and phenomena that could lead to novel photonic devices.
2. Unlocking the Potential of Light through advancements in technology and applications for information transmission and sensing.
3. Fostering interdisciplinary collaborations to develop innovative solutions to complex problems.

Overall, our vision for photonics research prioritises advancing fundamental understanding, developing new technologies, fostering interdisciplinary collaborations, promoting sustainable development, and advancing diversity and inclusion.

3.6.2 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 less sensing technologies, aiming for miniaturisation, 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.

Aligned with this research challenge, the focus for 2025 will be on the development of sensing devices and systems with the following features: better than present day standard accuracy, scalability, ease of use, miniaturisation, operational speed, and long-term reliability.

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 utilizing 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.

Aligned with this research challenge, the following actions are planned for 2025:

- Development and optimisation of distributed sensing systems for permanent deployment in infrastructures or extreme environments, based upon optical fiber distributed acoustic sensing to monitor and sense geophysical phenomena (seismic activity and tsunamis), oceanography studies and security and defence applications.
- Demonstration of the use this technology for bird collision detection in high power electric distribution lines in biodiversity studies to assess deterrent/avoidance/alarm processes.

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.

Aligned with this research challenge, the following action is planned for 2025:

- Research on the organisation and dynamics of complex quantum systems to improve quantum reservoirs systems for extreme learning machines.

3.7 Robotics

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

3.7.1 Scope and vision

Robotics became more intelligent, autonomous, and useful in a wide area of applications. This new paradigm poses new challenges and problems to be solved that require new scientific approaches.

The operation in complex and dynamic environments requires increasing levels of autonomy, with abilities to create and maintain maps of the environment, to react and adapt to unforeseen events, as well as to operate unattended for longer periods.

The increasing interaction between humans and robots poses new, often unforeseen, and risky situations that need to be mitigated. Programming and communicating with robots to assign tasks must be increasingly intuitive and accessible to any operator.

The possibility of acting through forms that did not exist before, such as interacting with flexible objects of manipulating objects from moving platforms, takes robotics to new fields and with new challenges.

New fields of application of robotic systems and novel operational scenarios also require novel design methodologies, simplifying the deployment of these technologies.

3.7.2 Research Challenges

A) Increase the autonomy of robotic systems

The operation of robotic systems in more complex and dynamic environments and for long term or permanently requires higher levels of autonomy of such systems, that will only be obtained by addressing the different stages of the sense-perceive-plan-act cycle. The following specific challenges directly contribute to achieve such gains in autonomy:

- Improvement of positioning accuracy of robotic systems operating in GNSS denied environments, including the proposal of novel landmarks and algorithms to position them.
- Establishment of navigation and guidance methodologies that allow smooth transitions between global localisation and local/relative localisation methods.
- Definition of distributed simultaneous localisation and mapping strategies that are robust to communication failures and delays.
- Definition of trajectory planning methodologies for active perception and adaptive sampling, for single or cooperating robots.
- Establishment of optimisation and task allocation algorithms that are fast enough to be applied in real-time to cope with very dynamic situations.
- Definition of novel mapping strategies that scale well with the extension of operation environments and duration of missions, for both single robots or heterogeneous robotics teams.
- Endow robots with failsafe mechanisms and ability to operate in degraded modes to cope with subsystem failures.

Aligned with this research challenge, the following actions are planned for 2025:

- Extension of perception, control, planning and decision capabilities of robotics systems to improve their autonomy in more complex operation and application scenarios, such as drones operating in indoor or underwater systems operating autonomously for long periods in complex underwater galleries.
- Research on novel AI approaches, such as Reinforcement Learning (RL), Federated learning, and Generative AI, that will be combined with innovative robot map representations based on semantics and ontology allow for the operation of teams of robots in less structured environments.

B) Improve manipulation and other physical interaction capabilities

We aim to address the state-of-the-art of robotic manipulation and other scenarios where a robot interacts physically with the environment. This will advance along three major lines: the first related to achieving a final relative position, as in the case of coupling or docking, the second related to the manipulation of flexible objects and the last addressing the use of manipulators from mobile platforms.

In the first line, the research challenge addresses:

1. Trajectory planning to simultaneously ensure observability of the target and pose constraints, while considering DoF limitations.
2. Control of actuators subject to physical constraints that dynamically affect their performance.

In the second line, research challenges are associated to:

1. Perception – definition of novel models and algorithms to cope with the changing shape of objects.
2. Grasping – incorporation of shape deformation models in motion planning and feedback control loops.
3. Assembly operations – path planning algorithms to consider deformation of objects to avoid entanglements.

In the third line research challenges address:

1. Coordinated control for the simultaneous motion of base and end effector.
2. Mobile manipulator planning and control systems to effectively reject terrain induced disturbances.
3. Control of actuators mounted on floating or underwater platforms.

Aligned with this research challenge, the following actions are planned for 2025:

- Design of innovative or more efficient docking systems and algorithms, systems for autonomous deployment of other systems, or physically interacting with other objects in the world for close inspection, maintenance or cleaning.
- Extension of robots' skills for the manipulation of flexible materials (e.g., textiles). This presents unique challenges due to their changing shape and inherent flexibility. Novel algorithms for perceiving and manipulating flexible objects by combining realistic simulation of flexible objects with training AI algorithms, computer vision, reinforcement learning, and tactile sensors will be developed.
- Generalisation of manipulation capabilities, particularly on dismantling complex products. Multi-sensor fusion, Generative AI, and meticulous manipulation will be investigated and integrated into a robotic framework. It is intended that the robot solution will also be capable of generalizing in the absence of a digital model representation. We will follow this holistic approach to advance AI-based robotics and ensure that progress aligns with essential existing safety and validation frameworks.

C) Enhance human-robot collaboration

Most recent technological and scientific advancements allow stand-alone robots to perform tasks with a high degree of autonomy and the difficulties associated with robotics are well-known and have reached a certain level of maturity. However, the inclusion of the human element disrupts this determinism and factors such as the user's mental model, emotional state, and perception influence robot behaviour. Therefore, this challenge aims the development of new algorithms, methodologies and tools that allow robotic systems to synergistically and dynamically collaborate with humans.

To achieve such a goal, the following topics will be addressed:

- Investigate algorithms for human real-time action/posture recognition and tracking, to improve natural and safe collaboration between robotic system and human.
- Investigate methods and tools for the transparency and explainability of robot actions/intentions using emergent technologies, such as virtual and augmented reality, and advanced use of software based human computer interfaces.

- Develop algorithms and systems which will empower the robot with human knowledge and skills, using high-level programming, teleoperation and shared control methods.

Aligned with this research challenge, the following action is planned for 2025:

- Development of processes aiming at achieving seamless interaction between humans and robots by addressing key challenges, such as (1) Bridge communications gaps by improving the translation of human intentions into robotic actions and enhancing the interpretability of robot feedback, fostering smoother and more intuitive interactions. (2) Enhance predictability and safety to effectively communicate intentions through multimodal cues such as visual, auditory, and tactile signals. (3) Leverage mixed reality devices to blend physical and digital environments seamlessly. This will enable more immersive, natural, and intuitive ways to communicate and collaborate with robots in various real-world applications. (4) Employ Large Language Models (LLMs) and Vision-Language Models (VLMs) to enable more natural and intuitive communication between humans and robots, enhancing the understanding of complex instructions and contextual cues. These models will facilitate seamless human-robot collaboration by integrating multimodal inputs such as language, vision, and gestures to interpret intentions and adapt robot behaviour accordingly. (5) Enable remote control operations under constrained communication bandwidth and high latency.

3.8 Systems Engineering and Management

Steering Committee: António Lucas Soares, José Pedro Rodrigues, Lia Patrício and Maria Beatriz Oliveira

3.8.1 Scope and vision

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

Major challenges arise from optimisation in complex organisations 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.

3.8.2 Research Challenges

A) Transitioning Socio-technical systems towards sustainability

RESEARCH CHALLENGE

Grand societal challenges require radical shifts in socio-technical systems, requiring research on:

- Understanding the role of businesses and industries in sustainability transitions, and
- Designing system innovations for transitions towards sustainability.

This research brings together service science, technology and innovation management, and public policy research for technology leveraged transitions of key socio-technical systems.

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?

Aligned with this research challenge, the following actions are planned for 2025:

- Co-creation of digital tools for the energy sector. These tools are designed to empower communities and organisations by providing actionable insights into resource management, facilitating energy efficiency, and promoting sustainable practices. By leveraging participatory approaches, we will foster active engagement from stakeholders, ensuring that the solutions developed are tailored to real-world challenges. This aligns with broader sustainability goals, such as the energy transition and the reduction of environmental footprints, contributing to the achievement of the United Nations Sustainable Development Goals (SDGs), particularly SDG 7 (Affordable and Clean Energy) and SDG 13 (Climate Action).
- Research on methods, tools, and technologies for an integrated twin-transition. Investigating how integrated optimisation/simulation hybrid approaches and process digital twins can help to design and reconfigure more adaptable and sustainable production systems. The De-Production Model will be a novel view of designing manufacturing systems devoted to more product and materials circularity. Circular Economy R-Strategies will be related to our so-called D-Strategies, and we will detail the role of each D-Strategy, aiming to propose a D-Ladder scale.

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 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 supply chain visibility, supported by emerging technologies, contribute to the development of resilient and sustainable supply chains?
- How can digital technologies facilitate joint innovation activities to increase the circularity of products, processes, and overall SCs?
- What is the impact on the organisations' end-to-end performance (w.r.t. these challenges) to integrate and interface Marketing and Operations?

Aligned with this research challenge, the following actions are planned for 2025:

- Development of responsive and resilient value chains capable of withstanding disruptions and adapting to uncertain conditions. Logistics optimisation efforts will focus on real-time routing and inventory management, using predictive and prescriptive analytics to enhance decision-making across supply chains. These innovations will be particularly impactful in sectors where operational disruptions have significant societal or economic impacts, such as healthcare, food supply, and transportation. By integrating flexibility and robustness into value chain design, these efforts will improve supply chain resilience while minimizing waste and inefficiencies, supporting both industry competitiveness and sustainability objectives.
- Combination of hybrid optimisation, simulation and ML approaches with Digital Twins to adaptively design and reconfigure production systems for high-mix, low-volume environments and real-time, multi-criteria decision-making frameworks to enhance system autonomy and resilience against unexpected events or disruptions are a continuing research topic as well.
- Design of supply chains that favour the implementation of circularity, including the contribution of digital technologies. Additionally, we will explore the emerging topic of regenerative operations and supply chains that positively contribute to society and the environment.

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 hybridisation 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?

Aligned with this research challenge, the following actions are planned for 2025:

- Development of innovative solutions designed to address the VUCA (Volatility, Uncertainty, Complexity, and Ambiguity) challenges of modern production systems, supported by advanced hybrid optimisation methods.
- Integration of the Production Design-for-eXcellence (ProductionDfX) method with the Simulation and Optimisation framework (FlexSIM and optimisation models) to enable a more systematic and accessible application of DfX strategies across complex production environments.

D) 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 organisations 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 organisational 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?

Aligned with this research challenge, the following actions are planned for 2025:

- Exploration of the ethical and practical dimensions of integrating AI into decision-support systems, with a focus on promoting fairness, transparency, and accountability in AI-driven processes. Our efforts will prioritise the development of accessible and user-friendly tools that cater to a diverse range of

stakeholders, including industry leaders, policymakers, and the broader community. This research will go beyond theoretical contributions, delivering practical, real-world applications designed to address critical societal challenges while advancing sustainability and resilience.

- Research on new concepts of information systems for industrial management with focus on human-centred AI integration in the manufacturing and business processes and digital platforms and governance methods to support circular business models.
- Development of architectures and specific models for categories of tasks in manufacturing processes and to model the organisational context from a socio-technical systems perspective.
- Development of a method to integrate AI-based technologies into supply chain management processes using a socio-technical perspective that considers organisational, social and human needs.
- Design and evaluate open innovation and co-creation initiatives to design, demonstrate, and validate human-centred socio-technical systems for sustainability and resilience.

4 THEMATIC LINES

The four thematic lines at INESC TEC—Digital Models, Sustainable Transformation, Tackling the Extreme, and Trustworthy Technology—serve as strategic frameworks for organising and advancing multidisciplinary research activities. These thematic lines facilitate collaboration among researchers from diverse scientific domains, enabling them to tackle impactful and complex research challenges through integrated and innovative initiatives.

4.1 Digital Models

Coordinator: Susana Barbosa

4.1.1 Scope and vision

This line aims to bring comprehensive, high-precision digital models of physical entities into the lab, leveraging the groundbreaking strides in pervasive intelligence, a core ethos at INESC TEC. The drive to create more complex digital twins has greatly increased, making it a priority in the EU's research agenda, with two flagship initiatives focused on developing advanced digital twins of the human brain (EBrains) and the Earth (DestinE).

Future digital twinning platforms will encompass a complete computing pipeline from sensing, edge computing, big data management, and processing for monitoring, analysis, training, inference, and forecasting, culminating in visualisation and actuation. A high level of maturity in digital twins leads to a seamless and interactive exchange of information between humans and digital counterparts. This will require cutting-edge technologies like cloud and high-performance computing, pushing the limits of what is possible in terms of scalability, performance, efficiency, reliability, security, and privacy.

Computer Science & Engineering and Artificial Intelligence will focus on the computational challenges of building large-scale, high-fidelity digital twins, including big data management, machine learning, human-computer interaction, information security, and advanced visualisation. The AI researcher's data-driven and symbolic AI knowledge will make the twins robust and explainable. Communications will enable bandwidth-intensive, latency-sensitive, and secure data transmission.

Robotics will focus on dynamic and autonomous sensing, cyber-physical models and integrating autonomous robots in areas shared with humans. Bioengineering will develop macro to nano biosensors as inputs to biological or "bio-inspired" models, enabling early disease detection, diagnosis, and prediction. Photonics will innovate in real-time nano-scale diagnosis and long-term sensing of extreme environments.

Power & Energy Systems researchers will model and optimise integrated energy systems. In contrast, in Systems Engineering and Management will optimise complex organisations, design customer-centric services, and manage technology-based innovation.

This line presents extensive opportunities to impact INESC TEC's core innovation areas:

- Industry: Optimising operations, maintenance, and safety;
- Healthcare: Revolutionising patient care through organ/individual simulation and adverse event prediction;
- Environment and Climate: Addressing weather, climate, ecosystems, and biodiversity for emergency response.

This multidisciplinary thematic line will strategically leverage and integrate INESC TEC's diverse research capabilities to realise the groundbreaking potential of complex digital models and twins. It calls for further collaborative research to enable more accurate, dynamic digital models that can optimise operations, improve maintenance, enhance safety, revolutionise patient care, and predict and respond to emergencies.

4.1.2 Achievement highlights

For 2025, the following major achievements are anticipated:

- Lung Disease Stratification: implementation of a digital twin approach through the AI4LUNGS project, revolutionizing patient stratification and treatment for lung diseases.
- AI-Driven Clinical Frameworks: Development of AI-based frameworks to optimise planning and treatment for lung pathologies, enhancing clinical precision and outcomes.
- Communications on Industrial Environments: Design of digital twinning for industrial applications, establishing international collaborations in 5G/6G communications and computer vision, fostering joint projects, training, and workshops.
- Reconfigurable IoT Nodes: The SuperIoT project will deliver digital representations of energy-autonomous IoT nodes, enabling advancements in cross-layer network performance and energy optimisation algorithms.
- Reproducible 5G/6G Experimentation: Through REPLICA and CONVERGE projects, novel digital models will be developed to replicate past experiments using machine learning, ensuring accurate and repeatable 5G/6G research.
- Digital Twins for Energy: Creation of advanced models for hybrid AC/DC grids and multi-energy systems, integrating renewables, storage, and distribution to maximise efficiency and resilience.
- Digital Twin of Iberian Power System: Establishment of a detailed simulation of the Iberian power grid will align with European efforts to develop a pan-European digital twin for enhanced reliability and flexibility.
- Hydrogen and Ammonia Systems: Definition of innovative models will optimise production, distribution, and consumption for renewable-based fuels, supporting multi-offtaker systems and sustainable solutions.
- Energy Flexibility Platforms: Hedge.IoT will enhance energy flexibility through interoperable digital platforms for Portuguese energy pilots.
- Ocean Digital Twins: Contributions to high-accuracy ocean digital twins through the ILIAD and Blue-X projects, integrating Earth observation and citizen science data to enhance maritime decision-making.
- Automated Mobility: The FRODDO project will develop federated digital twin environments for improved safety and decision-making in complex transportation systems.
- Dynamic Digital Models for Robotics: Establishment of digital twins for robots operating in unstructured environments, enabling advanced forecasting, analysis, and control.
- Hybrid Optimisation Models: Application of hybrid optimisation to tackle challenges in supply chains, logistics, and manufacturing through projects like PEER, BeFresh, and Produtech R3.
- Hybrid AC/DC Grid Optimisation: Enhancement of hybrid grid integration of renewables, improve grid resilience, and enable large-scale adoption of multi-energy networks, reducing energy waste and increasing system efficiency.
- Circular Economy in Manufacturing: Extension of research on digital twins for supporting product circularity, emphasizing sustainable industrial systems.
- Pan-European Digital Twins: Contributions to TwinEU and NewSpace projects by advancing interoperable systems and data spaces, enabling federated learning and seamless data exchange.

4.2 Sustainable Transformation

Coordinator: Clara Gouveia

4.2.1 Scope and vision

This thematic research line aims to harness interdisciplinary expertise to address the critical challenge of achieving long-term sustainability in social, economic, and environmental systems. It leverages the collective strengths of INESC TEC's Scientific Domains to create innovative solutions to accelerate sustainability transformation through science-based technology supported by circular economy principles and sustainable supply chain management.

As we navigate the complexities of integrating technology with natural and social systems, this thematic line explores sustainable business model and life cycle analysis, consumer-centric service design with advanced management, monitoring and control systems for supporting electrification of the energy sector and development of sustainable supply chains.

Systems Engineering and Management will tackle the challenge of designing sustainable business models and optimising complex organisational networks for environmental sustainability. This includes the development of decision-support systems for sustainable supply chain management and the integration of circular economy principles into business practices.

Power and Energy Systems will lead efforts in modelling and optimising integrated, sustainable energy systems. Their work will focus on the massive integration of renewable energy sources, energy storage solutions, and the electrification of transport and industry.

Artificial Intelligence and Computer Science & Engineering will develop algorithms and computational models that optimise resource efficiency and reduce environmental impact and can support AI-driven energy and transport management systems.

Bioengineering will contribute by advancing technologies for sustainable healthcare, including the development of biodegradable materials and energy-efficient medical devices. This domain will also explore bioengineering solutions to environmental challenges, such as bioremediation techniques for pollution cleanup.

Communications will work on enhancing the energy efficiency of digital networks, which is crucial for reducing the carbon footprint of our increasingly connected world. This includes the development of low-power communication protocols and the optimisation of data transmission for energy savings.

Photonics will innovate in the development of precision sensing, energy-efficient lighting and photovoltaic technologies, contributing to the reduction of energy consumption and the advancement of renewable energy sources.

Robotics will develop autonomous systems for environmental monitoring and conservation, including robots capable of planting trees, cleaning oceans, and monitoring wildlife. These robots will operate with minimal human intervention, reducing the ecological footprint of conservation efforts.

This thematic line strives to foster a collaborative approach among all INESC TEC researchers to enhance and bolster the sustainability of the developed technology by lowering its adoption, maintenance, social, economic and environmental costs.

4.2.2 Achievement highlights

For 2025, the following major achievements are anticipated:

- Green Electronics with AI Integration: Development of efficient electronic system architectures incorporating multifunctional elements like memristors, leading to environmentally sustainable mixed-signal processors.
- Circular Economy in Power Systems: Creation of digital product passports and interoperable data platforms, enabling extended equipment lifespans, improved recycling, and accelerated AI applications in energy systems.

- Sustainable IoT Nodes: Enhancement of energy-autonomous IoT nodes with cross-layer optimisation algorithms, ensuring efficient operation with minimal energy consumption.
- Environmentally Friendly Manufacturing: Establishment of sustainable manufacturing practices through methods like Design-for-eXcellence and the De-Production Model, while integrating human-centered AI for SMEs.
- Robotic Recycling and Circularity: Development of pioneering robotic solutions for dismantling and remanufacturing, focusing on recycling complex products and recovering critical raw materials through projects like iBot4CRMs and RENÉE.
- Digital and Green Transitions for SMEs: Initiatives such as the Twin Transition Accelerator and MANTRA will empower SMEs with advanced technologies and new business models to foster circular value chains.
- Renewable Energy for Seaports: Efforts will optimise seaport energy management by integrating renewables, minimizing fossil fuel dependence, and ensuring efficient onshore power operations.
- Energy Communities for Agri-Food Sector: Tools supporting energy communities will enable synergy and sustainable practices in the agri-food sector, bolstering local economies and reducing environmental footprints.
- Ocean and Biodiversity Monitoring: Deployment of autonomous robots for minimal-intervention monitoring of oceans and ecosystems, enabling precise biodiversity tracking and impact assessment.
- Digital Threads for Circularity: CircThread project will empower the circular economy by creating digital threads to enable secure, lifecycle-wide product data exchange among stakeholders.
- AI-Efficient Solutions: Delivery of AI-driven predictive tools to increase industrial efficiency while minimizing environmental impact, advancing sustainable innovation.
- Energy Community Living Labs: Operationalisation of living labs to test and scale community-based energy solutions, aligning with sustainability goals for urban and rural settings.
- Innovative Robotic Solutions: Advances in robots with AI-driven precision for selective pruning, harvesting, and textile recycling, supporting regenerative agriculture and forest restoration.

4.3 Tackling the Extreme

Coordinator: Eduardo Silva

4.3.1 Scope and vision

This line aims to address the challenges posed by extreme assumptions and design spaces that are increasingly prevalent due to the distributed, intelligent, and autonomous nature of modern digital technologies. This initiative recognises the diverse forms extremes can take, including uncooperative or hostile environments, high-risk activities, instantaneous decision-making requirements, and the handling of massive datasets or entities. A key challenge in these extreme scenarios is the difficulty of conducting proper experimentation and testing, often due to accessibility risks, costs, legal and ethical constraints, or the hypothetical nature of the scenarios.

INESC TEC's interdisciplinary expertise will develop novel design methods and tools aimed at delivering solutions that are trustworthy, robust, and capable of self-adaptation in the face of extreme conditions. This will involve the use of synthetic modelling techniques and the creation of comprehensive virtual environments to simulate and analyse extreme scenarios safely and effectively.

Computer Science & Engineering and Artificial Intelligence will focus on creating advanced algorithms and computational models capable of operating under extreme conditions. This includes the development of AI systems for rapid decision-making and the analysis of vast datasets.

Communications will concentrate on ensuring reliable and secure data transmission in extreme environments, developing technologies that can withstand interference, disruptions, and high-risk conditions, thereby maintaining the integrity and availability of critical communications.

Photonics will develop sensors and imaging technologies capable of operating in extreme conditions, such as high temperatures, pressures, or radiation levels, enabling the observation and analysis of otherwise inaccessible or hazardous environments.

Robotics will focus on designing and deploying autonomous systems capable of navigating and performing tasks in dangerous or uncooperative environments, from deep-sea exploration to disaster response, minimising human exposure to risk. Similarly, Bioengineering will explore the development of resilient biotechnologies for human monitoring extreme conditions, as well as bio-sensing techniques that can operate in hostile or contaminated environments, contributing to environmental monitoring and cleanup efforts.

Power & Energy Systems will address the challenges of energy management and distribution in extreme scenarios, focusing on developing resilient and adaptive energy systems that can ensure continuous operation under adverse conditions.

Systems Engineering and Management will tackle developing decision-support tools and methodologies for planning and executing high-risk and high-stakes activities.

Through this initiative, INESC TEC reaffirms its commitment to pushing the boundaries of innovation, contributing to a future where extreme environments are no longer barriers to exploration, discovery, and progress.

4.3.2 Achievement highlights

For 2025, the following major achievements are anticipated:

- Predictive Dispatch Tools for Renewable Integration: Development of advanced predictive tools to maintain stability in power systems like Madeira's, even under extreme renewable energy integration scenarios, ensuring reliable operation.
- Climate-Resilient Multi-Energy Systems: In collaborating with MIT, we will advance models for distributed energy resource integration and demand response strategies to minimise energy supply disruptions during extreme weather events.
- Deep-Sea Fiber Optic Sensing: Creation simulation models and machine learning tools in the GeoSense project to interpret disturbances in submarine cables, enabling geophysical monitoring at an unprecedented scale.

- Extreme Condition Sensors: Development of advanced sensing technologies, including dielectric photonic crystals and plasmonic sensors, to operate in high-temperature, pressure, and radiation environments, expanding capabilities in inaccessible locations.
- Real-Time Environmental Monitoring: Testing of wearable devices for hazardous scenarios, like firefighting, under the FIRE-RES project, enabling real-time data transmission to enhance safety and operational efficiency.
- Robotic Solutions for Extreme Operations: Advancement on autonomous systems for navigation and task execution in dangerous or uncooperative settings, from deep-sea exploration to disaster response, reducing human exposure to risk.
- Optimising Hospital Operations: Contributions to the SMARTgNOSTICS project will improve hospital adaptability and resource management, ensuring high-quality care during pandemics and other health crises.
- Addressing Public Health Challenges: Through pKEP and EURO-KEP projects, INESC TEC will enhance eligibility for organ transplantation, improving outcomes for end-stage renal disease patients and strengthening healthcare system resilience.
- Wildfire Management Models: Development of integrated models for optimizing firefighting resource deployment using geospatial analysis, simulation, and optimisation techniques, addressing the increasing frequency of wildfires.
- Logistics for Emergency Response: Advanced strategies for supply logistics will ensure timely delivery of critical resources like fuel and medical supplies during emergencies.
- Decision-Support Frameworks: A new European project will focus on advanced decision-support tools for climate adaptation and disaster management, leveraging interdisciplinary research to enhance resilience in regions affected by wildfires and other climate-related challenges.
- AI for Extreme Data Streams: Refinement of models for edge AI, including federated learning and extreme value detection, contributing to smarter and more adaptive algorithms for use in remote and challenging environments.
- Fire-Resilient Communities: The FIRE-RES initiative will develop solutions for wildfire resilience, leveraging innovative technologies and community-driven approaches to mitigate extreme events.

4.4 Trustworthy Technologies

Coordinator: Rui Oliveira

4.4.1 Scope and vision

This line aims to develop reliable, secure, and ethical digital technologies integral to modern society. This multidisciplinary strand leverages expertise from the eight INESC TEC Scientific Domains to address the challenges of creating technology that is not only advanced but also dependable and aligned with societal and environmental values.

As the world faces pressing challenges such as climate change, inequality, and geopolitical instability, trustworthy technology will become increasingly important in supporting sustainable and resilient societies. Transparency, equity, reliability, security, privacy, and meaningful human control need to be at the forefront of research and development in the upcoming years as our dependence on cutting-edge technologies increases.

Artificial Intelligence and Bioengineering will develop explainable AI models, ensuring fairness in algorithmic decision-making, enhancing robustness against biased or unethical outcomes, and, chiefly, for healthcare, developing transparent and replicable machine learning models for patient benefit.

Computer Science and Engineering will lead the research on the dependability-, security-, and privacy-enabled technologies orchestrating the various Scientific Domains concerns and expertise, notably on large-scale data-centric systems, towards robust digital and cyber-physical real-world solutions. Communications and Photonics will work on secure data transmission, protecting sensitive information, and defending against adversarial attacks.

Robotics and Computer Science & Engineering will explore human-computer interaction, designing intuitive and trustworthy communication channels for seamless collaboration between humans and autonomous systems.

Power & Energy Systems will leverage its expertise and long-standing experience in developing secure and efficient power grids to ensure data integrity and trustworthiness in decentralised autonomous system operations, as well as to promote cross-disciplinary translational research into related critical infrastructures.

Systems Engineering and Management will optimise complex organisations and networks, ensuring customer-centric service design, and managing technology-based innovation.

By encouraging collaboration among these diverse research groups, the thematic research line will create synergies that drive innovation in trustworthy technology. This multidisciplinary approach will enable the development of comprehensive solutions that address the technical, ethical, and societal challenges associated with the increasing reliance on digital systems.

The research line will also prioritise disseminating knowledge and best practices, engaging with stakeholders across academia, industry, and government to promote adopting trustworthy technology. Through this collaborative effort, the thematic research line aims to contribute to a future where digital systems are reliable, secure, and aligned with the values and needs of the communities they serve.

4.4.2 Achievement highlights

For 2025, the following major achievements are anticipated:

- Causality models in AI: Enhanced causality models and combined symbolic/non-symbolic approaches for transparent and interpretable AI solutions.
- Robust and reliable AI in medical diagnosis: Development of uncertainty-aware deep learning and interpretability-driven regularisation techniques for robust AI in medical diagnostics, forensics, and behavior analysis; Integration of machine learning and deep learning for explainable medical imaging models, ensuring reliable outputs critical for clinical collaboration.
- Human-Centered AI: Contributions to the NOUS project will ensure human oversight in federated learning systems, fostering ethical AI design and implementation. The PHASE IV AI project will address secure health data use through federated learning and multi-party computation techniques.

- Cybersecurity Innovations: Cutting-edge research in privacy-preserving mechanisms for federated learning, blockchain-based authentication, and robust security for edge IoT devices.
- Reliable cyber-physical systems: The IBEX project will enable rigorous reliability analysis for cyber-physical systems, while the PETALL project will deliver certified query results without compromising data confidentiality.
- Digital Identity and Data Protection: Advanced mechanisms for European Digital Identity Wallets (EUDIW) will promote secure, user-centric identity solutions.
- Human-AI Synergy: Design of socio-technical systems for seamless human-AI collaboration in critical infrastructure, ensuring alignment with human values and operational requirements.
- Testing and Experimentation Facilities: Development of advanced facilities for evaluating AI solutions in energy communities and maritime renewable energy scenarios under extreme conditions.
- Safe Robotic Systems: Research in explainable reinforcement learning, vision-language models, and large language models for robots operating in unstructured environments conducting to the establishment of safety standards and validation methodologies for AI-based robotics, enhancing autonomy and reliability.
- Responsible AI Governance: Expansion of the Responsible Innovation Assessment Tool under the Fire-Res project to ensure ethical, social, and environmental standards in R&D projects; Development of strategic roadmaps and business models for open-source AI solutions in the AI4REALNET project.
- Trust in Next-Generation AI Models: The Trust-AI project will address the opacity of large language models (LLMs), fostering transparency and interpretability in AI-driven decision-making.
- Blockchain and Data Integrity: Development of novel blockchain storage solutions under the BCD.S+M project, ensuring confidentiality and reliability.
- Software Correctness: Development of mathematical models for ensuring software correctness in cyber-physical systems.
- Neuro-Symbolic Systems for Human-Like Learning: Creation of neuro-symbolic systems integrating symbolic knowledge and learning mechanisms for human-like AI systems, enhancing adaptability and trust.
- Scaling Trustworthy Technology for Healthcare Applications: Optimisation of healthcare systems through projects like SMARTgNOSTICS, ensuring resource efficiency and adaptability during crises; Definition of ethical guidelines for AI-driven healthcare, ensuring compliance with the European Health Data Space (EHDS) standards.
- Ethical Technology in Climate Action: Integration of responsible AI practices in climate resilience projects, leveraging explainable models for managing wildfires and other climate challenges.

5 TEC4 INITIATIVES

5.1 Overview

TEC4: A Structured Approach to Market-Driven Innovation

TEC4 ("TEChnologies FOR …") is an organisational framework designed to streamline the market-pull innovation process, in contrast to the science-push approach commonly observed in research centres. This initiative fosters a balanced equilibrium between these two opposing motivations and facilitates the seamless transition of knowledge from inception to value creation.

Each TEC4 targets a specific market niche and stimulates cross-cluster multidisciplinary projects, promoting collaboration with businesses and generating solutions tailored for industry adoption. The effectiveness of each TEC4 is primarily assessed by its level of recognition and engagement (particularly direct contracts with companies and other relevant stakeholders) within its designated market and the number of inter-centre collaborations fostered. The TEC4s do not directly engage in project development; upon identifying an opportunity, negotiations are initiated with the relevant centres, which then assume responsibility for project management and execution.

