INESC TEC ACTIVITY PLAN

2024

INESCTEC

Editorial Notes

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1 STRATEGIC PRIORITIES FOR 2024

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 2023, INESC TEC's 13 R&D Centres hosted 867 integrated researchers (354 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, the 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 sensemaking in its research as it reaches from 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 to 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 everything the institution does, 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, TEC4ENERGY, TEC4HEALTH, TEC4INDUSTRY and TEC4SEA.

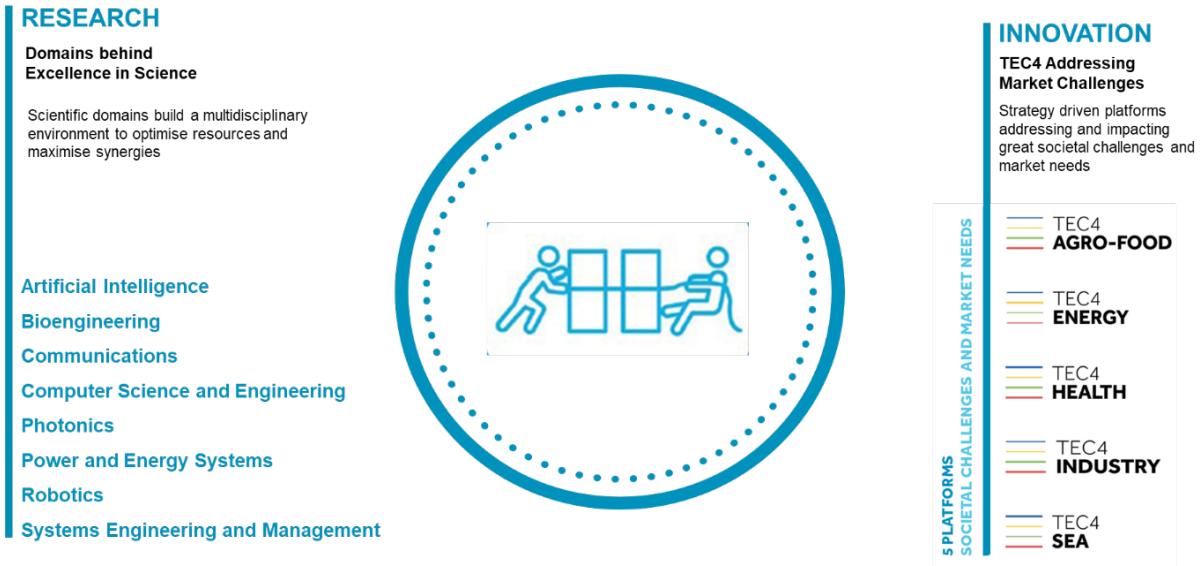


Figure 1.1 - High-level view of science and innovation at INESC TEC

1.3 Organisational structure

The institution's organisational structure (Figure 1.2) comprehends a Board of Directors composed of nine members and an Executive Board comprising five of those nine 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.

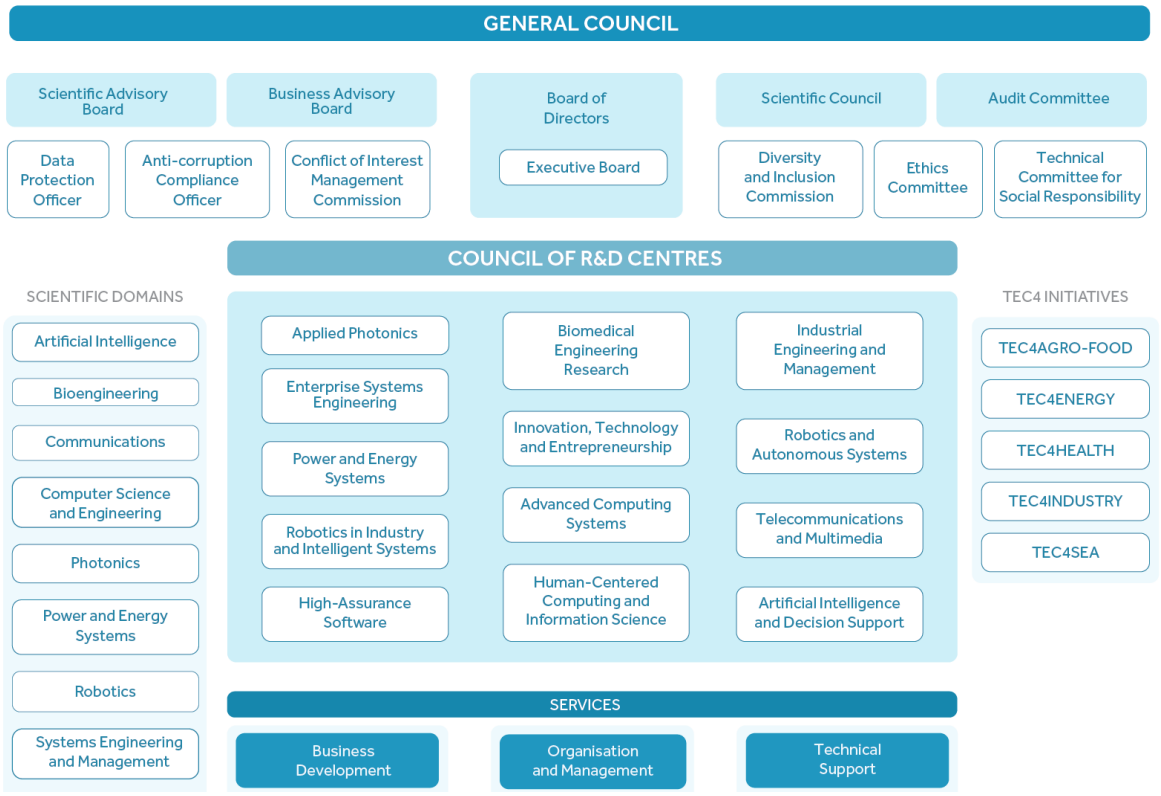


Figure 1.2 - INESC TEC organisational structure

The Scientific Advisory Board comprises twelve 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, and it 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 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 aims to excel and innovate across all its work, from research and innovation to its distinctive contribution to education and the collaboration between academia, the economy and society – to be a community that inspires and empowers. Its international standing will be underpinned by the individual and collective merit of its talented and diverse community, to which it will provide the fullest support in their personal and professional growth, while cultivating a freethinking and inclusive environment.

Strategic objectives to address this commitment span from raising the contribution and visibility of research, namely by increasing the involvement in the leadership of scientific initiatives, to improving the base conditions for technology commercialisation and developing closer and deeper relationships with innovation partners and the broader community. Other objectives, such as providing innovative learning experiences, increasing international embedment, reinforcing strategic alignment, and ever-closer collaborations with Higher Education Institutions (HEI), are also key priorities.

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 attract and retain world-class talent, 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 value and endeavour to act with openness, transparency, independence, and compliance with 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, it also entails 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 strive for sustainability and resilience in its economic model, providing its community with the best conditions to create new knowledge and 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 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.

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 shaped by contemporary megatrends, such as climate change, increasing demographic imbalances, shifting health challenges, or accelerating technological change and hyperconnectivity.

The sciences and technologies of 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 seven axes: Development of relevant knowledge and technology; Promotion of new skills in companies, dissemination and networking; Internationalisation; Attracting and developing talent and collaborating with HEIs; Internal training and promotion of technology transfer; Strengthening technological infrastructures for testing, validation, demonstration and training; and Budget sustainability and predictability.

1.7 2024 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.

As for the **macroeconomic scenarios** underlying the outlook for 2024, they are marked by heightened geopolitical tensions, the persistence of inflationary pressures and a tight monetary policy.

The projections of the Portuguese Ministry of Finance, underlying the preparation of the state budget for 2024, forecast 1.5% of economic growth and 4.1% of investment growth in 2024, under a still moderately high inflation rate of 3.3%, estimating that the national public accounts surplus should reach 0.2% of the Gross Domestic Product (GDP), and predicting that the Portuguese unemployment rate would increase to 6.7%.

Business investment growth will undoubtedly be impacted by increased uncertainty, rising financing costs and the continued impact of restrictions in global production and distribution chains on the costs and supply of materials and equipment. Those, combined with higher energy costs, the increase in fuel prices and the market pressure on recruiting qualified staff, may jeopardise the expected macroeconomic evolution and constrain the development of INESC TEC's activity.

Despite the uncertainties in the current context and the expected slowdown of the Portuguese economy, four significant programmes – PRR (Portuguese Recovery and Resilience Plan), PT2030, Horizon Europe and InvestEU 21-27 –will be essential for the development of INESC TEC's activity in the coming years, with a particular emphasis on the cooperation with the most innovative economic fabric.

1.8 Main initiatives for 2024

To fulfil its strategic commitments and reach its objectives, INESC TEC defined a set of institutional initiatives that will be a focus of the institute's activity in 2024. 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.

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**
    - Expand 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 260 PhD students and 600 Master's students);
    - Increase the attraction of new PhD students by further leveraging R&D projects and funding for PhDs in both academic and non-academic environments;
    - Reinforce INESC TEC's research team with the recruitment of researchers for key strategic areas, in line with the institute's scientific strategy;
    - Increase publications in high-impact journals and high-ranked conferences;
    - 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);
    - Prepare the coming FCT R&D Unit Evaluation process, taking into account the review and discussion of the institute's scientific strategy and goals undertaken by the Scientific Advisory Board;
    - Engage in international initiatives focused on new ways to assess research, namely CoARA – Coalition for Advancing Research Assessment, and EARTO's collective studies;
    - Reinforce the international recognition of researchers, through the encouragement of high-quality publication profiles, and actions to support applications to international awards, and ACM and IEEE Fellowships;
    - Launch an institutional programme to support applications of INESC TEC researchers to high-impact European Research Council (ERC) grants.
- **C1.2. Increase our involvement in the leadership of scientific initiatives**
    - Continued involvement in the leadership of national initiatives and European collaboration on HPC and Quantum Computing.

- **C1.3. Improve the base conditions for technology commercialisation**
    - Develop and launch a spin-off company in the areas of automation of containerisation, simulation, and deployment of robotic applications;
    - 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;
    - Focus on unlocking the potential of the institute's portfolio in all dimensions including its economic impact, intensifying the contact with relevant agents of the whole value chain.
    - Disseminate and create awareness on new technologies and trends.
- **C1.4. Develop closer and deeper relationships with our innovation partners and the broader community**
    - Take initial steps towards the establishment of a steady portfolio of flagship industry-funded strategic research programs;
    - Organise workshops and establish regular contact with technology-based companies.
- **C1.5. Provide innovative learning experiences**
    - Organise +20 advanced training courses, with a particular emphasis on the first edition of the Executive Master in Cybersecurity, in collaboration with Porto Business School;
    - Setting-up of a student-focused initiative to analyse and improve the attraction and retention of students as young researchers.
- **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;
    - 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;
    - Deepen INESC TEC - NARLabs MoU with the establishment of a collaborative framework to support joint exploratory research projects in areas of mutual interest.
- **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;
    - 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;
    - Initial steps of a formal 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.

- **C2.2. Increase our contribution to regional and national R&I-based sustainable growth**
  - Actively contribute to the definition of 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**
  - 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. Take full advantage of the new composition of the Business Advisory Board.
- **C2.4. Contribute to the digitalisation of public administration**
  - Initiate steps towards a collaboration 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**
  - Consolidate the Public Policy Office, the new 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;
  - Organise 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 two 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**
  - Increase the number of new projects and initiatives explicitly including activities for dialogue with the public.
- **C2.7. Communicate scientific and technological achievements and their impact**
  - Implement a comprehensive policy on Open Science at INESC TEC, following the best practices and aiming at a collaborative approach that will not only enhance the credibility of research but also contribute to the advancement of knowledge and the development of innovative solutions to complex challenges;

- Organise and co-organise several international conferences, namely IAMOT 2024 - Human-centred Technology Management for a Sustainability Future - one of the most reputed scientific conferences in the Technology Management research area, in July 2024;
- Promote talks and open days, organised by several of INESC TEC's R&D Centres, inviting society, academia, industry, and media to visit the institute and become acquainted with its main science and innovation contributions, following a tradition of openness and accountability;
- Presence in renowned international expositions and fairs to showcase the institution's cutting-edge research, innovations, and technological advancements to a global audience and technology takers;
- Deploy a new institutional website, crucial to reestablish the institution's online presence but also to serve as a vital tool for communication, outreach, and engagement with diverse stakeholders, including the scientific community, industry partners, policymakers, and the general public.

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 CoLABs' public policy objective through the active engagement in the twelve institutions that INESC TEC participates in;
  - Involve strongly in projects and activities of the European Knowledge and Innovation Communities (KICs) EIT Raw Materials and EIT Manufacturing;
  - Actively participate in several research associations, at national and international levels, namely EARTO, and EFFRA.
- **C3.2. Develop better linkages between knowledge production, development, and market uptake**
  - Create a new integrated approach to stimulate and support technological entrepreneurship.
- **C3.3. Increase strategic integration in national and international tech-intensive value-chains**
  - Actively participate in the DIH approved in the European DIH Call: ATTRACT DIH (Digital Innovation Hub for ArTificial Intelligence and High-PerformAnce CompuTing, coordinated by INESC TEC), DigitalBuilt and PRODUTECH DIH.
- **C3.4. Promote our pro-active participation in R&I agenda-setting at regional, national and EU level**
  - Involve in the update of the regional and national Smart Specialisation Strategies in the institute's areas of expertise.
- **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;
  - 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);
  - Phase 3 of UT Austin Portugal ends on December 31, 2023. INESC TEC, the host organisation of this international Partnership for the past five years, will remain committed to working with FCT in 2024 on the possible directions to ensure the continuation of this long-standing relationship between Portugal and The University of Texas at Austin. 2024 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**
  - Implement 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;
  - 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, implementing an explicit career development support policy.
- **C4.3. Expand the diversity of our community**
  - Launch new editions of INESC TEC International Visiting Researcher Programme;
  - 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;
  - 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 2024 are presented in Sections 1.8 and 1.9.

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

- **C5.1. Strengthen the sustainability and resilience of our economic model**
  - Monitor INESC TEC's strategy for successful participation in the European calls, especially in the scope of the Horizon Europe programme;
  - Launch a major initiative to replace the current Accounting and Financial information system;
  - Promote research and innovation services to national and international companies and public organisations.
- **C5.2. Promote and contribute to environmental sustainability**
  - 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**
  - Expand the current infrastructures and implement new laboratories integrated into the National Roadmap of Research Infrastructures of Strategic Interest (RNIE) to be funded until 2027, promoting their access by external researchers, as well as creating new living labs and joint laboratories with our partners.
- **C5.4. Strengthen the distinctive aspects of our institutional model**
  - Launch initiatives to strengthen the contributions of advisory boards and councils to strategic options.

1.9 Compliance Officers

1.9.1 Data Protection Officer

Data Protection Officer: Vasco Rosa Dias

Presentation

According to its legal statute the DPOs principal role is to inform, advise about and monitor compliance with data protection law provisions and with the 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 2024

Overall, the DPO role is aligned with several of INESC TEC's strategic 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, as well as to the resilience and sustainability of INESC TEC model.

Within the general tasks of the DPO we highlight in 2024 the following specific objectives:

- Strengthening of the internal awareness-raising initiatives, including the assignment of responsibilities within the organisation, thereby contributing to the dissemination of a data protection compliance culture;
- Strengthening of the training plan for staff members and researchers, including new resources and new models in the existing online training courses;
- Strengthening and implementation of the existing set of monitoring and auditing data protection tools available internally;
- Continuous cooperation and coordination efforts with ISPUP under the Protocol established in the field of Personal 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 and AI;
- Contribution to external awareness-raising and policy making initiatives, in close cooperation with national partners or international agencies and networks/ associations like Metared, EARTO or within the INESC's network and Brussels Hub.

1.9.2 Anti-corruption Compliance Officer

Officer: Ana Maria Mendonça

Presentation

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

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

Main objectives and initiatives planned for 2024

Although aligned with the strategic objective "**Strengthen our commitment to independence and compliance of research with ethical principles**", the Regulatory Compliance Programme for the Prevention of Corruption stems from the National Anti-Corruption Strategy 2020-2024 and goes beyond ethics in research.

While performing her legal duties, the anti-corruption compliance officer shall carry out the following main initiatives:

- Definition, monitoring and evaluation of the training actions targeting the members of the Board, employees and other members of INESC TEC Community, and promotion of awareness-raising actions against corruption;
- Clarification of doubts and questions about the code of conduct and the risk prevention plan;
- Control of the reporting channel on corruption and breaches of EU law in certain domains, receiving and following-up on reports;
- 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;
- Review 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 of 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.

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 caried 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 and appointed one Commission to ensure compliance throughout the Institution.

Main objectives and initiatives planned for 2024

The work of the Conflict of Interest Management Commission (Comissão de Gestão de Conflitos de Interesse - CGCI) is a continuous process that, in 2024, will carry out a set of initiatives and actions that fall under the Strategic Objective “Strengthen our commitment to independence and compliance of research with ethical principles” of the Strategic Commitment “Cultivate an attractive, people-centred and talented community”.

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 conflict of interest management plans (PGCI), if justified, to be approved by the Board of Directors;

c) Regular requests to the monitor person of each PGCI, previously designated for this role, to ensure compliance with PGCI recommendations under his/her responsibility;

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

e) Additional initiatives planned for 2024 that aim to facilitate the monitoring process of each PGCI, namely:

- Semi-automatic preparation of the monitor report to facilitate monitoring tasks;
- Training session for monitors;
- Automatic communication of non compliances to the Board of Directors.

1.10.2 Technical Committee for Social Responsibility

Chairperson: Joana Desport Coelho

Presentation

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

Main objectives and initiatives planned for 2024

Below we have listed the main initiatives and actions planned for 2024, aligned with INESC TEC's Strategic Objectives.

- Strategic objective: Provide a more dynamic and fulfilling working environment.
    - Promotion of initiatives that aim to create healthy working habits (ex: Laughter Yoga workshop; healthy eating workshop; Laboral gymnastics workshop and regular short walks);
    - Dissemination of information on Safety and Health at Work and revisitation of institutional signage related to this topic;
    - Promotion of initiatives to combat disinformation (ex: dissemination campaigns; schools visits);
    - Participation in Wellbeing games 2024.
- Strategic objective: Communicate scientific and technological achievements and their impact.
    - Dissemination of scientific information about new occupational diseases, through the follow initiatives: C-BER presentation to demonstrate the research that has been carried out at INESC TEC in the field of occupational health; Partnership with EU-OSHA through the dissemination of the material of the "Safe and Healthy work in the digital age" campaign (2023-25); organisation of a mental health seminar to INESC TEC community.
- Strategic objective: 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 the 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;
    - Humanising the Palliative Care service at Centro Hospitalar de Vila Nova de Gaia e Espinho (CHVNGE);
    - Collection of Plastic bottle caps, in a campaign called *Operação Tampinhas*, to be donated to institutions or individual families.

1.10.3 Diversity and Inclusion Commission

Members: Ana Filipa Sequeira (Chairperson), Ana Lopes, Rita Costa, Tiago Gonçalves, Tiago Silva

Presentation

The INESC TEC Board of Directors established the Diversity & Inclusion (D&I) Commission in September 2021. The D&I Commission (D&IC) is chaired by Ana Filipa Sequeira, who replaced Beatriz Oliveira in this role since Nov.2023, and is composed of diverse INESC TEC collaborators: Ana Lopes, Tiago Silva, Tiago Gonçalves and Rita Costa. 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 2024, the D&IC will focus on raising awareness, developing skills, monitoring the D&I landscape, and promoting initiatives in four priority areas: 1) **Gender equality**, focused on gender matters, following the approved Gender Equality Plan for 2022-2026, monitoring and assessing the implementation of the plan, whilst organising 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) **Age Diversity**, as the most recent data from the survey launched by D&IC revealed that one of the top 3 priorities for the community concerns ageism. In this context, the D&IC will develop initiatives that promote greater visibility and awareness towards this subject.

Main objectives and initiatives planned for 2024

The D&IC will continue fostering, empowering, 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 objectives. This work will focus on monitoring INESC TEC's culture, supporting diverse events and initiatives.

On the one hand, the Commission sets itself for a learning process, participating in events and training actions, promoted by relevant partners within the scientific community, that allow for a better counselling 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 2024, 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 2023, as well as new initiatives. Aligned with some of the strategic objectives, the D&IC activities for 2024 comprise:

- 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 fulfilling working environment.
    - Monthly initiatives following three main lines of action to promote a diverse workplace: i) organisation of events; ii) dissemination of information regarding specific dates and their relevance to the work conducted by the Commission; and iii) sharing curated knowledge towards good practices of inclusion.
    - Promote training on Portuguese Sign Language through workshops.
    - 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 was appointed by the Board of INESC TEC in 2022 and is chaired by Pedro Guedes de Oliveira, Professor Emeritus at the University of Porto and Senior Consultant to the Chairman of the Board of INESC TEC, and integrates Susana Magalhães, who holds PhD in Bioethics and is the Coordinator of the Unit for Responsible Conduct in Research at I3S and Assistant Professor at the Fernando Pessoa University, Vasco Rosa Dias, Data Protection Officer at INESC TEC and ISPUP, Lia Patrício and Alípio Jorge, professors, respectively at the Faculty of Engineering and Faculty of Sciences of the University of Porto and researchers at 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 2024

Framed in the main strategic goal of strengthening INESC TEC commitment to independence and compliance of research with ethical principles and the institute's code of ethics, the Ethics Committee will continue its mission of supporting INESC TEC researchers to ensure high ethical standards in their activities. This objective is pursued continuously, both through 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.

In addition, the Ethics Committee plans, for 2024, to include actions along the following lines:

- Publicise clear guidelines for ethical standards and principles governing research conduct, in aspects like data collection, informed consent of participants, confidentiality, conflicts of Interest and publication practices, in close cooperation with INESC TEC's DPO, Conflicts of Interest Management Commission, and Scientific Council.
- Offer regular training to researchers and other staff of INESC TEC, about ethical principles and the importance of compliance.
- Make sure that all members of INESC TEC may report unethical behaviour or concerns without fear of reprisal.
- 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.
- Update periodically ethical guidelines and policies to adapt to evolving ethical standards, particularly in issues concerning the development and use of Artificial Intelligence systems and algorithm.
- Improve the IT support for reporting and interaction between researchers and the Ethics Committee.

1.11 Other Institutional Initiatives

1.11.1 Public Policy Office

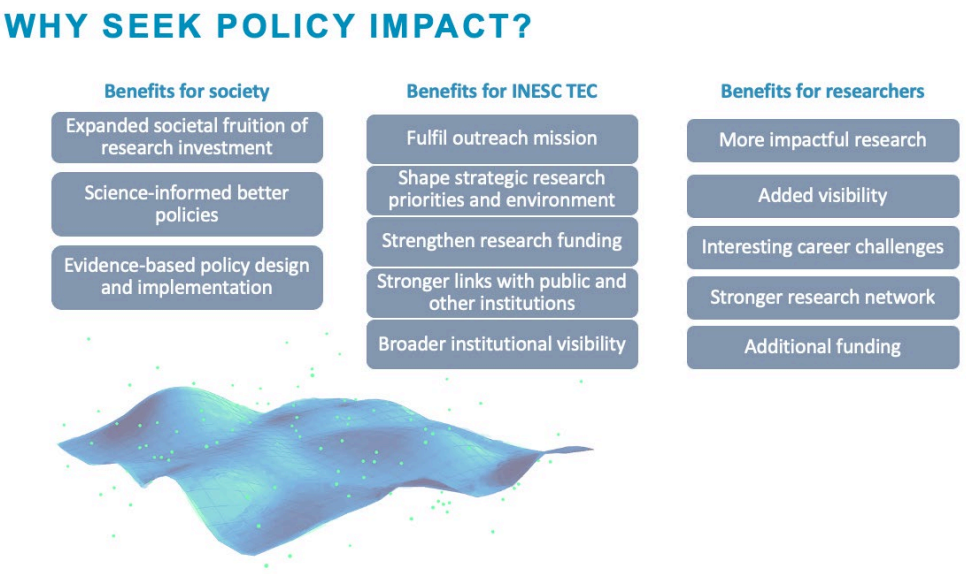
Team: José Manuel Mendonça, João Claro, Carolina Pedroso, Sara Brandão

Presentation

The Public Policy Office's mission is to advance INESC TEC's policy engagement, collaborating with our community to develop and implement bespoke engagement strategies with impact, at individual, group, and institutional levels. We offer support, services, and programs to enhance our community's policy impact.

To accomplish this mission, the office's activities are organised according to the following action lines:

1. Identify and disseminate recent and current contributions.
2. Connect and raise the impact on public policy dynamics.
3. Support the design and enactment of strategies for policy development and engagement.
4. Experiment and innovate with approaches to policy engagement.



Main objectives and initiatives planned for 2024

- **Raise our contribution to inform debates on issues that matter to society:**
    - Expand the institutional embedment of policy impact and related training;
    - Regular updating of the science-policy interface repository;
    - Routine production and dissemination of policy briefs and case studies;
    - Launch policy impact newsletter and website section;
    - Pilot events for engagement involving policy stakeholders and the INESC TEC community;
    - Design of strategies for co-production engagement and touchpoints (informal and by request).

1.11.2 INESC Brussels Hub

Coordinator: Ricardo Miguéis

Presentation

INESC Brussels HUB is the representation of the 5 INESC institutes in Brussels. It is managed at the highest level by the Board members of each institute, which have the responsibility of discussing and approving its triennial strategic plan, annual budget and plan of activities. The HUB's objectives are to:

1) Promote the visibility and reputation of all the INESC research and technology development capacity in Europe and beyond.
2) Facilitate and increase the representation in key thematic areas, platforms and networks with a view on guaranteeing an active participation in R&D agenda setting and promoting insertion in projects and programs of strategic interest from an early stage.
3) Contribute to capacity building of its technical, research and administrative staff in existing and new areas central to its activity.
4) Contribute to the development of informed science and technology related policies.
5) Position the organisation as a relevant stakeholder in thematic domains strategically and jointly pre-defined by the Management Committee.

Main objectives and initiatives planned for 2024

The HUB Annual Activities Plan is closely discussed with each of the 5 institutes and developed to respond to the very diverse challenges posed by all INESC institutes as a whole and each individually.

The strategic nature of the HUB's activities means that it contributes across the spectrum of the strategic objectives of INESC TEC. Below we select some of important initiatives and recommend consulting the HUB's 2024 Activities Plan for a full overview.

- **Increase our involvement in the leadership of scientific initiatives:**
  - Support the implementation of a programme to support ERC grant applications.
- **Provide innovative learning experiences:**
  - Executive Course in EU Research and Innovation Strategy and Management (in partnership with a Business School and other reputed EU R&I peer organisations).
- **Raise our contribution to inform debates on issues that matter to society:**
  - Regular publication (at least one per month) of Intelligence Reports, Event Reports with the participation of EU public policy organisations and other R&I stakeholders and Policy Briefs.
- **Communicate S&T achievements and their impact:**
  - Weekly publication of the Morning Brief on EU R&I and INESC S&T achievements and impact.
  - Weekly podcast on EU R&I with regular INESC invitees.
  - Publication and regular update of the INESC projects catalogue and track-record, automatise its relation with EU funding opportunities.
  - Yearly organisation of the INESC Summer Meeting, with participation of high-ranking EU officials and relevant EU partners.
  - Direct participation and support to participation in EU projects of strategic nature (CSAs and Tenders) (2 directly submitted proposals per year).

- **Build stronger knowledge-based and multidisciplinary R&I ecosystems:**
    - Identify and map INESC main knowledge domains, scientific areas and matching with EU policies and goals.
    - Create a network of *Thematic Delegates* across INESC institutes to promote joint and bilateral interests and participation in EU projects.
    - Organise a major annual INESC event with the participation of researchers from the 5 INESC institutes (HUB Winter Meeting – January).
- **Increase strategic integration in national and international tech-intensive value-chains:**
    - Work bilaterally with specific teams to identify EU PPPs of strategic interest and support their active participation.
- **Promote our pro-active participation in R&I agenda-setting at regional, national and EU level:**
    - Continue work to position INESC members in EU expert groups and platforms with responsibilities in advising the EC and developing strategy and reports.
    - Adhere formally to IGLO – Informal Group of Liaison Offices, bringing together more than 200 hundred liaison offices present in Brussels, from all across the EU.
    - Active participation and representation in EARTO (European Association of Research and Technology Organisations) working groups and strategic activities, namely the new launched Task Force on STEP – Strategic Technologies for Europe Platform.
- **Increase our international networking, leadership and competitiveness:**
    - Full deployment of SEPP tool (Support to Programme Participation), with easy and fast search engine to id relevant funding opportunities, automatic match of opportunities with research interests and with interests of colleagues in the INESC universe.
    - Promote (at least) one EU mission to strengthen networking and open collaboration opportunities with key partners in areas of strategic importance.
    - Implement INESC TEC monitoring unit in INESC Brussels HUB to promote INESC TEC's R&I engagement in EU agenda-setting, promote strategic positioning and international project integration.
    - Promote international cooperation with newly associated countries to Horizon Europe, namely Canada, through active participation in the CRIQUE network.
- **Improve attraction and retention of world-class talent:**
    - Support the process of reform of research assessment and implementation of open science practices associated with the COARA (Coalition for Research Assessment) initiative and EOSC (European Open Science Cloud).
- **Strengthen sustainability and resilience of our economic model:**
    - Support international competitiveness of research funding through bilateral work focused on teams with lower internationalisation rates and high potential for growth.

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 2024, 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 TEC4 initiatives in Section 4, and the Research Centres in Section 5.

The plans for the main Research Infrastructures and Laboratories, and for the Support Services, which also play a key role in many of the main initiatives foreseen for 2024, are presented in Sections 6 and 7, respectively.

2 MAIN INDICATORS FOR 2024

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 2024. The presentation of each R&D Centre and the detailed discussion of their objectives, activities and results are carried out in Section 5.

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 2024. Table 2.1 also includes the number of PhDs (381 planned at the end of 2023).

Table 2.1 - Evolution of INESC TEC's Human Resources

Type of Human Resources			2022	2023	2024	Δ 2023-24	
Integrated HR	Core Research Team	Employees	189	238	290	52	22%
		Academic Staff	185	185	187	2	1%
		Grant Holders and Trainees	354	405	369	-36	-9%
		Total Core Researchers	**728**	**828**	**846**	**18**	**2%**
		Total Core PhD	**272**	**288**	**310**	**22**	**8%**
	Affiliated Researchers		73	70	48	-22	-31%
	Management, Administrative and Technical	Employees	115	125	142	17	13%
		Academic Staff	10	9	9		0%
		Grant Holders and Trainees	6	2	1	-1	-50%
		Total Manag, Admin and Tech	**131**	**136**	**152**	**16**	**12%**
		Total Integrated HR	**932**	**1034**	**1046**	**12**	**1%**
		Total Integrated PhD	**364**	**381**	**382**	**1**	**0%**

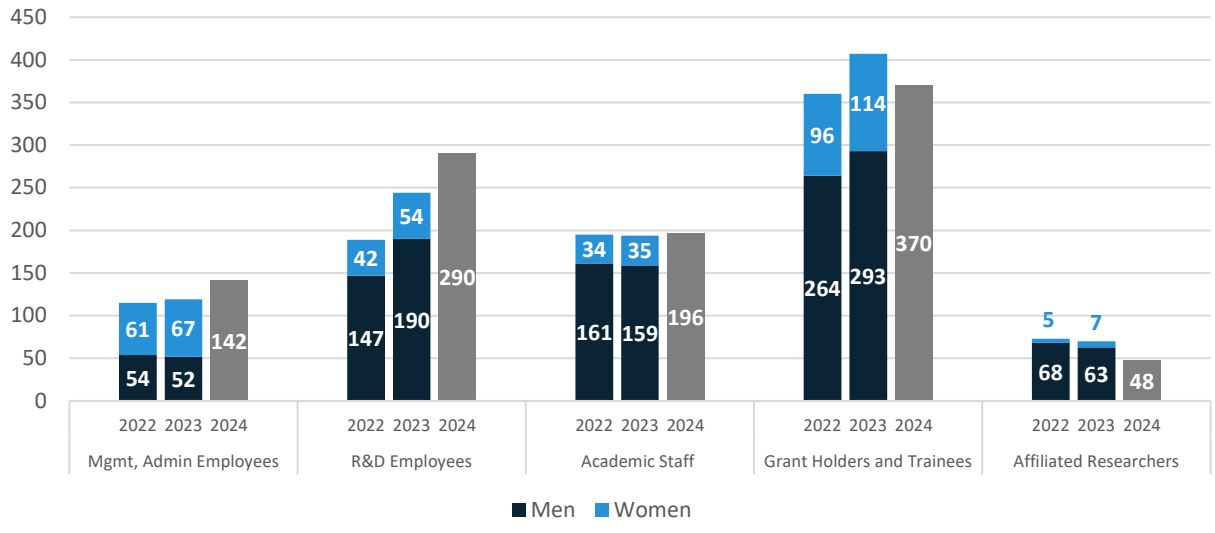


Figure 2.1 - Evolution of INESC TEC Human Resources

In Figure 2.2, the distribution of human resources planned for 2024 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.

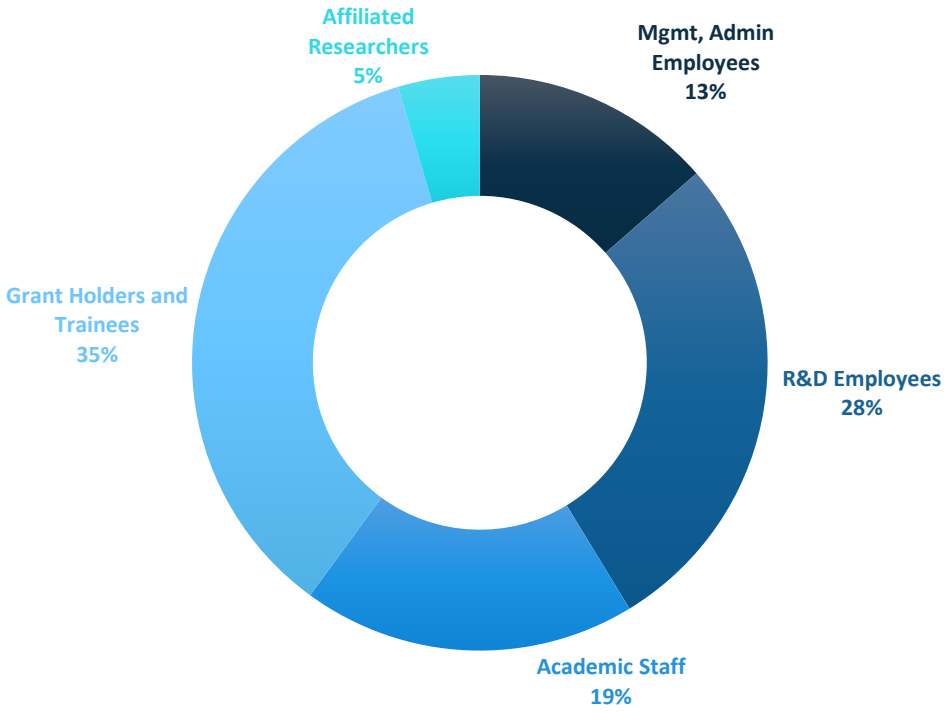


Figure 2.2 - Distribution of Human Resources (Plan 2024)

As highlighted in Figure 2.2, grant holders and trainees remain the largest human resources group (35%) at INESC TEC, showing a growth trend. As in previous plans, the number of grant holders and trainees is a conservative forecast, resulting from the fact that the numbers presented in the planning exercise for 2024 only consider ongoing projects and foreseen projects with a minimum level of certainty.

A significant increase in the number of R&D employees is planned, with a foreseen growth of 22%, 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 2024, the number of employees in the Support Services is planned to increase by 12%, 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 2024 are given in Table 2.2 for each R&D Centre.

Table 2.2 - Human Resources by type and R&D Centre (Plan 2024)

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	**290**	20	14	32	10	86	31	27	15	7	23	11	1	13	
		Academic Staff	**187**	15	8	12	6	9	6	13	19	2	34	23	16	24	
		Grant Holders and Trainees	**369**	83	8	21	14	64	13	32	25	3	27	22	10	47	
		Total Core Researchers	**846**	**118**	**30**	**65**	**30**	**159**	**50**	**72**	**59**	**12**	**84**	**56**	**27**	**84**	
		Total Core PhD	**310**	**30**	**19**	**16**	**12**	**38**	**18**	**22**	**31**	**6**	**41**	**30**	**17**	**30**	
	Affiliated Researchers		**48**	10	2			2	5	1	4		12	6		6	
	Administrative and Technical	Employees	**28**	1	1	5	1	2	2	3	1		1	1		8	2
		Total Admin and Tech	**28**	1	1	5	1	2	2	3	1		1	1		8	2
	Total Integrated HR		**922**	**129**	**33**	**70**	**31**	**163**	**57**	**76**	**64**	**12**	**97**	**63**	**27**	**98**	**2**
	Total Integrated PhD		**359**	**40**	**21**	**16**	**12**	**40**	**23**	**23**	**35**	**6**	**53**	**36**	**17**	**36**	**1**

2.1.3 Support Services indicators

The Human Resources figures expected for the end of 2024 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 2024)

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	114	18	9	2	3	3	10	13	9	3	4	6	8	5	8	5	8
	Academic Staff	9	6	3														
	Grant Holders and Trainees	1															1	
	Affiliated Researchers																	
	Total Integrated HR	**124**	**24**	**12**	**2**	**3**	**3**	**10**	**13**	**9**	**3**	**4**	**6**	**8**	**5**	**8**	**6**	**8**
	Total Integrated PhD	**23**	**12**	**5**		**1**	**1**	**1**		**1**		**2**						

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 2023 plan to the 2024 plan with an overall growth in activity of 20%.