TEC4 initiatives address regional, national, or international challenges by aligning short- and medium-term industry needs with INESC TEC's scientific and technological expertise. Typically, each TEC4 encompasses:

- A well-defined market domain, represented by businesses and associations;
- A group of centres with multidisciplinary expertise, dedicated to addressing the challenges of that market domain;
- An R&D infrastructure that supports scientific and innovation activities and provides value-added services to businesses that are not readily available in the market.

Each TEC4 adheres to a strategic agenda tailored to its market domain, encompassing three pillars: stakeholder perspectives, a comprehensive strategy and associated technological roadmap, and R&D infrastructure evolution to maintain state-of-the-art capabilities and support the roadmap's implementation.

The short-term objectives of TEC4 initiatives are to develop innovative solutions and services with high export potential, leveraging internationally competitive research and innovation capabilities to contribute to the resilience and growth of the Portuguese economy. Their long-term objectives encompass the identification of scientific and technical challenges that span multiple disciplines, harnessing and realising the full potential of INESC TEC in application domains that are readily understood and integrated by businesses. Fostering and sustaining these virtuous innovation cycles within each TEC4 represents the primary medium-to-long-term challenge.

The following sections provide a brief overview of the scope and objectives of the current TEC4 initiatives.

5.2 Current initiatives

The Global TEC4 Organisation

The global TEC4 organisation comprises:

- Five established TEC4s:
  - TEC4AGRO-FOOD: Agro-food and forestry
  - TEC4COMUNICATIONS: Communications and digital innovation
  - TEC4ENERGY: Energy-related activities and economy
  - TEC4HEALTH: Health and well-being-related activities and economy
  - TEC4INDUSTRY: Production technologies, manufacturing, distribution, logistics, and retail
  - TEC4SEA: Marine activities and economy
- A structure named TECPARTNERSHIPS, responsible for global coordination and support, to ensure the implementation of typical TEC4 functions in uncovered application areas and to explore new market segments and incubate potential new TEC4s until they reach the required maturity level.

TEC4s are dynamic organisational models that require periodic evaluation and adaptation to the evolving economic landscape. The application areas addressed by the TEC4s align with European, national, and regional priority domains, fostering the development and consolidation of internal R&D competencies around socio-economic pillars. Additionally, attracting international partners to TEC4 initiatives supports INESC TEC's internationalisation strategy, provides national companies with easy access to international partners, and facilitates attracting foreign direct investment into the region and the country.

5.3 Methodology

Each TEC4 has an implementation plan addressing the following stages:

- **Identification of market segments where INESC TEC competencies can create value:** This involves conducting thorough market research to identify specific areas where INESC TEC's expertise can be leveraged to address unmet needs and generate tangible benefits for businesses.
- **Identification of internal research lines with the highest potential impact in business:** Based on the assessment of market needs, this stage involves evaluating INESC TEC's existing research portfolios to identify areas with the most promising potential for commercialisation and impact on business operations.
- **Identification of the R&D infrastructure (i.e., laboratories, equipment, demonstration facilities, and other technical means) supporting the offer of added-value services to businesses:** This involves mapping the available R&D resources and capabilities to ensure that TEC4s have the necessary infrastructure to support the development and delivery of value-added services tailored to business needs.
- **Identification of new potential partners and stakeholders that can bring added value to the TEC and support its innovation cycle:** This stage involves actively seeking out new partnerships and collaborations with businesses, research institutions, and other relevant stakeholders to expand INESC TEC's reach, access new expertise, and enhance the innovation ecosystem.
- **Definition/alignment of the strategic agenda of each TEC4:** This involves developing a comprehensive strategic plan for each TEC4, outlining clear objectives, strategies, and targets for achieving the desired outcomes. The strategic agenda should align with INESC TEC's overall goals and priorities, while also addressing the specific needs and opportunities within each TEC4's designated market domain.

These stages form the foundation for the successful implementation of TEC4 initiatives, ensuring that each TEC4 is focused on creating tangible value for businesses and contributing to the growth and resilience of the Portuguese economy.

5.4 Global Contributions to INESC TEC's Strategic Objectives

The TEC4 framework significantly contributes to INESC TEC's strategic objectives, aligning with Commitments 1, 2, 3, and 5 by leveraging specific indicators across sub-commitments.

Commitment 1 focuses on fostering innovation and community engagement. TEC4 supports this by fostering major contracts with industry partners, nurturing deeper relationships, aligning with the indicator of major contracts.

Commitment 2 emphasises addressing societal challenges and enhancing industry alignment. TEC4 actively participates in national and international projects, collaboratively delivering R&I aligned with industry needs. Additionally, it contributes to public administration digitalisation by engaging in projects with regional and national authorities, as indicated.

Commitment 3 underlines integration across disciplines and market uptake. TEC4's focus on development projects stemming from internal research, technology licensing, and international networking aligns with these indicators, promoting knowledge uptake and global competitiveness.

Commitment 5's emphasis on sustainability aligns with TEC4's pursuit of international research funding and securing major contracts, ensuring a robust economic model.

Overall, TEC4 serves as a pivotal framework, integrating research, innovation, and strategic partnerships to drive INESC TEC's objectives across multiple commitments.

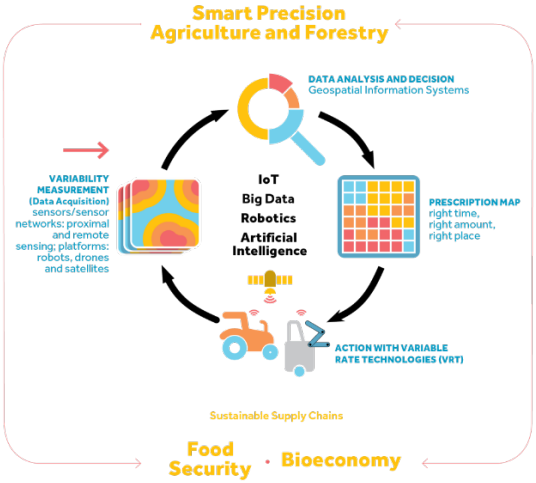
5.5 TEC4AGRO-FOOD

Coordinator: Filipe Neves dos Santos
Business Developer: André Sá

5.5.1 Scope and strategy overview

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:



TEC4AGRO-FOOD's strategy is to consolidate the importance it has achieved at both national and European levels and to sustain the considerable growth verified in the last years, especially since 2017. The presence in the relevant Collaborative Laboratories and National Competence Centres, the established partnerships, with INIAV, Herculano, Sogrape Vinhos and complementary partners, and specially in what concerns Europe, the start or the strengthen of the participation in relevant European programmes/initiatives, are essential to implement the strategy. The existing TEC4AGRO-FOOD's Strategic Plan includes a characterisation of the megatrends and trends in agro-food and forestry, internal and external diagnosis and a medium-long term action plan.

The current focus is on direct contracts and European projects, although not neglecting other sources of funding. Promoting the transfer of intellectual property rights for technologies that are at this stage is also part of TEC4AGRO-FOOD's current focus.

5.5.2 Main objectives for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025, TEC4AGRO-FOOD is prioritising significant advances in the following Strategic Objectives:

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

C2.3. Better align and deliver R&I with industry's needs: research and develop innovative robotics and automation solutions to cope with the labour shortage in agriculture and forestry. KPI: number of projects involving robotics and automation.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

C3.5. Increase our international networking, leadership and competitiveness: establish a formal partnership with Wageningen University & Research (WUR), the lighthouse of R&I for agro-food.

Commitment 5 – Strive for a sound, sustainable and effective operational model

C5.1. Strengthen the sustainability and resilience of our economic model: redouble efforts with companies. KPI: number of direct contracts.

Jointly with these key advances, in 2025, the other main objectives for the TEC4 towards its vision are:

- A. redoubling efforts at European level. KPI: number of European projects;
- B. Make TEC4AGRO-FOOD's most impactful results better known to INESC TEC's relevant internal stakeholders.

5.5.3 Action plan

This year, TEC4AGRO-FOOD will design and/or implement the following initiatives and actions:

Table 5.1 - TEC4AGRO-FOOD – Main actions planned

Initiatives	Key Results	Strategic Objectives
Continue to implement TEC4AGRO-FOOD's Strategic Plan	Implementation of TEC4AGRO-FOOD's Strategic Plan.	C2.3; C3.5; C5.1
Strengthen relations with WUR with a view to establishing a formal partnership	Formal partnership with WUR.	C3.5
Strengthen or establish contact with the main European project consultants	More European projects.	C3.5
Strengthen or establish contact with the "champions" of coordinating European projects	More European projects.	C3.5
Participate in World FIRA 2025	International networking and notoriety. Robotics and IoT technologies exhibition. Robotics and IoT R&I projects.	C2.3
Participate as "RTD Partner" in AgroIN 2025	National networking and notoriety. R&I projects.	C2.3
Participate in Agromek 2025	Keep abreast of the latest innovations.	C2.3
Organise a robotics and IoT event for INESC TEC's relevant internal stakeholders	Most impactful results better known to INESC TEC's relevant internal stakeholders.	C2.3
Develop new communication materials	Increase and improve TEC4AGRO-FOOD communication.	C3.5

5.6 TEC4COMMUNICATIONS

Coordinator: Manuel Ricardo

5.6.1 Scope and strategy overview

The digitalisation of vertical sectors of economy demands adequate communications networks, services and applications. The next generation of communications systems will be highly configurable and adapted to client needs, increasingly virtualised, and capable of providing also sensing services. The development of such complex systems demands the multi-disciplinary competences INESC TEC owns through its research centres including microelectronics, photonics, energy, robotics, artificial intelligence, computing, and business models.

TEC4COMMUNICATIONS brings together institutions, businesses and associations with the purpose of defining solutions with value for economy and society. Three types of partners are envisaged: producers of communications systems, large enterprise consumers of communications and sensing, and policy makers.

The innovation activities addressed by TEC4COMMUNICATIONS will be supported by the new Communications and Machine Perception Laboratory, to be created in Matosinhos, which will consist of a set world-level experimental zones, collocated with space for startup companies and new spaces for reference companies

5.6.2 Main objectives for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 TEC4COMMUNICATIONS is prioritising significant advances in the following Strategic Objectives:

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community. The TEC4COMMUNICATIONS business strategy will enable the identification of relevant innovation partners and the characterisation of the relationships to be established.

C3.5. Increase our international networking, leadership and competitiveness. The laboratory facility to be created will increase our international visibility and improve INESC TEC international networking and the Porto region competitiveness.

Jointly with these key advances, in 2025, the other main objectives for the TEC4 towards its vision are:

Help create the new Communications and Machine Perception Laboratory. This infrastructure shall consist of a set of experimental zones, including a reconfigurable anechoic chamber, a sensing laboratory, an autonomous systems arena, an electronics laboratory, and a computational cluster.

Create the INESC TEC innovation identity in Communications. This identity shall be defined and announced in the INESC TEC web site under its Innovation section. A promotional video will also be developed.

Define the business strategy of TEC4COMMUNICATIONS. After identifying a Business Developer, a business strategy will be defined based on the key competences of INESC TEC in the field and in cooperation with the INESC TEC centres.

5.6.3 Action plan

In 2025, TEC4COMMUNICATIONS will implement two initiatives:

Table 5.2 - TEC4COMMUNCATIONS – Main initiatives planned

Initiatives	Key Results	Strategic Objectives
INESC TEC Innovation identity in Communications	Website including promotional video, Dec/2025	C1.4, C3.5
INESC TEC business strategy for Communications	Business Plan, Dec/2025	C1.4, C3.5

5.7 TEC4ENERGY

Coordinator: João Peças Lopes
Business Developer: Alberto Bernardo

5.7.1 Scope and strategy overview

The energy sector faces the challenge of decarbonizing society and the economy. TEC4ENERGY aligns with EU policies on societal challenges and smart specialisation, emphasizing digitalisation, decentralisation, user-centric, market-driven approaches, large-scale integration of RES, electric mobility infrastructure, Smart Grids, and green hydrogen in a diverse energy mix.

TEC4ENERGY utilises INESC TEC's expertise to deliver innovative energy solutions, addressing societal challenges and industry needs. Through industry collaboration, it aligns with European strategic goals and PNEC2030 decarbonisation targets.

5.7.2 Main objectives for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025, TEC4ENERGY is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - Excel and innovate across the missions of academia.

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

- **Major contracts with Industry**

  TEC4Energy is focused on creating last long relationships with industry, valorising and transferring INESCTEC's R&D through strategic partnerships and contract programmes with the energy sector in Portugal and abroad when dealing with topics like offshore wind energy projects, provision of ancillary services, large scale deployment of electric mobility, controlling the operation of electrolysers, developing solutions for the hybridisation of wind farms with solar PV and batteries, deploying multi-level energy storage solutions.

- **Follow collaborative global electrical industry community initiatives and other strategic events**

  TEC4Energy should follow the innovative work of CIGRE, by participating actively in strategic working groups (WG C6.40 and WG C2.45), workshops and conferences promoted by this organisation, and become involved in collaborative initiatives like the working groups of ETIP SNET, SET Plan and CRESYM that will open doors for participation in new EU projects.

C1.5. Provide Innovative learning experiences

- **New training programmes**

  In addition to technology transfer, TEC4ENERGY is committed in promoting the knowledge created at INESCTEC through the development of advanced training initiatives for technical staff of important energy market players, involving the most relevant topics in the energy sector like the use of knowledge-based tools and AI for energy system management, utilisation of energy storage-based solutions, planning wind off-shore solutions, H2 technology for system services and security of supply and ancillary services markets.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

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

Promote new national and international projects with relevant partners in the energy sector, endeavouring long-lasting and synergistic relationships, allowing for the cross-fertilisation of R&D in domains relevant for the success of the energy transition, involving the electrification of the economy and the exploitation of complementary vectors like the hydrogen.

C2.7. Communicate scientific and technological achievements and their impact

Develop the following top priority initiatives, to divulge INESC TEC innovation capabilities:

- Participation in high-profile international Energy trade fairs and events as exhibitors with booths with demonstration of products and ideas born at INESC TEC and hosting pitch sessions

- Promote regular industrial laboratory visits to the X-Energy Lab (formerly known as Smart Grids and Electric Vehicles Laboratory), the Optical and Electronic Technologies Research Laboratory, Robotics and Autonomous Systems Laboratory and Laboratory of Computer Graphics and Virtual Environments.
- Organisation of the Energy Technology Open Day event with presentation of prototypes and solutions with high TRL related with innovative products that can bring added value to the energy industry needs in Power and Energy, Robotics, Autonomous Systems, Fiber Optics, Virtual Environments, Cyber security and Telecommunications. The next session of this event may address specific subtopics, such as AI or even the participation of technology takers sharing their innovation strategy and/or showcasing their own solutions, which were enabled by the technology developed by INESC TEC.

Tec4Energy intends to increase its participation in international fairs (e.g. ENLIT 2025) and consolidate the Energy Technology Open Day, disseminating the results of INESC TEC's research projects and seeking to create new business opportunities. In addition, the INESC TEC laboratory infrastructures will be strategically repositioned to deal with emergent energy topics, also increasing the exploitation of the X-Energy Lab when providing services to industrial companies.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

C3.5. Increase our international networking, leadership and competitiveness

As previously mentioned, TEC4Energy intends to organise the participation in major international events and will also continue its mission to seek partnerships with international partners, both on the European continent and on emerging markets such as Africa.

Commitment 5 – Strive for a sound, sustainable and effective operational model

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

As stated previously, one of TEC4ENERGY main efforts is in the promotion of R&D projects targeting the energy sector, capitalizing INESC TEC's technology and innovation competencies and resources. TEC4Energy incentivises variability in the typology of projects endorsed, covering a spectrum ranging from contract programmes to the provision of advanced consulting services, tenders for competitive research funding, both nationally and internationally. This effort aims to increase the contractualisation of R&D and innovation services, contributing for the sustainability and resilience of INESC TEC economic model.

5.7.3 Action plan

Table 5.3 - TEC4ENERGY – Main actions planned

Initiatives	Key Results	Strategic Objectives
Participation in international fairs like the ENLIT 2025	Increase visibility among potential partners and customers, increase networking opportunities, show new solutions and products, attract talent	Increase the international recognition; Exploit new markets and opportunities; Show technological and innovation capabilities; Foster collaboration opportunities. C1.4, C2.3, C2.7, C3.5, C5.1
Organisation of the "Energy Technology Open Day" event	Increase visibility among potential partners and customers, increase networking opportunities, show new solutions and products, attract talent	Increase recognition in Portugal; Exploit new opportunities; Show the organisation technological / innovation capabilities; Foster collaboration opportunities. C1.4 C2.3 C2.7 C3.5 C5.1
Promotion of regular industrial laboratory visits	Exposure of the latest research and development activities and products serving Energy needs; Increase of network opportunities; Foster new service contracts; Present innovations, and experiments that are at the forefront of technology.	Gain exposure to the latest research and development activities in the field of high technology leading to new contracts that involve the exploitation of the laboratorial infrastructures for testing and other services; Foster networking and new R&D projects. C1.4, C2.3, C2.7, C5.1

Initiatives	Key Results	Strategic Objectives
Follow collaborative global electrical industry community initiatives and other strategic events	Access to the latest industry trends, innovations, and best practices; Build a global network that can lead to collaborative projects. Stay informed about international standards.	Promote and foster major contracts with industry. C1.4

5.8 TEC4HEALTH

Coordinator: Miguel Coimbra
Business Developer: Carlos Alexandre Ferreira

5.8.1 Scope and strategy overview

TEC4HEALTH strategically implements a market-driven approach in R&D with the aim of engaging all value chain actors and processes within the healthcare and well-being sectors. To accomplish this, TEC4HEALTH explores opportunities in the health sector where technology needs and roadmaps align with INESC TEC's competencies. Recognizing the pivotal role of positioning itself not only between academia and the market but also by directly engaging with healthcare institutions, TEC4HEALTH considers the importance of establishing robust connections with these institutions. Such connections are crucial, serving as both the foundation for research challenges and a valuable source of data for analysis. Additionally, forging strong ties with companies is imperative, providing the opportunity for contributions to have a tangible impact through technology adopters.

Through collaborative endeavours with partners, TEC4Health is dedicated to fostering the advancement of prosperous projects, contracts, and technology transfers. This strategic approach aims to secure funding for INESC TEC's research initiatives, actively seeking opportunities with entities interested in investing in technology development, as well as engaging in dedicated programs that support and drive forward R&D.

5.8.2 Main objectives for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025, TEC4HEALTH is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

- Revisit all existing collaboration protocols to ensure they are up-to-date and aligned with current priorities.
- Initiate strategic visits to existing and new partners to reinforce collaborations and identify unmet needs.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

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

- Conduct a comprehensive reassessment of market R&D needs to recalibrate priorities in line with emerging trends.

C2.4. Contribute to the digitalisation of public administration

- Pilot innovative solutions addressing specific pain points in hospital systems and public health administration.

C2.7. Communicate scientific and technological achievements and their impact

- Develop engaging content formats (e.g., success stories, interactive reports, and multimedia presentations) to highlight the transformative potential of INESC TEC innovations in advancing healthcare and addressing critical challenges in the health sector.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

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

- Strengthen ties with local clusters to expedite the commercialisation of research outcomes.

C3.5. Increase our international networking, leadership and competitiveness

- Expand participation in Horizon Europe by targeting underexplored opportunities and initiating high-profile consortia.

Jointly with these key advances, in 2025, the other main objective for the TEC4 towards its vision is:

- [T4H1] Reassess internal R&D alignment by implementing a "Center-to-Impact" approach, encouraging each centre to define pathways from their existing capabilities to tangible societal and healthcare outcomes.

5.8.3 Action plan

This year, TEC4HEALTH will design and/or implement the following initiatives and actions:

Table 5.4 - TEC4HEALTH – Main actions planned

Initiatives	Key Results	Strategic Objectives
Organisation of internal meetings with INESC TEC Centres	More project proposals Proposals with higher quality	T4H1
Study and plan of European calls	More project proposals Proposals with higher quality	C3.5
International businesses visits	Increased visibility of INESC TEC within the health technology area Improve relationships	C2., C3.5, T4H1
National businesses visits	Increased visibility of INESC TEC within the health technology area Improve relationships	C1.4, C2.3, C2.4, T4H1
INESC TEC participating in relevant networks and clusters	Increased visibility of INESC TEC within the health technology area Networking and promotion	C2.3, C3.5
Enhancing technologies	Secure more technology transfers New products and spin-offs	C1.4, C2.3, C2.4, C2.7, C3.2, C3.5, T4H1
Participation in national and international fairs	Projects with new entities Market scouting (access to sectorial roadmaps)	C1.4, C2.3, C3.5
Healthcare technology demonstration days	Increased visibility of INESC TEC within the health technology area Projects with new entities	C1.4, C2.3, C2.4, C2.7, C3.5
(Re)take collaboration protocols	Improved alignment with partner needs Strengthened long-term relationships	C1.4, C2.3, C2.4, C3.5
(Re)engage with strategic partners	Improved relationships New project opportunities	C1.4, C2.3, C2.4, C3.5

5.9 TEC4INDUSTRY

Coordinator: Américo Azevedo
Business Developer: Pedro Senna

5.9.1 Scope and strategy overview

TEC4INDUSTRY is an initiative committed to fortifying the competitiveness of the Portuguese industry. We strive to assume a pivotal role in facilitating the advancement towards a digitalised industry, leveraging the full spectrum of digital technologies for the innovation of products, services, processes, and business models. Furthermore, we advocate for an autonomous industrial landscape propelled by information and knowledge, steering towards self-awareness and self-learning processes, thereby optimising overall performance. Our commitment extends to the cultivation of a human-centric industry, capitalising on human capabilities and fostering collaborative activities between humans and machines. These involve the reduction of risks and non-value operations conducted by individuals, as well as the enhancement of general well-being which, in turn, promote an attractive environment for young professionals. TEC4INDUSTRY is committed to promoting and facilitating the adoption of technologies and practices that contribute to a more resilient and sustainable industry. The key idea is to guarantee an industry with the capacity to adapt to contextual and domain changes. Additionally, digital and carbon neutrality remain a cornerstone of our strategy.

5.9.2 Main objectives for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025, TEC4INDUSTRY is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

In such a volatile economic, social and technological landscape, where problems are strongly multidisciplinary, it is necessary to build significant roots capable of connecting with different areas of knowledge. Bearing the ambition to leverage the impact in industry and technology companies, TEC4INDUSTRY will nourish the relationship with universities, technology and business schools, industrial clusters, innovation hubs, TestBeds, as well as start-ups, incubators and accelerators, not only towards entrepreneurial activities, but also to enable advanced training and capabilities building throughout the innovation partners and broader community.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

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

TEC4INDUSTRY performs as INESC TEC's driver for added-value, science-based research, promoting vision alignment between the 13 research centres and the industry's needs. Externally, TEC4INDUSTRY promotes a more vital National industrial ecosystem composed of added-value industrial companies, as well as disruptive and unique technologies and consultancy companies. TEC4INDUSTRY wants to take advantage of a novel combination of knowledge, competences, resources and infrastructures to promote INESC TEC to the ideal position to develop added-value applied research, based on science, according to the domain-specific challenges.

C2.4. Contribute to the digitalisation of public administration

Stemming from the development of digital transformation and digitalisation services, TEC4INDUSTRY seeks to promote a transition towards a more autonomous, self-sustained and highly optimised industrial complex. Through the multiplicity nature of INESC TEC's technical capabilities, TEC4INDUSTRY sets forth to encourage innovative solutions that make use of real-time simulation, artificial intelligence, data and information management, and business model development, towards enhancing the industries' "twin transition" – namely by promoting the switch from traditional shop-floors and silo process-based approaches into holistic, flexible and integrated management of operations, supported by well-established information systems, enabling new business models for adhering to circular economy standards.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

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

Our market-focused services build on a track record of successful technology transfers towards industrialisation and/or entrepreneurship support, stemming from a market-pull innovation approach where our core strategy is aligned with relevant challenges from main economic sectors. Key drivers include: long-term partnerships in manufacturing; RD&I collaborations with tech firms; targeted consultancy aiding digital transformation for diverse companies; collaboration with industry associations for digital progress; promoting iiLab as an industry TestBed for services such as advanced training, technology prototyping, and start-up support; monitoring PRR projects to facilitate academia, industry, and tech providers interaction for the development, demonstration, and dissemination of new Portuguese products, technology, and services (PPS).

C3.5. Increase our international networking, leadership and competitiveness

TEC4INDUSTRY seeks to contribute to the main groups of work, with connections with the European Commission, that are dealing with emerging topics such as Emerging and Disruptive Technology Scouting and Mapping applied to manufacturing, sustainability and circular economy, and digital transformation. The main objective is not only to influence and build channels to communicate INESC TEC's perspective, but also positioning INESC TEC's centres as relevant and active stakeholders in the main competitive consortiums for European projects, capable of supporting large-scale innovation strategies.

Commitment 5 – Strive for a sound, sustainable and effective operational model

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

TEC4INDUSTRY aims to enable INESC TEC's business model, by promoting new consultancy and technology transfer services within industry, through funding and direct contract services, as well as by leveraging INESC TEC's participation in European projects and possible establishment of spin-off initiatives, to keep a sustainable and effective science-based operational model.

Jointly with these key advances, in 2025, the other main objectives for the TEC4 towards its vision are:

- **C2.7. Communicate scientific and technological achievements and their impact**

5.9.3 Action plan

This year, TEC4INDUSTRY will design and/or implement the following initiatives and actions:

Table 5.5 - TEC4INDUSTRY – Main actions planned

Initiatives	Key Results	Strategic Objectives
Visit and contact new potential clients in Portugal and eventually abroad. Visits to European and International institutes facilities	Increase INESC TEC network of partners and customers	C1.4, C3.5
Participate in Summits and events promoted by European Commission and other EU initiatives. Participation in National and International conferences.	See the future of manufacturing from global experts and have visibility on EU initiatives. Disseminate and demonstrate the technologies and case studies developed in INESC TEC.	C2.3, C3.5, C5.1
Design and promote new advanced consultancy and technology services, supported by circularity and sustainability principles,	Increased number of service and consultancy projects, with focus on AMTs and KETs, considering the main economic sectors.	C2.3, C2.4, C5.1
Creation webinars, workshops and other dissemination material oriented to specific domains and specific white papers.	Produce videos, brochures and other promotional material for INESC TEC services and Tech dissemination	C3.2
Consolidate iILAB's value proposition and leverage service offering at national level.	Structured service offer and synergies with PT2030 projects. Provide Advanced Training Courses and Master Classes for target domains	C2.4, C3.2, C5.1
Promote INESC TEC and Industry collaboration within European Projects.	Facilitate collaboration between INESC TEC centres, industrial associations, technology companies and Industrial companies	C2.3, C3.5, C5.1

5.10 TEC4SEA

Coordinator: Eduardo Silva

5.10.1 Scope and strategy overview

TEC4SEA addresses the innovation challenges posed to industries working in the Blue Economy, facing a considerable number of challenges, driven by the increasing world population, urbanising and ageing, the pressure on global food supplies, increasing demand for metals and minerals, energy demand and energy transition, ocean health, climate-ocean interactions and climate changes, geopolitical tensions, increasing technological revolutions among others. It covers a wide range of established and emerging industries such as marine living resources (fisheries and aquaculture), extraction of non-living resources (minerals, oil & gas), marine renewable energies, desalination of water, maritime and fluvial transport, as well as coastal and maritime tourism. Examples of activities directly related to the marine environment include processing food of marine origin, marine biotechnology, shipbuilding and repair, port activities, technologies and equipment, healthy ocean (pollution and biodiversity), defence, and security for the Sea environment.

The 2025 strategy will be focused on leveraging a set of strategic initiatives that contribute transversally for the strategic objectives defined by the institution, namely: setting up a centre of excellence towards the ocean challenges, the INESCTEC.OCEAN, shared research infrastructures for ocean technologies and energy transition, the HUB AZUL de LEIXOES 1, leverage the TEC4SEA infrastructure and the Aguçadoura test-site, supporting the establishment of regional innovation ecosystems connected with other leading regions of Europe, expand the R&D+I activities around the Atlantic ocean.

5.10.2 Main objectives for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025, TEC4SEA is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

Leading the development of strategic infrastructures (like Hub Azul de Leixões 1 and the CEO) that will strengthen the relations with the academic and economic ecosystem, TEC4SEA contributes to the strategic commitments: “C1.2. Increase our involvement in the leadership of scientific initiatives”, “C1.4. Develop closer and deeper relationships with our innovation partners and the broader community” and C1.6. Increase the international embedment of our community”.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

TEC4SEA via the INESCTEC.OCEAN project is contributing to the development and establishment of value- and supply-chains, leveraging the INESCTEC´s, regional and national stakeholders’ competencies, into some of the most relevant challenges, such as decarbonisation, digitalisation and circular economy. These will contribute to: “C2.3. Better align and deliver R&I with industry's needs”, “C2.4. Contribute to the digitalisation of public administration” and “C2.7. Communicate scientific and technological achievements and their impact”.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

Leading complementary strategic infrastructures, devoting them to new scientific developments and opening them to national and international cooperation (e.g., INESCTEC.OCEAN- Human Resources capacitation; TEC4SEA infrastructures – means to test and operate in the ocean; Aguçadoura test site – offshore test and validation of renewable energy solutions, robotics, digital solutions, sensors and telecommunications; Hub Azul de Leixões Pólo 1 – ocean basin for scaled test of offshore renewable solutions, robotics, sensors, scientific diving, etc.) impacts in the strategic commitments: “C3.2. Develop better linkages between knowledge production, development, and market uptake” and “C3.5. Increase our international networking, leadership and competitiveness”.

Commitment 5 – Strive for a sound, sustainable and effective operational model

The combined set of initiatives and commitments to 2025, both in terms of the consolidates initiatives like INESCTEC.OCEAN and new initiatives (e.g., kick for the water and ocean, regional innovation valley, Atlantic collaboration), R&D projects and collaborative infrastructure´s, supports the Strategic Commitments: "C5.1. Strengthen the sustainability and resilience of our economic model".

5.10.3 Action plan

This year, TEC4SEA will design and/or implement the following initiatives and actions:

Table 5.6 - TEC4SEA – Main actions planned

Initiatives	Key Results	Strategic Objectives
Setting up INESCTEC.OCEAN	New high prestige grants Contracts with national and international industries Stakeholders' engagement and increased national and international visibility	C1.2; C1.4; C1.6 // C2.1; C2.2; C2.3; C2.4; C2.5; C2.7 // C3.1; C3.2; C3.3; C3.4; C3.5 // C5.1; C5.2; C5.3
Led the construction of shared research infrastructures for ocean technologies and energy transition (Hub Azul de Leixões I)	Engage with the national and international stakeholders. Advance in the construction, management, and sustainable models	C1.2; C1.4; C1.6 // C2.1; C2.2; C2.3; C2.4; C2.5; C2.7 // C3.1; C3.2; C3.3; C3.4; C3.5 // C5.1; C5.2; C5.3
Leverage the TEC4SEA infrastructure and the Aguçadoura test-site	Contracts with national and international industries Stakeholders' engagement and increased national and international visibility	C1.2; C1.6// C2.1; C2.2; C2.3; C2.5; C2.7 // C3.1; C3.2; C3.3; C3.4; C3.5 // C5.1; C5.2; C5.3
Support the establishment of regional innovation ecosystems connected with other leading regions of Europe	The establishment of formal and informal networks of stakeholders and regions aligned with common strategies and objectives. European Ocean & Waters KIC	C1.4; C1.6 // C2.1; C2.2; C2.3; C2.4; C2.5; C2.7 // C3.1; C3.2; C3.3; C3.4; C3.5 // C5.1; C5.2; C5.3
Expand the R&D+I activities around the Atlantic Ocean	Support the strategy alignment, connections, and activities with strategic players in the Atlantic Contracts with national and international industries	C1.2; C1.4; C1.6 // C2.1; C2.3; C2.5; C2.7 // C3.1; C3.2; C3.4; C3.5 // C5.1; C5.2; C5.3
Promote national visits and contacts with ecosystem	Strengthen and connect the regional and national ecosystem, develop new opportunities and projects	C2.1; C2.3; C2.5; C2.7 // C3.1; C3.2; C3.4; C3.5 // C5.1; C5.2; C5.3
Participation in international fairs, expositions, and relevant conferences	Promote INESC TEC results and activities in relevant forums Develop international activities with key players	C1.4; C2.3; C2.5; C2.6 // C3.1; C3.2; C3.5 // C5.1; C5.2; C5.3
Develop marine resources business awareness for the Galicia, Canarias, and Atlantic African countries.	Develop awareness and positioning for INESCTEC activities and results	C2.1; C2.3; C2.4; C2.5; C2.7 // C3.1; C3.2; C3.3; C3.4; C3.5 // C5.1; C5.2; C5.3

5.11 TECPARTNERSHIPS

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

5.11.1 Scope and strategy overview

TECPARTNERSHIPS focuses on identifying high-potential market sectors where INESC TEC's expertise can be effectively applied, and that are not covered by the other well established TEC4. This mission is to facilitate technology transfer, enhancing the international competitiveness of companies in these sectors. We aim to establish INESC TEC as a trusted technological partner and an innovation reference, fostering collaboration both within and beyond the organisation.