Table 2.4 - Funding sources and planned evolution

Sources	2023	2024	Δ (k€ / %) 2023-24	
National Programmes	19 054	24 360	5 306	28%
European Programmes	9 449	10 501	1 052	11%
R&D Services and Consulting	2 634	2 420	-214	-8%
Other Funding Sources	276	359	84	30%
Total Revenues	**31 414**	**37 641**	**6 227**	**20%**

Figure 2.3 illustrates the funding distribution planned for 2024, and its comparison with the plan for 2023. The total revenue planned for 2024 grows 20% in comparison with 2023, with variations per funding source, as explained below.

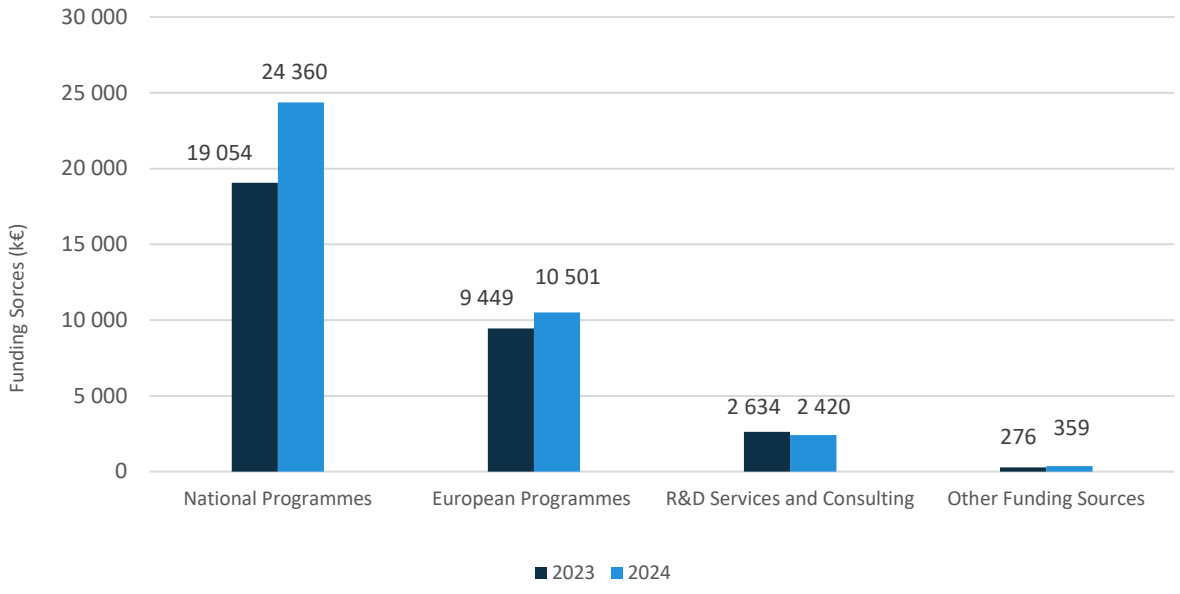


Figure 2.3 - Evolution of funding by source (k€)

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

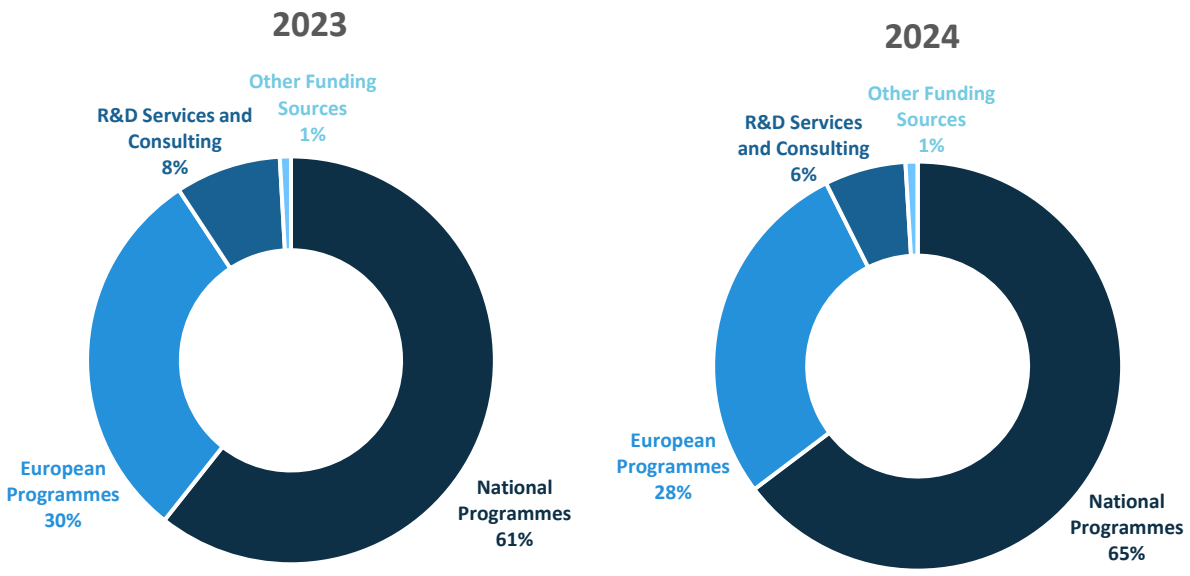


Figure 2.4 - Distribution of project funding by source - Plan 2023 (left) and Plan 2024 (right)p

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 2024)

Type of Project		Number of Active Projects		Δ (%)	Average Funding (k€)	
		2023	2024	2023-24	2023	2024
PN-FCT	National R&D Programmes - FCT	28	25	-3	52	63
PN-PICT	National R&D Programmes - S&T Integrated Projects	1	0	-1	113	0
PN-COOP	National Cooperation Programmes with Industry	63	32	-31	190	438
PUE-FP	EU Framework Programmes	63	73	10	135	138
PUE-DIV	EU Cooperation Programmes - Other	14	9	-5	41	36
SERV-NAC	R&D Services and Consulting - National	38	34	-4	40	44
SERV-INT	R&D Services and Consulting - International	4	4	0	25	75
OP	Other Funding Programmes	7	7	0	88	200
Total		**218**	**184**	**-34**	**114**	**159**

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

- The total revenue planned for 2024 grows to 37.6 M€, a value 20% higher than in the 2023 activity plan;
- The 28% 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 14 M€. This means that national programmes now represent 65% of the institution's total funding, compared to the 61% foreseen in the

2023 plan. Furthermore, due to the large size of PRR projects, the average funding per project in national cooperation programme with industry increases from 190k€ to 438k€;

- 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;
- Also quite relevant is the 11% increase in EU Framework Programmes (Horizon Europe and H2020) with 73 active projects, 9 of which are coordinated by INESC TEC;
- Regarding R&D services and consulting, this plan foresees a reduction of 8%, even though the volume of currently confirmed projects, 1.505 k€, is 167 k€ higher than the homologous value in 2023. The global decrease expected for 2024 essentially results from a reduction in more than half of the budget for uncertain projects, compared to 2023, as well as 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 2023, some changes can be highlighted:

- The most relevant variation is the already referred increase in National Cooperation Programmes with Industry (17%), 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 (18%) is mainly led by CRAS and CTM, while CPES and CRIIS maintain high levels of activity in this type of funding;
- National contract research and consulting (confirmed projects) is expected to increase slightly, namely led by CPES at national and international levels, while the remaining Centres expect a slowdown.

Table 2.6 - Project Funding (k€) and Uncertainty Analysis (Plan 2024)

			R&D Centres													
		Total (k€)	CTM	CAP	CRAS	CBER	CPES	CESE	CRIIS	CEGI	CITE	HUMANISE	LIAAD	CRACS	HASLAB	Special Projects
Projects	PN-FCT	**1 572**	190	85	628	116	82	0	16	198	0	34	140	0	82	0
	PN-PICT	**0**	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	PN-COOP	**14 024**	1 470	426	793	328	4 039	1 640	2 013	682	236	1 207	426	76	690	0
	PUE-FP	**10 082**	1 906	270	2 299	290	2 098	447	720	417	196	669	223	81	337	130
	PUE-DIV	**326**	0	4	6	0	0	4	0	0	17	118	8	32	77	60
	SERV-NAC	**1 507**	20	0	0	2	688	77	45	32	0	340	49	0	235	18
	SERV-INT	**298**	0	0	60	0	173	35	30	0	0	0	0	0	0	0
	OP	**1 399**	21	127	55	10	853	119	1	0	0	0	0	0	52	162
	Total Projects	**29 209**	**3 607**	**912**	**3 841**	**747**	**7 932**	**2 321**	**2 824**	**1 329**	**449**	**2 369**	**846**	**189**	**1 472**	**370**
Uncertain Projects		**886**	**35**	**62**	**14**	**119**	**80**	**102**	**75**	**10**	**10**	**5**	**57**	**0**	**317**	**0**
Total Funding		**30 094**	**3 642**	**974**	**3 855**	**866**	**8 012**	**2 423**	**2 899**	**1 339**	**458**	**2 374**	**904**	**189**	**1 789**	**370**
Uncertain Projects		**3%**	1%	6%	0%	14%	1%	4%	3%	1%	2%	0%	6%	0%	18%	0%

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.

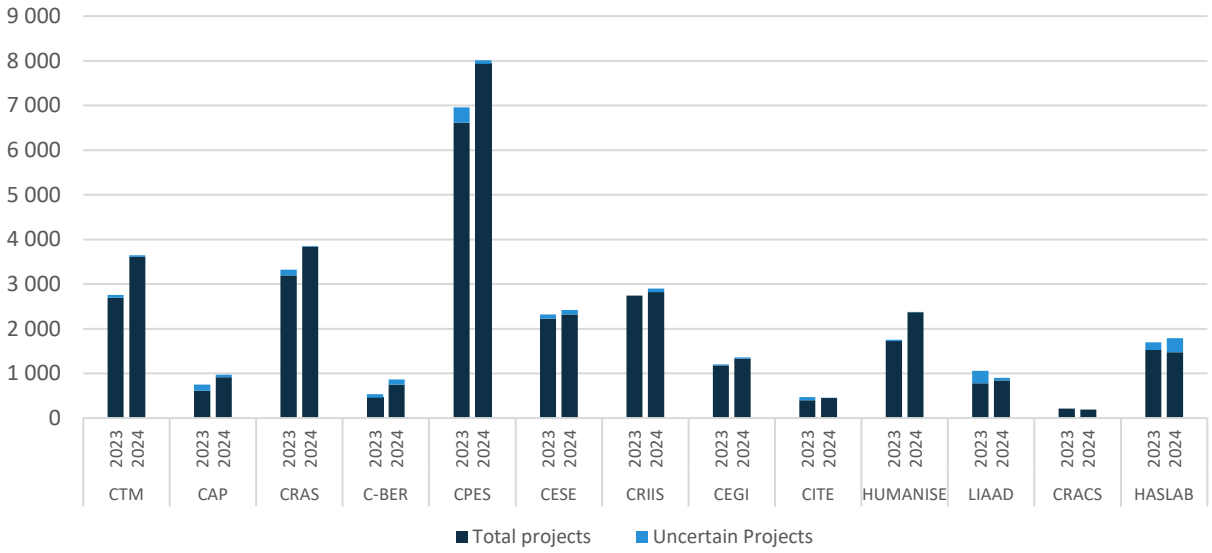


Figure 2.5 - Project funding and uncertainty analysis (k€) per R&D Centre (Plan 2023 vs Plan 2024)

2.3 Publications

2.3.1 Global indicators

Table 2.7 and Figure 2.6 show the number of INESC TEC publications in 2020, 2021 and 2022 and the planned figures from 2020 to 2024.

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 2023 and 2024 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 2021 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	2020 (Closed)	2021 (Closed)	2022 (Closed)	2023 (Forecast)	2024 (Plan)
Indexed Journals	444	451	539	399	404
Indexed Conferences	413	471	446	269	309
Books	2	4	4	2	6
Book Chapters	25	33	40	30	27
PhD Theses - Members	28	30	31	37	46

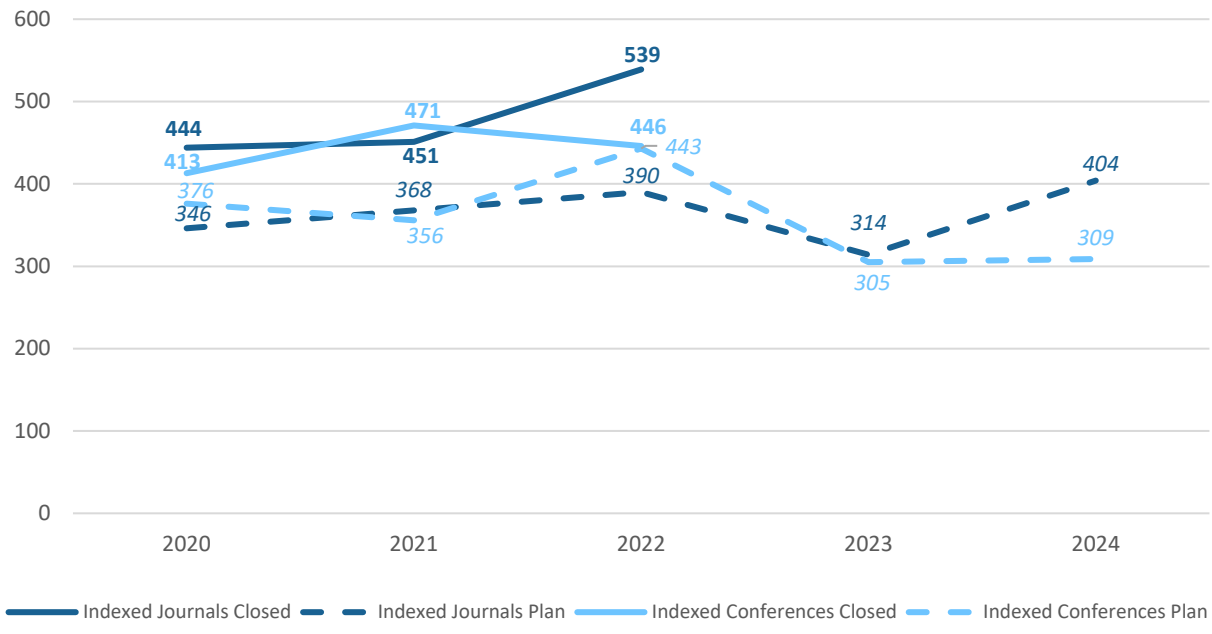


Figure 2.6 - Evolution of INESC TEC Publications

In 2024, 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. 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.

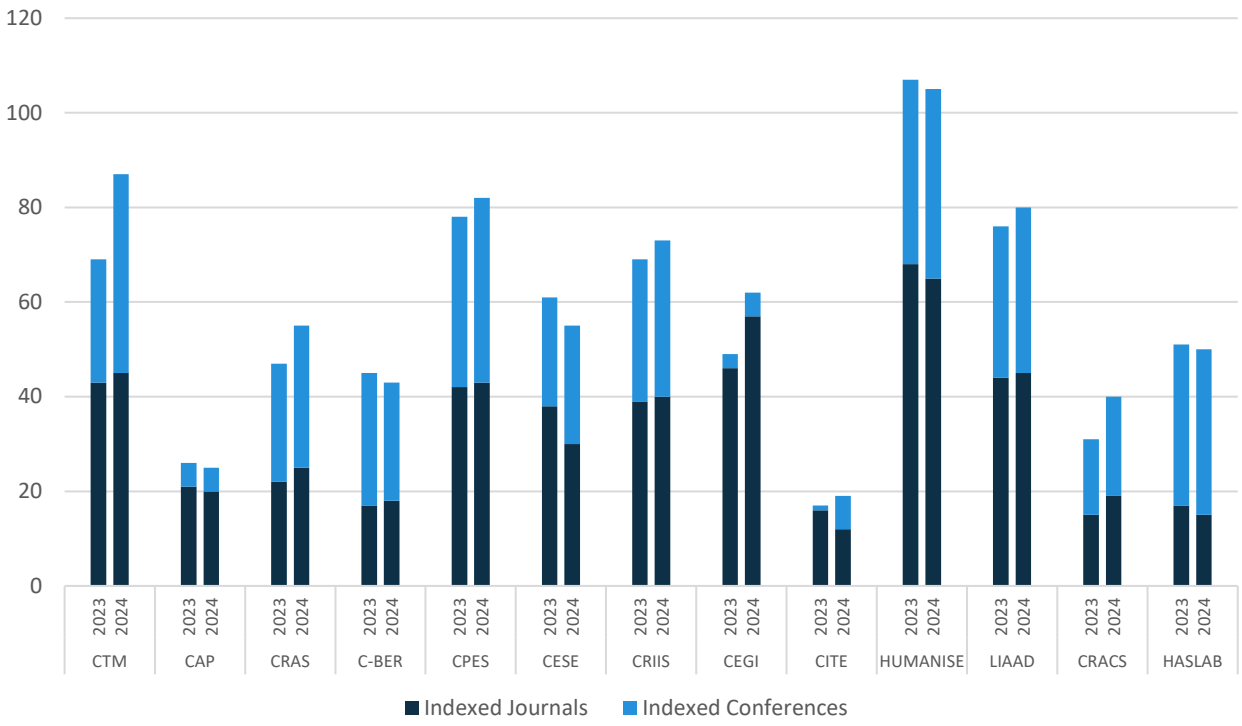


Figure 2.7 - Indexed Publications in Journals and Conferences (Forecast 2023 vs Plan 2024)

2.4 Knowledge transfer

Table 2.8 presents the number of INESC TEC's knowledge transfer (KT) results and the expected evolution for 2024.

Table 2.8 - Results related with Knowledge Transfer

Type of Result	2022	2023 (Forecast)	2024 (Plan)
Pre-disclosures	24	26	19
Invention disclosures	21	16	12
First Priority Patent Applications (New inventions)	5	6	8
First Patents Internationalisation	2	4	4
Commercial Contracts (Licences, Options, Assignments)	1	2	8
Spin-offs	0	1	2

In 2024, the number of new patented inventions is expected to increase, positioning INESC TEC as a top patent applicant both at domestic and European levels. The institute's IP portfolio strategy is increasingly prioritising market-driven or high-quality high-risk inventions, focusing on quality over quantity. The number of international patents and grants in upcoming years is expected to reflect this lean approach.

The figures for newly mapped R&D results (pre- and technology disclosures) are relatively moderate, reflecting conservative estimates by the Research Centres.

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, two spin-offs will enter a development phase, one in bioengineering and another in robotics application. Due to complex negotiations and formalities resulting from its international nature, the formal participation in iLoF is also expected for 2024.

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 2023 vs Plan 2024

Type of Activity	2023	2024
Participation as principal editor, editor or associated editor in journals	80	77
Conferences organised by INESC TEC members (in the organising committee or chairing technical committees)	49	49
International events in which INESC TEC members participate in the program committees	181	189
Participation in events such as fairs, exhibitions or similar	56	161
Conferences, workshops and scientific sessions organised by the R&D Centres	70	60
Participants in the conferences, workshops and scientific sessions organised by the R&D Centres	2 350	3 180
Advanced training courses organised by the R&D Centres	24	29

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 5, for each R&D Centre.

Besides scientific events, a special emphasis will be placed on the participation in international technology fairs and other exhibitions considered to be instrumental in building a global network, fostering collaborations, and showcasing the institution's achievements on an international stage.

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.

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.

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.

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.

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.

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 & will be involved in this RC, from Health informatics & Computational Biology to Bionics, Wearable and Implantable technologies.

C) New Challenges in Medical Signal & Image Analysis

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

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

D) BioRobotics & Human-Machine Symbiosis

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

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

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.

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.

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.

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.

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.

D) Managing the Increasing Complexity of Critical Information Systems

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 minimising 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.

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.

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 à 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., fertilizers);
- 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.

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

Electricity markets have proven to be effective tools to:

- Improve the efficiency in the production and pricing of electricity commodities such as energy, flexibility and capacity.
- 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.

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.

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 centers and architectures of power systems with the need for higher interaction with neighboring 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 minimising energy losses, as well as operator's cognitive load.
3. Structure the decision-making process, and design it explicitly for making decisions over tasks and not for monitoring (i.e., to avoid operating systems with information overload).
4. Let human operators become "navigators", defining forecasted trajectories over time and choosing options ahead of time rather than reacting in real-time.
5. Distributed and decentralised protection, automation and control, benefiting from 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.

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.

B) Photonic sensing for extreme environments

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

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

The development of high-performance optical tools and techniques can significantly increase the safety, efficiency, and sustainability of operations in extreme environments, including space and deep sea. It will also enable early detection of any potential problems, allowing for timely corrective actions to be taken. This can ultimately lead to cost savings, reduced downtime, and increased operational life of structures or systems.

C) Optical systems and devices for analogue quantum simulations

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

- Towards a top of the class analogue simulator of quantum fluids

Improving the versatility and circumventing the limitations (effective simulation time) of current setups.

- Towards a transparent framework to bridge optical computing and the end user

Explore neuromorphic paradigms easier to implement in the optical domain (e.g. Extreme learning machines, Reservoir Computing and Diffractive neural networks) to deploy a transparent and accessible platform for the end-user.

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.

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.

C) Enhance human-robot collaboration

Most recent technological and scientific advancements allow stand-alone robots to perform tasks with an 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 synergetically and dynamically collaborate with humans.

To achieve such a goals, 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 through the use of 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, through the use of high-level programming, teleoperation and shared control methods.

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-centred 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?

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?

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?

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?

4 TEC4 INITIATIVES

4.1 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.

4.2 Current initiatives

The Global TEC4 Organisation

The global TEC4 organisation comprises:

- Five established TEC4s:
  - TEC4AGRO-FOOD: Agro-food and forestry
  - 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.

4.3 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.

4.4 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.

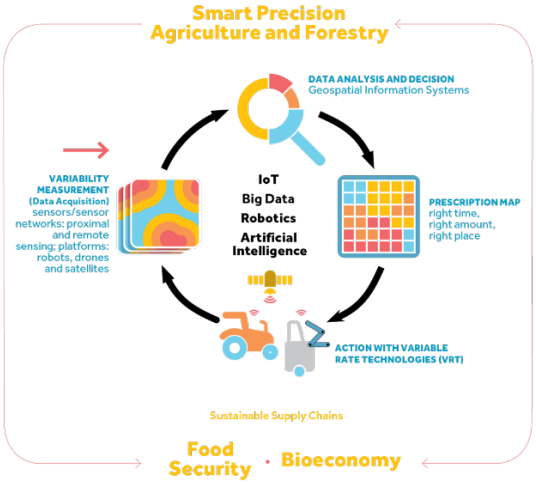
4.5 TEC4AGRO-FOOD

Coordinator: Filipe Neves dos Santos
Business Developer: André Sá

4.5.1 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 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, will be 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.

4.5.2 Main objectives for 2024

Aligned with INESC TEC's Strategic Objectives, in 2024, 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: nº 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 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: no. of direct contracts.

Jointly with these key advances, in 2024, the other main objectives for the TEC4 towards its vision are:

- A. Redoubling efforts at European level. KPI: nº of European projects.
- B. Make TEC4AGRO-FOOD's most impactful results better known to INESC TEC's relevant stakeholders.

4.5.3 Action plan

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

Table 4.1 - 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 aiming at establishing a partnership	Partnership with WUR	C3.5
Strengthen or establish contact with the main European project consultants	More European projects	A
Strengthen or establish contact with the "champions" of coordinating European projects	More European projects	A
Participate in World FIRA 2024	International networking and notoriety. Robotics and IoT technologies exhibition. Robotics and IoT R&I projects.	C2.3; A
Participate as "RTD Partner" in AgroIN 2024	National networking and notoriety. R&I projects.	C5.1
Participate in Agromek 2024	Keep abreast of the latest innovations.	C2.3; A
Organise a robotics and IoT event for INESC TEC's relevant stakeholders	Most impactful results better known to INESC TEC's relevant stakeholders.	B
Develop new communication materials	Increase and improve TEC4AGRO-FOOD communication.	C3.5; C5.1; A; B

4.6 TEC4ENERGY

Coordinator: João Peças Lopes
Business Developer: Nuno Campos

4.6.1 Scope and strategy overview

One of the main challenges of the energy sector is the need to act in response to the decarbonisation of the society and economy. Within this framework, TEC4ENERGY focuses on the Societal Challenges and Innovation Strategies for Smart Specialisation defined by EU policies - the energy sector will be heavily digitalised, decentralised, under a user-centric and market-based approach, involving a large-scale integration of RES and the development of a SG infrastructure that requires the development of disruptive solutions. TEC4ENERGY leverages INESC TEC's resources, competencies, and technologies in order to develop and transfer innovative solutions to the energy sector, addressing current societal challenges and the specific needs of our energy partners. This value proposition is attained by establishing a continuous dialogue with industry, developing fruitful collaborations that address the energy sector challenges under the framework of the European strategic goals set at the Fit for 55 and also following the ambitious targets on decarbonisation of the Portuguese economy defined by the National Energy and Climate Plan – PNEC2030.

4.6.2 Main objectives for 2024

Aligned with INESC TEC's strategic objectives, in 2024, 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 large scale deployment of electric mobility, controlling the operation of electrolysers running to produce green hydrogen, 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, workshops and conferences promoted by this organisation, and become involved in collaborative initiatives like the working groups of ETIP SNET 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, hydrogen technology for system services and security of supply.

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.

C2.3. 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 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 TEC4Energy OpenDay Innovation Event with presentation of protypes and solutions related with innovative products that can bring added value to the energy industry needs in Power and Energy, Robotics, Fiber Optics, Virtual Environments, Cyber Security and Telecommunications.

TEC4ENERGY intends to increase its participation in international fairs (e.g. ENLIT 2024), start preparing a participation in the EXPO OSAKA 2025 and create its own Technological Innovation OpenDay, 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 SGEV 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 with the energy sector, capitalising 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.

4.6.3 Action plan

Table 4.2 - TEC4ENERGY – Main actions planned

Initiatives	Key Results	Strategic Objectives
Participation in international fairs like ENLIT 2024	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, C2.4, C3.2, C5.1
Organisation of the TEC4Energy OpenDay Innovation 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's technological and innovation capabilities; Foster collaboration support C1.4, C2.3, C2.4, C3.2, C5.1

Initiatives	Key Results	Strategic Objectives
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, fostering networking and new R&D projects. C1.4, C2.3, C2.4, C5.1
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.	C1.4

4.7 TEC4HEALTH

Coordinator: Miguel Coimbra
Business Developer: Carlos Alexandre Ferreira

4.7.1 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. Recognising 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.

4.7.2 Main objectives for 2024

Aligned with INESC TEC's strategic objectives, in 2024, 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.

- Secure follow-up projects from previously closed contracts, showcasing commitment, and strengthened relations with our innovation partners;
- Establishing relationships with new companies through joint R&D opportunities in PT2030.

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 survey to characterise the R&D needs of the market to guide our centres.

C2.4. Contribute to the digitalisation of public administration.

- Foster formal partnerships with hospitals to systematise existing research lines, establish procedures and initiate additional projects;
- Enhance relations with the Ministry of Health's Shared Services (SPMS) to proactively facilitate the transfer of innovation.

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.

- Promote the interest of INESC TEC technologies in the market by showcasing our capabilities and innovations in events and fairs.

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

- Increase the participation and success rate in European funding consortia under Horizon Europe and associated programs, aiming to secure additional project opportunities and enhance overall project outcomes;
- Strengthen international visibility and recognition by securing additional international meetings, contributing to the expansion of our global presence.

Jointly with these key advances, in 2024, the other main objectives for the TEC4 towards its vision are:

- **[T4H1]** Facilitate a comprehensive internal assessment of INESC TEC's capacities and preferences to strategically lobby for and implement new opportunities with various stakeholders;
- **[T4H2]** Provide active support to researchers by assisting in identifying relevant calls and potential partners, fostering a proactive approach to engage in collaborative projects;
- **[T4H3]** Actively promote and endorse new health-related best practices, encouraging the adoption of innovative approaches, while keeping the community informed about the latest developments and achievements.

4.7.3 Action plan

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

Table 4.3 - TEC4HEALTH – Main actions planned

Initiatives	Key Results	Strategic Objectives
Organisation of internal meetings with INESC TEC Centres	More project proposals	T4H1, T4H2, T4H3
Invited talks on relevant health concerns	Proposals with higher quality	C3.5, T4H3
Study and plan of European calls	More project proposals	C3.5, T4H2
International businesses visits	Increased visibility of INESC TEC within the health technology area Improve relationships	C2.3, 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, C3.2, C3.5, T4H1, T4H2
Participation in national and international fairs	Projects with new entities Market scouting (access to sectorial roadmaps)	C1.4, C2.3, C3.5
Meeting with new entities	Projects with new entities	C1.4, C2.3, C2.4, C3.5

4.8 TEC4INDUSTRY

Coordinator: Américo Azevedo
Business Developer: António Almeida

4.8.1 Scope and strategy overview

TEC4INDUSTRY, is an initiative committed to fortifying the competitiveness of the Portuguese industry. We endeavour 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.

4.8.2 Main objectives for 2024

Aligned with INESC TEC's strategic objectives, in 2024, 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.

C1.1. 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.

C2.1. Better align and deliver RD&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.

C2.2. Contribute to the digitalisation of industry by promoting the "twin transition" paradigm shift.

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 a 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 for the main groups of work, with connections with the European Commission, that are dealing with emerging topics such as AI application in 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, to keep a sustainable and effective science-based operational model.

4.8.3 Action plan

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

Table 4.4 - 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

4.9 TEC4SEA

Coordinator: Eduardo Silva
Business Developer: Carlos Pinho

4.9.1 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, defence, and security for the Sea environment.

The 2024 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, shared research infrastructures for ocean technologies and energy transition, 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.

4.9.2 Main objectives for 2024

Aligned with INESC TEC's Strategic Objectives, in 2024, TEC4SEA is prioritising significant advances in the following Strategic Commitments:

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

Leading the development of strategic infrastructures 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 is contributing to the development and establishment of value- and supply-chains, leveraging 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:"C2.1. Develop impactful research and innovation aligned with the SDGs", "C2.2. Increase our contribution to regional and national R&I-based sustainable grow", "C2.3. Better align and deliver R&I with industry's needs", "C2.4. Contribute to the digitalisation of public administration", "C2.5. Raise our contribution to inform debates on issues that matter to society" 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., 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 telco; Hub Azul de Leixões Pólo 1 – ocean basin for scaled test of offshore renewable solutions, robotics, sensors, scientific diving, etc.) impacts the strategic commitments: "C3.1. Build stronger knowledge-based and multidisciplinary R&I ecosystems", "C3.2. Develop better linkages between knowledge production, development, and market uptake", "C3.3. Increase strategic integration in national and international tech-intensive value-chains", "C3.4. Promote our pro-active participation in R&I agenda-setting at regional, national and EU level" 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 2024, both in terms of new initiatives (e.g., ocean and waters KIC, 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", "C5.2. Promote and contribute to environmental sustainability" and "C5.3. Improve quality, management, and usage of our infrastructures".

4.9.3 Action plan

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

Table 4.5 - TEC4SEA – Main actions planned

Initiatives	Key Results	Strategic Objectives
Foster the setting up of a centre of excellence towards ocean challenges	New high prestige grants Contracts with national and international industries Public engagement 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 Public engagement Stakeholders' engagement and increased national and international visibility	C1.4; 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 Public engagement	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
Supporting fees for associate strategic sectorial initiatives	Gain access, participate and connect with relevant associations, clusters, or representatives of leading strategic initiatives	C1.2; C1.3 // C2.1; C2.2; C2.3; C2.4; C2.5 // C3.1; C3.2; C3.3; C3.4; C3.5 // C5.1; C5.2; C5.3
Develop marine living 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

4.10 TECPARTNERSHIPS

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

4.10.1 Scope and strategy overview

TECPARTNERSHIPS focuses on exploring market sectors with high potential for applying INESC TEC's expertise. Our objective is to transfer technology, thereby enhancing international competitiveness for companies in these sectors. The goal is to establish INESC TEC as a technological reference partner, fostering a scientific community within and beyond the organisation.

In the Financial, Construction, and Internet Market sectors, we align our actions with strategic plans (Planos Estratégicos de Mercado – SMP), utilising our established lists of technology takers (TTAKs). We organise offerings based on INESC TEC research lines, facilitate participation in networking events and fairs, and identify funding opportunities in Horizon Europe.

In Defense & Security, Space, Mobility, and Public Administration, our aim is to identify application areas, raise awareness of INESC TEC's competencies, create Communities of Practice, and explore synergies between different areas. We seek to identify opportunities under Horizon Europe's specific funding and other relevant entities.

The renewal of the "Agrément CIR" will permit the acquisition of an attractive factor, establishing the foundation for a sustainable internationalisation plan for the French market.

These initiatives are designed to strengthen INESC TEC's position in diverse sectors, fostering innovation and collaboration within and beyond our organisation.

TECPARTNERSHIPS is also responsible for the tools required to support TEC4 activity.

4.10.2 Main objectives for 2024

Aligned with INESC TEC's strategic objectives, in 2024, TECPARTNERSHIPS 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.

- Leverage TTAKs to connect with new companies capable of implementing INESC TEC's developments;
- Organise meetings with existing partnerships to identify new challenges;
- Organise regular stakeholder engagement sessions to gather feedback and insights;
- Leverage "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.

- Conduct a market analysis using SMP to identify areas where INESC TEC competencies align with industry needs;
- Conduct a comprehensive review of existing partnerships and identify areas for improvement.

C2.4. Contribute to the digitalisation of public administration.

- Develop projects that address these needs and contribute to the digital transformation of public services preferentially with TTAKs.

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

- Participate in high-profile national and international trade fairs and events;
- Organise laboratory visits and technology open days to showcase achievements;

- 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.

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

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

- Organise and participate in high visibility international events.
- Take a leadership role in EU projects, aiming for coordination roles and maximising budgets.

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

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

- Actively seek international competitive research funding outside Horizon Europe.
- Strengthen relationships with existing industry partners for major contracts.
- Explore philanthropic funding opportunities.

Jointly with these key operational actions, in 2024, two additional structural actions are envisaged:

- Web Site: Leverage the new innovation pages as a tool to promote TEC4 activities.
- CRM: Expand the internal overall use of the tool.

4.10.3 Action plan

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

Table 4.6 - TECPARTNERSHIPS – Main actions planned

Initiatives	Key Results	Strategic Objectives
Meeting with national and international entities	Contacts with new entities and projects with entities	C1.4, C2.3, C2.7, C2.4, C3.1
Participation in Seminars and Fairs QSP Summit, RDV Carnot, AED Days and Portugal Rail Summit	Projects with new entities	C1.4, C2.4, C2.7, C3.2, C5.1
Events organisation	Improve relationships	C1.4, C2.3, C2.7
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

5 RESEARCH AND DEVELOPMENT CENTRES

5.1 CTM - Centre for Telecommunications and Multimedia

Coordinators: Filipe Ribeiro and Rui Campos

5.1.1 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 audiovisual content management, machine perception, and medical image analysis.

5.1.2 Main objectives for 2024

5.1.2.1 Highlights

In 2024, the Centre is prioritising significant advances in the following Strategic Objectives:

Raise the contribution and visibility of our research. Increase the percentage of papers published in Q1 journals (KPI: % Q1 journals; Target: 80%). Create flagship prototypes around the solutions and technologies developed within the Centre (KPI: number of prototypes; Target: 4)

Increase our involvement in the leadership of scientific initiatives. Submit proposals for organising workshops in high-ranked conferences (KPI: number of workshops; Target: 2).

Develop better linkages between knowledge production, development, and market uptake. Increase the protection of the Intellectual Property coming out of the R&D activities developed within the Centre (KPI: number of IP protection result/FTE; Target: 1).

Improve attraction and retention of world-class talent. Attract new PhD students by leveraging ongoing R&D projects and funding for PhDs in both academic and non-academic environments (KPI: number of new students; Target: 10).

Strengthen the sustainability and resilience of our economic model. Submit international project proposals considering competitive research funding calls and contracts with industry (KPI: number of projects; Target: 4).

5.1.2.2 Research

CTM envisions the following distinctive research achievements for the next year:

Causal relationships for Lung Cancer Characterisation. Transition from mere data-fitting and fragmented models to the holistic understanding of cancer by developing integrated ML-based models that provide information about the causal relationships of the pathological phenomena. (SD: AI, BIO)

Chip integrating memristors with thin film transistors. First world demonstration of fabricated integrated circuit featuring a spiking neural network achieved through the integration of memristors with thin-film transistors, enabling Spike Timing Dependent Plasticity learning. (SD: CSE)

Generalisation and application transversality. Inspired by learning mechanisms demonstrated by early infants, exploration of the ML techniques developed at the implementation level in any vision problem attempted to be solved by ML models. (SD: AI)

Human body model modification for data generation. Development of algorithms and deep learning models for the generation of a human body model based on visual data, as well as to manipulate the model under biomechanical constraints enabling the generation of new hybrid videos. (SD: AI, BIO)

ML-based solutions to model, optimise, and enhance wireless networks. Development of cross-layer optimisation algorithms and Network Digital Twins using ML-based approaches aiming to achieve context-aware networking, quality of service estimation, and dynamic node positioning and wireless link adaptation. (SD: COM)

Node positioning and link adaptation in robotic-borne wireless networks. Algorithms and mechanisms for optimal node positioning and radio resource management in robotic-borne networks, optimising Line-of-Sight communications, essential for next-generation networks operating in higher frequency bands. (SD: COM)

Semantic-aware audiovisual representations. New ML-based approaches for modeling the characteristics of audiovisual data with the aim of obtaining a holistic understanding of movies and videos in general that unveil semantic relations between sub-elements of the narrative structure. (SD: AI)

Torso Morphing for Patient Engagement. Development of specific models 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)

Video-based music generation New ML models to automatically generate symbolic music for user-provided videos, employing a cascaded multimodal strategy that extracts both low-level temporal and high-level emotional information from video content, in order to map them into the musical domain and generate the soundtrack. (SD: AI)

Vision-aided communications and sensing. Experimental demonstration of beam steering to track a moving user and human pose identification, by using a Vision-aided Reconfigurable Intelligent Surface controlled by an FPGA and exploring the advantage of real-time Machine Learning algorithms. (SD: AI, COM, CSE).