In the **Financial, Construction, and Internet Markets**, our actions are guided by strategic market plans (Planos Estratégicos de Mercado – SMP) and supported by a robust network of technology adopters (TTAKs). Our approach includes structuring offerings based on INESC TEC's research lines, actively participating in networking events and trade fairs, and identifying funding opportunities through initiatives such as Horizon Europe.

In the **Defense & Security, Space, and Public Administration sectors**, we focus on identifying application areas, raising awareness of INESC TEC's capabilities, creating Communities of Practice, and leveraging synergies across disciplines. We strive to establish industry partnerships through direct contracts and funding opportunities.

The renewal of the "**Agrément CIR**" represents a significant milestone, enhancing our attractiveness as a partner and forming the basis for a sustainable internationalisation strategy targeting the French market.

Furthermore, we are implementing the strategy and action plan outlined in the document "**Análise de Mercado IA – Perspetivas, Oportunidades e Plano de Ação**", designed to reinforce existing action plans and promote the adoption of Artificial Intelligence (AI) across companies.

These efforts collectively strengthen INESC TEC's presence across diverse sectors, driving innovation and fostering meaningful collaborations that extend beyond the organisation.

TECPARTNERSHIPS is also responsible for providing tools that support TEC4 activities.

5.11.2 Main objectives for 2025

Aligned with INESC TEC's Strategic Plan 2023–2030, TECPARTNERSHIPS is prioritizing significant advances in the following strategic objectives for 2025:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

Actions for key indicator "Major contracts with industry"

- Leverage TTAKs to engage new companies capable of implementing INESC TEC's developments.
- Organise meetings with existing partners to identify new challenges.
- Host regular stakeholder engagement sessions to gather feedback and insights.
- Utilise "Agrément CIR" recognition to establish partnerships with French companies.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

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

Actions for key indicator "Number of national and international projects in partnerships with industrial players"

- Conduct market analyses to identify areas where INESC TEC's competencies meet industry demands.
- Review existing partnerships to identify improvement opportunities.
- Execute the AI market strategy action plan.

C2.4. Contribute to the digitalisation of public administration

Actions for key indicator "Number of projects that respond to digitalisation needs of public administration"

- Develop projects addressing digital transformation needs, with a focus on leveraging TTAKs.

C2.7. Communicate scientific and technological achievements and their impact

Actions for key indicator "Participate in high-profile international trade fairs and events and Laboratory visits and technology open-days"

- Participate in high-profile trade fairs and events.
- Organise seminars, laboratory visits, and technology open days.
- Highlight "Agrément CIR" recognition in international communications.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

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

Actions for key indicator "Number of development and demonstration projects resulting from previous internal research projects"

- Assess internal research projects to identify potential for development and demonstration.

C3.5. Increase our international networking, leadership and competitiveness

Actions for key indicator "Number of high visibility international events. Number of EU projects approved in coordination role. Revenue in EU projects."

- Organise and participate in high-visibility international events.
- Lead EU projects with coordination roles, maximizing funding and visibility.

Commitment 5 – Strive for a sound, sustainable and effective operational model

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

Actions for key indicator "International competitive research funding. Major contracts with industry and philanthropic funding."

- Pursue competitive international research funding beyond Horizon Europe.
- Strengthen relationships with industry partners to secure major contracts

.Jointly with these key advances, in 2025, the other main objectives for the TEC4 towards its vision are:

- CRM: Expand the internal overall use of the tool and support its evolutionary maintenance.

5.11.3 Action plan

In 2025, TECPARTNERSHIPS will implement the following initiatives and actions:

Table 5.7 - TECPARTNERSHIPS – Main actions planned

Initiatives	Key Results	Strategic Objectives
Engagement with organisations	New projects with entities	C1.4, C2.3, C2.7, C2.4, C3.1
Participation in national and international Seminars and Events with stand: RDV Carnot, AED Days, Techinnov	Projects with new entities	C1.4, C2.4, C2.7, C3.2
Organised Seminars:	Improve relationships	C1.4, C2.3, C2.7
Meeting with international entities	New projects with international entities	C2.3, C3.5, C5.1

Initiatives	Key Results	Strategic Objectives
Forum Participation (Cluster, Colabs..)	Networking and promotion	C1.4, C2.3, C3.5
Support Software Systems	Better Support of TEC4 activities	C1.4, C3.2, C3.5

6 RESEARCH AND DEVELOPMENT CENTRES

6.1 CTM - Centre for Telecommunications and Multimedia

Coordinators: Filipe Ribeiro and Vítor Grade Tavares

6.1.1 Centre scope and vision

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.

6.1.2 Main objectives for 2025

6.1.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is prioritising significant advances in the following Strategic Objectives:

C1.1 Raise the contribution and visibility of our research: Keep improving the percentage of papers published in Q1 journals overall (KPI: % Q1 journals; Target ≥ 85%) and target a minimum ratio of number of journal publications with PhD students as first author per PhD student (KPI: % (Journals student first-author)/(PhD student); Target: 50%). Organise a workshop to raise awareness of the importance of increasing the quantity and quality of publication production and its impact on scientific progress and career development — a mindset change.

C1.2 Increase our involvement in the leadership of scientific initiatives: Promote and support the engagement of researchers in editorial boards of leading journals (KPI: number; Target: 2). Support in all levels the resubmission to the ERC Synergy Grant program (KPI: number; Target: 1).

C1.6 Increase the international embedment of our community: Attract visiting researchers and promote mobility of CTM researchers (KPI: number of researchers; Target: 3) through INESC TEC International Visiting Researcher Programme, Erasmus programs, or other interchange programs.

Considering that major projects will end in 2025, CTM will make a strong effort to successfully complete current projects and develop new project proposals for the next triennium.

6.1.2.2 Research

In 2025, CTM aims to achieve the following key research outcomes:

Integration of a hardware accelerator with a RISC-V processor: the integration of a Coarse Grain Reconfigurable Architecture (CGRA) type accelerator with a RISC-V core will be achieved. This will showcase the potential for accelerating inference of AI models, by taking advantage of new compilation methods. (SD: CSE)

Human sensing with a large reconfigurable intelligent surface: prototyping of a scalable multi-tile design of a reconfigurable intelligent surface, experimental characterisation in anechoic chamber, and demonstration of optimal control for a human activity recognition application. (SD: COM, CSE)

ML-based solutions to model, optimise, and enhance wireless networks: development of semantic encoders/decoders, cross-layer algorithms, and Network Digital Twins using ML-based approaches aiming to achieve context-aware, self-adaptive and robust communications solutions for demanding scenarios. (SD: COM)

Zero-touch node positioning and link adaptation in robotic-borne wireless networks: algorithms and mechanisms for autonomous node positioning and radio resource management in robotic-borne networks, optimizing LoS communications, for next-generation networks operating in higher frequency bands. (SD: COM)

Dialogue-attended Audiovisual Dataset: a 280k video clips, each paired with a dialogue-based description, integrating data from existing benchmarking datasets. The dialogue is curated from both human-made captions and those generated by models pretrained on publicly available video and audio caption corpora. (SD: AI)

Methods for multimodal video classification and music generation: novel methods for video analysis and classification relaying on the extraction of high-level features related to several modalities, intelligently fused to support different dimensionalities and temporal lengths. (SD: AI)

Explainable Face Biometrics: propose novel interpretability-driven regularisation techniques to improve model robustness and generalisation in face biometrics. (SD: AI)

Generalisation and application transversality: development of a neurosymbolic system of object individualisation upon the main idea that stronger inductive biases - not only at the level of learning mechanisms, but also on built-in symbolic knowledge given a priori - are crucial for more human-like learning systems. (SD: AI)

Unified architecture for Visual Scene Description: unified and flexible architecture for complex visual scene understanding for 3D scene synthesis. (SD: AI, CSE)

Explainable AI-driven symbolic music information extraction: algorithms for computing harmonic-driven explanations from VAE representations of symbolic music. (SD: AI)

AI-based clinical support and robotic intervention: develop novel AI-based upper-limb optimised collaborative robotic intervention support based on vision data and clinical framework to support practice and improve the pipeline associated with the planning and treatment of procedures associated with lung pathologies. (SD: AI, BIO)

Torso Morphing for Patient Engagement: development of models specific to each type of breast cancer treatment as well as an aesthetically aware content-based image retrieval module with a data-driven optimised similarity measure and smooth control of the cardinality of the set of retrieved cases. (SD: AI, BIO)

6.1.2.3 Innovation

In 2025, CTM aims to achieve the following key innovation outcomes:

Vision-assisted xApp for RIS control: demonstrate the real-time control of a RIS beam suitable for tracking a target user, by leveraging the vision-based sensing capability integrated into the O-RAN architecture through an xApp operating in the Radio Access Network intelligent controller of an OAI-based gNB. This achievement will contribute to the commercialisation of a CTM patent.

Memristor controlled RIS unit cell: design and prototyping of a reconfigurable intelligent surface unit cell with an integrated memristor, allowing to demonstrate the control of the unit cell response through the electronic control of the memristor. This achievement will contribute to the commercialisation of an existing CTM patent.

Digital Twin of reconfigurable IoT node: software for digital representation of an IoT node – capable of communicating and harvesting energy through light and radio – enabling the development of new cross-layer network performance and energy optimisation algorithms.

Repositionable Mobile 5G Base Station: development and demonstration of a Mobile 5G Base Station and positioning module for the establishment of novel on-demand self-adaptable networking infrastructures that can transparently extend wireless connectivity to terminals operating in terrestrial and maritime environments. This achievement will contribute to the submission of a new CTM patent.

Hybrid in silico/physics-informed ML approach for multimodal data fusion: development of cutting-edge, high-fidelity digital breast models with breast magnetic resonance imaging pose transformation from prone to supine, to predict tumour location.

Software for planning breast cancer treatment: software enabling a new way of dealing with the locoregional treatment proposal. Patients will be familiarised with a cloud-based healthcare platform that they can use in their smartphones, tablets or PC, where they have information about the type of proposed treatment.

Toolkit for beverage and food quality control: the package will include a low-cost solution for mobile devices aiming at wine color analyses to detect degradation or adulteration of beverage and a label processing library for information extraction in unconstrained scenarios.

Multimedia emotion analyser: the toolkit makes available a library of models able to analyse audio and video inputs and extract several high-level features, including emotion conveyed, detection of similarities in content and ironic discourse.

6.1.2.4 Complementary advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - 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: keep improving the percentage of conference papers published in CORE A*/A/B (or equivalent h5-index) (KPI: % CORE A*/A/B or equivalent h5-index; Target: ≥ 75%).

C1.2 Increase our involvement in leadership of scientific initiatives: organise and co-organise international scientific events, being part of committee boards or chairing technical committees (KPI: number of events; Target: 4).

C1.3 Improve the base conditions for technology commercialisation: enhance CommsLab ability to pre-certify devices and systems for EMC and EMI compliance. Improve the new lab infrastructure for testing and characterisation of 5G/6G solutions. Continue planning the new laboratory facilities at Leça.

C1.4 Develop closer and deeper relationships with our innovation partners and the broader community: improve long-term relationships with international scientific and innovation partners beyond the temporal and cyclical boundaries of joint projects through joint supervisions (KPI: joint MSc and/or PhD; Target: 3). Organise extracurricular projects and/or workshops for undergraduate and master students (KPI: number of initiatives; Target: 2).

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

C3.2 Develop better linkages between knowledge production, development, and market uptake: improve skills through specialised training on professional engineering tools to increase technical expertise and efficiency in innovation activities, both in equipment use and software tools. (KPI: Training courses; Target: 3).

C3.5 Increase our international networking, leadership and competitiveness: participation as Chair or Co-Chair in international organisations relevant to CTM research lines (KPI: number of chair/co-chair positions; Target: 2).

6.1.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.1 - CTM – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Organise INVICTA Spring School, and joint SLICES-Converge summer school	Higher visibility and recognition. Improved networking with international peers. Increased chances of attracting high-quality researchers.	C1.1, C1.2, C1.6, C3.5, C4.1
Promote the "World Sleep Day Initiative"	Introduce and showcase the sleep research within INESC TEC collaborators and the public.	C2.6
Publish key research results in high-quality journals and conferences	Increased impact of the centre in the scientific community. Higher international recognition.	C1.1
Organise monthly CTMeet Up meetings, quarterly meetings between full-time researchers and Scientific Council meetings	Increased internal articulation & debate. Creation of new joint research & advanced training opportunities. Periodic monitoring of achievements.	C2.7
Organise extracurricular internships and workshops for undergraduate and MSc students	Attraction of future MSc and PhD students Higher visibility and recognition in the partner academic institutions.	C1.1, C1.5, C4.1, C4.3

Initiatives	Key Results	Strategic Objectives
Continue to build flagship prototypes around the solutions and technologies developed at the centre.	Raise the visibility of research. Demonstration of innovation capabilities and their impact.	C1.1, C2.7
Continue to lead the research and innovation component of the new laboratory facilities at Leça.	Improve the quality of our infrastructures. Strengthen multidisciplinary R&I.	C5.2, C3.1

6.2 CAP - Centre for Applied Photonics

Coordinators: Paulo Marques and Ireneu Dias

6.2.1 Centre scope and vision

CAP research activities objectives are grounded on fundamental physics and optical engineering, driven by the demonstration of practical solutions for demanding problems and the development of intellectual property with envisioned economic valorisation.

CAP develops its activity in integrated optics and microfabrication, optical sensors, and quantum optical engineering. The overall objective is to work towards the incorporation of our devices as novel perception tools, such as: 1) spectral imaging technologies, like analytical laser induced breakdown spectroscopy (LIBS) and ultraviolet/visible spectroscopy systems, providing real time analysis tools in hazardous environments, 2) optical sensing technologies enabling in situ and remote physical, chemical and biological parameters detection in demanding application scenarios and 3) deployment of accessible and versatile analogue quantum simulators and all-optical processing systems.

6.2.2 Main objectives for 2025

6.2.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - 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

- CAP will prioritise the increase of publications in high-impact journals, targeting both quality and a rise in productivity, to further consolidate its international position across its research areas. Thus, the Centre plans to grow the number of papers published in Q1 journals by 10%, up from the 2024 results.

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

- Considering the prestige of the high-impact European Research Council (ERC) grants, the Centre will endeavour to receive its first ERC Grant, starting or consolidator. For that purpose, at least one application will be submitted in 2025, in the fields of Quantum Science and Technologies.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

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

- To further develop and exploit the intellectual property generated in R&D copromotion projects the Centre plans to apply for demonstration projects in other areas of application, namely recycling and sustainability.

6.2.2.2 Research

CAP scientific domains focus on photonic sensing and optical systems and devices for antilog quantum simulations, along the following research pillars.

Advancing photonic-based Intelligent tools exploring innovations in optical materials and sensing technologies for environmental monitoring, medical diagnostic, and industrial applications.

The development of photonic-based devices represents a transformative approach to real-time monitoring and analysis across a range of sectors. By leveraging label-free and reagent-free sensing technologies, these systems offer unparalleled advantages in miniaturisation, ease of use, operational speed, and long-term reliability. This research focuses on the creation of Networked Optical Intelligent Tools that integrate cutting-edge optical materials with advanced biological and chemical sensing capabilities. These tools aim to provide accurate and reliable data collection for applications in environmental monitoring, aquaculture systems, biomass production, and energy distribution.

The approach combines state-of-the-art fabrication techniques, such as femtosecond laser direct writing, with the development of dielectric photonic crystals, plasmonic sensors, and molecularly imprinted systems. By integrating high-performance spectroscopy, sensor fusion strategies, and plasmonic materials, the initiative aims to pioneer next generation sensing devices tailored to address complex biological and chemical challenges. This innovative direction is set to enhance monitoring accuracy while ensuring scalability and adaptability of solutions to meet dynamic industry demands.

To achieve these objectives, the focus for the upcoming year will include the following areas and activities:

- Optical material processing - Employ the femtosecond laser direct writing technique for processing optical materials to develop integrated optics, gratings, and waveguides. An infrastructure upgrade will involve the update of the Bragg grating and long-period grating manufacturing system, with new motion controllers for X-Y Aerotech stages, possibility of writing on multi-core fibers, as well as on the cladding of optical fibers. The second update will be realised on the Amplitude Systemes Satsuma laser.
- Starting of fabrication of neuromorphic integrated optic devices; this involves the fabrication of very loss low optical waveguides and devices (i.e., directional couplers, MMI's, interferometers, for example). The main aspect will be the development of active components. The first action will be towards the development of active devices using thermo-optic effects by the means of thermal shifters on the device surface. While the fabrication of thermal heaters on the device surface is not a novel concept, the complete electrodes definition by laser direct writing is completely new for us. On this subject we will explore the feasibility of hybrid integration of glass written waveguides with electro-optic polymers, allowing fast switching times.
- Fabrication of cantilevers by glass micromachining; these cantilevers include multiple waveguides with Bragg gratings for vibration characterisation.
- Evaluation of the capabilities of femtosecond multiphoton polymerisation and machining on the development of photonics integration and advanced packaging.
- Optofluidic systems: fabrication of optofluidic systems to support multi-parameter sensing in fluidic environments.
- Advanced photonic structures – Development of dielectric photonic crystals and plasmonic sensors with high-quality nano-coatings.
- Nanoparticle integration – Synthesis and integration of custom-designed nanoparticles to enhance sensitivity and detection performance.
- Environmental monitoring solutions – Development of innovative solutions for air and water quality monitoring combining chemical processes with optical transducers.
- High-performance spectroscopy – Implement advanced techniques such as fluorescence, Raman, and absorption spectroscopy for higher detection capabilities.
- Complex industrial challenges - Integrate complementary optical methods to address complex sensing requirements in industrial applications.
- Real-time monitoring in aquaculture - Prototype and test devices for real-time biological and chemical monitoring in both inshore and offshore aquaculture systems.
- Biomass production applications – Develop optical systems to optimise process monitoring in biomass industry.
- Energy distribution monitoring - Customise sensing systems large-scale industrial energy monitoring needs.
- Oceanographic Advances - Enhance knowledge of ocean ecosystems with bio-integrated and chemical optical sensors for comprehensive monitoring.
- Design a proof-of-concept digitalisation pipeline for cultural heritage objects, combining spectral imaging diagnosis with augmented reality tools;
- Explore the combination of optical tweezers with Raman enhancers (particles or substrates) for the detection of molecular signatures.

Photonic sensing for extreme environments

The development and optimisation of distributed systems for permanent deployment in infrastructures or extreme environments using HDAS, High Fidelity Distributed Acoustic Sensor, or other types of distributed sensing systems, will be addressed to attain the following expected objectives:

- Monitoring of the behaviour of the Atlantic Ocean between Sines and Fortaleza with Distributed Acoustic Sensing (DAS) technology by means of its implementation in intercontinental submarine cables already deployed.
- Seismic detection and oceanography studies using DAS technology deployed in a submarine cable in Azores, connecting Faial and Flores islands.
- Monitoring of high-power distribution cables for bird collision detection, towards a more rigorous evaluation of that impact that may enable the design and implementation of deterrent/avoidance/alarm processes, contributing to biodiversity conservation.
- Implementation of an R&D distributed sensing cluster of submarine cables for the monitoring and detection of seismic activity, oceanography, Security and Defence.
- A national project in collaboration with the Portuguese Navy was submitted whose aim is maritime surveillance by integrating Distributed Acoustic Sensing (DAS) with underwater fibre optic cables and machine learning.
- Within the research line of distributed systems, a new methodology will be addressed – the State-of-Polarisation – to fully comprehend the behaviour of light transmission in the full extension of optical fibre cables, following the main objectives:
- Study and development of the state-of-polarisation (SOP) on a long-haul optical communications link including its sensitivity to the external environment.
- Implementation of machine learning algorithms to analyse and interpret the data collected for pattern recognition, anomaly detection, and trend prediction, laying the foundation for interpreting geophysical information in the future.
- Lasers Technology.
- In parallel, fibre lasers for space applications have been focus of research. The pursue of financing with key partners in the field will lead to:
    - Submission of a European proposal in the TRANSITION call, aiming to study and develop new 1 µm lasers with continuous emission for use in telecommunications and/or wireless energy recharge in space exploration vehicles.
    - Submission of a R&D project in the field of microchip lasers for Lidar technology as part of a Business R&D proposal in Co-promotion with an industrial partner.

Optical systems and devices for analogue quantum simulations

This research challenge envisions the medium-term deployment of accessible and versatile analogue quantum simulators and all-optical processing systems using tabletop optical experiments. Paving for this final goal, the work for the next year focuses on four operational objectives:

- Tackle innovative topological phenomena and the resilience of optical states to turbulence, seeking a proof-of-concept of the use of our simulator as an analogue quantum matter simulator;
- Explore quantum sources and quantum interference with photons for extreme learning architectures, benchmarking its performance in pattern classification in the low light limit;
- Deploy a proof-of-concept quantum sensing device based on Hong-Ou-Mandel Interference;
- Start exploratory research in the organisation and dynamics of complex quantum systems targeting from fundamental research to improvement of quantum reservoirs for extreme learning machines, high-temperature entanglement as a resource and quantum multi-agent systems.

6.2.2.3 Innovation

CAP research is applied in multiple sectors, with a focus on cork industry and mineral exploitation.

- In 2024 in the scope of project “Multimodal Knowledge Distillation: a disruptive approach to spectral imaging and sensor fusion for industrial applications”, a proof-of-concept (PoC) for a disruptive sensor fusion approach was developed. The approach uses novel algorithms, effectively utilizing multimodality,

capitalizing on individual strengths of distinct sources, (Laser-Induced Breakdown Spectroscopy, LIBS and Hyperspectral Imaging, HSI for example), combined and integrated to enhance the capabilities of the single modality system. In 2025 an industrial-grade prototype employing this multimodal spectral imaging approach and leveraging on the developed sensor fusion and knowledge distillation AI architectures and algorithms will be implemented and tested in real industrial applications, namely in the circular economy sector.

6.2.2.4 Complementary Advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

C1.6. Increase the international embedment of our community

Within the framework of international associations membership, EPIC for example, CAP researchers will participate in network and matchmaking meetings in order to explore new partnerships for Horizon Europe projects.

Younger researchers through the local SPIE Chapter will enhance their dissemination and science communication capabilities in international conferences and other events.

The organisation of the OFS29-Optical Fiber Sensors conference will be an opportunity to forge new partnerships and enhance existing ones.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

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

With the guidance and mentoring of TEC4x platform, CAP intends to design and participate in events with industry, namely Open Days, profiting from other INESC TEC centres experience and success. TEC4SEA, TEC4Industry and TEC4Agro will be the main platforms addressed.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

C3.5. Increase our international networking, leadership and competitiveness

Internationalisation, especially in the European context, is a permanent effort that has to be expanded and intensified. Membership and active participation in business, scientific and technical associations shall be increased (EPIC, SPIE, Optica, as examples).

Commitment 5 – Strive for a sound, sustainable and effective operational model

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

The economic model has to be redefined to accommodate for a changing employment environment that has previously relied in grants and PhDs contracts financed by FCT. The European and national policies concerning Scientific Employment will be evaluated in order to find new financing opportunities, attract and retain talent.

IP valorisation through royalties will be carefully assessed with the help of SAL.

6.2.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.2 - CAP – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Monitor the list of journals and conferences in which the Centre researchers will endeavour to publish	Increase in the quality of the publications	C1.1

Initiatives	Key Results	Strategic Objectives
Provide special conditions for top researchers to prepare their applications to ERC Grants and other specific financing programs	Submission of an ERC Grant application	C1.2
To participate in an Open Day for industry, with other INESC TEC centres, with the help and leadership of TEC4X initiative	Obtain new or deepen current leads with industry	C2.7
Support the preparation of applications to Scientific Employment initiatives like FCT Tenure	One successful proposal	C5.1 C1.6
Participation in matchmaking events	Submission of two proposals	C3.5

6.3 CRAS - Centre for Robotics and Autonomous Systems

Coordinators: José Miguel Almeida and Nuno Cruz

6.3.1 Centre scope and vision

CRAS tackles the challenges of operating in harsh, dangerous, and dynamic environments. By deploying robotic systems, the Centre minimises unnecessary risks to human operations and enhances mission effectiveness. The Centre activities are shaped by these challenges across both scientific and technological domains, along with key societal trends and funding priorities. The solutions cover various TRL levels, from foundational results to fully operational devices. The Centre's efforts align with major national and international priorities, including:

- The Extension of the Portuguese Continental Shelf and the National Plan for Recovery and Resilience.
- Horizon Europe Missions – 1) Adaptation to Climate Change, 2) Restore our Ocean and Waters, and 3) Climate-Neutral and Smart Cities.
- UN SDGs – Clean Water & Sanitation; Industry Innovation & Infrastructure; Climate Action; Life Below Water.

The Centre works towards a future where autonomous systems can operate proficiently in harsh environments, isolated or in collaborative teams, with aggregated performance far exceeding human capabilities.

SCIENTIFIC ACTIVITIES

CRAS activities are organised along the following research lines (RL):

RL1. Navigation and control

This RL focuses on navigating autonomous systems in environments without GNSS, using complementary multisensory data fusion. Key efforts include dynamic modelling of sensors and robotic behaviour through deterministic and stochastic approaches, alongside the development of time-efficient algorithms. The RL addresses challenges in simultaneous navigation and mapping, semantic navigation, multibody robot control, degraded modes of operation, environment-aware guidance, seamless transitions between open areas and confined spaces, underwater and surface docking, and information-driven path planning and trajectory tracking.

RL2. Interaction with environment

This RL addresses challenges in robotic operations requiring interaction with objects or features, such as autonomous interventions from floating platforms, object handling on surfaces or the seafloor, and vehicle docking. It focuses on developing precise algorithms to manage obstacles, mitigate risks like collisions or deadlocks, and address control issues for mobile and cooperative interventions involving moving platforms.

RL3. Perception and mapping

Mobile robots are evolving from simple data collectors to systems with advanced onboard processing for high-level decision-making. This RL focuses on computer vision, sensing strategies for single or multiple robotic systems, adaptive sampling, multi-sensor data fusion for underwater and overwater mapping, and processing of hyperspectral, electro-optic, and acoustic imagery, along with underwater acoustic positioning.

RL4. Platforms and operations

This RL addresses the development of innovative robotic platforms and support systems, focusing on new designs, efficient propulsion, energy harvesting, and auxiliary technologies for extended deployments, such as docking stations. The RL also targets novel operational concepts, including command and control of multiple platforms, integration of digital twins for planning and supervision, coordinated mapping of spatiotemporal variations of phenomena, and mobile beacons for underwater positioning and communication networks.

INNOVATION ACTIVITIES

INOV1. Robotics systems prototyping and upscaling

Prototyping of dedicated solutions for inspecting underwater and above-water infrastructures, from shallow to deep waters, with field testing within the scope of ongoing projects. Updating of existing robotic platforms used to support scientific work as well as industry demonstrations.

INNOV2. Navigation and mapping

Development of solutions for specific challenges in navigation and mapping for which CRAS expertise is instrumental. Examples are the reconstruction and mapping of the underwater environment, Eye-in-Hand manipulation strategies for underwater interventions, collision-free interactions in dynamic scenarios, BVLOS (Beyond Visual Line of Sight) operations, or the navigation in GNSS-denied scenarios.

INNOV3. Component development for robotics systems

Developing components for robotic systems to significantly enhance their performance. Examples are the structured light system for underwater applications, real-time detection of fiducial markers for close-range navigation, underwater stereo vision systems, and coupled observation/grasping mechanisms.

INNOV4. Underwater acoustics for positioning, navigation, and communications

Developing and deploying underwater acoustic systems to support cooperative navigation, underwater communications, and accurate relative and absolute positioning. Creating innovative, highly customizable solutions is a crucial competence for advanced autonomous operations with heterogeneous systems.

6.3.2 Main objectives for 2025

6.3.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, CRAS is prioritizing the following Strategic Objectives:

Commitment 1 - 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 – CRAS will prioritise publications in high-impact journals, mainly Q1 and Q2, maintaining indexed publications per FTE, even with the predictable increase in hiring. 2025 will also be a milestone for PhD theses, with at least three defences expected.

Commitment 5 – Strive for a sound, sustainable and effective operational model

C5.1. Strengthen the sustainability and resilience of our economic model – CRAS is fully committed to a sustainable operational model, ensuring long-term viability and resource optimisation. While competitive funding remains the primary financial source, the Centre is balancing income sources with contracts with industry and licensing innovative products. CRAS manages high-value robotic systems, as well as extensive laboratory facilities in two main locations (and minor at Leixões harbour), all requiring regular maintenance and upgrades. As the key TEC4SEA partner, CRAS oversees critical assets like the R/V Mar Profundo and Episea, essential for R&D but demanding continuous investment. To enhance sustainability, the Centre has initiated asset rental during periods of inactivity, targeting a stable income model by 2025.

6.3.2.2 Research

CRAS research activities span several scientific domains, mainly in Robotics, but also in Perception and AI. Regarding robotics, several research milestones are planned for 2025, addressing challenges in RL1-RL4: developing an integrated approach promoting communication and data exchange between UAV-UGV for cross-border maritime surveillance that will improve security and border management in Europe, promoting cooperative navigation. In the scope of RL3, the development includes the implementation of a cross-border surveillance system that incorporates multiple detection technologies integrated into fixed and mobile platforms that will include Unmanned Aerial, Surface and Underwater Vehicles, fixed buoys, submarine cables (SMART), with advanced analytics, decision support, and target tracking using 3D computer vision methods in dense GNSS environments. The development of electric mobility combined with robotics will be an exciting and strategic challenge for 2025. This combination can potentially transform various sectors, contributing to sustainability, efficiency, and technological innovation.

6.3.2.3 Innovation

CRAS research is applied in multiple sectors, but the main innovations are expected in the marine environment. The demonstrations of the use of robotics solutions to support the monitoring of offshore energy production, in particular, encompasses several innovations, namely the development of specific sensors to detect gradients of electric and magnetic fields along power transmission cables (INNOV3), the customisation of vehicles to transport such sensors with minimum contamination (INNOV1), and the navigation with respect to the cables and the iterative generation of 3D maps (INNOV2). Other key demonstrations are planned for vehicles optimised to detect underwater threats and for infrastructure inspection (INNOV1). Regarding navigation and mapping (INNOV2), highlights include the demonstration of real-time underwater adaptive sampling and algorithms for autonomous docking (AUVs and ASVs). Finally, in 2025 the Centre will proceed with the first field trials of a new set of acoustic transducers, spanning multiple orders of magnitude in frequency response (INNOV4).

6.3.2.4 Complementary advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

Besides its strategic objective of improving its publication records, the Centre will publish open-access datasets, exploring the ability to use operational devices in real scenarios. The Centre will also look for new opportunities to attract PhD students, namely by participating in European networks for higher education programs (e.g. Marie Curie networks) or taking advantage of existing relationships with partner institutions. The Centre will continue to encourage the participation of its researchers in organizing international events and exchange programs.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

CRAS will proceed with developing direct contracts with national and international companies dealing with current societal challenges, namely solutions to mitigate the shortage of raw materials, assess the impact of renewable energy production, or study the status of vulnerable ecosystems. The Centre aims to play an essential role in exploring renewable energy to reduce and monitor environmental impacts.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

CRAS researchers are already very active in multiple international societies, associations, and other organisations, addressing both the scientific challenges as well as market demand and innovation opportunities. In a more specific perspective, the relevance will also be increased by the presence of CRAS members in the advisory boards of institutions and companies, both in Portugal and abroad, as well as the participation in external evaluation committees.

Commitment 4 – Cultivate an attractive, people-centred and talented community

CRAS will pursue involvement in exchange programs, mainly taking advantage of partnerships with leading international institutions, offering top-level equipment and unique facilities to conduct research activities. The Centre will continue to support INESC TEC actions to attract students at early stages, for example, through summer internships and hosting and providing support to international students involved in exchange or mobility programs (e.g. Erasmus) to attract and motivate young researchers.

Commitment 5 – Strive for a sound, sustainable and effective operational model

The sustainability of the operational model is a priority for CRAS, in which the majority funding source is through competitive project calls. The Centre will prioritise service contracts with companies and the potential licensing of products to increase longer-term funding sources. The Centre manages expensive robotic systems and support equipment that require regular maintenance and upgrades, as well as a large area of laboratory space distributed in two main locations, with additional facilities in the Leixões harbour. The Centre has also been managing part of the TEC4SEA infrastructure, namely the R/V Mar Profundo and Episea, which have been fundamental to support R&D activities but require permanent investment. The Centre has started exploring renting these assets in specific periods of inactivity as an important income, which will reach a steady state in 2025.

6.3.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.3 - CRAS – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Define the list of journals and conferences in which the Centre researchers will endeavour to publish.	Increase in the quality of the publications.	C1.1
Provide special conditions for top researchers to prepare their applications to ERC Grants (Sessions of debate and preparation; relief of some other workload in other scientific activities, etc).	Obtain at least 1 ERC Grant.	C1.2
Organisation of events for industry and research partners (open day, INTHEBLACK, SOE).	Obtain new or deepen current leads with industry.	C2.7
Participation demonstration events (REPMUS25).	Increase cooperation with NATO Navies.	C3.2, C3.5
Trident field mission at Tropic Sea-Mount (between Canaries and Cape Verde islands at 1000m deep).	Positioning of INESCTEC as a player in the deep-sea monitoring community.	C2.1, C2.3

6.4 C-BER - Centre for Biomedical Engineering Research

Coordinator: João Paulo Cunha

Assistant Coordinator: Duarte Dias

6.4.1 Centre scope and vision

The Centre for Biomedical Engineering Research (C-BER) vision is to be a "promotor of scientific knowledge excellence through fundamental and applied research, advanced training and innovation in Biomedical Engineering".

To accomplish its mission, C-BER is guided by the following scientific goals:

- To create interdisciplinary knowledge enabling the innovation and technology transfer with economic impact.
- To develop bioengineering methods, instruments, 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.

C-BER scientific activity is mainly inserted in the Bioengineering research domain of INESC TEC, but the biomedical engineering transversal scientific application also inserts C-BER at other research domains such as Artificial Intelligence, Robotics and Photonics.

6.4.2 Main objectives for 2025

6.4.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - 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

- C-BER is a very active centre in high impact publications (Q1). In the next year we plan to increase our percentage in Q1 publication, but also to participate in more clinical national and international conferences. We believe that such publications jointly with clinicians will increase our visibility and will allow to foster further research lines internationally.

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

- C-BER is currently, and for the first time in INESC TEC, the leader (jointly with CTM) of an 18 organisation from 10 countries European Project in the Health area. AI4Lungs, a ~7M€ project is pursuing a disruptive new research line on lung diseases AI approach to patients' stratification at a European level which we believe will show INESC TEC potential in this area for further projects. In 2025, C-BER also aims to do the first submission to the European Research Council (ERC) aiming solidify international cooperation with key groups that have been cooperating in a high impact scientific area.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action

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

- In 2024, C-BER focused on creating strategic partnerships with industrial players and support them in the creation of joint project proposal to research and develop new technology to increase industry competitiveness. In 2025, C-BER aims to have some of these proposals accepted and be able to co-create, improve and transfer to the industry some of the technologies that are under research at INESC TEC.

C2.6. Engage in direct dialogue with the public

- C-BER and its spin-offs will be running in 2025 at least 4 clinical studies with ethical approval in national and international clinical centres, which is of major importance to retrieve not only clinical feedback from the results we are achieving (with new data processing methodologies), but also patients (public) feedback on the systems themselves. Newly submitted projects may expand this aspect of our outreach.

C2.7. Communicate scientific and technological achievements and their impact

- We will maintain a strong presence in several highly relevant IEEE conferences (ENBENG 2025, EMBC 2025,…) and a strong activity in news publication in social media channels and international technological magazines.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems

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

- Multidisciplinarity is key for Biomedical Engineering. C-BER is constantly partnering and bringing to our ecosystem different profiles related to this area. In 2025, besides engineers and data scientist from different fields (electrotechnical, informatics, biomedical, …) we envision to bring new experts on the field of biology, medical doctors and nursing to support in co-design our systems, data collection and annotation.

C3.5. Increase our international networking, leadership and competitiveness

- Besides the AI4Lungs leadership that will leverage INESC TEC and C-BER networking at an international level, C-BER also is part of EBRAINS, which is the first and only national research Centre to be part of this European Infrastructure. Such a network will also endorse our visibility for a higher competitiveness at a European level. Also, strong relation with Brazil and Rwanda (CMU-Africa) will endorse C-BER competitiveness around Point-of-Care (PoC) technologies. More international partnerships are being created to allow our medical technologies to be researched, developed and validated at multi-continent level, increasing the visibility and reliability of our results for successful exploitation.

Commitment 5 – Strive for a sound, sustainable and effective operational model

C5.3. Improve quality, management and use of our infrastructures

C-BER is expanding its laboratories and enabling them to perform a higher number of experiments with state-of-the-art equipment. Recently, a new 64-channels video-EEG system was acquired with fMRI synchronisation capabilities to support new studies on the neuroscience field. For 2025 we are planning to add a functional near-infrared spectroscopy (fNIRS) capability to our video-EEG system. Also, a new laboratory for students was created at FEUP in 2024, and we are equipping it with several medical/health systems that are already supporting student projects to be performed with much better support and guidance, increasing students' motivation to pursuit new research areas.

6.4.2.2 Research

C-BER is organised in three Labs carrying out complementary research activities within biomedical engineering field.

RL1. Biomedical Imaging Lab - Coordinator: Miguel Coimbra - The focus of the Biomedical Imaging Lab is the development of advanced image analysis and machine leaning methodologies, including generic approaches. These methodologies will be applied to medical and biological images, with the aim of creating computer-aided diagnosis tools to support medical decision making. For 2025 activities our main focus will be to co-leadership the ~7M€ Horizon-Europe AI4Lungs that is developing and validating novel, robust data-driven computational tools and computational models/algorithms to improve patient stratification in order to optimise diagnosis and treatment of infectious and non- infectious respiratory diseases.

RL2. BioInstrumentation Lab - Coordinator: Miguel Velhote Correia - The main goal of the BioInstrumentation Lab is to perform high-level interdisciplinary R&D in engineering and computational approaches applied to rehabilitation, occupational health, wellness, and sports performance, crossing knowledge from several scientific areas, such as Physics, Electronics Engineering, Computation, Physiology, Biomechanics, Physiotherapy and

Sports science. In 2025 our smart-wearables area, funded by the PRR projects, will be boosted with novel sensing devices and signal processing methods for monitoring of school sports activities (TexPact) and high-density electromyography (HfPT), as well as other innovative endeavours.

RL3. NeuroEngineering Lab - Coordinator: João Paulo Cunha - The main goal of the NeuroEngineering Lab (BRAINlab) is to perform high-level interdisciplinary R&D in engineering and computational approaches applied to basic and clinical neuroscience. Furthermore, we also aim to innovate and facilitate tech-transfer to the high-tech market. During 2025 we will be focused in two main areas, namely the novel adaptative Deep Learning neurological movement impaired quantification project (DeepEpil) and the novel Neurophotonics R&D approaches (iLoF 2.0) that aims to expand our previous successful iLoF-intelligent Lab-on-Fiber technology.

6.4.2.3 Innovation

We plan to start exploring the tech-transfer potential of our iLof 2.0 technology we've patented recently (under the code name Phaser) with our spin-off #8 – *SeedSight* - and continue potentiate our start-up future success with our support (it raised 500k€ and received several prizes, being the most relevant the Altice International Innovation Prize – 75k€).

Furthermore, as a result of our R&D efforts in novel deep learning (DL) models for neurological movement biomarkers from high-resolution video streams, we plan to submit a patent and start the process of creating start-up #9 from our Lab.

As a result of C-BER participation on PRR projects, in 2025, the last year of both *TexPact* and *HfPT* projects, we aim to create a licensing strategy to allow industry players to adopt the technology that is being research. We believe that this strategy will be a strong mechanism to ensure INESC TEC technology is used in near-future products.

6.4.2.4 Innovation

C-BER has been designing and exploring novel medium-TRL breakthroughs that have high-potential to be translational into our Science-based-Innovation (SBI) model pipeline namely in the DL neurological disease human motion biomarkers and a new evolution of the optical tweezer's advanced biosignal processing for micron-sized and nano bioparticles detection with micro-pinch functionalities. We expect that these novel approaches reach a patentable level in 2025 and follow the next innovation pipeline steps to a translational to the market direction.

6.4.2.5 Complementary Services

C-BER has been designing and exploring novel medium-TRL breakthroughs that have high-potential to be translational into our Science-based-Innovation (SBI) model pipeline namely in the DL neurological disease human motion biomarkers and a new evolution of the optical tweezer's advanced biosignal processing for micron-sized and nano bioparticles detection with micro-pinch functionalities. We expect that these novel approaches reach a patentable level in 2025 and follow the next innovation pipeline steps to a translational to the market direction.

6.4.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.4 - C-BER – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Enter ERC ecosystem.	Submit 1 proposal to the ERC programme.	1.2
Research cooperation protocols.	Create at least 1 research protocol with an international partner.	3.5
Purchase of state-of-the-art fNIRS technology.	Cutting-edge laboratory for INESC TEC and students' scientific research.	5.3

6.5 CPES - Centre for Power and Energy Systems

Coordinators: Manuel Matos and Ricardo Bessa

Assistant to the Centre Coordination: Catarina Oliveira

6.5.1 Centre scope and vision

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 (AI), blockchain, and interoperability. Results include concepts, models, methodologies, and software tools useful for addressing the decision problems of citizens, communities, multi-energy utilities, system operators, regulators, policymakers, and government bodies.

6.5.2 Main objectives for 2025

6.5.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025, the Centre is prioritising significant advances in the following Strategic Objectives:

- **C1.1. Raise the contribution and visibility of our research** – A policy session on interoperability during the European Sustainable Energy Week as part of the HE InterSTORE project, a workshop on electromobility and smart grids within the Green.Dat.AI project, continuation of the periodic Power & Energy Webinars series, and the organisation of the Shape of Energy to Come event.
- **C1.2. Increase our involvement in the leadership of scientific initiatives** – One of the goals in this commitment is to register with the Linux Foundation (LF) for Energy as an active member and submit the Exploitable Results from the HE InterSTORE project. Moreover, the centre is planning to sponsor the next LF Energy Summit and disseminate its open-source results, such as analytics markets, interoperability for smart grids and homes, storage optimisation, and operation of local energy communities.
- **C1.4. Develop closer and deeper relationships with our innovation partners and the broader community** - Involving them in European proposals aiming at creating strong ties with organisations with whom demonstrations of our developments can be performed.
- **C1.6. Increase the international embedment of our community** – This is accomplished by the LFE initiative described in C1.2, participation in fairs such as the SUSEW and Lisbon Energy summit and in international conferences such as EEM, IEEE Powertech, CIGRE and IEEE ISGT.
- **C2.1. Develop impactful research and innovation aligned with the SDGs** – Build on existing tools, bringing together in-house energy management tools, sentinel platform and Data Spaces components (to be developed with HASLab) and further develop them by integrating new features to promote adoption and increase participation, of users including data sharing. Promote front-end web applications in crucial tools such as for our optimisation models so that our potential clients' perception potential and adoption can increase and lead to contracts. Develop innovative grid management and control tools, incorporating the advanced solutions of relevant industrial partners for future electricity grids.
- **C3.5. Increase our international networking, leadership and competitiveness** – Continue building strong ties with common partners by participating in calls and increasing our network by calling new partners.

6.5.2.2 Research

The research efforts will focus on developing automatic testing procedures and performance metrics to assess the robustness, reliability, and resilience of AI-based decision systems for power grids. This includes creating new methodologies for uncertainty estimation and reinforcement learning to manage congestion while enhancing communication of potential AI failures to human operators. AI-based assistants will be developed to automate

control schemes for power systems with high renewable integration levels, with the distinct feature of leveraging expert knowledge (e.g., represented by symbolic equations or conventional control blocks).

The next generation of distributed control and protection strategies is being developed to be compatible with inverter-dominated grids. Innovative coordination strategies, grid islanding, and restoration methods will be developed for the secure integration of MVDC systems, based on steady-state and dynamic modelling and analysis of hybrid AC/DC distribution systems.

Offshore hybrid wind and wave farms will be studied to optimise internal grid layouts and manage energy with innovative solutions, such as battery energy storage systems, hydrogen pipelines or vessel transport, and cable design upgrades. Onshore, the hybridisation of pumped hydro plants with floating PV and batteries will be analysed to reduce turbine stress during fast frequency regulation.

Generative AI features will be integrated into Energy Management Systems to enhance decision-making, while consumer participation in data sharing will be promoted through new compensation mechanisms. Advanced energy community planning and operation tools will address interoperability and business models, supporting flexibility provision and energy sharing. The research will also focus on joint modelling of electricity and hydrogen markets, local flexibility market design, and extending multi-energy network tools to incorporate long-term and seasonal storage. AI-driven forecasting and real-time hybrid tools (combining conventional and AI-based approaches) will optimise energy management across the electricity, heat, gas, and hydrogen sectors.

6.5.2.3 Innovation

The construction of testing and experimentation facilities (TEFs) for AI in the energy sector will begin, focusing on applications in local energy communities and consumer energy efficiency, and maritime renewable energies. These facilities are two different nodes to be integrated into European TEFs, which are key concepts to validate the requirements of the European Union AI Act. In alignment with this, a data-driven suite of tools for managing low-voltage grids will be further refined and optimised within the AI innovation environments.

The first use cases and platforms for the energy data space will be finalised, enabling data sharing and consumer participation, supported by the integration of Energy Management Systems with data spaces and advanced AI-driven engagement mechanisms. Generative AI will enhance user interfaces and interpret energy data, backed by AI-controlled validation for reliability.

A computational suite for steady-state and dynamic analysis of hybrid AC/DC distribution systems will be developed for real-time and transient studies, enabling the secure integration of MVDC systems. An advanced tool for islanding, service restoration, and network protection in hybrid AC/DC grids will explore innovative coordination strategies, grid islanding, and restoration methods.

The RECreation platform for planning and operating energy communities will be improved, expanding scalability, price computation, and transaction modelling, with additional licensing potential. The CEVESA model will be adapted to analyse market dynamics under decarbonisation scenarios and high offshore wind penetration. Optimal stationary energy storage dispatch for utility scale energy storage systems, hybrid parks and microgrids will be concluded, integrating battery efficiency and degradation models, and enabling grid services.

High-TRL tools for long-term planning, scheduling, and real-time management will be expanded to optimise multi-energy systems from local to national levels, integrating flexibility and storage capabilities.

6.5.2.4 Complementary advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

Advance research in AI for energy systems through participation in European R&D projects, a network of excellence, and testing facilities. Engage in CIGRE JWG C5/C6.29 on energy communities, C6.45 on the impact of DER on the resilience of distribution networks new potential C6 WG on distribution network operation. Increase visibility by publishing in open-access journals, presenting at conferences, and leading international projects. Strengthen partnerships with industry, public authorities, and national and international organisations such as CIGRE, BRIDGE, ETIP SNET, and EERA to enhance international collaboration.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

Launch a real-life pilot of an analytics market with Elia Group (Belgium's TSO) and continue collaboration in the EU-US working group on foundational models for power systems. Host the Tools4AgriEnergy webinar series to address sustainable energy transitions in agriculture, focusing on Agri-PV, IoT, business models, energy communities, and decarbonisation. Advance impactful R&I aligned with SDGs by developing tools for renewable integration and resilience. Tailor solutions for multi-energy microgrid optimisation, energy storage dispatch and grid control and automation to industry needs and communicate achievements to raise public awareness of societal, environmental, and economic benefits.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

Continue releasing open-source code and increase participation in Linux Foundation for Energy events. License the RECreation energy communities platform to industrial partners in Portugal and collaborate with SAP to integrate it into their marketplace under the BeFlexible project. Strengthen R&I ecosystems by fostering interdisciplinary collaboration to develop integrated solutions for multi-energy systems. Link research and market needs by creating tools for commercialising innovative energy management solutions. Expand international reach by participating in global networks to enhance leadership in multi-energy research.

Commitment 4 – Cultivate an attractive, people-centred and talented community.

Continue training young researchers through BII and BI grants in power systems. Attract top talent by offering cutting-edge research opportunities, advanced tools, and international collaboration. Promote diversity and inclusion by engaging individuals from varied backgrounds and disciplines, fostering a multicultural and multidisciplinary approach to addressing energy challenges.

Commitment 5 – Strive for a sound, sustainable and effective operational model.

Expand the IN-DATA (Innovation Energy Data Spaces for Local Energy Communities) infrastructure (or living lab) with additional assets and real consumers while enhancing the simulation capabilities of the x-Energy platform. Lead a European project proposal under Cluster 5. Diversify funding through consultancy services and participation in national and EU projects. Collaborate with INESC TEC's x-energy for advanced testing and optimising energy management systems, leveraging new infrastructure as a pilot for Horizon Europe RIAs, showcasing innovative approaches to sustainable energy and air quality management.

6.5.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.5 - CPES – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Internal course on the use of commercial tools for power systems analysis	Engage junior researchers in using industrial-proven tools for power system analysis.	C1.5
Create a repository for power system analysis routines and scripts	Reduce the burden and avoid the replication of routines that can be adapted for the solution of new problems.	C1.1
Develop trustworthy AI-based decision systems	Methodology to automatically evaluate the robustness, reliability, resilience, and uncertainty of AI-based systems.	C1.2

Initiatives	Key Results	Strategic Objectives
Promote policy session in the European Sustainable Week.	Disseminate our work on interoperability, leveraging on the work done in InterSTORE, ENPOWER and InterConnect, in particular the semantic interoperability toolbox and the developments in the IEEE2030.5 standard.	C1.1
Participation in at least three top conferences.	Expose our work done using AI services and optimisation. Build on solid tangible deliverables, reviewed by the scientific community. Participation in EEM, IEEE Powertech, CIRED WS and ISGT.	C2.1, C3.5
Linux Foundation for Energy active participation.	Initiate a procedure with the LFE to put forward the InterSTORE developments. Sponsor the next Summit and organise a breakout session.	C1.2, C1.6
Coordinate HEurope proposals to increase our network of contacts.	Solidify our position as a recognised, rigorous and state of the art organisation in the European research landscape.	C3.5, C1.4
Carry out developments related to digitalisation and AI in energy management and market bidding.	New versions and developments of tangible tools towards energy management, digitalisation and consumer engagement. Use our tools in European projects to demonstrate successful cases and reach out to potential industrial clients for potential contracts.	C2.1, C1.2, C1.4
Develop high TRL tools for multi-energy system planning and management.	Creation of high-TRL tools for long-term planning, day-ahead scheduling, and real-time management of multi-energy systems, including energy storage.	C1.4, C2.1, C3.5
Develop tools to increase network resilience.	Creation of tools to improve network resilience through multi-vector flexibility optimisation, advanced protection schemes, and better simulation capabilities with digital twins and power-hardware-in-the-loop.	C2.1

6.6 CESE - Centre for Enterprise Systems Engineering

Coordinators: António Lucas Soares and Rui Rebelo

6.6.1 Centre scope and vision

CESE is an interdisciplinary research centre contributing to a sustainable, resilient, and human-centred industry through systems engineering. It plays both roles of research and business partner in creatively co-developing solutions for complex challenges and in developing the capabilities of industrial organisations 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.

6.6.2 Main objectives for 2025

6.6.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025, the Centre is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - 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.

- CESE is positioned to be a reference in applied research of AI-based systems engineering in the industrial area, with a particular impact on SMEs.

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

- CESE will organise two reputed international conferences: the 12th EurOMA Sustainable Operations and Supply Chains Forum and the 26th IFIP Working Conference on Virtual Enterprises PRO-VE25.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

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

- CESE will release a proof of concept and prototype of the first industrial data ecosystem in Portugal, based on the results and case studies of several projects (not achieved last year).

6.6.2.2 Research

Manufacturing Systems Design and Management.

This research line will continue to develop multi-disciplinary manufacturing systems design and management methods grounded on the integration of digital technologies to support **"twin transition" strategies**. The main goals are (i) to combine **hybrid optimisation, simulation and ML** approaches with Digital Twins to **adaptively design and reconfigure production systems** for **high-mix, low-volume** environments; (ii) to develop a **real-time, multi-criteria decision-making framework** to increase resilience and (iii) to emphasise the role of **human-machine collaboration**, in line with the Industry 5.0 recommendations, by researching **inclusive AI-based interaction models** to support operators' decision-making and well-being, aligning worker satisfaction and productivity goals with sustainability goals.

Supply Chain and Collaborative Networks Management

This research line will continue studying innovative supply chain models and strategies that support companies in facing the complexity and uncertainty of contemporary environments. The goals for this period are (i) to develop, within several projects, supply chain design and management strategies **that favour the implementation of circular supply chains**; (ii) to apply the **Supply Chain Resilience Fit Model**, developed by INESC TEC in the context of the RISE SME project, to the textile, agri-food, mobility and digital ecosystems and (iii) continue developing a method to **integrate AI-based technologies into supply chain management processes using a socio-technical perspective** that considers organisational, social and human needs.

Industrial Information Systems

This research line aims to develop new concepts of data and information management systems for industrial organisations and ecosystems, with a focus on AI-based systems. In this period, the main goals for **human-centred AI integration** are (i) to develop **architectures and specific models for categories of tasks in manufacturing processes** and (ii) to **model the organisational context from a socio-technical systems perspective**. For **digital platforms and governance methods to support circular business models**, the objectives are (i) to investigate a **multidimensional representation of the knowledge associated with the Digital Product Passport (DPP)** and (ii) to finish the **development of the socio-technical design propositions for an architecture of a Digital Platform** managing digital twin instances**.**

Technology Management in Industry

This research line will continue its core strategy that aims to contribute to the **theory and practice of Technology Management**, mainly through the application of theories and frameworks related to technology adoption concepts. The main objectives for 2025 are (i) to characterise the **business models and scalability strategies related to circular technologies;** (ii) to characterise the role of emergent technologies in the development of **SC Resilience Capabilities**; (iii) to identify the main barriers and enablers to **adopting digital technologies for sustainability, circularity and traceability** in the footwear industry and (iii) the development of **strategies for the adoption of Human-Centred Technologies** also foreseeing the development of a service related to the i4.0 maturity assessment.

Logistics and Mobility

This research line develops research of an interdisciplinary nature, grounded on a recognised know-how and experience in decision support systems, simulation, optimisation and information and knowledge management, applied to **transportation and logistics, urban freight and mobility, including Intelligent Transportation Systems.** The objectives for this period lie in MaaS (Mobility as a Service), and **decision-making in intermodal freight operations** and **global supply chains using synchro-modality**. The main goals are (i) to design **integrated mobility services (both for people mobility and urban logistics), based on the co-creation of solutions and on digital platforms**, and (ii) design of **hybrid approaches smartly integrating ML techniques with optimisation and simulation models**.

6.6.2.3 Innovation

CESE research results are applied in multiple sectors, **including shoes, textiles, automotive, metalworking, plastic, packaging, food, ports, forestry and mobility**. The PRR projects in which the centre is involved will end in 2025, having produced exploitable research results, described below, and that will be developed so that they achieve TRL 8. In the area of **simulation and optimisation tools**, we will exploit the **Digital Twin "Low Code," a simulation-based platform** designed to quickly evaluate and deploy production systems. In the domain of **eco-efficiency and sustainability**, an **eco-efficient planning algorithm based on multi-objective optimisation** together with a simulation technique that **evaluates the outcomes of planning algorithms, providing detailed insights into stoppages, emissions, and the impact of renewable energy sources** will be used in more advanced consultancy services in this area. In the field of **digitalisation and interoperability**, the research involving data spaces (IDS) on several projects set the basis for advanced services for the **implementation of data ecosystems**. **Data and AI-based tools and services** will be developed in this period under the financing of CTI. These are: (i) a **self-service AI tool for quality control**, facilitating the use of advanced computer vision techniques by industrial users who do not necessarily have the necessary technical skills; (ii) a **RAG (Retrieval-Augmented Generation) system, to improve access to and use of the knowledge existing in the technical documentation** which guides the implementation of an ERP or MES systems in an organisation; (iii) a strategic, value-added, consulting service for Portuguese companies for **designing and implementing industrial data ecosystems based on the IDS specifications**, including the **levelling of data management maturity** of the organisations involved; and (iii) a tool and methodology for **mapping the levels of AI integration** in the human, social and organisational socio-technical dimensions of an industrial organisation. In the **technology adoption** area, we are planning for this period to develop **services for focused digitalisation**, addressing **product and process digital twin systems** adoption, **IIoT Platforms and Shop Floor digital technologies** adoption, and **green technologies** adoption with impact in circular value chains, including **business models for circular economy**, **human-centred technology adoption** (including an assessment framework), and **supply chain visibility and resilience** assessment and management.

6.6.2.4 Complementary advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

We improved the relevance and ratio of publications/FTE, both journals and journals+conferences, in 2024, but didn't achieve the goals defined by the coordination in 2022 (3 publications/FTE, 1 Journal pub/FTE and average relevance above 4.5): We will continue to work for these goals in 2025.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

We are positioned to become a national and European reference on digital technologies research and development to support and disseminate the Digital Product Passport, product traceability and circular economy in general.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

The iiLab (Industry and Innovation Lab) represents a privileged equipment to demonstrate exploitable research results and launch innovation projects with industrial companies. We will develop an **integrated ecosystem of enterprise information systems** where the first step is to implement the Manufacturing Execution System (MES) resulting from the collaboration **agreement with the company Critical Manufacturing**.

Commitment 4 – Cultivate an attractive, people-centred and talented community

CESE will continue to review its procedures for micro-managing performance and supporting actions to the centre researchers. **Project management and the teams' organisation** will be further developed.

Commitment 5 – Strive for a sound, sustainable and effective operational model

In 2025, CESE will be working with CEGI for a strategic convergence in scientific goals (framed by the Systems Engineering and Management domain) and operational integration.

6.6.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.6 - CESE – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Organise and host the 12th EurOMA Sustainable Operations and Supply Chains Forum.	Approximately 150 participants and 100 presented papers.	C1.2
Organise and host the 26th IFIP Working Conference on Virtual Enterprises PRO-VE25.	Approximately 90 participants, 70 papers presented.	C1.2
Organise (together with Efacec and CPES) the yearly meeting of the Joint Working Group A2/D2.65 of CIGRE — **Transformer Digital Twin – concept and future perspectives**, with the participation of several international key players in this area.	Approximately 30 participants.	C2.3

6.7 CRIIS - Centre for Robotics in Industry and Intelligent Systems

Coordinators: Luís Freitas Rocha and Manuel Santos Silva

6.7.1 Centre scope and vision

The Robotics and Intelligent Systems Centre designs and implements innovative solutions within 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 lemma from research and development to innovation and passing through design, prototyping, and implementation.

6.7.2 Main objectives for 2025

6.7.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025, the Centre is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - 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.

- Define and implement a policy to promote the creation of robotic datasets and tools, making them publicly available.
- Prioritise the publication of scientific articles in journals of high merit and the leading international conferences in robotics, such as ICRA and IROS.

C1.6. Increase the international embedment of our community

- A strong network of international collaborations is critical to increasing the Centre's global recognition and research excellence. CRIIS intends to increase the number of international visiting researchers. CRIIS aims to have at least four visiting senior researchers from internationally renowned institutions.

6.7.2.2 Research

CRIIS's scientific domains focus on enhancing robot autonomy and manipulation capabilities, human-robot collaboration, and the development of more sustainable robotic systems.

Robot Autonomy and Manipulation Capabilities: CRIIS is focused on extending robots' autonomy by leveraging the latest developments regarding AI. This will be explored across various robotic research domains. (1) In the mobile robotics domain, robotic systems still face significant challenges in operating and perceiving less structured environments (indoor and outdoor), distributed decision-making, and coordinating teams of robots and collaborative learning. To overcome this limitation, CRIIS aims to investigate novel AI approaches, such as Reinforcement Learning (RL), Federated learning, and Generative AI, that will be combined with innovative robot map representations based on semantics and/or ontology. (2) Manipulation of flexible materials (e.g., textiles), presents unique challenges due to their changing shape and inherent flexibility. CRIIS will continue developing novel algorithms for perceiving and manipulating flexible objects by combining realistic simulation of flexible objects with training AI algorithms, computer vision, reinforcement learning, and tactile sensors, to transfer the knowledge from simulation to the real environment. (3) Generalisation of manipulation capabilities, with a particular emphasis on dismantling complex products. Multi-sensor fusion, Generative AI, and meticulous manipulation will be investigated and integrated into a robotic framework. The robot solution will also be capable of generalizing in the absence of a digital model representation. CRIIS will follow this holistic approach to advance AI-based robotics and ensure that progress aligns with essential existing safety and validation frameworks. CRIIS will aim to propose new methodologies and updates to the safety standards.

Human-Robot Interaction: Achieving seamless interaction requires addressing communication gaps and enhancing user experience through intuitive and safe interfaces. In 2025, CRIIS aims to build on current developments to address key challenge, such as: (1) Bridge communications gaps by improving the translation of human intentions into robotic actions and enhancing the interpretability of robot feedback, fostering

smoother and more intuitive interactions. (2) Enhance predictability and safety to effectively communicate intentions through multimodal cues such as visual, auditory, and tactile signals. This includes using expressive gestures, gaze, LED-based signals, and augmented motion trajectories to improve motion predictability and collaboration dynamics in shared spaces. (3) Leverage mixed reality devices to seamless blending physical and digital environments. This will enable more immersive, natural, and intuitive ways to communicate and collaborate with robots. (4) Employ Large Language Models (LLMs) and Vision-Language Models (VLMs) to enable more natural and intuitive communication between humans and robots, enhancing the understanding of complex instructions and contextual cues. (5) Enable remote control operations under constrained communication bandwidth and high latency time.

Sustainable Development of Robotic Systems: By leveraging the cloud's vast processing and data capabilities, CRIIS will aim to create a highly realistic simulation environment to provide robotic developers with a way to swiftly and effectively test their software before deployment, leading to safer and more efficient robotic applications. This approach accelerates the development process and significantly reduces costs by minimizing the need for constant real-world testing and the challenges of recreating complex environments. Additionally, by incorporating best practices from software development, CRIIS will enhance the reliability and scalability of robotic systems. Containers allow for easier deployment and management, while Kubernetes, which helps coordinate and distribute these containers, ensures smooth updates without significant downtime.

6.7.2.3 Innovation

To Support Sustainable Circularity of Textiles: iiLab will build on the research findings related to manipulating flexible objects and the use of computer vision systems to demonstrate three prototypes at TRL 6-7 concerning: (1) Accessory Removal and (2) Textile Sorting by fiber composition for recycling, and (3) Clothe sewing operations.

Mobile manipulator for Trail Unloading: Building on its recent success in showcasing an autonomous mobile manipulator for intra-logistics operations within a retail warehouse, iiLab will now shift its focus to automating trailer unloading operations, through new advancements in perception and robot path planning, with a comprehensive approach that considers the entire robot system as one complex kinematic chain.