5.1.2.3 Innovation

CTM envisions the following distinctive innovation achievements for the next year:

Automatic vessel detection module. Software for computer-aided detection of deep inferior epigastric perforators in computed tomography angiography scans, reducing the time and subjectivity inherent to the manual annotation of perforators' vessels and facilitating the pre-operative planning of DIEAP flaps.

Digital Twin of reconfigurable IoT node. Software for digital representation of an IoT node – capable of communicating and harvesting energy through light and radio – as well as its energy consumption and harvesting capability, enabling the development of new energy optimisation algorithms.

Hybrid anomaly detection software. Video anomaly detection software combining ML and traditional CV techniques for flexible monitoring of unexpected/anomalous situations in video surveillance applications, mitigating the lack of adequate data in open problem scenarios.

Modelling RIS-aided wireless signal propagation in a room: Software for modelling the propagation of signals inside user-configured geometrical spaces, which includes the effects of having a user-configured n-bit Reconfigurable Intelligent Surfaces of specified size placed a specific point of the room.

Positioning of a Mobile 5G Base Station. Development 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.

Software for planning breast cancer treatment. Software capable to enable 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 physiological sonification in Max. Library for prototyping sonification strategies based on physiological signals. The package will include a dataset that describes physiological responses from 10 professional actors in 5 emotional states.

Vision-radio research infrastructure. Development of a REST-based service architecture that enables a user to configure an experiment that takes advantage of an 5G Base Station, a User Equipment and a RIS and enables the collection of vision and radio datasets.

5.1.2.4 Complementary advances

Jointly with these key advances, in 2024, 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.

Raise contribution and visibility of our research. Increase 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: 70%). Publish open access datasets that result from the research lines of the Centre (KPI: number of datasets; Target: 2).

Increase our involvement in leadership of scientific initiatives. Co-organise international scientific events, as organising committee or chairing technical committees (KPI: number of events; Target: 8). Organise advanced training programs within the Centre, including 2 summer schools (KPI: number of training programs; Target: 2)

Improve attraction and retention of world-class talent. Attract new national and international young students to the research lines of the Centre taking advantage of the CTM Summer Internships (KPI: new undergrad/MSc students; Target: 40). Attract visiting researchers to the research lines of the Centre (KPI: number of researchers; Target: 4).

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

Develop better linkages between knowledge production, development, and market uptake. Increase the transfer of the technologies developed within the Centre to the market (KPI: number of technology transfer contracts; Target: 1)

Increase our international networking, leadership and competitiveness. Organise scientific events in international cooperation (KPI: number of events; Target: 4). Publish papers within international collaborations (KPI: number of papers; Target: 10). Set up new international collaborations through student/staff exchanges (KPI: number of exchanges; Target: 4).

5.1.3 Main initiatives planned for 2024

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

Table 5.1 - CTM – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Organise CTM Summer Internships	Attraction of future MSc and PhD students Higher visibility and recognition	C4.1
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 main objectives achievement	C2.7
Promote internally high-quality journals and conferences for publication of key research results	Increased impact of the centre in the scientific community Higher international recognition	C1.1, C2.1, C2.7

Initiatives	Key Results	Strategic Objectives
Take advantage of INESC TEC International Visiting Researcher Programme	Improved networking with international peers Increased chances of attracting high-quality international researchers	C4.1
Participate in national and international fora (e.g. ETSI, 6G-IA, NEM, COST actions, ANACOM WGs and stakeholder group mission cancer)	Higher visibility and recognition Influence national and EU funding programmes and research priorities	C1.2, C1.4, C1.6, C3.5
Periodic meetings with INESC TEC's TTO for identifying at earlier stage IP protection and technology transfer opportunities	Increased IP protection and technology transfer results	C1.3, C1.4, C3.2
Create new lab infrastructures for validating 6G solutions and characterising biological tissues	Attraction of new MSc/PhD students and R&D projects	C5.3

5.2 CAP - Centre for Applied Photonics

Coordinators: Paulo Marques and Ireneu Dias

5.2.1 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.

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.

SCIENTIFIC ACTIVITIES

The scientific activities are developed in three main areas of research, described below. In all areas, expansion and consolidation of national and international partnerships with complementary expertise required for the goals described will be actively pursued.

5.2.2 Main objectives for 2024

5.2.2.1 Highlights

In 2024 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%.

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. For that purpose, at least one application will be submitted in 2024, 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 projects CorkSurf and CaVaLi that concluded successfully in 2023, the Centre plans to apply for demonstration projects in other areas of application.

5.2.2.2 Research

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

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

This research activity foresees the medium-term development of photonic based devices that allow monitoring and analysis of specific targets, using label free and reagent free sensing technologies, aiming for miniaturisation, handling simplicity, speed of operation and long-term stability. This would be accomplished with Networked

Optical Intelligent Tools for real-time monitoring, incorporating robust biological and chemical sensing capabilities to ensure reliable and accurate data collection to be implemented in a wide set of sectors as inshore and offshore aquaculture systems, biomass production industry, and energy distribution. To advance with these objectives, next year work will focus on the following activities:

- Processing optical materials through advanced fabrication techniques, as femtosecond laser writing, to develop integrated optics, gratings, optical waveguides and optofluidic systems.
- Development of dielectric photonic crystals and plasmonic based sensors combining high quality nano coatings and specially designed nanoparticles for high efficiency sensing devices for biological and chemical detection.
- Development of solutions for air and water quality monitoring, combining chemical processes and high-performance optical transducers through a set of advanced spectroscopy techniques.
- Explore sensor fusion strategies to enhance LIBS systems performance for industrial purposes.

  Explore the use of optical tweezers systems for the detection of nanovesicles supported by molecularly imprinted polymers.

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 Azores and Sines with Distributed Acoustic Sensing (DAS) technology by means of its implementation in intercontinental submarine cables already deployed.
- Study and development of the distributed sensing system using polarimetry (SOP, state of polarisation) for ultra long-distance sensing.
- Implementation of an R&D distributed sensing cluster of submarine cables for the monitoring and detection of seismic activity, oceanography, Security and Defence.
- 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.

In parallel, we continue to study, design and develop high-power lasers for wireless energy recharge in space exploration environments, namely, CubeSat applications.

A European proposal was submitted whose aim is to study and develop new 1mm lasers with continuous emission for use in telecommunications and/or wireless energy recharge in space exploration vehicles.

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 two operational objectives:

- Upgrade the existing experimental system for analogue quantum simulations by increasing the versatility of the scenarios that can be explored, in particular exploiting the use of two beams for the exploration of truthful quantum turbulence playgrounds;
- Explore quantum sources and quantum interference with photons for extreme learning architectures.

5.2.2.3 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 will be developed. The approach will be using novel algorithms, to be developed, that will effectively utilise

multimodality, capitalising on individual strengths of distinct sources, (Laser-Induced Breakdown Spectroscopy, LIBS and Hyperspectral Imaging, HSI for example), combined to enhance the capabilities of the single modality system.

5.2.2.4 Complementary Advances

Jointly with these key advances, in 2024, 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.

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.

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, APIE, 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 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.

5.2.3 Main actions planned for 2024

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

Table 5.2 - CAP – 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	Submission of an ERC Grant application	C1.2

Initiatives	Key Results	Strategic Objectives
To participate in an Open Day for industry, with other INESC TEC centres	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

5.3 CRAS - Centre for Robotics and Autonomous Systems

Coordinators: José Miguel Almeida and Nuno Cruz

5.3.1 Centre scope and vision

CRAS addresses challenges associated to activities in harsh, dangerous, complex, and dynamic environments. In these scenarios, the replacement of human presence by robotic systems avoids unnecessary risks, while providing room for improvement in mission performance. The Centre activities are driven by these challenges, both at the scientific and technological domains, as well as several trends and concerns, both from the societal and funding perspectives. This explains the broad range of TRL addressed by CRAS activities, from fundamental concepts to effective devices used in field operations. The Centre activities are aligned with major priorities and concerns at national to international levels, as addressed, for example, in:

- 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 Sustainable Development Goals – Clean Water and Sanitation, Industry Innovation and Infrastructure, Climate Action, and Life Below Water, among others.

The Centre works towards a future where autonomous systems can operate proficiently in harsh environments, either 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 addresses the navigation of autonomous systems in environments where global positioning aiding systems are not available. At its core lie methodologies for multisensory data fusion applied to localisation and navigation problems. Dynamic modelling of sensors and robotic behaviour, using either deterministic or stochastic approaches play a key role. This RL also tackles challenges associated with the design and implementation of time efficient data processing algorithms enabling their implementation in real field going robots. Specific problems addressed include the following: algorithms for simultaneous navigation and mapping, semantic navigation, control of multibody/variable geometry robots, degraded modes of operation, environment aware navigation, guidance and control, seamless transition between open area and close to features operations, underwater and above water platform docking, and information aware path planning and trajectory tracking.

RL2. Interaction with environment

This RL addresses challenges motivated by the operation of robots in environments or scenarios where explicit interaction with objects or features is required. Relevant examples are autonomous intervention from floating bases (AUVs, ASVs, drones), object placing or picking from surface or sea bottom, or vehicles docking to other vehicles or systems. Methodologies and algorithms are sought to deal with obstacles (greater accuracy required to handle objects as compared to avoiding them, need to assess and mitigate risks – collision, imprisonment, or dead-locks, for example), to address control problems related to mobile intervention (end effectors mounted on moving platforms), and to deal with cooperative intervention.

RL3. Perception and mapping

Traditionally, mobile robots operate as data collectors with limited onboard data processing capabilities. This paradigm is shifting to robots with heavy onboard data processing capabilities allowing for high level onboard decision making. This RL addresses the new challenges posed for such scenarios. At its core lie the development of computer vision techniques and algorithms, sensing strategies for single or multiple robotic systems, adaptive sampling techniques, multi sensor data fusion for underwater or overwater mapping, hyperspectral, electro-optic and acoustic image processing, and underwater acoustic positioning systems.

RL4. Platforms and operations

This RL addresses the development of innovative robotic platforms as well as novel concepts of operation. Core areas of work are command and control of multiple coordinated platforms, development of mobile beacons for underwater positioning and communication networks, and coordinated operations of heterogeneous platforms. These can be planned or supervised under new frameworks associated with the concept of digital twins. Coordinated mobile platforms are enablers for advanced solutions in multiples domains. Relevant examples are the use of multiple airborne robots for the establishment of non-permanent wireless communication networks, or the use of coordinated robots to simultaneously map time and space variations of a given phenomenon. The design of efficient propulsion systems for underwater or surface vehicles, the development of long-range navigation algorithms, the development of energy harvesting systems for robotic platforms, and the development of auxiliary systems for long term deployments (e.g. docking stations, energy transfer systems suitable for underwater operation) are also addressed by this research line.

INNOVATION ACTIVITIES

CRAS innovation activities are the following:

INOV1. Robotics systems prototyping and upscaling

The Centre will proceed with upgrading the robotic prototypes for operations in flooded mines and deep waters. Dedicated solutions for inspection of infrastructures, both underwater and above water, will be prototyped and field tested within the scope of ongoing projects. Furthermore, a continuous update of existing robotic platforms used in tests, demonstrations and support of scientific work will be pursued.

INOV2. Navigation and mapping

This activity encompasses the development of solutions for specific challenges for which CRAS expertise is instrumental. Examples are the reconstruction and mapping of 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.

INOV3. Component development for robotics systems

Development of components for robotic systems that are expected to greatly increase the performance of the robotic solutions. 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.

INOV4. Underwater acoustics for positioning, navigation and communications

This activity involves the research, development and deployment of underwater acoustic systems embedded in custom designed vehicles and platforms for the aquatic subsurface environment, to enable support for precise relative and absolute positioning, cooperative navigation, and communications. The ability to create innovative solutions in this domain, highly customised and flexible, is a key competence essential for going further on multiple aspects of underwater autonomy.

5.3.2 Main objectives for 2024

5.3.2.1 Highlights

In 2024, 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 – CRAS will prioritise a steady increase of publications in high-impact journals, mainly Q1 and Q2, ensuring both quality and quantity improvements. The objective is to reach a 10-15% increase in indexed publications per FTE researcher. The year of 2024 will also be a milestone in terms of PhD theses, with at least 3 defences being expected.

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 – The year of 2024 will set a milestone in terms of IP protection, with many initiatives of valorisation of the results of recently finished European projects. This will be complemented with dissemination activities to strengthen the image of the Centre as an innovation hub, particularly in scenarios related to marine robotics.

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

C5.1. Strengthen the sustainability and resilience of our economic model – One objective for 2024 is to pave the way for a more sustainable operational model, by applying for longer term research projects, trying to license products that generate alternative income, and reach a steady state exploitation program for infrastructure assets, such as the R/V Mar Profundo.

5.3.2.2 Research

The main scientific activities of CRAS lie in the Robotics domain, with some other activities in Perception and AI.

In terms of Robotics, several research milestones are planned for 2024. Examples that address challenges in all research lines RL1-RL4 will be: the demonstration of a fully autonomous docking system for an AUV, the development of new autonomous exploration capabilities of the UX1-neo robot for confined complex environments. Another example addressing RL4 is the implementation of a hybrid propulsion system in a hovering AUV, fusing electric actuated thrusters with a variable buoyancy system. Another example addressing the RL3 is the research in multi modal perception and awareness methods for a WIG autonomous vehicle.

5.3.2.3 Innovation

CRAS research is applied in multiple sectors, but the main activities are dedicated to the marine environment.

In 2024, in the scope of a specific service being planned for Brazil, CRAS will customise and demonstrate a high accuracy localisation device for underwater divers and equipment (INNOV4). The DART AUV will have a first demonstration in a deep water mission (INNOV1 and INNOV2). Following the successful implementation of a SMART Cable off the coast of Sesimbra, in project K2D, CRAS will demonstrate an improved version of the system in a collaboration with University of Algarve and the Portuguese Navy (INNOV3 and INNOV4). In 2024, will start the licensing of the UX1-neo to Unexmin Spinoff (UGR). Additionally, in 2024, two new versions of the e-DNA sampler prototypes will be developed for a Belgian institute.

5.3.2.4 Complementary advances

Jointly with these key advances, in 2024, 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. These demonstrations will also serve to improve the base for technology commercialisation, by using meaningful scenarios for partner institutions. The Centre will also look for new opportunities to attract PhD students, namely with the participation in European networks for higher education programs (eg. Marie Curie networks), or taking advantage of existing relationships with partner institutions. Some initiatives to provide innovative learning experiences will be reinforced, such as the case of organising and/or participating in competitions. The Centre will maintain its encouragement to the participation of its researchers in the organisation of international events and in international exchange programmes.

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 the development of direct contracts with national and international companies dealing with current societal challenges, namely solutions to mitigate the shortage of raw materials, to assess the impact of renewable energy production, or to study the status of vulnerable ecosystems. These will result from ongoing discussion fora, where CRAS researchers already have an active role. CRAS plans to maintain the same level of

participation in exhibitions and fairs, both national and international, which serve as a showcase of research and technology results, and also to communicate scientific and technological achievements.

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. The Centre will encourage such participation, not only through regular membership and sponsorship, but also by taking relevant roles in the organisation of events. 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 the 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 also hosting and providing support to international students involved in exchange or mobility programs (eg. Erasmus), as a way 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 source of funding is through competitive project calls. The Centre will prioritise service contracts with companies and potential licensing of products to increase longer term sources of funding. The Centre manages expensive robotic systems and support equipment that require regular maintenance and upgrades, as well 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, that have been fundamental to support R&D activities, but require permanent investment. The Centre has started exploring the rental of these assets in specific periods of inactivity as an important income, and this will reach the steady state in 2024.

5.3.3 Main actions planned for 2024

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

Table 5.3 - 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 (REPMUS24)	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

5.4 C-BER - Centre for Biomedical Engineering Research

Coordinator: João Paulo Cunha
Assistant Coordinator: Duarte Dias

5.4.1 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.

5.4.2 Main objectives for 2024

5.4.2.1 Highlights

In 2024 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.

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

- In 2024 C-BER will, for the first time in INESC TEC, lead jointly with CTM an European Project in the Health area. *AI4Lungs*, a ~7M€ project will allow to lead a 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.

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

C2.6. Engage in direct dialogue with the public

- C-BER will be running in 2024 more than 5 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. We will have planned at least 2 clinical studies that will provide smart Applications to be used by patients for the home monitoring.

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

- A strong presence in several highly relevant IEEE conferences (MELECON 2024, EMBC 2024, …) and a strong activity in news publication at the social media channels and international technological magazines. new achievements.

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 at Biomedical Engineering. C-BER is constantly partnering and bringing to our ecosystem different profiles related with this area. In 2024, besides engineers and data scientist from different fields (electrotechnical, informatics, biomedical, …) we envision to bring new experts on the field of biology, medical and nursering to support in 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 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 in the area of Point-of-Care (PoC) technologies.

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

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

- C-BER is expanding its laboratories and enabling to perform a higher number of experiments with state-of-the-art equipment. Recently, in the end of 2023, a new 64-channels video-EEG system was acquired with fMRI synchronization capabilities in order to support new studies on the neuroscience field. Also, a new laboratory for students will be created at FEUP, equipped with several medical/health systems that will support student projects to be performed with a much better support and guidance, increasing students' motivation to pursuit new research areas.

5.4.2.2 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 2024 activities our main focus will be to co-lead the ~7M€ Horizon-Europe AI4Lungs that will develop and validate 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.

2024 will be a year of focused activity in the smart-wearables area funded by the PRR projects where we will develop 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 is to perform high-level interdisciplinary R&D in engineering and computational approaches applied to basic and clinical neuroscience, namely crossing several areas, such as

Physics; Engineering (Electronics, Computation, etc.), Neurology, Neurosurgery, Neurophysiology, Neuroradiology and Neurobiology. Furthermore, we also aim to innovate and facilitate tech-transfer to the high-tech market.

During 2024 we will be focused in two main areas, namely the novel adaptative Deep Brain Stimulation approaches under the SmartDBS project and the novel Neurophotonics R&D approaches that aims to expand our previous successful iLoF-intelligent Lab-on-Fiber technology.

5.4.2.3 Innovation

C-BER complement it's the scientific goals with a proven *science-based innovation model* (already with +40 patents of 9 different technologies and 3 startups created with ~8.5M€ raised… and counting) that is based on the following principles:

- Patent protect medium TRL results so that they constitute assets to future TRL progression and promote the spin-off of these results to new startups that we incubate in our lab.
- To promote internal synergies and strategic partnerships with other Centres of INESC TEC, clinical partners, research institutes, medtech companies & startups and foster international cooperation.
- Mentor and help drive the technology to the market with our startups in a bootstrap model of sharing lab facilities and provide knowledge based services.

For the year of 2024 we are preparing the spin-off of startup#4 from our centre in 2024 (details cannot yet be disclosed). Jointly with our start-up *inSignals Neurotech* we will roll-out in 2024 clinical studies in 3 international clinical centres for Parkinson Disease treatment. These trials aim to improve and validate at an international level the medical device under development for the quantitative evaluation of Parkinson Disease motor symptoms.

5.4.2.4 Complementary Services

We have 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 smart-wearables for pregnant women monitoring 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 2024 and follow the next innovation pipeline steps to a translational to the market direction.

5.4.3 Main initiatives planned for 2024

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

Table 5.4 - C-BER – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
AI4Lungs kick-off meeting	Successful integration of all consortium partners and their roles and tasks.	Strength relations with partners for project success and even for other possible projects.
Participation in the ARTEX (ARmy Technological EXperimentation) exercise	Test new functionalities of the Human Machine Symbiosis C-BER research line.	Show to the army the most advanced research on this research line for future partnerships and projects.
Organization of the Biomedical section of the MELECON 2024 IEEE conference	Increase C-BER and INESC TEC visibility in the health area with the coordination of the Health track program	Create new scientific partnership for further collaborations and research projects.
Two C-BER meetings	Bring all C-BER members together for scientific discussion and knowledge share	Promote inner-center collaboration and resources and knowledge sharing

Internationalization of health research at INESC TEC with worldwide travels to scientific partners	Increase our connection with key partners that are already working or have strong synergies to work with C-BER	Expand C-BER activities by creating partnerships with international institutions for further research and scientific projects/activities

5.5 CPES - Centre for Power and Energy Systems

Coordinators: Manuel Matos and Ricardo Bessa

Assistant Coordinator: David Rua

5.5.1 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.

5.5.2 Main objectives for 2024

5.5.2.1 Highlights

In 2024, 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

- Create a positive list of journals and conferences to disincentivise publications in predatory publishers.
- Define and implement a policy for making datasets and tools publicly available.

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

- Participate in formal and ad-hoc reflection groups at the EU and international levels.

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

- License the energy communities platform to industrial partners in Portugal and continue collaborating with SAP to integrate this R&D result in their marketplace.
- Strengthen already existent relationships with relevant power sector technology providers as well as emerging companies developing innovative smart grid solutions.

5.5.2.2 Research

CPES's scientific domains focus on Power and Energy and AI, divided into six pillars whose expected outcomes for 2024 are described below.

Power system planning, reliability, and resilience

Definition of probabilistic hosting capacity criteria for planning the integration of renewable energy resources into the distribution grids. Moreover, new probabilistic methodologies for assessing the adequacy of distribution

systems with demand response will be developed, considering energy-limited resources and fast reconfiguration procedures.

Probabilistic methodology for the planning of energy systems within energy valleys. In 2024, the Centre will start a new EU-funded project named Crete Valley, where the planning of storage, energy carriers, networks, renewable energy resources, and demand response will be addressed locally to promote the development of sustainable communities.

Network operation, management, and automation

CPES is coordinating the HE AI4REALNET project, with the involvement of CITE, CBER, and LIAAD, focused on hybrid decision-making between humans and AI in the operation of critical infrastructures (power grid, railway, and air traffic management). In 2024, the main outcome will be a conceptual framework combining SSH (psychology, ethics, philosophy), AI, and domain knowledge. It will start research in developing an alarm engine for reinforcement learning algorithms and robustness tests for AI.

Electricity markets and regulation

CPES is leading a WP in the ENPOWER project. In 2024, the main outcome will be the continuous development and improvement of the SITEC (energy communities sizing), OSTEC (centralised energy management of energy communities) and FATEC (flexibility potential assessment) tools to design a cross-commodity DER/DR flexibility-centric digital tools for flexibility assessment and planning.

Multi-carrier energy systems

New methods for optimal operation and planning of gas networks with injection of green hydrogen.

In the PRR H2driven project it is addressing the integration of hydrogen electrolysers in the electrical grid at the MW scale and investigating their capabilities to provide grid ancillary services. In 2024, the main outcomes expected are: detailed dynamic model for the electrolyser based on experimental data, frequency and voltage support capabilities from hydrogen electrolysers using voltage source converter technology (simulations and experimental results using prototypes), and frequency and voltage support capabilities from hydrogen electrolysers using current source converter technology (simulations)

Demand-side energy management

The dynamic discounts for electrical mobility experiment with real users, in cooperation with Sonae MC in the H2020 InterConnect project, will start in 2024, and the Centre expects to apply causality inference techniques (double machine learning) to study the behaviour and elasticity of EV drivers to these signals. The results of this work will be disseminated to Microsoft.

CPES is leading a WP in the MAGPIE project, focused on developing digital tools to aid the planning and management of green energy supply, demand and smart logistics in ports. In 2024, the main outcomes will be a set of open-sourced models that will allow port stakeholders, such as port authorities, shippers, terminal, and electricity infrastructure operators, to optimise the management of the local supply of renewable energy considering the flexible and non-flexible loads associated with different port and terminal assets, e.g., cranes, yard trucks, Onshore Power Supply infrastructure, reefers, buildings. The outputs will also include models for renewable energy planning, mainly focusing on local wind and solar resources for ports.

As part of the ATE subproject for Zero Energy Buildings, CPES is responsible for creating a digital platform that enables efficient management and optimisation of commercial building facilities and systems. The platform will provide a single graphical interface to ensure seamless integration of all systems.

RES & storage integration

In the HE ENFIELD project, CPES is developing a novel approach to AI: symbolic learning from data for supervised and reinforcement learning, where humans are an active part of the design and learning process. This approach will be applied to i) dynamic security assessment and inertia dispatch in isolated power systems, and ii) real-time operation of hybrid storage systems.

Predictive multi-temporal optimisation algorithm for hybrid energy storage systems considering dynamic security constraints.

In the HE InterSTORE project, it will develop control methodologies for hybrid energy storage systems for improved performance in multiservice provision. Building upon the sizing model of hybrid storage systems

already developed within the project; further developments are foreseen for the inclusion of control strategies to improve the performance in multiservice provision compared to a base case with a single battery.

Moreover, CPES will continue the research in analytics and data markets, e.g., extend its application to classification problems, and improve the data-by-data exchange mechanisms; new developments on the interpretability of deep learning techniques applied to load forecasting.

5.5.2.3 Innovation

CPES research is applied in multiple sectors, with a focus on the Power and Energy sectors and complementary utilities' business.

Power system planning, reliability, and resilience

In 2024, in the scope of project MORADIST, the Centre will demonstrate the integration of the new version of the PS-MORA software within the advanced computing infrastructure set up at REN premises, enabling the adequacy assessment of large interconnected networks, such as the Iberian interconnected system, via the Sequential Monte Carlo Method.

In 2024, within the framework of a consultancy project with EEM, the Centre aims to showcase the technical viability of islanded networks in providing renewable electricity to large cruise ships during their time at the dock.

Network operation, management, and automation

To contribute to improving distribution network protection by integrating inverter-based generation taking advantage of distributed computing capabilities, in 2024, CPES will develop and test new algorithms that adapt protection settings to current operation conditions.

In the ATE project (PRR), new functionalities will be implemented in the real-time model for simulations, including advanced and enhanced adaptive protections. The development and practical application in the laboratory setup of the algorithms to be worked on are expected, aiming to ensure the coordination of protections in MV networks with the presence of renewables.

Start of the HE TwinEU project to construct the digital twin for the European power system. In 2024, CPES will develop the conceptual model for the Digital Twin and identify the relevant technologies.

Electricity markets and regulation

HE BeFlexible project will continue the development of the Grid Data and Business Network with SAP, in cooperation with HASLab, and integrate flexibility-centric community services in SAP cloud technology and store. The goal is to bring this result to the market, in partnership with energy companies and cloud providers like SAP.

RECreation (platform for the management of energy communities) will be integrated in the GDBN and SAP App store, enhanced with the provision of flexibility by the energy community behaving as an aggregator and demonstrated.

INESC TEC coordinates the Tools4AgriEnergy project for the development of digital tools for energy communities in the agrifood sector, with new business models exploiting the links among the agrifood sector activities, energy, and collective self-consumption and energy communities. Tools4AgriEnergy involves key partners such as EDIA, FENAREG, INIAV, and small and medium companies in the agri-food sector.

The new algorithms developed in the ATE subproject that INESC TEC has with Mota Engil Renewing will be implemented into the existing energy management tool for energy communities to operate in cluster of services and industry facilities, as well as the connectors and interfaces to integrate INESC TEC tools into the existing Renewing software platforms.

Multi-carrier energy systems

The MAGPIE project will develop modules for sizing and forecasting of renewable supply and energy demand for green ports. The goal in 2024 is to develop a set of modules that model the supply of (local) green energy production and demand of port assets, considering the full decarbonisation of port operations till 2050. This will allow ports to better plan for the upcoming transition on the one hand, considering their own set of assets and logistics goals, and on the other to manage the future supply and demand for green vectors (e.g., green electricity, hydrogen, ammonia) for an increased number of port assets and maritime, inland shipping, road, and rail transport.

Demand-side energy management

HE ENERSHARE project will continue integrating data-centric services for local energy communities with the Energy Data Space concept (and software components) and create the conditions for field demonstration of these energy services. This work will be done in cooperation with HASLab. Moreover, it will improve the data market prototype.

The NEXUS project will develop and integrate predictive systems for the energy resources of the Porto de Sines ecosystem articulated with distributed management and control systems exploring cloud and edge computing functionalities. The goal in 2024 is to implement multicriteria optimisation tools for the decarbonisation of the Port of Sines energy system and promote flexibility services both internally and externally.

ATE's Zero Energy Buildings subproject will develop models and algorithms to enhance the management of building energy flexibility based on the building's energy needs and the management of EV charging to provide energy services to the grid. In 2024, the models and algorithms will be developed and integrated into a digital twin of the commercial building. In addition, we will define systems interoperability architectures and data exchange models.

RES & storage integration

CPES is involved in the NEXUS project, focused on developing an energy monitoring service based on the existing energy monitoring infrastructure of the port of Sines and proposing new measuring processes and devices when needed, to provide a comprehensive energy picture of the real-time energy consumption and generation resources. In 2024, the main outcome will be the provision of an energy management system tool with capabilities for exploiting energy analytics, energy monitoring, energy storage, energy management, and a technical grid operation module while sourcing locally generated renewable electricity.

Finally, a subproject in PRR ATE will start the development of an automated machine learning platform, leveraging past developments of CPES in time series forecasting, feature engineering, and federated learning. This platform will be applied to multiple energy use cases. In a contract with Elergone Energias, CPES will continue the development of new functions for the company's operational load forecasting system, which is a successful case of technology and knowledge transfer to the industry. The Vine&Wine_PT project will focus on enhancing the energy analytics layer. The objective for 2024 is to successfully develop, implement, and conduct initial testing on data-driven functions for energy management.

5.5.2.4 Complementary advances

Jointly with these key advances, in 2024, 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 maintain its efforts in publishing open-access datasets, with a foresight of 2 new datasets in 2024. Furthermore, it will prioritise open-source initiatives from research projects and publications. The Centre plans to consolidate the open-source results from different EU projects, namely ATTEST, InterConnect, ENERSHARE, and AI4REALNET.

The Centre will strive to increase the number of PhD students by opening 14 additional positions. The Centre plans to implement internally an initiative to send researchers and Ph.D. students for short international stays in the framework of EU projects.

CPES will continue its collaboration in AI applied to energy systems via the HE ENFIELD project, a European Lighthouse to Manifest Trustworthy and Green AI.

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

CPES plans to maintain (or even increase) by at least 10% the volume of contracts with the industry, keeping a good combination of specialised consultancy and R&D contracts fully funded by industrial partners.

CPES will organise an external event dedicated to the topics of decarbonisation of electric power systems and creativity in science and plans to continue its participation in Enlite 2024 and leading positions in CIGRE and IEEE working groups. The contribution to International Associations (ETSI, AIOTI, EERA, CIGRE, IEEE) will continue to be active, and it will start an active participation in the ADRA Association.

The organisation of monthly scientific sessions will continue in 2024.

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

The policy of hiring researchers with a good publication rate will continue in areas such as power systems, electricity markets, emerging challenges for digitalising the power system, and seeking to build a multidisciplinary team. CPES expects to hire Ignacio Hernando Gil, Associate Professor at ESTIA Institute of Technology. In the first semester of 2024, CPES will host Dr. Mladen Kezunovic, Regents Professor at Texas A&M University, IEEE Life Fellow, and a CIGRE Fellow.

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

CPES will continue developing its research infrastructure (Smart Grids and Electric Vehicles Laboratory), with an expected investment of 352,000€ in equipment and software. Furthermore, the areas of the Centre will be revised to accommodate recent changes in INESC TEC science model.

5.5.3 Main actions planned for 2024

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

Table 5.5 - CPES – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Define a positive list of journals and conferences in which the Centre researchers will endeavour to publish	Increase in the quality of the publications	C1.1
Organise a public event for industry and research partners	Disseminate the R&D work	C2.7
Develop new frameworks and methodologies for AI-human teaming in the operation of critical infrastructures and also targeting sustainability targets	Publish at least 2 Q1 journal papers and influence other researchers. Gain international visibility in this area	C3.1
Participate (by invitation of a small group of EU research institutions) in the EU-US cooperation on AI for Public Good (Focus Area: Electricity Grid Optimisation).	Demonstrate international capacity and excellent of the Centre in the areas of power systems and AI	C3.1
Adopt the Data Space concept and software components for the energy use cases at the Centre. Demonstrate at least 4 data-centric solutions for energy systems	Alignment with and contributions to the European Common Data Spaces program.	C1.2
Prioritise open-source initiatives from research projects and publications.	Increase impact from R&D work and attract interest from industry in industrialisation	C1.2
Expand the research infrastructure (Smart Grids and Electric Vehicles Laboratory)	At least 2 new test beds: smart EV charging, citizen-centric services	C5.3

5.6 CESE - Centre for Enterprise Systems Engineering

Coordinators: António Lucas Soares and Rui Rebelo

5.6.1 Centre scope and vision

CESE is a multidisciplinary 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 on-going 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.

5.6.2 Main objectives for 2024

5.6.2.1 Highlights

In 2024, 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 will take action to **increase the average relevance of its publications in 2024 by 20%** and **pursue the goal of 3 indexed publications by FTE per year** to consolidate its international position across its research lines;

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

- CESE will organise **the IAMOT 2024 - Human-centred Technology Management for a Sustainability Future -** one of the most reputed scientific conferences in the Technology Management research 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 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.

5.6.2.2 Research

Manufacturing Systems Design and Management

This research line will continue to develop digitally driven approaches towards more sustainable, resilient, and human-centred manufacturing production systems through integrated, multi-disciplinary methods grounded on integrating digital technologies. In the research topic “digital transition of production systems”, the main goal is to **investigate how integrated optimisation/simulation hybrid approaches and process digital twins can help to design and reconfigure more adaptable and sustainable production systems**. In the research topic “real-time decision-making”, the main goal is to **develop a reference framework oriented to planning and scheduling decision-making in complex operations environments** for high-mix production and “one-of-a-kind” products.

Supply Chain and Collaborative Networks Management

This research line will continue studying innovative supply chain models and strategies that support companies to face the complexity and uncertainty of contemporary environments. In the context of the project ReSChape, this research line will work on identifying the **necessary skills for future supply chains**; developing **a model to evaluate the social impact of supply chains;** and developing **a cross-country analysis of existing public policies concerning supply chains in Europe**. We will also **explore implementing new circular supply chain business models, especially for the textile, plastic, packaging and food sectors** within the scope of the SoTecIn Factory project and continue **investigating the role of visibility and trust in different supply chains.**

Industrial Information Systems

This research line aims to develop new concepts of data and information management systems for industrial organisations and ecosystems. In the research topic "digital enterprise architectures", the goals are to continue developing an **architecture for a Digital Platform managing digital twin instances by integrating the combination of Large Language Models and Knowledge Graphs approaches**. In the research topic "Industrial data & information management", we will develop a methodology for the socio-technical design and implementation of **digital platforms for data ecosystems**. In the research topic "design and impact of IIS" the goals are to **contribute to the design theory of digital platforms for data ecosystems**.

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. In the context of SoTecIn Factory, we will investigate **the adoption factor of circular strategies by packaging companies** and their influence in the value chain, in a comparative study Portugal x Poland, and the **relation between the adoption of R strategies and the scalability of born circular start-ups**. In the context of project DEO, our research aims to **characterise the enablers and barriers to the adoption of augmented reality technology in the manufacturing industry**, and to specify **design propositions** to raise their adoption.

Logistics and Mobility

This research line integrates know-how and experience in decision support systems, simulation, optimisation and information and knowledge management, applied to transportation and logistics. In the research topic "MaaS (Mobility as a Service)" the main goal is to develop a **participatory design of innovative mobility services (both for people mobility and urban logistics) based on the co-creation of solutions and on digital platforms**. In the research topic of "intermodal logistics and transportation systems", the main research deliverable will be **a framework to support decision-making in more sustainable intermodal freight operations and global supply chains using synchro-modality in transportation networks**.

5.6.2.3 Innovation

CESE research is applied in multiple sectors, focusing on Shoes / Textiles, Automotive and Metalworking.

Simulation combined with optimisation techniques will be used in several projects **to increase the TRL from research results and provide consultancy services**. In a contracted project with Cornerstone BB – USA (together with CRIIS), scenarios will be developed using simulation to facilitate the decision-making process in **fleet management**.

Eco-efficient production planning will also be a target of the above approach, namely for the production planning of shoe injection machines, where strategies to achieve production objectives consider **sustainable factors, such as the number of CO2 emissions**. Furthermore, we will apply it in the **pharmaceutical industry** (project FuturePharma) and in **multimodal transport systems** (project NEXUS).

In the topic of industrial data management, the development of all the required software components that enable the **creation, deployment, usage, and management of data spaces according to the International Data Spaces (IDS) Reference Architecture** version 4 (2022) will be consolidated and concluded.

The **Digital Product Passport** is an important topic for the centre, as it directly impacts our strategic goal of engineering sustainable systems. We will start deploying **pilot demonstrators being developed for the textile and footwear sectors in the field of circular economy using DPP for traceability** along the value chain.

The **application of AI techniques to quality control** will continue to be explored. For this period, a specific example is the **Active Learning workflow for image classification tasks** (e.g., object detection, quality inspection) that can be used for developing applications in new domains or providing hands-on training courses. This will contribute to the iiLab and Produtech R3 projects.