Localisation of Pallets and Pallet Pockets: CRIIS is advancing its portfolio of technological solutions for mobile robots with a computer vision application (based on low-cost RGB-D sensors) for the detection and localisation of pallets and its pockets, allowing stacker-type AMRs to pick pallets from the shopfloor, even when these are not exactly placed on the expected locations.

Novel Robotics for Agriculture and Forestry: The TRIBE-LAB robots, Modular-E and Weta, are being further extended with advanced manipulation capabilities and advanced AI-based perception systems to enable precise and selective pruning and harvesting activities to reach TRL6-7, but also to enable regenerative agriculture and forest restoration.

Novel and Advanced IoT-based Solution: In the TRIBE-LAB, IoT technology is being researched to enable advanced Phenotyping operation and take the full benefits of the use of edgeAI and federating learning. This technology will be explored from the perspective of one-health perspective.

Dual-use Technology: The TRIBE-LAB robotics technology, namely Modular-E, is being explored and further researched to enable advanced logistics operations in a military context. These robots are being extended with tethered to support long range communications and advanced monitoring capabilities.

Novel Long-term SLAM: iiLab will expand the operation of AMRs to new environments previously inaccessible due to their high dynamics, through the development of the RicoSLAM solution. CRIIS aims to advance the state-of-the-art in long-term SLAM by combining sensor fusion techniques and AI, thereby extending and enhancing AMR applications.

Robot Fleet Coordination: iiLab will deploy a new fleet coordination system called "Maestro" with the ability to manage the operation of multiple AMRs of different types in confined spaces with maximum efficiency. It is robust to failures, such as communication breakdowns and unforeseen events inherent in coexisting with humans.

Sustainable Robot Development Lifecycle: CRIIS will aid developers in establishing a robotic software lifecycle that integrates software development best practices, over-the-air deployments, and advanced cloud-based simulation environments for testing and optimisation.

Advanced Digital Twin Representations: CRIIS will advance the use of digital twin technology by integrating real-time robot-collected data with detailed environmental and application-specific data, like 3D models of targeted objects. This approach will enable the creation of dynamic, digital representations of unstructured environments, allowing robots to perform more systematic and accurate reasoning in ever-changing settings.

6.7.2.4 Complementary advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society through bold creativity and transformative action.

- Promote the participation in international robotic forums, working groups, and trade fairs, namely euRobotics and Adra forum, AIM-NET and AIOTI working groups, and Hannover and FIRA trade fairs.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

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

- Materialisation of the three CRIIS spin-offs currently under development.
- Encourage active search for new partnerships with companies for diversifying and improving technology transfer channels and creating, at least one, long-term programme contracts.

Commitment 4 – Cultivate an attractive, people-centred and talented community.

- Regularly conducting training activities, improving the cohesiveness, efficiency, and knowledge in essential areas for CRIIS activities.

6.7.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.7 - CRIIS – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Actively promote the training of CRIIS researchers in the fundamentals of emergent deep tech technologies.	Increase in the quality of the work and related publications.	C1.1
Maintain regular team building activities.	Improve employee satisfaction index and attract new applicants.	C4.1
Organise Open Days for industrial companies and research partners.	To promote the CRIIS-iiLab technologies and reinforce our position at the European level.	C2.7
Promote the second edition of Synergy Day: Robotics and IoT for Vineyards.	To promote the CRIIS-TRIBE technologies and reinforce our position at the European level.	C2.7

6.8 CEGI – Centre for Industrial Engineering and Management

Coordinator: Maria Antónia Carravilla and António Almeida

6.8.1 Centre scope and vision

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 rigor 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.

CEGI's competences are organised across five core scientific domains: Operations Research & Operations Management; Performance Evaluation; Business Analytics; Service Science; and Public Policies. By integrating qualitative and quantitative approaches, it creates scalable and robust methodologies for real-world applications in different sectors, such as: **Retail and Agro-Food**; **Mobility**; **Energy Transition**; **Healthcare**; and **Forests and Wildfire Management**.

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.

6.8.2 Main objectives for 2025

6.8.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is prioritising significant advances in the following Strategic Objectives:

Commitment 1: 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

- Focus on publishing high-quality research that adheres to the principles of responsible research assessment, ensuring the alignment with COARA commitments. Instead of prioritizing journal rankings or impact factors alone, emphasise the intrinsic value and scientific contribution of the research.

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

- Strengthen partnerships with leading institutions such as CMU Portugal, MIT, TU Delft, and the University of Southampton, and others.

Commitment 2: 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 SDGs

- Expand research addressing energy transition (SDG 7), resources sustainable consumption (SDG 12), and climate action (SDG 13). Drive impactful initiatives in food waste reduction, renewable energy optimisation, and wildfire management.

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

- Explore partnerships to integrate advanced methodologies into real-world applications in transport and mobility, manufacturing, healthcare, and retail.

C2.6. Engage in direct dialogue with the public

- Engage with policymakers through workshops and forums to shape strategies for energy transition and sustainable mobility.

Commitment 3: Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems

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

- Develop and apply hybrid methodologies that combine machine learning, optimisation, and decision analytics to address complex systems challenges.

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

- Foster relationships with industry to secure new contracts and partnerships, enabling the practical application of research outputs. Focus on connecting CEGI's expertise with key sectors such as energy, health, transports and mobility, and manufacturing to drive impactful projects and innovations.

6.8.2.2 Research

In 2025, CEGI will continue advancing excellence in Management Science and Service Science, addressing societal and industrial challenges through innovative and multidisciplinary approaches. Research will focus on key scientific domains and specific projects, both ongoing and new, to deliver impactful results.

Management Science

Management Science research at CEGI spans operations research, operations management, data analytics, and performance evaluation. In 2025, efforts will centre on leveraging hybrid optimisation methods to address complex problems in logistics and supply chains, building on the success of ongoing projects such as PEER. This project, conducted in collaboration with partners like Fujitsu and Sonae, focuses on production planning and inventory routing in dynamic and uncertain environments. Additionally, the BeFresh project will complete its activities related to inventory and pricing management of perishable products, with key insights being documented in two planned publications in international journals.

In the energy sector, the EURO-SCORES project will expand methodologies for optimizing renewable energy systems, contributing to the broader effort of improving sustainable energy solutions. Business analytics research will complement these efforts, with a focus on developing data-driven tools for forecasting and recommendations, enhancing operational efficiency and marketing strategies in collaboration with retail partners like Sonae MC. Performance evaluation will remain a focus, particularly in sectors like energy and education. The EduBest project will apply advanced efficiency analysis techniques to evaluate and enhance the performance of educational institutions.

Service Science

Service Science research at CEGI is dedicated to designing and innovating service systems that are both human-centered and technologically advanced. In 2025, the focus will remain on transformative projects like POCITYF, which develops tailored strategies for citizen engagement in energy transition initiatives across European cities. This project includes innovative methodologies, such as mental model-based communication strategies, to better align public perceptions with sustainable energy goals.

Digital transformation will also be a key priority within service systems, particularly in projects like DECODIT, which focuses on co-creating digital tools for the energy sector. These tools aim to empower communities and organisations to better manage resources and achieve their sustainability targets. In addition, the Energy Community Living Lab will transition into its operational phase, serving as a platform for testing and scaling community-based energy management solutions. Sustainability in service systems will also be addressed through contributions to the AI-EFFECT project, which explores the use of artificial intelligence to improve energy sector operations. These initiatives exemplify CEGI's commitment to addressing systemic challenges such as energy transition and climate resilience through innovative service system design.

6.8.2.3 Innovation

CEGI's innovation efforts in 2025 will focus on applying advanced research to tackle real-world challenges across key sectors, driving technology transfer and industry collaboration. These activities will be organised into distinct areas of innovation, building on ongoing projects and integrating emerging topics to maximise societal and industrial impact.

INOV 1: INDUSTRY

CEGI will expand its contributions to Industry 4.0, focusing on dynamic production planning, predictive maintenance, and optimisation algorithms for collaborative human-robot production lines. In the context of the Produtech R3 project, tailored algorithms for logistics and production will be implemented with industrial partners, addressing challenges in supply chain management and manufacturing efficiency. These innovations will strengthen the competitiveness of manufacturing systems while supporting sustainability goals.

INOV2. ENERGY

Innovation in energy systems will emphasise the operationalisation of the Energy Community Living Lab, which will transition into full operation in 2025. This living lab will serve as a testing ground for co-created solutions in distributed energy management, focusing on citizen engagement and renewable energy optimisation. Additionally, the EURO-SCORES project will drive prescriptive analytics in sustainable energy planning, directly supporting the European Green Deal and advancing strategies for achieving net-zero goals.

INOV3. RETAIL & AGROFOOD

CEGI's ongoing innovation in retail and agro-food sectors will focus on reducing food waste and optimizing supply chain operations. Building on the BeFresh project, the Centre will enhance inventory management strategies for perishable goods and develop predictive tools to improve operational decision-making. Partnerships with industry leaders, such as Sonae MC, will ensure the application of these solutions in real-world contexts, addressing sustainability challenges while improving efficiency**.**

INOV4. HEALTHCARE

In healthcare, CEGI will drive innovation in resource optimisation and patient-centered services. Through the EURO-KEP project, efforts will focus on improving the efficiency of kidney exchange programs and designing decision-support systems to enhance resource allocation in hospitals. Additional research will explore digital health tools, including advanced scheduling algorithms for operating rooms, supporting the broader goals of improving healthcare delivery and patient outcomes.

INOV 5: FORESTS & WILDFIRE MANAGEMENT

Addressing the growing risks posed by climate change, CEGI will develop innovative solutions for wildfire management and sustainable forest operations. Research will integrate optimisation, simulation, and geospatial analysis to enhance firefighting logistics and fuel supply chains. These activities will be part of a new European project expected to begin in 2025, focusing on building climate-resilient systems. This work will contribute to SDGs 13 (Climate Action) and 15 (Life on Land), enhancing societal preparedness for extreme climate events.

6.8.2.4 Complementary Advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

The centre will submit one ERC grant proposal, building on ongoing research strengths in logistics and supply chain innovation or dynamic decision-making. Also, FCT and Horizon Europe proposals will be submitted, in collaboration with other centres, emphasizing interdisciplinary research in energy, sustainability, manufacturing and mobility. Moreover, the centre will advance the Energy Community Living Lab, fostering co-creation and innovation in sustainable energy solutions. In manufacturing, the centre will promote strong collaboration with other centres with active participation in the industry and innovation Lab (iiLab).

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

In 2025, CEGI will prioritise research in emerging areas that address critical societal challenges and leverage innovative technologies to improve decision-making and resilience. Among these areas, the integration of artificial intelligence (AI) with decision-support systems will be a central focus. Specific applications will include energy consumption forecasting, enabling more accurate predictions for renewable energy management, and advanced scheduling algorithms to optimise resources across diverse sectors such as healthcare, logistics, and

manufacturing. Furthermore, logistics optimisation efforts will target real-time routing and inventory management, particularly in sectors where disruptions or uncertainties have significant operational impacts.

By leveraging collaborations with international partners and utilizing multidisciplinary approaches, CEGI will contribute innovative solutions to enhance resilience and sustainability in regions affected by wildfires and other climate-related challenges. Complementing these efforts, supply logistics strategies will be developed to address the unique challenges posed by crisis scenarios, such as ensuring the timely delivery of critical resources like fuel, water, and medical supplies during emergencies.

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

CEGI will prioritise technology transfer by finalizing licensing agreements for platforms like Digital CER and leveraging partnerships established through living labs. Collaborate with TEC4 initiatives to ensure research addresses critical market demands and societal challenges, including sustainability, energy transition, manufacturing, and transportation and digital transformation. These activities aim to bridge the gap between research and practice, ensuring that CEGI's innovative solutions have a tangible impact on industry and society.

Commitment 4 – Cultivate an attractive, people-centred and talented community

The centre is committed to build a multidisciplinary and talented research team, capable to be a reference in the Systems Engineering and Management domain. The focus is to promote a distributed management approach, based on a bottom-up strategy, capable to capture, retain and leverage young and talented researchers, from different scientific backgrounds, capable to work in a collaborative and productive team-working environment.

Commitment 5 – Strive for a sound, sustainable and effective operational model

CEGI will invest and promote a stronger involvement in the related INESC TEC research infrastructures, such as the Industry and Innovation Lab (iiLab), with the objective to increase visibility on the research performed in the centre, as well as leverage collaboration with other centres.

6.8.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.8 - CEGI – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Digital Technologies Demonstration at the Industry and Innovation Lab (iiLab).	Active participation and development of 1 to 2 demonstrators at the Industry and Innovation Lab (iiLab).	C3.2
Support researchers to prepare competitive applications for ERC grants.	Submission of one ERC grant proposal focusing on logistics and supply chain optimisation.	C1.1
Promote the dissemination of high-quality research aligned with responsible research assessment principles, following COARA guidelines.	Publish research outputs emphasizing their intrinsic value and societal impact, ensuring quality dissemination in key journals.	C1.1
Operationalise the Energy Community Living Lab.	Conduct at least two co-creation workshops and implement three pilot tests for distributed energy solutions.	C2.3
Expand research on wildfire management and climate resilience.	Initiate activities for the European project on wildfire logistics and sustainable forestry submitted in 2024.	C2.1

6.9 CITE – Centre for Innovation, Technology and Entrepreneurship

Coordinator: Alexandra Xavier

6.9.1 Centre scope and vision

Vision: To empower researchers and organisations by advancing the adoption of socio-technical innovation systems, cultivating a dynamic culture of innovation, and fostering entrepreneurial excellence. We envision a world where research-driven outputs significantly contribute to building a sustainable economy and society.

Scope: CITE conducts multidisciplinary research at the intersection of technology, innovation, sustainability, and management to promote responsible, innovative, human-centered socio-technical systems in engineering, facilitating a responsible twin transition. By focusing on the research areas of Innovation, Technology Management, and Entrepreneurship, CITE explores theories, methods, models, and tools to support the innovation process. Through research and innovation activities, including consulting and advanced training, CITE addresses environmental, social, and economic challenges, contributing to research and innovation impacts aligned with the SGD goals.

Through strategic collaborative initiatives, CITE comprehensive and applicable knowledge under the following research lines:

RL1. Innovation Management and Front-End of Innovation (FEI): Advancing the conceptual and methodological frameworks of Innovation Management and the Front-End of Innovation through the integration of Responsible R&D and Open Innovation principles, with a focus on driving Sustainability Transitions.

RL2. Technology Management and Policy: Exploring the challenges of adopting and implementing new technologies, identifying key drivers of techno-economic transformation across individual, organisational, and ecosystem levels while examining the role of public policies in fostering structural change, facilitating socio-technical driven transitions, and maximizing societal and economic impact through effective R&D exploitation, innovation, and knowledge transfer.

RL3. Entrepreneurship & Business Model Innovation: This interdisciplinary strategic research explores the intersection of technology, entrepreneurship, and social innovation, emphasizing a human-centered approach to leveraging socio-technical advancements and transformative business models that mutually promote twin transition competitive advantage and meaningful societal impact.

CITE also aims to impact the economy and society by leveraging cutting-edge conceptual models and tools in Consulting Activities, Advanced Training (Inov1), and Entrepreneurship Support Initiatives (Inov2).

6.9.2 Main objectives for 2025

6.9.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is prioritising significant advances in the following Strategic Objectives:

Commitment 1 - 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

- **Innovation Resource Centre**: Create a policy to use Creative Commons licensing to promote knowledge dissemination and exploitation of non-technological R&D results and establish a repository of innovation studies, models, use cases, and tools for INESC TEC, piloting with CITE results. Also contribute for C1.3.

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

- Submission of The Journal of Innovation Management (JIM) to Wos. The Journal has already been indexed by Scopus.

- Participation as associate editors in the following journals: Journal of Innovation Science, European Journal of Innovation Management, Journal of Information Systems Engineering and Business Intelligence and Educational Technology Quarterly.

C1.3. Improve the base conditions for technology commercialisation

- Entrepreneurship Office (Inov2): Launch the Entrepreneurship Office, design and pilot services in collaboration with SAL to support INESC TEC in building a culture of innovation and assisting early entrepreneurs on their entrepreneurship journey. Expected a strong contribution to C4.1.
- Seed Projects Bootcamp| 2nd edition (Inov2): Continue collaborating with SAL to deliver the second edition of the Seed Projects Bootcamp to support seed and early-stage entrepreneurial projects.

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

- Be an active member of EEN Sector Groups (SG) and Thematic groups (TG): Through connections with stakeholders and policy feedback, and by exploring new research opportunities in the thematic areas of the SG (Proximity & Social Economy, Retail) and TG (Sustainability, Intellectual Property, Start-ups & Scale-ups, Women Entrepreneurship).
- Participation in EIT Jumpstarter coaching community through EIT Manufacturing Portuguese HUB.

Commitment 2 - 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 SDGs

- Responsible Innovation Digital Self-Assessment tool: Following the research conducted in 2024 under the Fire-res project, CITE will launch a cutting-edge digital tool for Responsible Innovation Self-Assessment. This tool will be applicable to the design, development, and exploitation phases of the R&D and innovation journey. It will be integrated with a sustainable business model to drive impactful and responsible innovation outcomes.
- CITE strengthens its team by integrating a new senior researcher to explore the topic of Sustainable Occupational Health and Well-being. “We expect that this innovative research topic will contribute to the future Commitment 5.

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

- Sustainability Needs Assessment: Under the Mantra project, a sustainable needs assessment tool will be applied to identify the sustainable transition requirements of the textile, metal, and food industries.

C2.7. Communicate scientific and technological achievements and their impact

- Workshop “Extracting value from R&D Results “: Implement the first edition of an Internal series of workshops for the key Exploitable results in different TRLs to work on their value propositions and Exploitation routes (connected with Innovation Connect Initiative).

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems

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

- Innovation Connect: Launch a multi-sided platform to engage with innovation ecosystem stakeholders and promote TechOffers under CITE’s participation in the ATE project.

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

- Organising a Public Workshop on "Private 5G Opportunities for the Port of Sines" to present and discuss new opportunities and key factors for 5G adoption in a seaport. This workshop will elucidate the port community on services, business models, and technology-enabling opportunities as part of the NEXUS project.

Commitment 5 – Strive for a sound, sustainable, and effective operational model

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

- Training and Consulting Business Model and Catalogue: Design and Implement a catalogue for advanced training and consulting as an extension and exploitation strategy for models and tools disseminated in the "Innovation resource canter," presented in C1.1. The "Responsible Innovation Digital Self-Assessment tool" (C2.1) will be part of this repository.

6.9.2.2 Research

RL1|Commitment 2| C2.5: Developing a Monitoring and Impact Assessment tool to evaluate OIC campaigns. (under Fire-RES project).

RL2|Commitment 2| C2.1: Research on the dynamics of diffusion of digital technologies within the energy sector to turn it into a more sustainable industry (Every1).

RL1 | Commitment 2| C2.1: Responsible Innovation Tool validation with the SoTecInFactory ventures' projects.

RL2|Commitment 3| C3.2: Investigation and mapping of the key factors, trends, and technological prospects to evaluate the techno-economic opportunities and risks from Portuguese Alliance for Energy Transition (ATE) initiatives.

RL3|Commitment 3| C3.2: Research on new services and business models for a private 5G Network in the context of a See Port (under Nexus project).

RL3|Commitment 3| C3.2: Research on business models for AI open-source software and algorithms (under AI4REALNET).

6.9.2.3 Innovation

RL1, Inov1| Commitment 2| C2.1.: Responsible Innovation Digital Tool to test in the SoTecInFactory and Fire-Res projects.

RL1. RL4, Inov2| Commitment 3| C3.2 Commitment 3| C3.2: Support program for Business Acceleration under ATE and FIRE-RES.

RL1. RL4, Inov1| Commitment 3| C3.2: Design an Executive Training Catalogue and pilot 2 initiatives on TWIN Transitions taking advantage of the Professional Certificate achieved by a CITE researcher.

L1. RL4, Inov1| Commitment 3| C3.2: Design and implement a first edition of Advancing Training initiate, exploring the Challenge Workshop for Innovation Management, developed in 2023-2024 under the FIRE RES project.

6.9.2.4 Complementary advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community

- RL1| Commitment 1| C1.2: Participate actively in the National, European, and International Technical Committee of Innovation Management (CT169, CEN/TC 389 and ISO/TC 279).
- RL1| Commitment 1| C1.2: Participation in the National Technical Committee CT194 - Standardisation of Nanotechnologies - SC4 - Health, Safety, and Environment) of IPQ.
- Nomination of "European IP Helpdesk Ambassador" under EEN project.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action

- Launch of a "thematic sessions program" in the fields of innovation, technology management, and entrepreneurship for the INESC TEC community and partners - Aim to enhance academy-industry relationships and partnerships while promoting internal education on relevant exploitation subjects.

6.9.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.9 - CITE – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Design and Digitalise the CITE Innovation methods and tools. Make it available using Creative Commons Licencing and commercialisation under new business model.	Innovation Resource Centre. Catalogue of Advanced Training and Consulting. Responsible innovation digital. Assessment tool.	C1.1, C2.7, C5.1
Design and Implement 1 International Acceleration program |EIT JumpStart.	Support 10 new venture projects.	C1.3, C2.1, C2.3
Design and organise a set of activities to support INESC TEC innovation culture and entrepreneurship. Implement a second edition of Seed project Bootcamp.	Entrepreneurship Office. Support at least 6 entrepreneurial projects.	C1.3, C2.7
Design a muti-sided platform to engage with innovation ecosystem stakeholders and promote TechOffers under CITE's participation in the ATE project. Implementation of an Innovation program under ATE, to accelerate Energy transitions systems.	Innovation Connect.	C2.3, C2.4,

6.10 HUMANISE – Human-Centred Computing and Information Science

Coordinators: Ademar Aguiar, Artur Rocha and Hugo Paredes

6.10.1 Centre scope and vision

The Human-Centred Computing and Information Science (HumanISE) is an interdisciplinary centre of research at the forefront of human-centred computing (HCC) with broad and deep expertise in computer science (CS) and information science (IS). HumanISE engineers, scientists and designers focus on the research and development of software and systems, methods, and tools, capable of leveraging human abilities and practices within their communities and environments, involving high technical and managerial complexity due to large scale, high heterogeneity, high uncertainty, high integrity, severe compliance to standards and legal frameworks, or domain-specific organisational issues.

HumanISE mission is to pursue high-quality research, strongly linked to industrial partnerships, consultancy, and technology transfer, in six main research areas: Computer-Human Interaction, Computer Graphics and Interactive Digital Media, Information Management and Information Systems, Software Engineering, Large Scale and Special Purpose Computing Systems, Languages and Tools, and Computing for Embedded and Cyber-Physical Systems.

In addition, innovation activities aim to leverage the research areas above in four primary application areas: Platforms and Methods for Personalised Health Research, Platforms and Methods for Earth, Ocean and Space Science, Geospatial Information Systems Engineering, and Information Systems and Applied Computing.

Furthermore, the centre is firmly committed to training young researchers and professionals, with a significant yearly track record in supervising master and doctoral students.

Presently, HumanISE researchers originate from the University of Porto (UP), Polytechnic of Porto (IPP), University of Trás-os-Montes e Alto Douro (UTAD), and Universidade Aberta (UAb).

6.10.2 Main objectives for 2025

6.10.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the centre is prioritising significant advances in the following Strategic Commitments and Objectives:

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. HumanISE will continue to prioritise the increase of publications in high-impact journals (prestige Q1) and CORE A* and A conferences, favouring relevance as much as possible, to further consolidate its international position across its research areas. In line with this objective, the centre will reinforce the involvement in PhD programmes to gradually increase the number of new and concluded theses.

C1.2. Increase our involvement in the leadership of scientific initiatives. Considering the prestige of editorial roles in leading journals and conference proceedings, we will motivate our researchers to get more involved in these roles. We will also plan to be aware of opportunities to submit for major and high-prestige grants.

C1.3 Improve the base conditions for technology commercialisation. The centre will continue to pursue IP valorisation through software patents Pre-Disclosures, Technology Disclosures and technology transfer practices with the results of research projects. To achieve this, the centre will proceed with the effort of promoting and streamlining internal IP valorisation practices to increase the impact of its research.

C1.6. Increase the international embedment of our community. The centre will seek to host more international and visiting researchers, as well as engage researchers to enrol in international mobility programmes.

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. The centre will actively look to be involved in multi-scientific domain and multi-stakeholder national and international initiatives.

C3.2. Develop better linkages between knowledge production, development, and market uptake. To further develop and exploit the intellectual property generated in projects Inno4vac, NOUS, VR2Care and ILIAD.

C3.5. Increase our international networking, leadership and competitiveness. The centre will continue committed to increase the participation and leadership in international networks, highly-visible international events, and flagship EU and non-EU international projects, especially in the core innovation areas of the centre.

6.10.2.2 Research

In 2025 we envision the following research lines and activities for each of the centre's research areas:

Computer Human Interaction. This research area seeks to understand how people interact with technologies and how technology changes society, by designing new interaction techniques and interfaces, following the mission of ACM SIGCHI. Major research topics concerning human factors for interactive systems include human-centred artificial intelligence (HCAI), cooperative systems and accessibility. Hybrid human-AI collaborations and committing to exploring human factors in AI through cooperative and crowd-empowered systems are currently hot topics within the CHI community. Cooperative systems' traditional research topics, namely groupware tools, nowadays focus on human-ai cooperation and crowd computing, aiming to reach an Human-AI symbiosis. Moreover, citizen science has a rising interest in the Digital Twins, engaging stakeholders to contribute and participate in these digital ecosystems. Research trends in accessibility and assistive technologies aim to apply computing and information technologies to empower individuals with disabilities and older adults by eliminating the gap between the average user and those with special needs, promoting equal rights and opportunities for all. Active ageing research aims to enhance the relationship between seniors and technology, by personalising their user experience and adapting the interaction to the context and the user profiles. This contextual availability of information triggers user motivation and highlights the benefits of using technology in daily life. Moreover, it endeavours to contextualise services based on pervasive monitoring and prediction of user interaction.

Computer Graphics and Interactive Digital Media. Computer Graphics is one of the main drivers for innovation in the IT sector, as an underlying layer on Extended Reality solutions (including Multisensory VR and AR), Visualisation, Digital Games, and Interactive Multimedia applications. Our main challenge has been and remains to raise the contribution and visibility of the research we produce in these areas *(INESC TEC commitment C.1.1)*. We are committed to participate and organise scientific and public events in the area, as well as participating in the organs of important international scientific associations, as is the case of the EUROGRAPHICS, the Immersive Learning Research Network and the working group IEEE Digital Twin of the Earth group *(C.1.2)*.

Our knowledge in immersive environments, with regular industry collaborations (C.1.3) and digital games constitutes an excellent potential to increase, in 2025, our involvement with current and new partners and communities that work in the area (C.1.4). Taking this into consideration, we will continue to use all the opportunities, namely those created by groups of interest of our students and with e-learning organisations. Our experience in the study and development of Immersive Learning Environments, as well as in Serious Games can promote applications in Education, Cultural Heritage, Tourism, and Professional Training and therefore continues providing innovative learning experiences (C.1.5).

Virtual and Augmented Reality integrating multi-sensory information to enhance the feeling of presence and immersion in Virtual Environments, is particularly interesting for the industry 4.0 paradigm, providing new planning, supervision, operation tools, and specialised training. This allows building stronger knowledge-based and multidisciplinary R&I&D ecosystems, together with other groups inside INESC TEC as is the case of IILab (C.3.2).

Immersive Environments and Serious Games require multidisciplinary teams to address Human-Computer Interaction (HCI) challenges. Gameful and Playful Design are approaches to improve User Experience in distinct processes, promoting behaviour change, and increased engagement. Furthermore, research on 3D interaction, DeskVR and haptic devices, as well as immersive analytics are also relevant lines in terms of potential advancements in UX in those environments. We will increase our activity in this scope, especially on User Interaction, Human Cognition, and Human perception, exploring the connections with Data and Scientific Visualisation (C.3.1).

Information Management and Information Systems. Information systems have evolved from specialised institutional databases to pervasive structures that integrate diverse technologies, combining structured and unstructured data from multiple sources. This evolution brings new technical and social challenges that we address by building on our previous work to enable significant results. It includes research in information management, information retrieval, information interaction, information processing, digital preservation, and research data management. Research data management continues to be a key focus area, which includes

significant challenges in developing tools and workflows that incorporate them into research processes. The recently approved FAIRway project, co-promoted with CIIMAR and BIOPOLIS-InBIO, will strengthen this line of work by advancing Research Data Management practices and promoting Open Science through improved data lifecycle management. Computer information interaction also signifies an ongoing focus, leveraging the advanced eye-tracking equipment, and introducing new dimensions to understanding user engagement and behaviour. This context poses challenges and promises relevant opportunities for collaborations in application context.

Software Engineering. The Software Engineering area aims to develop novel methods, techniques, and tools that advance how software is designed, constructed, and assessed. It seeks to ensure that the research results have a lasting impact on software development practices and contribute to improving the industry's competitiveness. The main research lines are (1) software requirements, design, and construction: requirements management, software architecture and design, model-driven development, and cloud-native software engineering; (2) software testing: model-based testing, mobile testing, distributed systems testing, and IoT testing; (3) software process and tools: agile processes, process improvement, tools for collaboration and knowledge management; serious games in software engineering education. Continue to identify, get to the essence, and document what actually constitutes good solutions in modern-day software engineering, working closely with professionals. Continue advancing the state of the art in techniques, practices, and tools that can, in different ways, improve the effectiveness, efficiency, and experience of software developers.

Large Scale and Special Purpose Computing Systems, Languages and Tools (LaSPeCS). The research addressed by the LaSPeCS area is focused on methods, algorithms, techniques, software tools, and compilers to map computations to the new and emerging computing systems. LaSPeCS also focuses on researching algorithms, data structures, and programming languages to cope with those systems' heterogeneous, parallel, and distributed hardware support. The research findings can enable computations in devices with strict restrictions (such as mobile and handheld devices) but also can contribute to more efficient embedded, cloud, and high-performance computing (e.g., in terms of energy consumption, scalability, and other performance requirements), empowering the competitiveness of companies and the innovation and research findings in many areas. This research track will explore the opportunities to develop code analysis and transformation libraries and tools, targeting several languages including C/C++, Java, Fortran and Android bytecode, which will be used, among other things, to map data-flow and streaming-oriented computations to multiple targets (e.g., custom RISC-V extensions, CGRA), and improve the safety of existing C code by applying analyses inspired by known and proved languages and standards (e.g., Rust, MISRA-C). This goal is tightly related to the projects A-IQ READY, UNIFY, POEMS and DARE.

Computing for Embedded and Cyber-Physical Systems. The development of embedded systems went from the small-scale development of isolated embedded monitoring and control devices to the development of complex, connected, system of systems, integrating hardware, software, control, and physical processes, in what is referred to as Cyber-Physical Systems (CPS). Embedded and cyber-physical systems are omnipresent in our environment, with applications as diverse as automotive autonomous systems, air quality systems, and renewable generation control, being enablers of a smart society. The CECPS research area focuses on research and development in (1) middleware for CPS, Internet-of-Things (IoT), and edge computing; (2) high-performance and predictable management of advanced computation in IoT/edge ecosystems; and (3) methods, tools and languages for the development, deployment, and maintenance of embedded and cyber-physical systems software.

6.10.2.3 Innovation

HumanISE research is applied in multiple sectors, with a focus on health, earth, ocean, space and organisations.

[Platforms and Methods for] Earth, Ocean, and Space Science (EOSS). This area aims to support researchers and stakeholders in the EOSS field in achieving evidence-driven science by providing systematic and collaborative methods, assisted by data science tools, to address relevant societal challenges such as climate change or the sustainable management of the environment and its resources. Semantic interoperability, IoT, real-time data stream processing, simulation, big data analysis, immersive realistic visualisation, Human AI and Digital Twins are a few examples of trends and challenges this innovation area encompasses, which align with research challenges such as computing systems to empower human capabilities, methods, and tools to boost the quality of future software systems, and performance, interoperability, and dependability of critical information systems. This area also aims to explore technology and know-how transfer in the context of research projects through consultancy

projects, specifications, and software prototypes, resulting in the licensing of inventions and software copyright registrations aligned with the industry's needs. These goals are in line with INESC TEC's strategy for the ocean.

[Platforms and Methods for] Personalised Health Research. This area seeks to empower health researchers to achieve evidence-driven science towards personalised treatments. It splits into two sub-areas: a) personalised Internet-based treatments; and b) human data storage, harmonisation, and controlled sharing. Important trends and challenges include collaborative tools and methods for health research, leveraging FAIR principles, security, and privacy preservation. This area is in line with the goals of the research challenge computing systems to empower human capabilities, by fostering distributed ML techniques, AI reproducibility, and new visualisation paradigms. In addition, the challenges addressed under this innovation area overlap with research challenges such as methods and tools to boost the quality of future software systems, and trustworthy control of data confidentiality and provenance.

Geospatial Information Systems Engineering. This area delivers R&I focused on applied research leading to products and services, better aligned with the industry's needs. One branch aims to provide specialised and advanced consultancy, technology transfer and innovation, and support adopting good practices and emerging standards by companies and public administration entities. Another branch aims to help induce a market pull drive into research and technological development and generate a convergence of knowledge, competencies, and synergies to help produce solutions for Agro-Food and Industry, involving companies and public entities. We are also pushing for the adoption of ICT solutions using geospatial information systems based on OGC (Open Geospatial Consortium) standards and spatial data infrastructures.

Information Systems and Applied Computing. The ISAC area develops R&D activities centred on models, theories, and conceptual frameworks that frame the use of information and information technologies that support organisational processes, including human, social, and organisational phenomena that involve access and availability of information, when computers and computer applications are used for the processing and availability of information. Its key areas are Enterprise Engineering; Enterprise Computing; Data Management Systems and Applications; and Digital Business.

6.10.3 Complementary advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community

Besides the mentioned strategic objectives, the Centre will maintain its efforts in publishing open-access datasets. Furthermore, the Centre will strive to provide innovative learning experiences by involving in R&D projects more students from master and doctoral programmes and organising new training programmes, both internal and external.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action

Although the innovation areas of the centre already address global and national grand challenges, industry's specific needs, and public administration challenges, it is planned to create more internal awareness about it. Another line of activity is to increase the engagement of the centre with the local and regional community, namely schools, citizens and the public in general. It is of high importance to improve the communication of our achievements.

Commitment 4 – Cultivate an attractive, people-centred and talented community

The centre will continue improving the work environment (rooms, equipment, events, etc.) to bring people together, make them comfortable, and bring new people to join the centre, including foreign researchers, mobility students, and new hires.

Commitment 5 – Strive for a sound, sustainable and effective operational model

The centre will continue to make sure to run on a healthy and sustainable operational model, by ensuring a projects' portfolio blending small and large projects, EU and national, research and applied research, partnering with universities, research centres, industry, public organisations, and distinguished national and international consortiums.

6.10.4 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.10 - HumanISE – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Continue to encourage publication in high-ranking journals and conferences.	Maintain or increase the number of publications in Q1 journals and Core A/A* conferences.	C1.1
Reinforce the involvement in PhD programmes.	Maintain or increase the number of active and concluded PhDs.	C1.1
Increase the involvement in the leadership of scientific initiatives.	Foster the participation of researchers in the program committees for strategic venues.	C1.2
Submit proposals to major and high-prestige grants.	Submit at least 1 proposal to the ERC programme.	C1.2
Increase the effort in IP valorisation.	Encourage the practice of preparing pre-disclosure forms and license agreements.	C1.3, C3.2
Increase the number of international and visiting researchers.	Attract more international researchers .	C1.6
Enhance the proportion of researchers enrolled in international mobility programmes.	Encourage researcher to participate in international networks and mobility programmes.	C1.6
Strengthen the participation in knowledge-based and multidisciplinary R&I ecosystems.	Foster participation in multi-scientific multi-stakeholder national and international initiatives.	C3.1
Increase international networking, leadership, and competitiveness.	Encourage the participation of researchers in high-level and flagship events for selected application domains.	C3.5, C3.2
Leading edge transfer: Connecting Industry Partners with breakthrough technologies.	Achieve successful technological transfer partnerships with at least 2 industry partners, resulting in at least 2 implemented innovations within the next 12 months.	C2.3

6.11 LIAAD – Artificial Intelligence and Decision Support Laboratory

Coordinator: Alípio Jorge

Assistant to the Centre Coordination: Joana Dumas

6.11.1 Centre scope and vision

LIAAD works on Artificial Intelligence, Machine Learning and Mathematical Modelling for Decision Support. Our scientific foundations are computer science, machine learning, statistics, optimisation and mathematics.

Our activity is motivated by three main vectors: 1) Ubiquitous and interconnected data; 2) Complex and comprehensive models for inference and decision support; 3) Interaction of humans and the society with AI systems assuring safety, equity and transparency through a human-centred approach.

The overall challenge we take is to **Produce AI systems to empower human capabilities for a better society**, by improving the trustworthiness and transparency of AI systems, providing increased cognitive power, including the ability to ground language, images, sounds and other signals on larger bodies of knowledge, enabling causal inference. We aim to provide AI systems with controlled autonomy having the ability to explain and trace their actions, as well as to interact with human agents and society in safety and respecting human dignity and fairness. Enable AI systems to benefit from learned and human provided models to accelerate the safe application of AI.

Our strategy is to take advantage of the pervasive digitalisation and growing importance of AI, and specifically ML, by exploiting and developing algorithms, methods and models that will help shorten the gap between collected data and knowledge, offer diverse modelling solutions and resources (data and reusable models) and promote a high level and high-quality interaction between humans and AI. We pursue fundamental research in computer science and mathematics, sustained on post-graduation programs. We position ourselves in the international scientific communities of our areas, editing and publishing in the top journals and conferences, which we frequently organise. Our team is application ready while pursuing fundamental research goals.

6.11.2 Main objectives for 2025

6.11.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is prioritising significant advances in the following Strategic Objectives:

C1.4. Develop closer and deeper relationships with our innovation partners and the broader community

- LIAAD has a strong scientific base and has been growing in the interaction with public administration, companies and community in general. LIAAD will pursue its research on highly applicable areas as predictive maintenance and natural language processing, where several of our projects include societal partners. We will promote the collaboration of the Portuguese NLP community. We are involved in the Digital Innovation Hub. We aim to gather intelligence on the status of companies and public administration towards digitisation and AI.

C2.1. Develop impactful research and innovation aligned with the SDGs

- As transversal technologies, Artificial Intelligence and Decision Support contribute to all the SDG, namely Good Health and Well Being (projects in the health domain), Industry, Innovation and Infrastructure (predictive maintenance and business intelligence) and Peace, Justice and Strong Institutions (responsible AI, environment and natural language processing in collaboration with journalists, finance and law).

C3.5. Increase our international networking, leadership and competitiveness

- We will organise ECML-PKDD 2025, one of the best and largest conferences on Machine Learning. We will organise as usual a wide variety of international workshops.

C5.3. Improve quality, management and usage of our infrastructures

- Organise LIAAD meet-ups to promote interaction with other centres and strengthen LIAAD's team of hired PhD researchers as an important propeller of LIAAD's success, promote experience exchange in bimonthly meetings with previous, current, and aspiring project leaders.

6.11.2.2 Research

In **Machine Learning, AutoML, Large Scale ML and Human Artificial Intelligence** we work on the problems of data unbalance, complex networks, online and and automated ML. These are some of our 2025 **challenges**:

- Improve causal inference from data using machine learning and Bayesian reasoning and use causal models for explainability and enable the transparency of black box fault models.
- Advancing the state of the art in the prediction of extreme values and online outlier and event detection.
- Design ML techniques for imbalance data streams and obtain post hoc explanations for anomalies detected in predictive maintenance scenarios.
- New approaches to integrate multi-modal biomedical data (genomics, clinical, histopathological images) for fair and accurate clinical and healthcare predictive systems.
- Improve algorithms for Edge AI, namely Federated Learning (FL) approaches and defence mechanisms for FL.

In **Complex Data Analysis** we develop statistical and machine learning approaches for the representation and analysis of complex data, arising from the aggregation of large amounts of open/collected/generated, or directly available in a structured or unstructured form. Some of our main challenges:

- Improve data privacy guarantees, namely on the internet, and in official statistics.
- Develop methods for outlier detection in multivariate distributional data.
- Develop nowcasting approaches for macro-economic data using un-conventional and administrative data sources.
- Develop algorithms to ensure time series data privacy.

In **User Modelling** we work on algorithms and methods for stream-based recommender systems and consumer modeling. In **NLP** we pursue the semantic and adaptive extraction of narrative structures from news, clinical records, business reports and tweets, their understanding and visualisation. Some important challenges:

- Improve semantic entailment using enriched language models.
- Deepen the semantic layers of narrative extraction and understanding from text in Portuguese.
- Exploit ontology-based semantic enrichment using Generative AI.
- Use Reinforcement Learning for training Generative AI models.
- Train Large Language Models for European Portuguese.
- Use Language Models and Generative AI for structured output generation from text.

Modelling and Optimisation: Heuristic and exact methods are developed and applied to combinatorial optimisation problems in multiple fields, including scheduling, storage, and distribution. Agent-Based models are developed and used as computational tools in topics such as in Artificial Economics and Social Simulation.

- Develop metaheuristic methods to evaluate the impact of considering perishable/deteriorating goods on production and manufacturing schedules.
- Developing efficient heuristics for a new variant of the order scheduling problem.
- Improve the prediction of crisis and pandemics using agent-based learning resorting to conscious and non-conscious learning models.
- Forecasting crises using link prediction in multilayer bipartite networks.

Mathematical Modelling: We develop fundamental research on game theoretical modelling.

- Analyse the persistence of the Barrett paradox for quasi linear utilities.
- Explain the mechanism of price formation in the presence of positive network effects.

Genomic Data Science and Biomedical Data Mining: we develop the full data analysis pipeline for large scale genomic datasets obtained from multi-modal high-throughput biomedical technologies.

- Integration of multi-omics datasets to obtain disease insights.
- Using Large Language Models and Generative AI to Generate Pathology Reports from Whole Slide Images and other clinical data.

6.11.2.3 Innovation

- Natural Language Processing, Large Language Models and ontologies for information extraction, structuring and presentation in the contexts of Clinical Applications and Legal Reasoning using Agent based approaches (including RAG).
- Contribute to a stronger health system through AI.
- Large Language Models for assisting software configuration in a low-code setting.
- Data Science for accounting harmonisation in the context of Humanitarian Aid.
- Machine Learning and Transparent AI for Predictive Quality.
- Define guidelines for AI development best practices using repositories, MLOps and responsible AI
- Automated Value Models for Real State.
- Generative AI for assistants.

6.11.2.4 Complementary advances

Jointly with these key advances, in 2025, the other main objectives for the Centre towards its vision are:

Commitment 1 - Excel and innovate across the missions of academia, harnessing the collective strength of our community.

- Organisation of the European Conference on Machine Learning (ECML-PKDD 2025), which will bring more than 1000 participants to Porto, including Main Scientific Track, Workshops, Tutorials, Applied Data Science Track and Special Industrial Sessions. The conference also features a Journal Track on two of the most important journals in the domain: Machine Learning Journal and Data Mining and Knowledge Discovery Journal.

Commitment 2 - Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action.

- Aggregate the communities working in Computational Linguistics in Portugal, Brazil and Galicia for the development of joint scientific efforts, resources and applications with a strong emphasis in the collaboration with humanities (e.g. Linguistics).

Commitment 3 – Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems.

- Collaborate with other centres to deliver more value to the market as a ONE INESC TEC multi-expert team.
- Continue developing synergies with humanities experts in Linguistics in the context of a larger movement towards Computational Linguistics in Portuguese.

Commitment 4 – Cultivate an attractive, people-centred and talented community

- Host visiting scientists and students as part of their PhD, postdoc or sabbatical.

Commitment 5 – Strive for a sound, sustainable and effective operational model

- Promote coding principles

6.11.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.11 - LIAAD – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Workshops: Text2Story, SoGood, Conferences ECML PKDD 2025, Conference track ACM SAC Data Streams.	Increased visibility of the group, international community development.	C3.5
HfPT, Hospital da Póvoa.	Tools for clinical narrative extraction.	C2.1
LIAAD day.	Scientific meet-up of LIAAD.	C5.3
PI forum.	Bi-monthly meeting of past, current and aspiring principal investigators. The expected outcome is an increase in project submission.	C5.3
Coding principles sessions.	Promote code reusability and share.	C5.1
Host visiting researchers.	Promote international contacts and raise scientific level.	C4.1

6.12 CRACS – Centre for Research in Advanced Computing Systems

Coordinator: Ricardo Rocha

6.12.1 Centre scope and vision

CRACS pursues scientific excellence in the areas of programming languages, parallel and distributed computing, information mining, security and privacy, with a focus on scalable software systems for challenging multidisciplinary applications in Engineering, Life Sciences, Social Networks and the Internet of Things.

6.12.2 Main objectives for 2025

6.12.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is prioritising significant advances in the following Strategic Objectives:

C1.1. Raise the contribution and visibility of our research. Consolidate CRACS's international visibility, notoriety and publication output, prioritising publications in high-impact journals and high-ranked conferences. Four young researchers are expected to complete their PhD theses with publications in leading journals/conferences.

C1.2. Increase our involvement in the leadership of scientific initiatives. We estimate the organisation of 3 international conferences, the participation in 7 journals as editor and in 23 international events as PC members.

C1.5. Provide innovative learning experiences. Further develop the improvement in efficiency of programming education and its student-perceived experience, focusing our research on the automatic generation of courses using generative AI, and in deploying educational chatbots able to deliver accurate, context-aware, and pedagogically relevant responses.

6.12.2.2 Research

In 2025, the Centre's research will focus on:

Heterogeneous parallel computing with multi-core CPUs and iGPUs. Multi-core CPUs and integrated GPUs (iGPUs) have become a common reality in modern parallel data processing. We plan to develop a heterogeneous parallel framework supporting dynamic scheduling mechanisms able to analyse the computational resources available and intelligently partition the workloads between multi-core CPUs and iGPUs. We also plan to contribute to the assessment of languages for heterogeneous parallel computing in three components: (i) efficiency of the code generated by the compiler; (ii) overhead introduced as the number of cores/threads increases; (iii) energy consumption of the same operation performed in each language.

Lock-freedom. Advance the development of a generic lock-free coalescing-capable mechanism for memory management capable of satisfying memory allocation requests with desirable low fragmentation characteristics. In particular, we want to address open problems related with the dynamic allocation of nodes for the internal data structures and with coalescing and allocation failures due to temporary ownership of blocks.

Logic programming. Logic programming faces significant challenges as the world of programming languages evolves. In recent work, we have pursued an effort in addressing such challenges by defining a typing schema for logic programming that can provide disciplined access to data structures. We believe further theoretic advances are required and are working in this direction. Threading and parallel execution also needs to be rethought so that they can be programmed at a more abstract level.

Machine learning models. Continue the development and publish first results of ongoing multidisciplinary projects that use machine learning models for: (i) indoor localisation derived from RSSI datasets from Bluetooth beacons and computer vision applied to photos of indoor premises; (ii) automatic identification of Portuguese native species of multiple taxa (c.f., https://rubisco.dcc.fc.up.pt/biolens); and, (iii) automatic determination of cool star atmospheric parameters and elemental abundances from datasets of stellar spectra.

Automatic course generation using generative AI. Research the automatic generation of courses using Generative AI, focusing on producing outputs compliant with the IMS CC specification to ensure seamless interoperability across Learning Management Systems (LMS), to create scalable and portable courses that foster

interactive learning experiences. Explore integrating native gamification elements supported by LMS, such as, conditional content access, achievement badges, and leaderboards, to enhance learner engagement.

Leveraging RAG for training educational chatbots with LLMs. We aim to explore the generative power of Large Language Models (LLMs) with the precision of curated knowledge bases by leveraging the Retrieval-Augmented Generation (RAG) paradigm to train and deploy educational chatbots, enabling chatbots to deliver accurate, context-aware, and pedagogically relevant responses.

E-learning system interoperability, analytics and generative AI for microlearning. Fusion of e-learning system interoperability with learning analytics exploring the power of data-driven insights to tailor educational content to individual learners, fostering a more effective and engaging educational environment. Another path will be to explore the use of generative algorithms to dynamically create personalised microlearning content based on individual learner profiles, preferences, and progress.

Link prediction on quantile graphs for collaborative forecasting. Develop a new method for making collaborative time series forecasting while preserving data privacy. We will first design a link prediction method tailored for quantile graphs derived from univariate time series. As a second step, we will develop an inverse mapping method that transforms the quantile graphs into synthetic interval time series data. The work will be applied for collaborative forecasting of interval time series data with privacy-preserving, using a set of electrical energy time series data, and comparing it with state-of-the-art approaches in the literature.

Time series privacy-preserving via complex networks. The ability to generate synthetic data from original data in a way that privacy is preserved is critical to ensure reliability and security of critical systems, and to facilitate data sharing and collaboration. Building on recent work, we will employ time series transformation methods into networks as a privacy preservation mechanism and show that by representing the data in another space we can ensure privacy of the original data. Furthermore, we will investigate inverse methods to generate a new and synthetic time series from complex networks and show that the synthetic time series conceals confidential information while preserving essential data properties of the original series.

Domain-specific and context aware approaches to entity extraction. Investigate methods for detecting domain shifts (drift) in Natural Language Processing (NLP), focusing on understanding how evolving lexicons impact entity recognition and developing strategies to abstract and identify entities within dynamic corpora.

Disinformation detection. Building on prior work in fake news detection, this research delves into the role of sentiment and emotional traits in identifying deceptive information, examines the correlations between disinformation and emotional sequences, aiming to uncover linguistic and psychological markers of deceit.

Gamified approaches applied to cyberawareness. Leverage game design elements and mechanics to enhance engagement, motivation, and retention of cybersecurity knowledge among diverse user groups that show, traditionally, low user participation and limited retention of information. By integrating elements like rewards, challenges, storytelling, and real-life simulations, gamified methods can create interactive and immersive learning experiences that foster proactive security behaviours, with the potential to transform how individuals and organisations approach cyberawareness, driving more effective risk mitigation and a culture of security.

Cyber threat intelligence. Further develop the CTI sharing proxy, which uses an encrypted shared index for IoC searching, to both resolve its single point of failure (one index) and to support user generated sharing groups.

Privacy. Advance previous work in the following topics: (i) research results on the privacy implications of Wi-Fi connectivity for tracking users; (ii) privacy attacks and defences against distributed/federated learning mechanisms; (iii) blockchain-based mechanisms for distributed authentication and authorisation.

European digital identity wallets. Research interoperability, security, and user-centric novel mechanisms for European Digital Identity Wallets (EUDIW). Key goals include integrating informed consent mechanisms into Verifiable Presentations (VPs), ensuring compliance with eIDAS 2.0 standards for cross-border interoperability, and leveraging privacy-preserving technologies like Zero-Knowledge Proofs (ZKPs). The integration of EUDIW with the User Managed Access (UMA) protocol will be based on adapting UMA workflows to support OpenID for Verifiable Credentials (OID4VC) and enabling dynamic, claims-based access controls mediated by EUDIW. Authorisation server extensions, such as for Keycloak, will support wallet authentication, issuance of informed consents as Verifiable Credentials, and real-time policy updates.

Security in edge IoT devices and cascade failures. Edge IoT devices play a pivotal role in modern networks by processing data locally, reducing latency, and enabling real-time decision-making. However, their decentralised

architecture and connectivity can expose them to significant security vulnerabilities, such as unauthorised access, malware, and data breaches. A critical concern is the potential for security breaches to trigger cascade failures, disrupting entire systems. Novel contributions are expected to explore the security challenges unique to edge IoT devices, specifically mechanisms for the cascade failures, and mitigation strategies.

Digital forensics. We plan to study the integration of Benford's Law, which predicts the frequency distribution of leading digits in naturally occurring numerical datasets, with digital forensics. This integration can be used to identify irregularities that may signal manipulation or tampering of data, strengthening the capacity to identify subtle inconsistencies, detect anomalies and uncover fraudulent activities in digital context.

6.12.2.3 Innovation

CRACS research is applied in several areas. In 2025, the Centre's innovation activities will focus on:

Logic programming. We have worked on integrating YAP Prolog with Python and C++ environments, namely, in interfacing to AI systems and in extracting data from large XML datasets. We would like to develop a unified core interface for external access, including data-base access and transparent interface to solvers.

Multidisciplinary applications of MLMs. We plan to continue ongoing projects that use Machine Learning Models (MLMs) for multidisciplinary applications. MLMs provide a novel approach to the problem of indoor localisation and the development of indoor positioning systems. The development of MLMs for automatic spectral characterisation of stars is of crucial importance nowadays due to the huge datasets generated by ongoing or soon-to-be-started surveys (e.g., the Legacy Survey of Space and Time at the Vera Rubin Telescope). The development of MLMs for automatic species identification and providing their corresponding train and test datasets contributes to a better knowledge of Earth's biodiversity and ecosystems.

Distributed shard index. An efficient Distributes Shard Index (DSI) tool to support CTI sharing can minimise disruption and maintain its operation even when attacked. The DSI to be developed is planned to have a real societal impact, by improving the cybersecurity capabilities of any entity, but also to contribute to the existing body of knowledge in distributed encrypted searching mechanisms and tools. An open-source contribution is expected to be made available for generic use by any entity in the context of project PRIVATEER.

NIS-2 directive. Study how the NIS-2 directive's expanded scope, which includes stricter risk management measures, incident reporting requirements, and cross-border collaboration mandates, can influence organisational practices and regulatory compliance. We seek to identify best practices and to propose innovative solutions for enhancing resilience, such as harmonizing standards across diverse sectors and scaling its provisions to small and medium-sized enterprises. Additionally, the study could assess the effectiveness of NIS-2 in fostering a culture of cybersecurity and its implications for global organisations operating within EU jurisdictions.

6.12.3 Main initiatives planned for 2025

The Centre will carry the following initiatives and actions towards the above objectives and as part of its continued activity towards its vision:

Table 6.12 - CRACS – Main planned initiatives and actions

Initiatives	Key Results	Strategic objectives
Prioritise publications in high-impact venues.	Raise research visibility.	C1.1
Increase involvement in scientific initiatives.	Foster international recognition and promote networking.	C1.2
Organise events and advanced training courses on Gamification.	Develop new relationships to unlock collaboration opportunities.	C1.4
Submit proposals to national and European calls.	Increase leadership and competitiveness.	C3.5

6.13 HASLAB – High-Assurance Software Laboratory

Coordinators: Alcino Cunha and António Luís Sousa

Assistant to the Centre Coordination: Catarina Leones Fernandes

6.13.1 Centre scope and vision

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 research areas within INESC TEC Computer Science and Engineering domain — Cybersecurity, Distributed Systems, and Software Engineering — complemented by other competencies such as Human-Computer Interaction, Programming Languages, Mathematics of Computing, and Quantum Computing. Through a multidisciplinary approach that is based on solid theoretical foundations, HASLab aims to provide solutions — theory, methods, languages, and tools — for developing complete ICT systems that provide strong guarantees to their owners and users.

6.13.2 Main objectives for 2025

6.13.2.1 Highlights

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is prioritising the following Strategic Objectives:

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

HASLab will continue to prioritise publications in high-impact conferences and journals, particularly in the context of PhD theses. To achieve this, we will implement the following initiatives: continue our PhD student mentoring program, focusing on defining a high-quality publication plan; encourage senior researchers to disclose their submission plan for the upcoming year and make sure all have at least one submission to a top-venue planed. More specifically, we aim to have at least 15 papers submitted to CORE A* and A conferences or equivalent top-ranked journals, half of which are CORE A* and A conferences or equivalent top-ranked journals, half in the context of PhD theses.

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

Many HASLab researchers are regular members of ACM and IEEE, but in 2025 we intend to propose at least 2 researchers to be Senior Members of these societies.

C1.6. Increase the international embedment of our community

Research excellence is often a by-product of a solid network of international collaborations. As such, we intend to increase both the mobility of our researchers (both senior researchers and graduate students) and the number of incoming international visiting researchers. More specifically, our goal is to have at least 2 visits of senior researchers to internationally renowned institutions, 2 graduate student internships in internationally renowned institutions, 5 PhD theses co-supervised by renowned international researchers, and 2 incoming international visiting researchers.

6.13.2.2 Research

In 2025, we intend to focus our research on the following topics:

Cybersecurity

HASLab continues to be a key partner in the Formosa Crypto project, which federates several initiatives in machine-checked cryptography and high-assurance cryptographic engineering. In the upcoming year, the main goal within this project is to produce a formally verified implementation of the upcoming standard for a post-quantum secure signature scheme (Dilithium) and obtain verified implementations for the ARM architecture. HASLab is also focusing on consolidating research in digital identity management systems, advancing efforts in malware detection, and exploring emerging technologies in threat intelligence.

Distributed Systems

In 2025, HASLab will continue to contribute data management technology in the context of research projects and industrial collaborations, aiming at deliver results at multiple levels, ranging from data replication and high-performance query processing techniques to interoperability middleware and applications. HASLab will also focus on storage systems, aiming at delivering results on distributed fault-injection testing, in collaboration with the SingleStore company. Also in this topic, HASLab will work with several HPC centres on designing new storage and operating systems primitives to improve the performance and energy efficiency of large-scale infrastructures and AI workloads, such as National Institute of Advanced Industrial Science and Technology (AIST), from Japan, National Applied Research Laboratories (NARLabs), from Taiwan, Texas Advanced Computing Center (TACC) and Florida International University (FIU), from USA, and McGill University, from Canada. HASLab will also contribute to continuing the work in semantic interoperability (papers and HE projects) and expand the work scoping data spaces. Furthermore, HASLab is also exploring new contributions in the area of IoT data processing and benchmarking, evaluating not just the quantitative but also the qualitative differences between the different edge-cloud continuum layers.

Software Engineering

HASLab is an active contributor in the development of several formal methods for software engineering. In 2025 we intend to focus our research on applying these formal methods to specific application domains, in particular to the design of mobile apps, transactional database systems, and quantum algorithms.

6.13.2.3 Innovation

In 2025, HASLab intends to attract new R&D consultancy services to major international IT companies. In particular, we are currently engaging with Huawei with the goal of providing consultancy services for implementing cryptographic schemes to be incorporated into a cryptographic library of the company.

In terms of EU projects, the big focus of HASLab in 2025 is on the topic of interoperability. In the BeFlexible project, HASLab will deploy a Grid Data and Business Network digital platform, as a solution that integrates all stakeholders in a flexible value chain. In the Hedge.IoT project, HASLab will continue the development of data spaces, namely INESC's Data Space Connector tailored for AI. In the INSIEME project, HASLab will contribute with the provision of a Data Space Connector, providing interoperability services, being specifically tuned to unlock sovereign and efficient handling and exchange of AI models, together with supporting the federated learning schemes in the data space. In the ATE project, HASLab is dedicated to develop and install a digital platform for interoperable data service for energy stakeholders, which will allow energy use-cases with AI to be expedited by allowing a fast deployment of AI pipelines by a non-expert in DEV OPS.

6.13.2.4 Complementary advances

Aligned with INESC TEC Strategic Plan 2023-2030, in 2025 the Centre is planning the following complementary advances:

C1.5. Provide innovative learning experiences

HASLab will continue to invest in attracting and providing an innovative learning experience for MSc students to conduct a thesis in R&D projects in the centre, as MSc students are key to ensuring the sustainability of our team. In particular, in 2025, we aim to have 40 concluded MSc theses supervised by our senior researchers and 15 new grants for MSc theses in the context of R&D projects in the centre.

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

In the upcoming year, we will continue to engage with other domains inside INESC TEC to establish new partnerships to apply for internationally competitive research funding. In particular we intend to foster new collaborations in the cybersecurity domain with CPES and CESE, and in the area of software engineering for robotics with CRIIS. As a part of the InterConnect European project a Memorandum of Understanding has been prepared to explore the InterConnect results in direct company contracts and pursue the R&D side of the SIF (Semantic Interoperability Framework) with TNO and Vizlore Labs.

C4.3. Expand the diversity of our community

HASLab aims to attract and cultivate a diverse and balanced team, particularly regarding gender equality. While at the graduate student level, the centre has made considerable progress in this respect in the past years

(currently, 8/30 PhD students are female), that progress still had no counterpart in the team of hired and senior researchers (only 3/1 of the former and 3/30 of the latter). To increase the gender balance in the senior ranks, we expect to hire 1 more female MSc researcher in 2025.

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

The HASLab economic model is not very sustainable at the moment, particularly when it comes to high-margin projects, we have only a handful of contracts with industry and projects from international competitive research funding, and the fundraising and execution of these projects are centred on a handful of senior researchers. To increase the sustainability and resilience of this economic model, we are planning the following initiatives: continue the stabilisation of core development teams around the key senior researchers involved in the fundraising and execution of high margin projects (3 new MSc and 1 new PhD hirees); raise awareness inside the centre for the current imbalance in fundraising among senior researchers, in particular, finish the development of a heatmap-like internal assessment mechanism (similar to the one currently used to assess the centres inside INESC TEC) so that the senior researchers can better perceive what their contribution to the overall centre performance is.

C5.3. Improve quality, management and usage of our infrastructures

In 2025, HASLab will continue to hold team lunches to encourage interaction and networking between members, but also to ensure that everyone is aligned with the common goals of the centre. In terms of physical infrastructure, a new meeting room at UMinho will be properly equipped and branded with the INESC TEC image. This effort is aimed at creating recognition and a sense of belonging among team members, despite the fact that the main centre facilities at UMinho are located far from the headquarters building.

6.13.3 Main initiatives planned for 2025

Table 6.13 - HASLab – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Encourage disclosure of paper submission plans.	15 submissions to CORE A* and A conferences or equivalent top-ranked journals.	C1.1
Increase the number of ACM and IEEE Senior members.	Submit 2 proposals for senior members.	C1.2
Promote the interaction and networking between members.	6 lunches, 2 team building activities, PhD Bytes .	C5.3
Increase researchers mobility.	2 outgoing visits; 2 outgoing student internships; 2 incoming visits.	C1.6
Keep stabilizing core development teams.	3 new MSc and 1 new PhD hires.	C5.1
Create awareness about the current imbalance in fundraising among senior researchers.	Develop a heatmap-like internal assessment mechanism for senior researchers.	C5.1
Attract MSc students.	15 grants for MSc students; 40 concluded MSc theses.	C1.5
Increase the collaboration with other centres.	2 new project proposals.	C3.1
Increase the sustained collaboration with external entities.	1 new MoU.	C3.1

7 RESEARCH AND TECHNOLOGY INFRASTRUCTURES

INESC TEC maintains state-of-the-art laboratories that support both research and technology transfer activities, besides its active participation in several national Research Infrastructures (RIs). The main objectives and actions planned for the year 2025 of a selection of those research and technology infrastructures are presented below in this Section.

7.1 CLOUDinha Laboratory

7.1.1 Mission and positioning

The CLOUDinha laboratory provides computational support to research and development activities of INESC TEC and the University of Minho, providing bare metal, virtualisation, and security features.

The cluster comprises different generations of hardware: Haswell, Kaby Lake, Comet Lake, Coffee Lake, and Raptor Lake. It includes 106 micro-ATX servers based on commodity hardware with Intel Core i3, i5, and i9 CPUs, 8GB, 16 GB, and 64GB of memory, and heterogeneous storage hardware, including HDDs, SSDs, and NVMe devices. The servers are connected through either a 1 Gb or 10 Gb network. In addition, the cluster has four rack servers based on Intel Xeon hardware, with 32, 64GB, and 192GB of memory, and heterogeneous storage hardware, including SSDs, NVMe, and persistent memory devices. They are connected through either a 1 Gb or 10 Gb network, while some also have programmable network capabilities (DPDK).

The heterogeneous hardware nature of the cluster is essential for supporting different research projects that may require specific hardware features (e.g., different storage or network technologies, access to trusted hardware capabilities).