The **consultancy services related to technology management and digital transformation** will continue to evolve, aiming at two objectives: (i) to develop Manufacturing Process Digital Twins and IT/OT **Integration adoption methodologies,** and (ii) to develop and update the **Digital Maturity Assessment and Roadmapping framework including circularity and sustainability dimensions**.

5.6.2.4 Complementary advances

Jointly with these key advances, in 2024, 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 established a plan, to be implemented during 2024, for adopting generative AI tools to support all research and innovation activities. The plan includes identifying methods, models, and procedures that can profit from genAI, and the characterisation of training needs for the centre researchers.

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

In alignment with the industry's needs, CESE plans to develop one project as direct contract research in the fields of Product Digital Twin and Digital Platforms. As contributions to the communication of scientific and technological achievements, CESE plans to participate in 2 expositions and fairs.

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

CESE will lead the creation of a Business Alliance between stakeholders in the Portuguese textile sector as an organisational setup for managing and governance of an IDS data space, enabling the digital integration of a relevant number of Portuguese ERP suppliers.

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

CESE will review its procedures for micro-managing performance and supporting actions to the centre researchers. Also, we will provide training (both external and internal) in EU project management and proposal writing.

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

CESE will continue managing its investment in the iiLab by refining the dissemination, communication model and training models derived from its research results.

5.6.3 Main initiatives planned for 2024

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

Table 5.6 - CESE – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Develop and implement a plan for the use of generative AI in all the internal research and innovation activities of the centre and devise the impacts of this technology in industry	Increase in the quality and efficiency of the research activities and technology transfer and adoption	C1.1, C1.5
Provide training (both external and internal) in EU project management and proposal writing	Four researchers trained	C1.6, C3.5
Organisation of IAMOT 2024 - Human-centred Technology Management for a Sustainability Future - one of the most reputed scientific conferences in the Technology Management research area	Target of 200 participants	C1.2
CESE use of iiLab completely planned		C2.3

5.7 CRIIS - Centre for Robotics in Industry and Intelligent Systems

Coordinators: António Paulo Moreira and Germano Veiga

Assistant to the Centre Coordination: Luís Rocha

5.7.1 Centre scope and vision

The Robotics and Intelligent Systems Centre designs and implements innovative solutions within the areas of industrial, agriculture and forestry robotics and intelligent systems. The Centre closely cooperates with Companies, other INESC-TEC Centres and other Institutes and Universities, following the lemma from Research and Development to Innovation, passing through Design, Prototyping and Implementation.

5.7.2 Main objectives for 2024

5.7.2.1 Highlights

In 2024, 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.

- CRIIS will continue to prioritise the publication of scientific articles in journals of high merit positioned in the Top 5 of the bibliometric reference databases. In addition, the centre will encourage the publication of papers in the leading international conferences in robotics, such as ICRA and IROS.
- The centre will also focus on developing open-source contributions for strategic application areas such as Cloud-Robotics and Containerisation.

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

- Encourage active search for new partnerships with companies (national and international) for diversifying and improving technology transfer channels and creating long-term programme contracts. CRIIS will aim for at least one major contract with the industry during 2024.

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.

- Continue the pursuit of developing a spin-off company that will attempt to commercially explore the automation of containerisation, simulation, and deployment of robotic applications.

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

- Development of a joint laboratory for robotics in the textile industry with the national technological centre for the sector.

5.7.2.2 Research

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

Robot Autonomy and Manipulation capabilities: To improve robot autonomy, physical interaction capabilities and dexterity in more complex environments by progressing in the following research areas: (1) multi-modal sensor fusion and calibration; (2) Long-term SLAM to allow the robotic system to both adapt to new environment changes, in challenging indoor and outdoor environments (3) Enhanced manipulation through AI-based perception and grasping to dynamically recognise, locate and carry out object picking (including flexible objects) to sustain the robot's autonomy; (4) multi-robot coordination with manually operated vehicles in the heterogenous environment, with the human in the loop; (5) Seamless integration with digital twin-based infrastructure, promoting their trustworthiness and harnessing the transformative power of AI.

Human-Robot Collaboration: To develop new algorithms, methodologies and tools that allow robotic systems to collaborate with humans synergistically and dynamically by researching in the following topics: 1) AI-based algorithms for human real-time action/posture recognition and tracking, enhancing natural and safe collaboration; (2) spatial and mixed augmented reality and remote-control systems for enabling human operators to interact with complex production resources intuitively for improving productivity.

Sustainable development of Robotic Systems: To design advanced robotic system to target extreme scenarios by progressing in the following research topics: (1) novel coordinated motion control and planning algorithms for complex kinematic and redundant robotic systems, exploring classical control theory and AI; (2) Construction of modular and multi-purpose robotic systems addressing challenging environments. (3) Pioneering Continuous Integration (CI) and Continuous Deployment (CD) solutions for robotics, powered by cloud-based simulations and AI-driven validation processes, all within the streamlined containerised software development pipeline;

5.7.2.3 Innovation

CRIIS research is applied in multiple sectors, focusing on Manufacturing, Agriculture, and Forest.

Dexterous textile manipulation: To advance robotic systems in the textile industry, CRIIS will build on research findings related to manipulating flexible objects, perception, and control. CRIIS, in a joint effort with CITEVE in the projects PRR BE@T and TEXP@CT, will demonstrate the first iteration of two prototypes that allow the manipulation of a fabrics or clothing and prepare it for sewing or accessory removal and sorting for recycling.

Mobile manipulator for logistic activities: In 2024 CRIIS will build on top of their most recent research results, covering mobile robot navigation, object perception and grasping and path planning, to create a functional (TRL 8) mobile manipulator prototype specialised to pick-up packed objects in a retail warehouse scenario. The solution will be demonstrated at Worten's warehouse by the end of 2024 as part of the EIT MomaFlex project.

Cloud-based robotic systems: In a forward-looking collaboration with Amazon AWS, CRIIS has charted an innovative roadmap, recognising the transformative potential of cloud-based solutions for industrial robotics. This innovative initiative unfolds along two dynamic innovation tracks: (1) creating a web-based robotic toolkit harnessing cloud-based simulation technology and AI capabilities; (2) leveraging the cloud's scalability and computational prowess, along with AI services, to assist robots in tackling computationally-intensive tasks.

Remote control of forklift autonomous mobile robots: Remote control is an intriguing option for allowing human operators to supervise and take control of autonomous forklifts, manually operating them to overcome failure and resume their primary autonomy mode. In the PRR GREENAUTO project, the team will investigate the usage of a 5G network with either joystick controls or a similar interface to manually operate forklifts.

Modular and Safer Forest and Agricultural Robots: CRIIS has built two modular and safer robots for application in agriculture and forest, WETA and Modula-E robots. These robots can realise with high levels of precision monitoring, mowing and spraying operations. In 2024, with the ongoing projects (national and international) the centre will aim to both advance the technology for pruning and harvesting operations in agriculture and forests, and study advanced safety systems to ensure the robot's functionality and reliability in agricultural/forestry.

Modular and advanced IoT technology Forest and Agriculture Robots: CRIIS has successfully developed over 16 IoT prototype technologies, all of which have reached TRL 6. These prototypes mark a significant leap forward in supplying decision support systems for agriculture and forestry. Some key features include productivity mapping, in-situ disease and water stress quantification, and macro-nutrient assessment, among others. For the upcoming years, the main focus will be on integrating novel AI-based algorithms that leverage edge computing and federated learning concepts. This advancement aims to enhance the capabilities of our systems further. The overarching goal is implementing a national IoT sensing plan aligned with a one-health mission.

5.7.2.4 Complementary advances

Jointly with these key advances, in 2024, 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.

- Increase cooperation with international groups through exchange/internship of PhD students. A PhD internship is envisaged for 2024 in the Sapienza Università di Roma, with Pr. Dr. Giogio Grisetti that

owns a recognised international merit in the scientific domains of robot localisation, sensor data interpretation, and SLAM.

- In 2023, CRIIS members have gathered 3 Amazon Web Services (AWS) Associate Solutions Architect Certifications. The team working on Cloud Robotics will attempt to pursue additional training and certification in 2024.

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

- As contributions to the communication of scientific and technological achievements, CRIIS plans to participate in international expositions and fairs, namely Hannover and FIRA. CRIIS will promote greater participation in international working groups of interest (e.g., Adra, euRobotics, ROS-Industrial, AWS).
- CRIIS plans to develop three projects as direct contract research in robotics applied to internal logistic activities, perception and quality control. Furthermore, CRIIS will also hold its Open Day in synergy with iiLab's and Tribe's activity plan to engage in a more direct dialogue with companies and academia.

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

- In terms of knowledge valorisation and transfer, the Centre plans to close 3 licence programmes in the fields of industrial robotics, agriculture and forestry as a result of ongoing projects.
- After the initial success with a US company, there is an expectation to increase the number of Extra-EU projects by exploring other opportunities within the same company, related suppliers or clients.

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

- The development of regular (monthly) on-site team-building activities to tackle issues raised by remote work and promote employee satisfaction index. Moreover, external visibility of such initiatives will be promoted to further attract potential applicants.

5.7.3 Main initiatives planned for 2024

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

Table 5.7 - CRIIS – 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
Organise an Open Day for industry and research partners	Obtain new or deepen current leads with industry	C2.7
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.	C2.7
Regular Team Building Activities	Improve employee satisfaction index and attract new applicants	C4.1
Create a laboratory for robotics in the textile industry.	Reference joint laboratory for robotics in textiles.	C3.1
Actively promote new contracts in articulation with TEC4Industry.	Increased number of contracts with industry	C3.2

5.8 CEGI – Centre for Industrial Engineering and Management

Coordinator: Lia Patrício

5.8.1 Centre scope and vision

Centre scope and vision

CEGI Research Centre (RC) is an international reference in systems engineering and management, with a focus on management science (operations research, operations management, business analytics and performance evaluation), and service science (human-centred approaches, and service system design and innovation). CEGI research builds upon these scientific domains to advance knowledge and address relevant engineering classes of problems in multiple application areas. As such, CEGI research can be characterised in three vectors: scientific domains, classes of problems, and areas of application.

The Centre leverages research competences in systems engineering and management with a vision of innovative technology enabled system solutions and an ever-integrated and flexible value chain across different industries (e.g., manufacturing, energy, mobility, among others). To address the challenges posed by this vision, the combination of the Centre competences in Service System Design and Innovation, Business Analytics, Operations Research and Operations Management are crucial. Such vision is materialised through research with a blend of qualitative and quantitative methods for systems innovation and for adequately handling the readily available data from a system perspective and provide robust solutions.

The contribution to society through knowledge transfer is also a central point of the activity of the Centre. Building up on its experience, CEGI continues to develop advancements in the Manufacturing Sector, with a focus on logistics, production and operations problems. Additionally, CEGI continues to contribute to the Energy Sector with novel strategies for engaging citizens with sustainable energy solutions, asset management expertise and enhanced performance evaluation. Aligned with the European agenda, it also contributes to the de-materialisation of processes and the improvement of insights in the Health sector, and to sustainable operations of the supply chain in Retail and the Agro-Food sector. The Centre also contributes to the Transportation and Mobility field, through advanced decision-support systems for improved urban transports and shared mobility services.

5.8.2 Main objectives for 2024

5.8.2.1 Highlights

In 2024 CEGI 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.

CEGI will continue to 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 strive for the impact of its publications, with an increase in the number of papers within the 75% percentile of citations.

Considering the prestige of the high-impact European Research Council (ERC) grants, the Centre will endeavour to receive its first ERC Grant. For that purpose, one Centre researcher One has submitted a starter application in 2023 in the area of mobility, and one researcher will submit a consolidator application in 2024 in the area of supply chain.

The Centre also plans to make a strong effort in submitting FCT projects in the 2024 call, and in European projects, particularly Horizon Europe – RIA calls, which have stronger research potential. In this regard, CEGI aims to secure funding for at least two FCT projects and two Horizon Europe projects.

CEGI also plans to strengthen internationalisation and connection to the research communities in key CEGI areas. To this end, CEGI will encourage international collaborations with international research centres, with both visits to and from international researchers, and will also strive to continue its strong representation in the editorial boards of key journals and conference scientific committees in its focus research areas.

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

CEGI plans to increase its research connected to SDGs. To this send, CEGI will increase research on innovating technology enabled service system toward sustainability, particularly for energy transition. CEGI is also involved in an international research effort on the connection on how service research can contribute to SDGs, with two planned publications in this topic. CEGI will also continue to develop research on citizen engagement with energy transition,

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

To further develop and exploit the intellectual property generated in projects Digital CER, a software registration was concluded in 2023, and the Centre plans to close its licensing in 2024. In collaboration with CPES, CEGI is also developing an Energy Community Living Lab, to become an important physical and social infrastructure for CEGI to build its competences on multidisciplinary R&I ecosystems. Following the installation of the technology infrastructure in 2023, the aim is to set the governance and co-creation strategy for the Living Lab to be developing and testing new services for energy transition in 2024.

5.8.2.2 Research

CEGI's scientific domain focuses on Systems engineering, industrial engineering, and management, particularly on management science and service science. Building upon these research domains in management science (business analytics, operations research, operations management and performance evaluation), and service science (human-centred approaches and service system design and innovation), CEGI tackles classes of problems covering the full cycle of systems development life cycle, from understanding, to conceiving, developing, implementing, operating and evaluating.

Service science

Service System Design and Innovation: The Centre will continue to promote research on service system design and innovation, in B2C, B2B and B2G environments. Research lines cover both the study of customer experience with technology enabled services and citizen engagement with sustainable technology solutions, as well as the design of technology enabled services in complex service systems and service system transformation. To this end, the Centre develops conceptual and empirical work, using social science qualitative and quantitative methods, as well design science research. In this area, in 2024, CEGI will conclude the project POCITYF with the study and development of tailored strategies for engaging citizens with sustainable energy transition in eight European cities, and the development of communication strategies based on a mental model approach, within the project FIRE-RES. Three Q1 publications and 5 submissions are planned.

Management science:

Operations Research / Operations Management: The Centre will continue to contribute to several sectors of activity within this domain. The main contributions will be on the advancement of the state-of-the-art in quantitative decision-support, namely for classes of problems within logistics, strategy, production and operations and decision-support systems development. New real-world challenges will be tackled with the development of hybrid optimisation methodologies, capable of providing relevant managerial insights and solutions that are robust to scenario changing or quickly react to a dynamic environment.

In 2024, CEGI will complete the BeFresh project and the corresponding activities with the submission of 4 articles in international journals around the themes of pricing and inventory management of perishable products. A set of activities is planned to explore adjacent topics in Retail Operations of great impact/interest for the scientific and business communities (e.g., impact of cyber attacks on the operational performance of these organizations). The renewal of the funding cycle is also planned, with the submission of a COST Action and am ERC consolidator grant.

The second major version of the TRUST-AI framework is being finalised, with important extensions that complete the main functionality that was intended. Therefore, 2024 will be dedicated to test, experiment and evaluate this platform, as well as disseminate it across multiple communities. At the same time, different use cases will be explored within and outside of the project, including tumour growth prediction, time slot management, energy consumption forecast, production scheduling and inventory routing. 2024 will also be marked by the first full

year of the project PEER, focusing on the definition of the Use Case requirements which include specifications and refinements about the problem setting (Sonae), the algorithms to be used (University Partners), and the infrastructure to be implemented (Fujitsu).

Business analytics: Main lines of research under this topic will include individual methods and techniques in knowledge acquisition and visualization, and their application in the construction of forecasting and recommendation methods. It will address Marketing and Customer analytics and Artificial Intelligence for markets such as business, education and healthcare.

Performance Evaluation: The main contributions of this line of research are based on the development of advanced efficiency and productivity measurement techniques, with clear insights and real-world application in sectors such as Energy, Health and Education. Particularly in education, major developments will be undertaken in 2024 within the project EduBest.

Emerging topics

Designing and Innovating technology enabled service systems toward sustainability

Systemic challenges such as climate change and the pursuit of UN's Sustainable Development Goals require profound changes in service systems such as in energy transition. CEGI is addressing more systemic challenges on the design and innovation of technology enabled service systems toward sustainability, which can be applied in areas such as Energy, Mobility or Healthcare.

Advanced decision-support in dynamic, uncertain and complex environments

New market challenges in an increasingly dynamic and uncertain setting, associated with a significant rise in data availability, require innovative and fundamental advances in quantitative decision-support methods. The key challenges that CEGI is exploring and contributing to are real-time and dynamic decision-making, responding to uncertainty with robustness and resilience, and the development of innovative hybrid methodologies (e.g. combining Machine Learning with Optimization) to deal with the increasing complexity of real-world systems across sectors of applications.

Sustainability in business models, decision-support and analytics

The UN's Sustainable Development Goals set new challenges for research on systems, with the rise of new business models and the need to further innovate on business analytics tools and decision-support methods to incorporate in a realistic and insightful way the social, environmental and economic perspectives of decision-making.

5.8.2.3 Innovation

CEGI research has been applied in multiple sectors such as manufacturing, energy, retail, agro-food, mobility, and healthcare.

INOV 1: INDUSTRY

CEGI has a strong expertise in Industry 4.0 related concepts framework. In particular: (1) advanced production planning and scheduling algorithms, (2) blockchain protocols over the supply chain, (3) improved asset management, (4) intelligent algorithms for logistic operations. Through the ongoing research projects, we expect to establish innovation activities to start transferring the knowledge that has been developed (e.g., dynamic scheduling algorithms for collaborative human-robot production lines). Besides, in the Produtech R3 project, within the Recovery and Resilience Plan, advanced algorithms for logistic operations will be customised to the different partners. These innovation activities are tightly related to TEC4 Industry.

INOV2. ENERGY

The energy application area is a core area for CEGI in terms of technology transfer. Asset management, decision support and prescriptive analytics have been used to significantly improve processes in this industry, particularly in predictive and prescriptive maintenance, as well as Power system planning. The conclusion of European Project XFLEX_HIDRO and development of EURO_SCORES provides now with the necessary exposition for international collaboration. CEGI has advanced the understanding of citizen engagement with sustainable energy solutions and has developed novel strategies for citizen engagement within the European Project POCITYF. These

activities will be leveraged in 2024 with the development and operation of the Energy Community Living Lab. These innovation activities are tightly related to TEC4 Energy.

INOV3. RETAIL & AGROFOOD

Over the last years there were a set of PhDs focused on developing empirical and analytical methods for better decision making in both offline and online retail settings. This innovation line can now benefit from such results and start transferring knowledge to industry. In pursuing these objectives, the continued involvement of business partners (e.g., Sonae MC and Farfetch) will be essential. These innovation activities are tightly related to TEC4 AgroFood.

INOV4. HEALTHCARE

The healthcare area has evolved due to the close collaboration between CEGI and several entities of the public sector, namely hospitals and central regulatory entities. Both Service Design and Operations Research /Operations Management have contributed with best practices to this sector. CEGI has conducted research on understanding and mapping the patient experience and designing technology enabled services for people-centred care. Open collaborations have also targeted digitalisation of medical reports, towards development of Decision Support Systems that, based on data treatment and extraction, provide the clinician with useful information obtained through data inference. These innovation activities are tightly related to TEC4Health.