7.1.2 Main objectives and actions planned for 2025

As in previous years, the laboratory's primary goal remains to support cutting-edge research and development by providing advanced computational resources. Our efforts will focus on fostering innovation in key computer science areas, including:

- Distributed systems and scalable data management
- Storage systems, AI frameworks, and databases
- Privacy and security
- Emerging technologies such as Blockchain, Internet of Things, and Digital Twins
- Software engineering

This objective is aligned with the Strategic Objective of Building stronger knowledge-based and multidisciplinary R&I ecosystems.

As another objective, the laboratory will actively foster research aligned with INESC TEC’s thematic lines, namely Digital Models, Sustainable Transformation, Tackling the Extreme, and Trustworthy Technology, by prioritizing key infrastructure enhancements and tailored support for researchers. This will include providing novel computational resources for advanced modelling and simulations, optimizing energy efficiency in system designs to promote sustainable practices (reducing energy consumption and carbon emissions), and offering robust, scalable architectures to tackle extreme-scale challenges. Additionally, the laboratory will ensure secure and reliable environments to advance research in privacy, security, and trustworthy digital systems, creating a foundation for impactful innovation in these critical areas. These actions will be key for the achieving the Strategic Objective of improving the quality, management, and usage of our infrastructure.

7.2 EMSO-PT Research Infrastructure

7.2.1 Mission and positioning

EMSO-PT is a research infrastructure lead 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 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. 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 had built 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.

7.2.2 Main objectives and actions planned for 2025

The main objectives for 2025 are the following:

- Deployment of the EGIM system – In the line of relocatable nodes, longer term deployments in the northern Portuguese coast and in Setubal canyon will be performed.

Building on the experience from the first implementation phase, ended in December 2022, INESC TEC will be strongly committed in the preparation of a successful plan for the second implementation phase. This includes an active participation in discussions and reporting of the first phase, welcoming and collaborating with new candidates for the infrastructure, and establishing priorities for the second implementation phase, to ensure a successful transition to the operational phase.

7.3 iiLab - Industry and Innovation Laboratory

7.3.1 Mission and positioning

Empowering companies and people for the digital transformation of industry. iiLab's vision is to be the industry's preferred partner for development and innovation in the area of digital transformation. iiLab brings together skills, competencies, and resources that provide a practical environment for exploring, experimenting, and applying digital and analytical solutions along the value chain as part of the digital transformation of industry by offering the following capacity-building actions:

- **Developing and demonstrating** advanced concepts and technologies in robotics, automation, cyber-physical systems, the Internet of Things (IoT), and the integration of AI 'vertically' in industry, in an environment close to that of industry.
- **Carrying out experimentation and prototyping** for technology companies, solving 'challenges' posed by the 'Client' and presenting the 'Client' with the solutions developed in the Laboratory for them.
- **Providing consultancy** to facilitate and reduce the risk of the digital transformation process and the development of solutions.
- **Providing** general or tailor-made **advanced training** for top managers and senior executives, with programmes in the areas of Digital Transformation Management and Advanced Production Technologies.

7.3.2 Main objectives and actions planned for 2025

- Prepare a set of at least three demonstrators for the design of simple products in different industries that simulate production lines, using equipment, INESC TEC's research project results, and other existing resources.
- Promote a series of demonstrations for manufacturing companies by combining INESC TEC solutions with technologies from national companies, thereby strengthening digital technology sovereignty at the national level.
- Prepare base modules to enable the rapid (re-)configuration of production lines and value chains for specific demonstrations requested by external organisations (including for testing their solutions).
- To support sustainable and effective digital transformation journeys, the following actions to publicise iiLab and recruit users will be carried out: (a) Half-day hands-on workshops, one per quarter, with a maximum of five external participants from companies; (b) Two workshops for participants from within INESCTEC to publicise the potential of iiLab.
- Create a procedure to offer rapid access to iiLab's expertise, facilities, and activities. Through this procedure, organisations with a specific innovation issue can request a no-obligation consultation, for example, to validate a new concept or independent technological advice.
- To achieve certification in the training areas.
- Increase iiLab's international networking, leadership, and competitiveness: Organise or participate in organizing at least one high-visibility international event (such as the FoF International Smart Factory Summit at SUPSI, Switzerland). / Provide laboratory support to several EU-funded or other international projects. / Promote the connection to at least one other international Industry Laboratory.
- Design, promote, and execute training actions (at least 5 in areas such as simulation, IoT Platforms, Shop Floor Digitisation, AI integration in industrial processes, etc.) aligned with iiLab's area of action for specific target audiences in manufacturing companies. These trainees will act as agents for publicizing and marketing iiLab.
- Seek financing in national and European initiatives to continue investment and update of iiLab infrastructures.
- Finalise the pilots associated with the 5G Testbed in collaboration with NOS and foster new initiatives to enhance and maximise the benefits of the dedicated 5G network infrastructure.

7.4 Laboratory of Communications

7.4.1 Mission and positioning

The main objective of the Communications Laboratory (CommsLab) is to support the experimental evaluation and testing of next generation communications, localisation and sensing solutions in a controlled environment, covering the gap between simulation-based analysis and real-world testing.

The CommsLab was established in 2006 at INESC TEC's main building. It was created after a successful proposal to the Foundation for Science and Technology (FCT) under the National Program for Scientific Hardware Renewal (PNRC), which aimed at renewing the national scientific infrastructure by financing the acquisition, updating and expansion of scientific equipment. 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 having now not only excellent conditions for researchers but also better 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 digital vector/analogue modulations, as well as low frequency characterisation equipment and a 3D printing machine. Also, it includes a compact anechoic chamber (1.2 m x 0.6 m x 0.6 m) designed for evaluating different antennas at mmWave bands 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, 5G Open Radio Access Network (O-RAN) equipment, 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.

7.4.2 Main objectives and actions planned for 2025

The following actions are planned for 2025, grouped by the objectives of INESC TEC's Strategic Plan 2023-2030:

Improve quality, management and usage of our infrastructures

- Deployment of a vision-aided reconfigurable intelligent surface and vision-aided OAI-based 5G mobile base station supported by a 10 Kg capable robotic arm; these platforms will be installed as user controllable research tools through an API;
- Deployment of a marker-based multi-camera vision system with sub-mm precision supporting automatic ground truth annotation of localisation of moving entities in experiments;
- Establishment of EMC/EMI pre-certification capacity through the deployment of a technological infrastructure suitable for the characterisation electromagnetic compatibility and immunity testing;
- Upgrade the maximum frequency of the existing compact anechoic chamber to 170 GHz;
- Finish expansion of the laboratory facilities to a complementary room enabling research on 5G and 6G solutions in cooperation with a mobile operator;
- Develop and test new obstacle-aware 5G and Wi-Fi-based backup communications solutions for emergency/disaster management scenarios, using Unmanned Aerial Vehicles (UAVs) as companions of Unmanned Ground Vehicles (UGV) for better communications and improved situational awareness.

Provide innovative learning experiences

- Continue to foster the use of CommsLab in the context of research activities involving students, such as Summer Internships in CTM, Curricular Internships, and also hands-on demos for Telecommunications courses.

Better align and deliver R&I with Industry's needs

- Use of the improved CommsLab infrastructures, in close cooperation with mobile operators, to conduct at least two 5G pilots aligned with the validation of 5G-connected commercial solutions of different industrial players.

7.5 Laboratory of Computer Graphics and Virtual Environments

7.5.1 Mission and positioning

The Laboratory activity is at the intersection of Computer Graphics and Human-Computer Interaction, focusing on Virtual and Immersive Environments. The teamwork concentrates on both, consolidating the fundamental and impactful research activities on multisensory virtual reality and on immersive and interactive environments, with a particular concern on transferring knowledge to the industry.

7.5.2 Main objectives and actions planned for 2025

In 2025, the research on multisensory virtual reality and ways of interacting with virtual environments and digital content in close connection to the Immersive Learning Research Network (iLRN) is planned to continue. The laboratory will be developing projects for transferring this scientific knowledge to the industry, with close connections to the EIT Manufacturing and other institutions, as well as specific industries (Energy Production, Defense, Health, Tourism). The collaboration with the iiLab will also allow impactful projects with the industry, with demo and training actions to be developed.

To attain this, the main objectives to accomplish are:

- Development of Extended Reality (XR) solutions by providing effective solutions for specific activities, taking advantage of multimodal and multisensory environments, advanced 3D interaction techniques, improved and properly evaluated usability and accessibility, as well as developing authoring tools for non-technical staff.
- Study and define Interactive and location-based narratives, promoting behaviour change in health and well-being. New opportunities for collaboration will be explored in the research network “Immersive for Health and Well-being” in the context of the project EUGLOH from UPorto.
- Study and develop procedural content generation techniques to adapt them to distinct locations and situations, namely in enhanced training scenarios.
- Innovate on co-creation methodologies applied to digital games and gamification strategies, focusing on immersive learning, applicable to game-based solutions for learning and behaviour change, and integrating performance metrics based on game analytics.
- Study and apply new information visualisation solutions and visual summaries/narratives to the context of ocean and earth sciences and digital twins.

Complementarily, the commitment to disseminate R&D activities and attract new talent involves organising several events with STEM students from the different schools of the region.

To disseminate the research across the science body, we plan to continue our best efforts to publish 20 journal papers and present at least 15 conference papers.

7.6 Laboratory of Microfabrication

7.6.1 Mission and positioning

The Laboratory of Microfabrication does fundamental research on laser direct writing microfabrication using a femtosecond laser and develops functional devices in integrated optics, optofluidics, gratings fabrication, etc. The laboratory also provides fabrication services to other areas of research within the Centre of Applied Photonics (CAP).

7.6.2 Main objectives and actions planned for 2025

This microfabrication laboratory explores non-traditional microfabrication techniques based on femtosecond laser direct writing processes, ranging from localised, high resolution, tridimensional refractive index modification in transparent substrates to silica micromachining. For example, microfluidics and optofluidics chips are produced to implement biosensors and micro and nanostructures. First order Bragg gratings are made by laser point-by-point direct writing to implement new and more reliable sensing heads.

- Infrastructure upgrade: this involves the update of the Bragg grating and long-period grating manufacturing system. This update involves the use of new motion controllers for X-Y Aerotech stages, possibility of writing on multi-core fibers, as well as on the cladding of optical fibers. The second update will be realised on the Amplitude Systems Satsuma laser that it will be completely refurbished.
- Besides the fabrication of integrated optics or optofluidic devices, identify other areas of application where the installed micromachining capabilities can add value due to its unique characteristics. As an example, the evaluation of the capabilities of femtosecond multiphoton polymerisation and machining on the development of photonics integration and advanced packaging will be investigated.
- Fabrication of microfluidic and optofluidic devices using FLICE techniques for sensing applications.
- Fabrication of cantilevers by glass micromachining; these cantilevers include multiple waveguides with Bragg gratings for vibration characterisation.
- Explore the creation of nitrogen vacancies centres on diamond.
- Starting of fabrication of neuromorphic integrated optic devices; this involves the fabrication of very loss low optical waveguides and devices (i.e., directional couplers, MMI's, interferometers, for example). The main aspect will be the development of active components, either by electro-optic or thermo-optic control.

These 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 INESCTEC which made its micro/nanofabrication equipment available on this infrastructure for widespread use.

7.7 TRIBE - Laboratory of Robotics and IoT for Smart Precision Agriculture and Forestry

7.7.1 Mission and positioning

Established in 2013, TRIBE LAB (Laboratory of Robotics and Internet-of-Things for Smart Precision Agriculture and Forestry) is dedicated to pioneering research and development in robotics, automation, and IoT-based solutions. Its mission is to enhance smart precision practices—ensuring the "right time, right product, right amount, and right place"—while improving the profitability, sustainability, and automation of agriculture and forestry. The lab primarily focuses on three environments:

- **Permanent Crops:** Including steep-slope vineyards, olive groves, and fruit orchards.
- **Forest Biomass Harvesting:** Aiming to optimise resource extraction while preserving environmental balance.
- **Protected Cultivation:** Developing advanced solutions for controlled-environment agriculture.

Through multidisciplinary collaboration, agile methodologies, and design thinking, TRIBE LAB strives to establish itself as a global reference in IoT and robotics research and development for smart agriculture and forestry. By integrating iterative and user-centric approaches into its innovation process, the lab ensures that solutions are responsive to stakeholder needs and rapidly adaptable to emerging challenges. Guided by key European Union priorities, including the Common Agricultural Policy (CAP) Strategic Plans, the European Green Deal, the Farm to Fork Strategy, and the One Health approach, TRIBE LAB is committed to advancing sustainable, resilient, and health-conscious agri-food systems).

7.7.2 Main objectives and actions planned for 2025

Table 7.1 - TRIBE – Main actions planned

Initiatives	Key Results	Strategic Objectives
Define target journals and conferences.	Increase in the quality of the publications, on top journals of Q1.	C1.1
Increase patents originating from TRIBE LAB.	Increase the numbers of patents to make easier the technology transfer.	C1.3
Coordinate one Horizon project.	Coordinate a very competitive proposal to HORIZON framework for agriculture/forest. Submit ≥1 competitive proposal/year.	C2.1, C3.5
Organise the 2nd Synergy Day of Robotics and IoT for agriculture.	To promote the CRIIS-TRIBE lab technology and reinforce our position at the European level.	C2.5
Promote the creation of a Start-up with TRIBE LAB technology.	Reach one start-up, to explore TRIBE technology that do not has potential technology takers.	C3.2
Actively promote new contracts in articulation with TEC4AGRO-FOOD.	Increased number of contracts with industry.	C3.2
Keep organizing regular team building activities.	Improve employee satisfaction index and attract new applicants	C4.1
Explore the creation of demo woody crop farm for robotics and IoT demonstration a technology validation in higher TRL's.	Reference pilot farm for robotics and IoT validation and certification	C5.3

7.8 Neuro-Engineering Lab – BRAIN Lab

7.8.1 Mission and positioning

The main mission of this laboratory is to perform high-level interdisciplinary R&D in engineering and computational approaches applied and translational to basic and clinical neuroscience, namely crossing several areas, such as Physics; Engineering (Electronics; Computation; etc.); Neurology; Neurosurgery; Neurophysiology; Neuroradiology and Neurobiology. It is divided in 5 main research lines: 1) Brain imaging (&signals); 2) Man-machine symbiosis with edge-AI (a.k.a."beyond Brain-Computer Interfaces & Human-Computer Interaction"); 3) Quantified Movement multimodal analysis in neurological diseases; 4) Neurosurgery Aiding Systems; 5) Macro-to-nano bio-neuro-sensing.

We operate several heavy R&D equipment of which our unique functional MRI simulator fully equipped with our new 64ch video-EEG medical systems and a neurophotonics micro&nano sensing workbench.

BRAINLab research group counts in 2024 with 2 postdoc researchers, 4 PhD and 8 MSc students.

BRAINlab has also become the first Portuguese research infrastructure to be part of EBRAINS, an European Infrastructure that is part of ESFRI. This membership will continue into 2025 and new interaction will start to happen in order to strength our connection with other members and pursuit new research projects.

7.8.2 Main objectives and actions planned for 2025

BRAINlab strategy defined for 2024 was a success with scientific and internationalisation achievements, mainly concerning high impact publication and an IEEE AI Innovation prize (at GITEX Global in Dubai) that increased our visibility and partnership with several European research groups and organisations that endorsed our international network. Furthermore, the full operation of the new video-EEG 64ch integrated in the MRI simulator already started to get some return in clinical collaborations, namely with S. João University Hospital and LMU Grosshadern University Hospital in Munich.

For the next year of 2025, we aim to continue this effort aligned with some INESC TEC strategic objectives, namely:

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

We hope the EBRAINS relation will be a substantial vehicle in the achievement of this result. Also, the integration of a possible new PhD students shared with LMU partners will also contribute for a higher visibility of our research. Recent contacts with Carnegie Mellon University, namely with the Institute of Neurosciences, may also lead to possible project and joint research and joint PhD student.

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

After starting a new clinical trial at Maastricht University Hospital jointly with our start-up InSignals Neurotech we plan to implement 2 more international clinical studies in other EU centres for Parkinson Disease patient's data collection. These trials aim to improve and validate at an international level the medical device we've been developing for the evaluation of Parkinson Disease motor symptoms. In 2024 we co-found one more startup (SeedSight) and are aiming to explore more tech transfer by 2025 to improve the startup's potential to be successful. One more new startup will probably be created resulting from IP of our lab (not disclosable at this moment).

C5.2. Improve quality, management and usage of our infrastructures

For 2025 we are planning to add a functional near-infrared spectroscopy (fNIRS) capability to our video-EEG system, improving our R&D capacity and differentiating our lab in the neuroscience community. INESC TEC research programs jointly with EBRAINS and new possible funding opportunities will allow further improvement of our infrastructure in order to have high-quality system in a more organised and structured way.

7.9 Robotics and Autonomous Systems Laboratory

7.9.1 Mission and positioning

The Laboratory of Robotics and Autonomous Systems has two physical locations within the ISEP and FEUP campuses. These dedicated facilities support R&D activities, technical training of human resources, and 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.

7.9.2 Main objectives and actions planned for 2025

The main objectives of the Robotics and Autonomous Systems Laboratory for 2025 are the following:

- Upgrading laboratory working conditions – The laboratory infrastructure on the ISEP Campus needs upgrades to improve the working conditions in the open space, address the harsh working conditions in extreme weather, and some aging of the office equipment. The process began in 2024 and will be completed in 2025. Space solutions at FEUP and equipment storage, which have already been identified as a problem, will be analysed to fill this gap.
- Upgrading laboratory equipment and tools – the growing R&D activity and expansion to new application areas require up-to-date laboratory equipment and tools. Investments planned for 2025 will contribute to the maintenance and update of development equipment, make available fast prototyping equipment, and provide high-performance systems that allow for the conduct of field experiments.
- Training of technical staff – to allow researchers to be more focused on innovation and research activities, an effort will be pursued to train technical staff to support experimental activities, mainly onboard vessels.
- Consolidation of the technical support team – Given the planned activities for 2025, there will be a strong demand for technological developments; therefore, there will be a need to continue the efforts to increase the support team.
- Integration with R&D Infrastructure – take advantage of some of the services provided by the infrastructures (e.g. TEC4SEA) to optimise logistics, simplify outsourcing, and accelerate the development and testing of equipment. In addition, some infrastructures associated with INESC TEC will also be taken advantage of, such as CEO - Companhia de Energia Oceânica and the preparation and monitoring of possible interactions with Hub Azul Leixões.

7.10 x-Energy Lab – Smart Grids & Electric Vehicles

7.10.1 Mission and positioning

x-Energy Lab's mission is to enable the application of concepts, algorithms, and scientific insights developed in the Power and Energy Systems domain. This encompasses activities ranging from basic prototypes or proof-of-concept designs to fully operational demonstrators deployed in the field. Additionally, x-Energy Lab (formerly SGEVL – Smart Grids and Electric Vehicles Lab) strives to foster the creation and transfer of scientific knowledge in collaboration with industry, while offering technical training and educational opportunities to industrial partners and academic institutions. Currently, x-Energy Lab focuses on four primary areas: smart grids, electric mobility, energy management, and power electronics. This work is driven by the dedicated I&D staff at x-energy Lab and by senior academic researchers collaborating closely with the Power and Energy Systems domain, along with graduate students conducting their research at x-Energy Lab.

7.10.2 Main objectives and actions planned for 2025

The main objectives are the consolidation of human resources and enhance x-Energy Lab's testing infrastructure to better support research activities in INESC TEC, provide services to industry, and support training and educational activities in accordance with CPES guidelines. Among other sources, the laboratory infrastructure will be reinforced with funding from the Portuguese Recovery and Resilience Plan (PRR) and the Portuguese Innovation Agency (ANI) through the Centros de Tecnologia e Inovação (CTI) program. The CTI program will also support advanced training for x-energy Lab human resources. Key focus areas include hybrid AC/DC distribution grids, EV charging, energy storage, hydrogen, converter-dominated power grids, energy management, real-time digital simulation with HIL, and Artificial Intelligence.

- **Hybrid AC/DC distribution grids**: Expand the laboratory scale hybrid AC/DC microgrid with the commissioning of a new AC/DC electric panel using PRR funding, and completion of AC/DC and DC/DC converter prototypes initiated in the scope of P2020 SmartGlow project.
- **EV charging**: Continue developing the EV smart charging testbed by integrating EVSE with V2G capabilities (H2020 POCITYF, HE GreenDataAI, and PRR). Alongside AC charging, a hybrid solution incorporating DC charging, energy storage, and PV generation will be added. This will support pre-certification services for EV smart charging appliances and create new solutions for interoperability between EVSE, distributed energy resources, and household/building loads. Additionally, it will provide a virtual domain for testing edge AI algorithms for e-mobility within low voltage grids and Energy Data Spaces.
- **Energy Storage**: Increase energy storage capacity to expand the microgrid testbed, funded by the PRR project Next Generation Storage (NGS). The acquisition of two systems will commence in the last quarter of 2024.
- **Hydrogen**: Complete the implementation of a laboratory-scale green hydrogen test bed, allowing testing of a proton exchange membrane (PEM) electrolyser and controlling its power electronic interface (PRR H2Driven project).
- **Power Grids dominated by Power Converters**: Finalise the implementation of a testbed for low inertia power grids with grid forming converters, aiming to support the realistic emulation of the static and dynamic behaviour of electricity grids with synchronous generator emulator targeting.
- **Real-time digital simulation**: Expand Power-Hardware-In-the-Loop (PHIL) testing capabilities to support real-time simulation for detailed electronic power converters and protection systems, as well as large power systems.
- **Energy efficiency and management and Testing and Experimentation Facility (TEF):** The infrastructure will expand to integrate domestic consumers located in the area operated by *Cooperativa Eléctrica do Vale d'Este* (CEVE), featuring energy meters (aggregated and individually controllable loads) and sensors for monitoring in-house comfort (temperature, humidity, CO2). This will create a data-centric testing setup for energy efficiency, local energy communities, and low-voltage grid operations. Data will integrate with a Data Space from the HE ENERSHARE project, forming a new Testing and Experimentation Facility for Energy Communities under the HE AI-EFFECT project.

The following is also planned: Promote the exploitation of CPES research by developing new value-added services for industry, including functional testing and validation of EV charging, hydrogen electrolysis, grid protection, synthetic inertia, and DC grid solutions; build a data infrastructure to provide industry actors with accessible data; and enhance dissemination efforts, foster international collaboration with scientific partners, attract new clients and strategic partners, publicise the x-Energy Lab website, and produce support materials to showcase developed services.

7.11 Tec4sea Research Infrastructure

7.11.1 Mission and positioning

The technologies for the Sea (TEC4SEA – www.tec4sea.com) infrastructure finished the first implementation phase in December 2022. This research infrastructure will fully validate and evaluate technological solutions designed for the ocean environment, allowing researchers to evolve from simulation/lab experiments to field trials. It aims to become a unique and pioneer platform in Europe to support research, development, and testing of marine robotics, telecommunications, and sensing technologies for monitoring and operating in the ocean environment. It shall be able to offer the first services to the academic and business players.

7.11.2 Main objectives and actions planned for 2025

The main objectives for 2025 are the following:

- Validation of services – the definition of services was finalised at the end of the implementation phase. Some validation tests have already been carried out, but others are still needed as new services are offered to the community.
- Increase the number of services – Continue disseminating TEC4SEA resources and services to interested parties and potential users to increase the number of services contracted in 2025.
- Infrastructure upgrade – Upgrades to infrastructure assets are planned.
    - In 2025, the process of adding a dynamic positioning system to the Mar Profundo will be completed.
    - Add a side post for mounting underwater sensors on the EPISEA rigid inflatable boat.
- Marketing TEC4SEA's services – Taking advantage of contact networks and promotion in technical magazines.

Based on the experience of the first implementation phase, INESC TEC will be firmly committed to preparing a successful plan for the second implementation phase. This includes active participation in the first phase discussions and reports and in establishing priorities for the second implementation phase to ensure a successful transition to the operational phase.

8 SPECIAL PROJECTS

8.1 INESCTEC.OCEAN

8.1.1 Mission and positioning

INESCTEC.OCEAN is a Centre of Excellence in Ocean Research and Engineering in Portugal. Synergistically addressing Marine Structures, Marine Robotics, Ocean Energy, and Ocean Data domains while developing R&D excellence from deep-sea to earth and space interactions, with new knowledge transfer culture and expanding innovation frontiers. This centre of Excellence will fulfil the increasing technology and scientific needs of emerging markets in a broad set of "blue" and "green" economy applications. such as offshore renewable energies, offshore aquaculture, shipping and fisheries, deep marine resources exploration, and bioprospection, among other emerging and established marine and maritime sectors.

8.1.2 Main objectives and actions planned for 2025

The strategic goal of this teaming is to **build a Centre of Excellence in OR&E with global recognition** and to contribute to the development of the field of Ocean engineering addressing all the key players in the quadruple-helix ecosystem. The **INESCTEC.OCEAN** is conceived to support effective and self-sustained cutting-edge research, development, innovation, and advanced training activities devoted to technologies to **Observe and Operate in the Ocean environment,** considering the challenges inherent to the harshness, dimension, and depth of the Portuguese Sea.

These goals are so strategically important for the country (PT) and for the EU that the Centre of Excellence will have access to complementary funding from national programs, to be combined with EU project funding devoted to Brainware capacitation and complementary funding dedicated to activities to reinforce the partnerships, improving 4H ecosystem links and re-equipment and re-qualification of existing infrastructures, including support for at least 5 chairs and 20 PhD scholarships. This Centre of Excellence in Ocean Engineering will encompass various elements to effectively advance research, innovation, education, and collaboration in the field. It will contribute to scientific advances in different fields related to Ocean Research and Engineering, establish a higher level of interaction and cooperation between the partners and stakeholders, pursue partnerships, protocols and programs with academia, business associations, incubators/accelerators, funding entities and Venture Capital entities, strengthening the relation with the ecosystem actors, promoting knowledge transfer and bridging the gap between research and industry and leveraging a set of novel technological infrastructures.

Specific objectives planned for 2025, in accordance with INESC TEC Strategic Plan 2023-2030 are:

- Reinforce strategic alignment and close collaboration with High Education Institutions
    - By establishing protocols with academia
- Build stronger knowledge-based and multidisciplinary R&I ecosystems
    - By the definition and operationalisation of 4 main scientific areas
    - By establishing MoUs/partnerships with business associations, incubators/accelerators, funding entities and/or networks addressing the 4 main domains and cutting edge/emerging opportunities
- Better align and deliver R&I with industry's needs
    - By promoting the creation of corporate research chairs with companies with key activities in Ocean Research and Technology
- Engage in direct dialogue with the public
    - By setting up the Stakeholder forum, already counting with 30+ committed entities, as an international set of key entities that will contribute to the alignment of the Centre of Excellence strategy
- Improve quality, management and use of our infrastructures
    - By creating protocols with existing infrastructures

9 SUPPORT SERVICES

9.1 Legal Support Service

Manager: Rita Barros

9.1.1 Presentation of the Service

The Legal Support Service ensures that INESC TEC's activities comply with national and European legal frameworks, striving to adopt best practices across its diverse areas of intervention. These areas include human resources, international relations, public procurement, and data protection, as well as matters involving binding agreements, such as those related to intellectual property, commercial law, and business law. In its broad scope of activity, the Legal Support Service consistently prioritises defending the Institution's best interests by proposing solutions that align INESC TEC's strategic objectives with its legal obligations, always considering the Institution's unique nature.

9.1.2 Service catalogue

- Assistance in the procurement process for goods, services, and works subject to public procurement rules, including support in contract execution, such as amendments or terminations.
- Facilitation of negotiations for different types of agreements, including service contracts, consortium agreements, collaboration protocols, licensing agreements, Non-Disclosure Agreements, Data Protection Agreements, and Memoranda of Understanding.
- Support in drafting, reviewing, and revising Grant Contracts, Employment Contracts, Service Agreements and related documentation.
- Promotion of knowledge and awareness regarding applicable legislation.
- Assistance in the establishment and participation in other entities.
- Engagement in litigation and other legal practices as required.

9.1.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2025:

Improve the base conditions for technology commercialisation

- Ensure high-quality legal documents that align legal requirements with strategic interests, fostering partnerships and supporting technology transfer, preservation, and result dissemination.

Develop closer and deeper relationships with our innovation partners and the broader community

- Strengthen negotiation tools for R&D Centres to enhance industry collaboration, streamline stakeholder discussions, and raise awareness of internal procedures while reducing legal and bureaucratic barriers.

Increase the international embedment of our community

- In-depth analysis and study of international legislation and comparative law, focusing on finding legal solutions to the diverse issues faced by the Institution.
- Investigation of issues related to the concept of "dual use" and the legal challenges associated with export and import, and the evolving position of EU regarding the dual use technology, in a challenging geo-political context.
- Promotion of the sustainability of INESC TEC's operations and the continuity of its international partnerships through specialised legal knowledge.
- Minimisation of legal risks and maximisation of collaboration opportunities in the fields of research, innovation, and technology transfer.

Reinforce strategic alignment and close collaboration with HEI

- Collaborate with Higher Education Institutions (HEIs) to create strategic opportunities, maximise their potential, and optimise collaboration for long-term benefits.

Contribute to digitalisation of public administration

- Support initial discussions on public service digitalisation projects by providing legal tools aligned with national and European frameworks, reducing bureaucracy, and fostering collaboration.

Promote our proactive participation in R&I agenda-setting at regional, national and EU level

- Monitoring legislative developments and participating in public consultations, including engagement in working groups, policy evaluations, and thematic studies, to shape a legislative framework that addresses Science and Technology challenges, fosters progress, and ensures effective knowledge transfer to society.

Increase our international networking, leadership and competitiveness

- Analyse leading international practices to align law with knowledge, technology, and innovation, ensuring the necessary expertise to provide effective solutions. This will enhance INESC TEC's participation in international initiatives, fostering greater involvement and impact.

Improve attraction and retention of world-class talent

- Provide strategic legal support to HR by implementing effective legal instruments, ensuring compliance, and supporting the attraction and retention of top scientific talent.

Strengthen our commitment to independence and compliance research with ethical principles

- Strengthen research independence and ethical compliance through ethics awareness, anti-corruption efforts, data protection training, and legal tools aligned with national and European standards.

Promote and contribute to environmental sustainability

- Promote eco-friendly and socially responsible public procurement, ensuring compliance with national and European standards and supporting social improvements, including gender equality.

Strengthen the distinctive aspects of our institutional model

- Develop Appropriate Legal Tools: Create and adapt legal instruments and internal processes to ensure the compliance of the Institution’s operations, including proposals, agreements, and contracts, aligning them with national and European regulations.
- Monitor and Evaluate Compliance: Establish continuous monitoring processes to ensure that all research and innovation activities meet legal requirements, quickly identifying and addressing any non-compliance issues.
- Protect Data and Privacy: Ensure strict adherence to data protection regulations, ensuring that all processes and projects respect individual rights and comply with current privacy laws.
- Support Collaboration with Strategic Partners: Ensure that international partnerships and collaborations are based on clear contracts that comply with legal regulations, strengthening INESC TEC’s position in the global arena and fostering effective and secure collaboration.
- Constantly Assess Regulatory Changes: Continuously monitor and analyse changes in national and international legislation that could impact the Institution’s operations, adjusting compliance strategies as needed to maintain effectiveness and compliance.

9.2 Accounting and Finance Service

Manager: Paula Faria
Assistant Manager: Libânia Caetano

9.2.1 Presentation of the Service

The Accounting and Finance service is responsible for coordinating and executing the accounting operations, ensuring compliance with fiscal obligations, for managing INESC TEC´s cash flow and ensure the availability of enough funds to meet the payments due. Acting as a liaison between the institute and external stakeholders, the service operates in alignment with the Board's guidelines.

From an administrative perspective, it is also responsible for the purchasing and travel processes and for managing the institute insurances and fixed assets.

9.2.2 Service catalogue

The Accounting and Finance department provides a wide range of services to several recipients both internal and external to the organisation:

- Purchasing Process
- Travel Process
- Procurement Process
- Invoicing R&D Services and collection
- Tax and Reporting Obligations
- Accounting records
- Financial Management
- Fixed Asset Management
- Insurance Management

9.2.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2025:

Improve quality, management and usage of our infrastructures

- Increase efficiency on Fixed Assets Management;
- Enhance the organisation procurement process;
- Implementation of a new ERP system;

Strengthen the sustainability and resilience of our economic model

- Reinforce continuous improvement of activities and practices;
- Increasing financial logistics for organizing events;

Promote and contribute to environment sustainability

- Consolidate the digital archive process;

Improve attraction and retention of world-class talent

- Provide financial guidance and resources to assist new transnational hires;

Increase our international networking, leadership and competitiveness

- Develop efficient systems for managing international payments, tax compliance, and currency exchange to support global collaborations;
- Engage with international networks of finance and accounting professionals to adopt best practices and showcase INESC TEC's financial excellence;
- Compare financial and operational performance with international peers to identify areas for improvement and align with global standards;

Expand the diversity of our community

- Enhance support for international initiatives through a robust understanding of tax frameworks and compliance;

Increase the international embedment of our community

- Leverage tax frameworks to support participation in international initiatives effectively;
- Implement an ERP system with robust international functionalities, enabling seamless transactions.

9.3 Management Control Service

Manager: Vanda Ferreira
Assistant Manager: Bárbara Maia

9.3.1 Presentation of the Service

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 to ensure that all resources are obtained and used effectively and efficiently 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.

9.3.2 Service catalogue

The management control service provides a set of services related to internal control and to the financial report of projects, whether to national or European entities, such as:

- Control of the financial and management aspects of Contract Research Projects;
- Validation of requests for invoicing;
- Budgetary control of the various cost centres, financed or otherwise;
- Time-cards register of all HR of the INESC TEC Team;
- Submission of payment requests;
- Support in project audits;
- Support in the auditing of the institution's accounts;
- Administrative and financial management of projects, particularly those coordinated by INESC TEC;
- Financial management related to financed projects (receipts from financing entities and payments to partners);
- Verification and classification of expenses eligibility under financed projects;
- Accounting registers related to financed projects;
- Monitoring and submission of time and/or budget changes to the funding agencies.

9.3.3 Main objectives and initiatives planned for 2025

For 2025 the Service selected some Strategic Objectives and defined the following initiatives for 2025:

- Strengthen the sustainability and resilience of our economic model
    - Participate actively in the implementation of the new ERP;
    - Development of the new ERP management module for funded projects;
    - Planning available funding and resources for the next five years;
    - Continue to develop and implement management guidelines and internal procedure guidelines;
    - Continue to reinforce the use of appropriate internal management tools, based on Power BI or others.
- Increase our international networking, leadership and competitiveness
    - Reinforce the team in the area of European Projects to support the increasing number of European projects, some of them coordinated by INESC TEC
    - Review of the workflow associated with proposals register and subsequent cost center opening
    - Commitment to simplifying and automating quarterly processes, with continuous improvement, resulting in better quality of information delivered and increased productivity
    - Continuous investment in internal training of “stakeholders”

9.4 Human Resources Service

Manager: Luís Seca
Assistant Manager: Margarida Gonçalves

9.4.1 Presentation of the Service

The Human Resources service coordinates and executes all activities pertaining to human resources administrative management and to the development and implementation of HR related policies. The service has a key role in the effective management of the organisation's human capital, fostering a positive work environment, and ensuring legal and regulatory compliance. The HR department plays a crucial role in supporting the overall success and well-being of both the employees and the organisation.

9.4.2 Service catalogue

Recruitment and Staffing; Analysis on potential candidates at LinkedIn; Employee Onboarding; Training and Development; Employee Relations; Compensation and Benefits; Policy Development and Compliance; Employee Engagement; Health and Safety; HR Information Systems; Legal Compliance; Termination and Offboarding

9.4.3 Main objectives and actions planned for 2025

Activities in the Strategic Development Area

In detail, during the year 2025 the following activities will take place: (presented in the frame of the Strategic Objective listed in Section 9 of the INESC TEC Strategic Plan)

Strategic objectives – improve attraction and retention of world-class talent; ensure opportunities and recognition of carer achievements; strengthen the distinctive aspects of our institutional model

- **Implement the job descriptions and competencies policy**: implement the allocation of employees to roles; complete the identification of behavioral competencies for each position and update the role catalog to include newly defined functions.
- **Implement and communicate the career policy**: implement the promotion mechanism for PhD researchers from junior to auxiliary roles; develop promotion mechanisms through professional development tailored to the R&D job family; define and structure role-specific tiers within the organisation; communicate the career policy.
- **Implement and communicate the performance appraisal policy**: implement goal-based management linked to variable compensation, including validating and approving the framework, communicating its integration into the 2025 performance evaluation process, training evaluators and evaluates in the process of defining objectives, and drafting an individual goals catalogue.
- **Present and implement the new recruitment and selection policy**, integrating EC feedback on strategic guidelines and implementing the policy.
- **Implement the HR Excellence in Research award** to align organisational HR policies and practices with the European Charter for Researchers principles, enhance the institution's international reputation, improve working conditions for researchers, and attract and retain top talent in a competitive global research environment.

Strategic objective – providing innovative learning experiences

- **Implement the training policy:** implement the training planning for 2025 based on the diagnosis of training needs and contribution from the relevant stakeholders.

Strategic objective – provide a more dynamic and fulfilling working environment

- **Develop well-being and occupational health actions:** develop and implement internal initiatives to build institutional capacities on occupational health and to promote workers' wellbeing; endorse the existing support team to provide personal support and promote wellbeing.

Activities in the Operational Area

In detail, during the year 2025, the following activities will be undertaken:

Digitalisation and Automation

- **Implement new integrated HR management software** and provide training for the HR team to ensure effective use.
- **Develop a centralised training registration system** to consolidate all employee-related information.
- **Issue automated declarations** with the administrator's or HR manager's signature, accessible through employee requests via the intranet or the new HR management system.
- **Monitor the use of the new INESCTEC digital card** / App INESC TEC.

Recruitment and Selection

- **Enhance the visibility of job postings** on the INESC TEC website and create a weekly "Highlight" on Instagram to promote vacancies.
- Provide training sessions for "vacancy managers" to improve recruitment and selection processes.
- **Conduct benchmarking to identify and implement new trends** and best practices in recruitment.

Training and Development

- Promote actions aimed at obtaining INESC TEC's certification as a training organisation by DGERT.
- Launch a module to record the training carried out by employees.
- Disseminate a user-friendly guide for Multicare Health Insurance to ensure employees are fully informed about their benefits.

Employee Benefits and Partnerships

- **Establish new partnerships** that benefit INESC TEC co-workers
- **Strengthen institutional relationships with IES** to enhance tuition fee management and related processes.

Communication and Internal Organisation

- **Reorganise HR documentation on the intranet**, including FAQs, an HR guide, and streamlined information on HR processes (NC and ML).
- **Provide personal access to important HR documents**, such as training certificates and declarations.
- **Enhance internal communication channels** to ensure employees are informed about HR updates and initiatives.

Strategic Vision

- Position HR as a strategic partner within the organisation, moving beyond a purely operational role.
- Continuously improve HR processes by seeking feedback and implementing innovative practices.
- Develop and share insights from benchmarking reports to guide the evolution of HR activities.

9.5 Management Support

Manager: Isabel Macedo

9.5.1 Presentation of the Service

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.

9.5.2 Service catalogue

- Prepare and operationalise decision-making processes at multiple levels
- Support internal initiatives of the Board and monitor organisational priorities, goals and metrics
- Ensure institutional reports/responses and assist in internal/external communications
- Document management of general archives and content management of INESC TEC institutional platforms
- Support the development of Data Management Plans (DMP), data publication and project output reporting
- Process improvement proposals and actions

9.5.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2025:

- Raise the contribution and visibility of our research
    - Enhance the adoption of Open Science practices at INESC TEC, namely by coordinating its activities as a recognised National Centre for Research Data Management, leading a consortium with BIOPOLIS and CIIMAR, and contributing to a national network that supports research data management and sharing, while promoting FAIR Data principles.
    - Build institutional capacity for R&D management by leveraging advanced insights through scientific benchmarking analyses, enhanced analytics, bibliometric reporting, and document management guides.
    - Provide ongoing support in research assessment, including the internal conclusion of INESC TEC's application in the FCT R&D Units Evaluation 2023/2024 process, and assist the Board in its involvement in international initiatives focused on new ways to assess research such as CoARA – Coalition for Advancing Research Assessment.
- Strengthen the distinctive aspects of our institutional model
    - Implement and operationalise high-level strategic management processes in collaboration with the Board.
    - Drive strategic initiatives and organisational change, including comprehensive restructuring and enhancement of administrative areas, as well as the development and execution of an internal digital transformation plan for INESC TEC, encompassing both R&D activities and the Support Structure.
    - Strengthen the area of continuous improvement, namely by implementing advanced data analysis capabilities for strategic decision-making, such as trend analysis and scenario planning. This also includes optimising the curation of institutional databases and systems and fostering cross-service collaboration and knowledge sharing.
    - Revise the document management policy to introduce a new procedure for record digitalisation as an initial step toward a digital preservation plan. This revision will also address access to information requirements within security accreditation.

9.6 Secretarial Coordination

Managers: Ana Isabel Oliveira and Grasiela Almeida

9.6.1 Presentation of the Service

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.

This team, composed of 20 employees, develops their work directly under the responsibility of a coordinator within a structure, centre or service, being also coordinated by one of the above-mentioned managers: Ana Isabel Oliveira manages the team of Executive Assistants of the Board of Directors and Grasiela Almeida manages the team of Assistants that support the Research Centres and Services.

9.6.2 Service catalogue

- **Team Coordination:**
  - Promotion of training and coaching sessions, to assure compliance with internal rules and processes;
  - Development of skills to allow continuous growth, motivation, and recognition of the team;
  - Recruitment and onboarding training of new assistants, performance evaluation and feedback.
- **Focus on Continuous Improvement:**
  - Identification of improvement opportunities in the institutions' processes, tools, and best practices;
  - Contribution to the design, implementation and testing of new processes and tools.
- **Supplier Relationship Management:**
  - Contract management with specific suppliers, such as travel agencies, rental car companies and other private transport companies, hotels, catering and other frequent service providers.
- **Information Management:**
  - Development and maintenance of Information Directory with useful information, templates, and documents necessary for the team's daily activity.

9.6.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC's Strategic Objectives, the Secretarial Coordination team selected some Strategic Objectives, and it is prioritising the following initiatives in 2025:

- **Strengthen the distinctive aspects of our institutional model**
  - **Implement Continuous Training Programs**: Facilitate training sessions and workshops to prepare the team with updated skills, fostering excellence and innovation in their roles.
  - **Encourage Interdisciplinary Collaboration**: Develop and implement an *Event Management Platform* to promote stakeholder interaction, enabling the exchange of knowledge and experiences.
  - **Create an area for sharing procedures:** create a Knowledge Base area to share processes and good practices (not available on the Intranet), to enhance internal training and compliance with regulations.
  - **Enhance Team Capacity**: Conduct regular meetings with leaders, different services, and individual assistants to foster team development and also recruit and train new members to reinforce the team's capacity to better respond to the challenges of 2025.
- **Provide a more dynamic and fulfilling working environment**
  - **Strengthen Partnerships**: Organise "Show & Tell" sessions to share best practices, improve secretariat tasks, and enhance connections with partners.
  - **Promote Well-being Initiatives**: Plan activities that support work-life balance and well-being to create a healthier and more engaging work environment.

9.7 Funding Opportunities Office

Manager: Marta Barbas

9.7.1 Presentation of the Service

Identification of opportunities to access the necessary and appropriate funding for the institution's Research, Development and Innovation (RDI) activities, aligned with the mission and with the strategic objectives of the institution and monitoring the preparation and submission of proposals to the different funding programmes in articulation with the R&D Centres.

9.7.2 Service catalogue

- Search and identify the most suitable funding opportunities, and disseminate information about external events related to funding programmes (e.g., information days, webinars, etc.).
- Monitor and support the preparation and submission of proposals to the different funding programs and support the contracting process of approved proposals, ensuring a smooth transition from projects to management control service
- Institutional contact point with funding entities
- Follow-up of the registration of proposals on the Intranet
- Compilation and dissemination of indicators

9.7.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2025:

- Increase our international networking, leadership and competitiveness
    - Recruitment of new human resources to reinforce the European Funding team in order to increase the number of EU projects approved in coordination role and other international projects, namely ERCs initiatives and EC tenders.
    - Raise awareness among our researchers about existing funding opportunities by providing training on how to prepare applications by promoting workshops with contributions from internal and external specialists about Horizon Europe proposal writing.
    - Promotion of training sessions for new researchers, aimed at informing them about the services provided by the SAAF, as well as equipping them with the necessary skills to identify the appropriate types of funding for the different lines of research.
    - Production of a guide to help attract funding, containing basic information on the different types of funding available, to be made available to researchers, with particular emphasis on younger researchers.
- Strengthen the sustainability and resilience of our economic model
    - Improvement of “proposals workflow” together with SIG
    - Improvement of the new area in the internal website for funding opportunities based on the results of the “Survey on Funding Pages on the Intranet” to better serve our researchers and update the pages with 2025 opportunities.
    - Identify the main challenges researchers face in submitting applications through a questionnaire, to define the most appropriate action strategy tailored to their needs, and continuously improve the funding and opportunities office services.
    - Increased efforts to publicise tenders’ opportunities and explain the advantages of the centers' participation in them.

9.8 Technology Licensing Office

Manager: Daniel Marques de Vasconcelos

9.8.1 Presentation of the Service

The Technology Licensing Office (TLO) exists to **maximise the societal impact of INESC TEC's R&D**. In 2025, the TLO will have the largest team ever with five technology and intellectual property (IP) managers focused on INESC TEC's core longest-established verticals: Agro-Food, Energy, Health, Industry, and Sea. The TLO plays a critical role in shaping and executing the institution's Innovation Strategy, driving societal progress, enhancing knowledge management and valorisation, and strengthening the entrepreneurial ecosystem at the international level.

9.8.2 Service catalogue

- **Scouting and registration of new R&D results:** 1) Systematic monitoring of strategic projects; 2) technology disclosure; and 3) IP awareness and training.
- **Intellectual Property Strategy:** 1) Knowledge management; 2) support for IP rights registration; 3) market-oriented portfolio management.
- **Knowledge valorisation and technology transfer:** 1) Customer discovery & industry liaison, support to the negotiation of IP exploitation, license monitoring; 2) support deep-tech spin-offs and venturing.

9.8.3 Main objectives and initiatives planned for 2025

Aligned with the 2030 Strategic Plan, the service is prioritising the following strategic objectives and initiatives for 2025:

<u>STRATEGIC IP MANAGEMENT FRAMEWORK</u>

- **1.3 Improve the base conditions for technology commercialisation:** Reinforce strategic scouting of PRR projects to ease identification of new R&D results and efforts towards knowledge valorisation; Develop a simplified way for researchers to disclose R&D results; Increase new patent filings while ensuring quality and international impact.
- **3.2. Develop better linkages between knowledge production, development, and market uptake:** Format and publicise the exploitable results of INESC TEC's research activities adequately for valorisation and further exploitation (including licensing and utilisation as pre-existing know-how in later projects); Create and refine new templates for express licensing and agreements to reduce friction and lengthy negotiations.

<u>ACTIVE INDUSTRY ENGAGEMENT FOR PARTNERSHIPS AND ECOSYSTEM</u>

- **2.3 Better align and deliver R&I with industry's needs:** Promote regular meetings with experts and potential customers/partners in the different areas, to identify and quantify suitable exploitation strategies and relevant market needs for INESC TEC IP; Leverage new AI tools to speed up market analysis and other tech transfer activities.
- **3.1 Build stronger knowledge-based and multidisciplinary R&I ecosystems:** Focus on unlocking the potential of the portfolio in all dimensions, including its economic impact, intensifying the contact with relevant agents of the whole value chain at the international level; Evolve the current portfolio management approach to include improved metrics and to support cross-fertilisation among technologies and verticals; Explore closer connections with key partners at the TTO Circle for best practice sharing.

<u>CAPACITY BUILDING FOR KNOWLEDGE TRANSFER HUB</u>

- **1.4 Develop closer and deeper relationships with our innovation partners and the broader community:** Reinitiate monthly training on IP for INESC TEC researchers and start open webinars on IP; Identify, prepare and disclose a set of 10 to 20 INESC TEC success cases where IP played a key role.
- **4.1 Improve attraction and retention of world-class talent:** Consolidate the current team of four IP and tech managers by supporting international training and dedicated and close mentoring.
- **5.4 Strengthen the distinctive aspects of our institutional model:** Deepen connections with key researchers by scheduling regular lab days and meetings with project coordinators to identify promising results early and support their formalisation; Improve the adoption and use of OKRs-based management.

9.9 International Relations Service

Manager: Andreia Passos

9.9.1 Presentation of the Service

The service mission in 2025 remains unchanged: ***to help the institution's Board of Directors and R&D Centers maximise global opportunities, reach and reputation***. This entails targeting but also advising on potential high-level international partnerships to help the concerned internal stakeholders make well-informed decisions; support researchers' international mobility and capacity building for global engagement; external environment produce briefings with insights on trends and directions that may influence cooperation with foreign actors; help communicate stories where international engagement leads to successful experiences.

Realising this mission calls for adjustments in our mode of operation. For the past years, the internal demand for the team's assistance in HR recruitment of non-national staff and the coordination of the UT Austin Portugal Program, coupled with the fact that the core team has been shrinking, did not provide much room for the service to establish itself as a business development service. Not knowing yet whether the coordination of the FCT partnership will be handed over to INESC TEC and where the team will stand in this transition, the service aims to have a more prominent role in the identification of opportunities for strategic international alliances and help INESC TEC raise its international profile. To accomplish this goal more quickly and effectively, closer and more consistent collaboration with IBH will be fostered. Ultimately, the envisaged adjustments should lead to a shift from activity tracking (e.g., number of new international collaborations) to impact tracking (e.g., the economic value of collaborations.

9.9.2 Service catalogue

The SRI service portfolio includes the following:

- Information services to support global engagement and international partnership alignment.
- Inbound and outbound mobility advisory services.
- High-level coordination INESC TEC International Visiting Researcher Programme.
- Management of International S&T Partnerships (special projects).
- Support for the negotiation, drafting, signing, implementation, and evaluation of MoUs and similar agreements.
- Support of high-level international delegations and visitors.

9.9.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2025:

- Increase the international embedment of our community
    - Go on looking for initiatives and funding schemes enabling inbound and outbound staff mobility to improve the organisation's exposure to internationalisation, support its human capital attraction and retention strategy and provide opportunities for our research staff to advance their scientific careers. Articulation with internal stakeholders (e.g.: HR and SAAF) and external ones to fine-tune the opportunity and funding radar will be of the utmost importance to step up this specific support.
    - Drawing on the main learnings from the previous pilot editions of the INESC TEC International Visiting Researcher Programme, design and organise an upgraded version of this initiative, potentially more focused (on scientific domains and/or application areas prioritised by the BoD) and related to challenges where European and international scientific cooperation is particularly needed.
    - Monitor the implementation of the first joint call for research with partner NARLabs to inform the BoD and help them decide about the adequacy of having similar initiatives launched with other strategic foreign partners.

- Ensure awareness of safe research in international cooperation / responsible internationalisation among our community. This could be done through the organisation of at least an informative session to equip INESC TEC staff with the tools to engage in international activities without compromising the integrity and safety of their research work.

- Increase our international network, leadership, and competitiveness
  - Proactively engage and pitch INESC TEC's research capabilities to organisations acting as **internationalisation brokers**, most notably Embassies, the Portuguese Trade & Investment Agency (AICEP), funding agencies, private foundations, regional development agencies, etc., to get them to help our research centres, TEC4s and the Licensing Office connect with potential partners abroad. Identify key brokers to invite to INESC TEC and meet with internal stakeholders (thematic missions).
  - Work more closely with SAAF and the IBH to identify funding opportunities and alternative funding models for partnerships with non-EU countries / comprehensive internationalisation. This closer collaboration should be directed, in the first instance, towards active international MoUs to help them progress from intentions to concrete actions and, thereby, generate returns.

- Expand the diversity of our community
  - Work with the HR's Training Group or other internal actors as we see fit to propose training actions to help staff navigate cultural differences successfully when participating in or conducting negotiation processes with foreign partners / interacting with foreign staff.

9.10 Communication Service

Manager: Joana Coelho
Assistant Manager: Sofia Maciel

9.10.1 Presentation of the Service

The Communication Service (SCOM) is responsible for the design and implementation of the institution's internal and external communication actions. Internal communication aims to promote knowledge of INESC TEC activities and interactions among its community. External communication focuses on promoting the institutional image at various levels, consolidating its prestige, and working with researchers to disseminate their science and innovation activities.

9.10.2 Service catalogue

SCOM encompasses five core competencies: content production, design and multimedia, organisation of events, leadership and support in R&D projects' dissemination and communication, and translation. Leveraging these competencies, the communication strategies implemented by the service include science communication (podcasts, videocast, editorial and long-features), digital marketing (social media channels, website, newsletters), public relations (national and international press relations, events) and advertising (annual report, booklets, informative features).

9.10.3 Main objectives and initiatives planned for 2025

Aligned with the 2030 Strategic Plan, the service is prioritising the following strategic objectives and initiatives for 2025:

- **Develop Strategic Communication Management:** Enhance brand visibility and consolidate the institute's reputation as a leader in research and innovation; Implement communication campaigns for key milestones, such as the 40th anniversary, leveraging different formats and channels to engage diverse audiences; Define clear goals, and objectives, and key performance indicators (KPIs) for each communication initiative, ensuring alignment with institutional goals and measuring effectiveness. *(Strategic Objectives 1.1, 3.5, and 2.7.)*
- **Lead Digital Communication and Innovation:** Adopt cutting-edge digital communication tools, including generative AI, to optimise communication processes and to disseminate tailored high-quality content; Develop a digital communication strategy that integrates the new INESC TEC website, social media, and other digital platforms to increase outreach and engagement. *(Strategic Objectives 1.1, 2.7, and 3.5.)*
- **Strengthen Internal Engagement and Culture Development:** Design and implement an internal communication strategy to foster a sense of belonging, increase knowledge of institutional activities, and support a collaborative work culture. *(Strategic Objectives 3.1, 4.1, and 4.4.)*
- **Enhance Stakeholder Relations and Public Engagement:** Promote INESC TEC's contributions to public policy and societal impact through strategic engagement and targeted messaging, enhancing its role as a thought leader and policy contributor; Develop initiatives aimed at increasing visibility and understanding of INESC TEC's research infrastructure and capabilities among potential collaborators and funders; Engage in more science communication initiatives to raise public awareness of INESC TEC's work and its societal benefits, contributing to scientific literacy and informed public discourse. *(Strategic Objectives 2.5, 2.7, and 3.4.)*
- **Implement the 40th Anniversary Communication Strategy:** Plan and execute a comprehensive communication campaign, including events, publications, digital content, and stakeholder engagement activities; Integrate messages that highlight the institute's history, achievements, and future aspirations, positioning INESC TEC as a key player in European research and innovation; Use the anniversary to strengthen the INESC TEC brand and promote its alignment with European values and strategic priorities. *(Strategic Objectives 1.1, 2.7, and 3.5.)*
- **Reinforce External and Internal Communication Consistency:** Implement the institutional rebranding across all communication materials, ensuring consistency and alignment between the INESC TEC brand and its sub-brands; Develop and disseminate communication guidelines and templates for both internal and external use, and promote training, facilitating a cohesive and professional image in all communications; Align communication efforts across different units, research centres, and initiatives to present a unified and coherent message to all stakeholders. *(Strategic Objectives 3.1, 4.4, and 5.4.)*

9.11 Networks and Communications Service

Manager: Gil Coutinho

9.11.1 Presentation of the Service

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 utilisation 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 datacenter resources, network equipment, videoconferencing solutions, etc..

9.11.2 Service catalogue

- Local network connectivity: fixed and Wi-Fi network access, customised laboratorial networks;
- Internet and external network connectivity: national research and education network (RCTS), commercial operators and other external networks;
- Physical facilities management: INESC TEC's headquarters' datacenters, off-site disaster recovery;
- Cybersecurity: firewalls, network access control, intrusion detection/protection systems, anti-spam and anti-virus mechanisms within mail transfer agents, interface with official entities like FCCN, CNCS;
- Networked services: VPN, printing and scanning, telephony, videoconferencing.

9.11.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, namely towards the strategic objective to **improve quality, management and usage of our infrastructures**, the Networks and Communications Service is prioritising the following initiatives in 2025:

- Enhance datacenter power systems:
  - Deploy auto-switching redundant external power supplies
  - Upgrade existing datacenter UPSs to higher power three-phase models
  - Connect datacenter infrastructure to external battery banks
- Replace Outdated Firewalls:
  - Deploy scalable solutions to accommodate evolving network demands and enable resource expansion as needed
  - Redefine internal network routing, increasing granularity on the enforcing of security policies across different network zones
- Advance towards NIS2 compliance:
  - Establish a governance model for information security
  - Define and formalise security policies for information systems
  - Plan and initiate processes for asset management and risk analysis
  - Formally create a Computer Security Incident Response Team (CSIRT) with permanent contacts and integrate it in the national CSIRT network
- Enhance Network Access Security:
  - Assess and implement safer network access measures, such as 802.1x for wireless and wired networks or Zero Trust Network Access (ZTNA)
  - Adapt systems to support Multi-Factor Authentication (MFA) where feasible
  - Evaluate and potentially adopt Identity and Access Management (IAM) tools

9.12 Management Information Systems Service

Manager: José Carlos Sousa

9.12.1 Presentation of the Service

The Management Information Systems Service oversees the development and maintenance of INESC TEC's management information system.

9.12.2 Service catalogue

- **IRIS - INESC TEC Research Information System**: Members, Conflicts of interest, Teaching Accumulation, HR reports, Projects, Publications, Theses, Timecards, Scholarships and tuition fees, Specialisation, HR Shares.
- **Intranet – Institutional information and workflows**: Institutional data, regulations; Human Resources: Public Notices, New collaborator, HR records management, Performance assessment, Scholarship contracts; Project proposals, Ethics, Travelling, Requests, Conflicts of Interest Management, Invoice integration, Resource booking.
- **Connect** – European projects management: Financial reports, Payment requests, Project activities (work packages, tasks, deliverables, milestones), Automatic report generation (financial and progress).
- **CRM** – Customer relationship manager: Entities and their contacts, Leads and opportunities, Integration with proposals and projects, Reports.
- Interoperability with the Human Resources System.
- Interoperability with the SAP financial system.
- Website maintenance.
- Repository maintenance.
- External HR reporting.
- Helpdesk and development of web sites.

9.12.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2025:

- Improve quality, management, and usage of our infrastructures:
    - Extend the development of middleware for a new website.
    - Implement new features in the INESC TEC mobile App.
    - Increase systems integration in the new ERP.
    - Transfer the control of requisition, ordering, and electronic invoice entry for purchases to the new ERP system, to streamline the work of the Finance Department.
    - Evaluate and implement a new HR management system in the new ERP, with data migration.
    - Evaluate the possibility of migrating the processes to the new ERP.
    - Reengineering of the Project Proposals process, enhancing the user experience and better integration with Project databases.
    - Extending the use of the Connect application to support new features, expanding its scope to include a wider variety of projects.
    - Add new project portfolio management tools (Aggregation, KPIs, Planning) to Connect application.
    - Use of Connect application as a vehicle to help implement the PMO's actions and vision.
    - Support the implementation of a new HR performance evaluation process.
    - Developing a patent management tool with a HR performance evaluation process integration. Tool for managing and sharing individualised information related to voice and data communications.

9.13 System Administration Service

Manager: Jaime Dias

9.13.1 Presentation of the Service

The System Administration Service manages servers, computer systems, common applications and services, and supports end-users, administrative staff and research and development teams. SAS is a multidisciplinary Data Protection Team member appointed to support and monitor the implementation and compliance with the GDPR.

9.13.2 Service catalogue

System administration

- Setup, configuration, and management of computation, virtualisation and storage infrastructures;
- Backup of critical services, virtual machines and personal computers, at local and off-site disaster recovery site;
- Identity and authentication infrastructures, including the INESC TEC Directory and the federated Identity Provider, to enable seamless authentication across INESC TEC resources, and resources on FCCN and eduGAIN;
- Hosting of websites;
- Email mailbox service with disaster recovery site for enhanced data resilience;
- File-sharing and collaboration application services;
- Administration of the INESC TEC Office 365 tenant and other Software as a Service (SaaS) subscriptions;
- Purchase and management of software volume licenses;
- Cybersecurity at the system administration level, including servers, virtual machines, websites, mail service (mail server), endpoint security, authentication infrastructures, digital certificates, illegal software incidents, and computer forensic analysis.

End-user support

- Helpdesk, desktop support, and support for available services.

Data protection

- Evaluation and recommendation of computer systems' security and privacy to ensure compliance with GDPR.

9.13.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2024:

- **MLOps.** Setup an MLOps platform, including a model registry, that exploits the INESC TEC S3 data storage and integrates with third-party emerging ML/LLM services to maximise the automation of ML tasks while increasing resource usage efficiency and minimizing energy costs;
- **DevOps.** Extend current platforms, such as Gitlab, and create procedures and documentation;
- **Computing infrastructure.** Improve the CCloud platform with new resources, features, and monitoring interfaces so that users and managers can track and manage resources more efficiently and minimise energy costs;
- **RDM.** Contribute to developing an RDM alternative for dataset publication that supports S3 data storage and facilitates data upload, query, and download procedures with controlled access;

- **Infrastructure monitoring and management.** Improve system monitoring solutions to verify and automate updates for user-managed virtual machines and containerised services (Kubernetes and Docker);
- **Computer installation service.** Deploy new service to automate the installation of the Windows OS and software on computers;
- **IT resource contribution/usage Policy.** Define a policy for IT resource distribution among Centres that encourages contribution to INESC TEC's computing infrastructure while ensuring fair and efficient usage and minimizing energy costs;
- **Collaborative platforms.** Provide platforms, such as a Wiki and private Forum, to facilitate collaborative documentation and promote knowledge sharing between INESC TEC researchers. This includes internal procedures documentation and Q&A discussions on topics that cannot be shared in public forums (e.g., MLOps, DevOps, GitOps, ML/DL, LLM);
- **IT procurement.** Improve joint software and IT equipment procurement processes. Evaluate the creation of a task force with CF;
- **IT asset inventory.** Contribute to the deployment of an IT asset inventory service;
- **Identity and authentication.** Upgrade INESC TEC's IdP to support trust profiles and MFA.

9.14 Infrastructure Management Service

Manager: Jorge Couto

9.14.1 Presentation of the Service

The Infrastructure Management Service guarantees the support services necessary for adequate management and maintenance of INESC TEC's building and infrastructures.

Overall, for 2025 a set of measures to improve the conditions for co-workers is the priority of the service, with a set of actions in the main buildings as well as in ISEP/CRAS, photonics lab and Portic.

Additionally, we will support the R&D Centres in the management of the outsourcing car rental, an innovative service that will reduce operational costs and provide a significant gain in time and comfort to users.

9.14.2 Service catalogue

- General maintenance of INESC TEC buildings, including the ones in the associates
- Managing rental cars
- Coordinate security and cleaning services
- Management of the various contracts for the purchase of civil/electrical works, furniture, security, hygiene and cleaning

9.14.3 Main objectives and initiatives planned for 2025

Aligned with INESC TEC Strategic Plan 2023-2030, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2025:

- Increase the number of solar panels to increase electricity production capacity, and continue to replace lighting with LEDs;
- Carry out a fire drill to test the self-protection measures and associated teams;
- Purchase and installation of a chiller / heat pump in parallel with the existing one for heating and cooling the building;
- Implementing a fire net at the rear of buildings, consisting of reels and water curtains on the glass façades to protect against potential fires in an electric vehicle;
- Equip the water pumping system for firefighting with a self-powered electricity supply that can last for at least one hour;
- Completion of the installation of an electrical cabinet in the SITE of building ~~A~~, including a battery support system to limit the impact of power interruptions (natural causes and maintenance);
- Overall refurbishment of open spaces and offices of Building B, namely with repairment of walls, painting and lighting;
- Improve working conditions in CRAS (ISEP building) by installing a raised floor to create a better working space.