5.8.3 Main actions planned for 2024

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

Table 5.8 - CEGI – 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 Publications in Q1 journals - 80%
Support researchers to prepare their applications to ERC Grants, and encouraging researchers to start preparing	Submit ERC Grants	C1.2 submission of one ERC grant
Promote collaboration sessions to support researchers in submitting high quality projects	Submission of projects with high research potential	C1.3 Submit at least 5 FCT projects and 5 European Projects C1.3 Be successful in two FCT and two Horizon Europe projects
Organise an Open Day for industry and research partners	Obtain new or deepen current leads with industry	C2.7 Establish at least one partnership with companies
Participation in the Brussels Hub activities and other initiatives related to European priorities	Strengthen positioning in EU network	C1.6 Conduct 1workshop in the Brussels Hub and
Leverage multi-annual budget allocation to support activities strategically relevant for the Centre, especially regarding the emergent research areas	Submission and development of new research projects addressing	C1.2 Submission of projects in new CEGI areas

5.9 CITE – Centre for Innovation, Technology and Entrepreneurship

Coordinator: Alexandra Xavier

5.9.1 Centre scope and vision

Vision: Driving innovation, technology adoption, and entrepreneurial excellence, towards a socially responsible and sustainable economy and society. Empower researchers, and public and private organisations in the processes of Innovation, and Technology Management, and Entrepreneurship.

Scope: CITE research activities aim to promote sustainable and socially responsible innovation that addresses environmental, social, and economic challenges. By conducting multidisciplinary research with a particular focus on Innovation, Technology Management and Policy, CITE contributes with theories, methods, models, and tools to support the design and adoption of user-centred innovations. The CITE Research Lines are:

- **RL1. Innovation Management and Fuzzy Front-End of Innovation (FEI):** Strengthening the conceptual and methodological foundations of Innovation Management and the Front-End of Innovation, towards a responsible, ethical, and sustainable industry and society.
- **RL2. Technology Management and Policy**: Study of the challenges of implementing and adopting new technologies, analysing how new technologies can foster industry transformation at the individual, organisational, and ecosystem levels, as well as exploring how public policies can promote technology-enabled transformation.
- **RL3. Technology Entrepreneurship & Business Model Innovation**: This cross-disciplinary strategic research line delves into the symbiotic relationship between technology and entrepreneurship, exploring the dynamics of leveraging technological advancements to drive innovation in business models.
- **RL4. Research on Co-creation methods and open innovation strategies for user-centred design, empowering and nurturing entrepreneurship:** research on collaborative co-creation methodologies and open innovation approaches within user-centred design to amplify sustainable solutions and cultivate innovation ecosystem where users and communities actively participate in shaping environmentally and socially conscious products and services.

CITE also aims to impact on economy and society by leveraging cutting-edge conceptual models and tools in **Consulting Activities and Executive Training (Inov1)**, and **Entrepreneurship Support Initiatives (Inov2**).

5.9.2 Main objectives for 2024

5.9.2.1 Highlights

In 2024, 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.

- Create a repository of innovation models and tools. Using Creative Commons Licenses to make CITE research results accessible and available for innovation communities and society.

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

- Design and develop a new curricular unit with the University of Tromso in Norway, on entrepreneurship for doctoral students. The course will take place at the University of Tromso (RL2, inov2).
- The Journal of Innovation Management (JIM), already indexed by Scopus, is preparing the submission to Web of Science (WoS). The submission will be done at the beginning of 2024.

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

- Launch in collaboration with SAL the first edition of Seed Projects Bootcamp (Inov2) to support the Technology Exploitation and Entrepreneurship Initiatives.

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

- Participate and contribute to the EEN Sector Groups of Retail and Mobility and Thematic Groups of Sustainability and Women Entrepreneurship by providing network-oriented / capacity-building activities, connecting with thematic stakeholders, and providing policy feedback.

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

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

- Launch a Responsible Assessment tool to monitor the R&D developments.

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

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

- Launch the Visual Strategic Scientific Map of CITE
- Engage INESC TEC employees in brainstorming sessions to generate innovative ideas for improving operations. Developing a proposal to submit to INESC TEC CA to implement a challenging design and Idea context for Sustainable Operational Models.

5.9.2.2 Research

RL1|Commitment 2| C2.7: Developing an Impact Assessment tool to evaluate the impact of innovation and technology initiatives on the economy, society, and environment. This includes measuring success metrics of research on outputs and societal implications of technology advancements and OIC campaigns. (under Fire-RES project).

RL1|Commitment 2| C2.6: Developing an ecosystem value map methodology to facilitate the identification, analysis, and engagement of relevant stakeholders. This methodology will be developed under the projects FIRE RES, Ai4Realnet, and Nexus.

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)

RL2|Commitment 3| C3.2: Research on the dynamics of diffusion, adoption, and use of digital technologies in manufacturing SMEs, the challenges these companies face, and how they may be overcome (in new projects collaborating with other centres, with MIT, IN+ - Instituto Superior Técnico, University of Coimbra and other external partners)

RL3|Commitment 3| C3.2: Research on new business models for a private 5G Network in the context of a Port (under Nexus project).

RL3|Commitment 3| C3.2: Research on business models for AI open-source software and algorithms (under AI4REALNET)

5.9.2.3 Innovation

RL1. RL4, Inov2| Commitment 3| C3.2 Commitment 3| C3.2: Launch FIRE RES International Acceleration Bootcamp, which includes a mentorship program, offering access to demonstration infrastructures, and networks for the increase of the investment and market readiness level.

RL1. Inov1| Commitment 3| C3.2: Provide support to the transition of innovation management systems of Portuguese organisations to NP4457-2018, aligned with ISO TC ISO/TC 279 - Standardisation of terminology, tools, methods, and interactions between relevant parties to enable innovation". Assist at least 3 Portuguese SMEs. (RL1. RL4, Inov1).

RL1. RL4, Inov1| Commitment 3| C3.2: Design and implement a first edition of an Executive Training, exploring the Challenge Workshop for Innovation, developed in 2023 under the FIRE RES project.

RL1. RL4, Inov1| Commitment 3| C3.2: Develop and launch the inaugural edition of an Executive Training Program focused on Sustainability, leveraging the 2023 investment in a specialised training initiative conducted by a CITE researcher.

5.9.2.4 Complementary advances

RL2| Commitment 1| C1.2: CITE will participate in the organisation and the scientific committee of the IAMOT Annual Conference for 2024, one of the worldwide leading conferences in the Management of Technology.

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, RL2, RL3|RL4| Commitment 4| C4.1: Strengthen its team by attracting at least 3 master's students and 2 new PhD students.

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).

5.9.3 Main initiatives planned for 2024

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

Table 5.9 - CITE – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
CITE Strategic co-creation Workshops	CITE Visual Strategic Scientific Map	C1.1, C2.3, C4.1, C5.1
Design and Digitalise the CITE Innovation methods and tools. Make it available using Creative Commons Licencing	Innovation Repository	C1.1, C2.7
Design and Implement 2 International Acceleration program (FIRE RES and EIT Jumpstart) Organise an International hackathon for FIRE RES Partners	Support 50 new venture projects	C1.3, C2.1, C2.2
Developing and testing an innovative Impact Assessment tool under the FIRE RES project Supervise a master thesis on this topic	Innovation Impact Assessment Tool	C2.7
Continue to provide Advisory services on Innovation under EEN-PORTUGAL 2022-2025	10 Companies supported	C1.4, C1.6
Research on new business models for 5G private networks under NEXUS project	Development of a business model for monetisation of private 5G networks for Port Sines Authority	C2.4, C1.3, C1.4
Design an Open Innovation methodology, under ATE project	Open Innovation campaign for Energy Transition	C1.3
Design a Challenge Design and Idea Competition for INESC TEC	10 ideas for Improving the sustainability of INESC TEC	C4.1, C5.1
Design and Implement a Seed project Bootcamp for Internal Entrepreneurships Initiatives	Increase the Market and Investment readiness of the proof-of-concept seed projects and entrepreneurial initiatives	C1.3

5.10 HUMANISE – Human-Centred Computing and Information Science

Coordinators: Ademar Aguiar and Artur Rocha

5.10.1 Centre scope and vision

The Human-Centred Computing and Information Science (HumanISE) is an interdisciplinary centre researching 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 of 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).

5.10.2 Main objectives for 2024

5.10.2.1 Highlights

In 2024, 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 to 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.

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 iReceptor+ 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.

5.10.2.2 Research

In 2024, 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) and cooperative systems, active and healthy ageing, and technology for persons with disabilities. 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. 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 VR and AR), Visualisation, Digital Games, and Interactive Multimedia applications. The high-performance hardware and new algorithms push global illumination rendering to real-time, particularly in the digital games area and 3D movie production. Virtual and Augmented Reality applications can also take advantage of high-performance and affordable hardware for distinct applications, particularly with the Industry 4.0 paradigm, providing new planning, supervision, and operation tools. A significant trend is the integration of multi-sensory information to enhance the feeling of presence and immersion in Virtual Environments (VE). Serious Games (SG) can push their applications in Education, Tourism, and Professional Training taking advantage of these advances and on intuitive authoring tools. VE and SG require multidisciplinary teams to address Human-Computer Interaction (HCI) challenges. We focus on User Experience (UX), User Interaction (UI), Human Cognition, and Human perception. Within this area, Gameful and Playful Design are other approaches to improve UX in distinct processes, promoting behaviour change, and increased engagement. Pushing the borders of HCI into Human-data Interaction, Scientific Visualisation is also necessary to explore and provide knowledge on Big Data.

Information Management and Information Systems. Information systems have evolved from specialised systems operating on curated data managed at the institutional level to pervasive structures, incorporating different technologies and data from multiple sources. This evolution brings new technical and social challenges to information management and access. This research area is committed to addressing some of the resulting challenges, selecting the topics where previous work can enable more significant results. It includes research in information management, information retrieval, information interaction, information processing, digital preservation, and research data management. Research data management is an area of focus in recent years, which includes significant challenges in the required tools and workflows that incorporate them into research processes. Computer information interaction also signifies an ongoing focus, especially with the recent acquisition of advanced eye-tracking equipment, introducing new dimensions to understanding user engagement and behaviour. This context poses challenges and promises relevant opportunities for collaborations in application contexts.

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-based 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 also explore the opportunities to develop custom or domain-specific languages and code transformation tools to help port applications across platforms or recover existing code bases. Obtain knowledge and know-how regarding state-of-the-art compiler technologies (i.e., MLIR), in order to create a high-level representation for data-flow computations that allows mapping to multiple targets (e.g., custom RISC-V extensions, CGRA). This goal is tightly related to the projects A-IQ READY and UNIFY.

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) management of computation in parallel and distributed IoT/edge ecosystems; and (3) methods, tools and languages for the development, deployment, and maintenance of embedded and cyber-physical systems software.

5.10.2.3 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 important 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, and Digital Twins are a few examples of trends and challenges. In terms of the research challenges of the computer science research domain, this innovation area encompasses several 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. Explore technology and know-how transfer in the context of research projects, namely consultancy projects, and specifications developed and software prototypes (e.g. the InOlive project, Health, Industry, Textile and Space Recovery and Resilience Plan approved agendas), resulting in licensing of inventions and software copyright registrations, align with industry's needs. In 2024, in the scope of project ILIAD, HumanISE will customise and demonstrate interoperable data processing pipelines and customizable virtual environment descriptions to apply in advanced visualisation techniques for Digital Twins. This goal is tightly related to TEC4SEA.

[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 and technology transfer 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, 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.

5.10.3 Complementary advances

Jointly with these key advances, in 2024, the other main objectives for the Centre towards its vision are:

C1. 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.

C2. 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.

C4. Cultivate an attractive, people-centred and talented community. Especially after the pandemic, the challenge of attracting people to prefer to come back to the office versus work from home, increased a lot. The centre will continue improving the work environment (rooms, equipment, events, etc.) to bring people together again, make them comfortable, and bring new people to join the centre, including foreign researchers, mobility students, and new hires.

C5. 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.

5.10.4 Main initiatives planned for 2024

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

Table 5.10 - HumanISE – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Continue to encourage the 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

Initiatives	Key Results	Strategic Objectives
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 program.	C1.2
Increase the effort in IP valorisation.	Encourage the practice of preparing pre-disclosure forms and licence agreements.	C1.3, C3.2
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

5.11 LIAAD – Artificial Intelligence and Decision Support Laboratory

Coordinator: Alípio Jorge

Assistant to the Centre Coordination: Ricardo Sousa

5.11.1 Centre scope and vision

LIAAD works on Intelligent and Adaptive Systems and Mathematical Modelling in Decision Support. Our scientific foundations are machine learning, statistics, optimisation and mathematics.

Our activity is motivated by three main vectors: 1) Ubiquitous and interconnected data; 2) The increasing importance of complex and comprehensive models for inference and decision support; 3) The 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 link perceived language, images, sounds and other signals to 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 systems 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.

5.11.2 Main objectives for 2024

5.11.2.1 Highlights

In 2024, 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 set-up a Technology Intelligence Laboratory to gather intelligence on the status of companies 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 have, for our centre, a record number of European Projects running and submitted, and do the final stretch of HumaneAI-Net. We will organise as usual a wide variety of international workshops and conferences.

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

- Organise LIAAD day to promote interaction between LIAAD members, strengthen the 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.

5.11.2.2 Research

In **Machine Learning, AutoML, Bioinformatics and Human Artificial Intelligence** we work on the problems of data unbalance, complex networks, data stream mining and automated ML. These are some of our 2024 **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
- Boosting for 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.

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 modelling. 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
- Advance in multi-class classification of text data streams with ontology-based semantic enrichment.
- Train Large Language models for European Portuguese

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 dataset obtained from high-throughput sequencing technologies. The overall goal is to obtain insights into the biology of health and disease by identifying patterns of variation across different tissues, conditions (i.e. Tumor vs Normal) and individuals in the population.

- Gene differential expression and functional enrichment between conditions.
- Analysis of gene network differential topology. Identify sub-networks specific of a given condition.
- Predictive models of gene expression for different traits, phenotypes or time from death.
- Integration of multi-omics datasets to obtain disease insights.
- Predictive models based on histological images (e.g. CNNs) for phenotype prediction. Link between image features and genes.

5.11.3 Main initiatives planned for 2024

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

Table 5.11 - LIAAD – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Workshops: Text2Story, ORSUM, SoGood, Conferences Q2024, JOCLAD, NOMA, Conference track ACM SAC Data Streams, Journal track ECML PKDD 2024	Increased visibility of the group, international community development	C3.5
PT-Pump-UP	NLP resources Hub for PT, PT NLP community meeting	C1.4
HfPT, Hospital da Póvoa	Tools for clinical narrative extraction	C2.1
AIBoost, FAIST	Tools for predictive maintenance	C2.1
Emeritus, HumanAI-Net	Responsible AI, Environment	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

5.12 CRACS – Centre for Research in Advanced Computing Systems

Coordinator: Ricardo Rocha

5.12.1 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.

5.12.2 Main objectives for 2024

5.12.2.1 Highlights

In 2024, 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

- To further consolidate CRACS's international visibility, notoriety and publication output, we will prioritise the increase of publications in high-impact journals and high-ranked conferences.

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

- We aim to maintain the numbers of international events organised by CRACS's members, participations as editor in international journals and participations in program committees. We estimate the organisation of 6 events and the participation in 11 journals as editor and in 25 program committees.

C1.5. Provide innovative learning experiences

- To further develop and exploit the intellectual outputs generated in the project *'FGPE Plus: Learning tools interoperability for gamified programming education'* that concluded successfully, we will continue working in the improvement in efficiency of programming education and its student-perceived experience through the *'FGPE++ Gamified Programming Learning at Scale'* Erasmus+ project.

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

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

- Become internationally relevant in the areas of searchable encryption and Cyber Threat Information (CTI) sharing, opening new research directions and generating more networking opportunities.

5.12.2.2 Research

In 2024, the Centre's research will focus on:

Lock-Freedom. Advance the development of a generic high-level interface implementing synchronisation procedures for memory reclamation in lock-free data structures based on the Optimistic Access method and exploiting the virtual memory system provided by the operating system and hardware in order to make it possible to release reclaimed memory to the operating system where garbage collection is not available.

Assessment of Languages for Heterogeneous Parallel Computing. Multicore CPUs and GPUs have become a common reality in modern systems, offering significant potential for parallel data processing. We plan to develop a new framework that allows the comparison 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.

Machine Learning Models (MLMs). Development of MLMs based on techniques such as Convolutional Neural Networks, Regression, Decision Trees, Similarity Analysis and the more recent Vision Transformers. We plan to

continue ongoing multidisciplinary projects using MLMs for: indoor localisation (using RSSI datasets from Bluetooth beacons and computer vision applied to photos of the premises); automatic identification of Portuguese native species of multiple taxa (c.f., https://rubisco.dcc.fc.up.pt/biolens) and a collaboration in astrophysics for the automatic determination of cool star parameters from a dataset of stellar spectra.

E-learning System Interoperability, Analytics and Generative AI for Microlearning. Fusion of e-learning system interoperability to foster standardised communication between systems, 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 explore the use of generative algorithms to dynamically create personalised microlearning content based on individual learner profiles, preferences, and progress.

Network Science. Advance the development of graph-based semantic measures by leveraging linked data: extracting semantic graphs from linked data to establish domain-specific semantic proxies; and curating reference datasets for evaluating semantic measures using large language models. We will develop novel algorithms for detecting topological patterns on higher-dimensional graph domains, such as multiplex networks and hypergraphs; we will work on graph querying and how to express general families of patterns through forbidden subgraphs and topological constraints and how to efficiently discover them; we will work on innovative spatio-temporal fingerprints of networks, that have high characterisation power and high interpretability; and we will work on the application of graph neural networks to the motif finding problem.

Time Series. Continuation of previous work on time series analysis via network science, with a focus on novel mapping methods of time series into graphs that capture their characteristics and are able to provide insight that classical methods do not provide. We will develop a novel quantile mapping method for multivariate time series analysis; we will create novel visibility methods that map multivariate data into multilayer networks; and we will work on how to use mapping methods that combine data privacy assurance with high characterisation power.

Fake News Detection. Continuation of previous work with a focus on balancing the dataset through the use of synthetic samples generated by GANs and by using concept drifts. The exploration of promising architectures and their application to well-known datasets has been a key part of the research. Preliminary results indicate an improvement over the outcomes reported in existing literature. A new multilabeling technique supporting concept drift is currently being integrated into the system.

A Generic Framework for Proof Representation and Management. In the context of the ongoing COST Action EuroProofNet that aims at increasing the interoperability and usability of proof systems, we have a long term project with King's College London that has two main research lines: i) develop a generic language for the representation of proofs, which can serve as a tool to translate proofs from different systems; ii) give a general definition of proof system using Higher order Port graphs (HoPs), which generalises previous work on graphical proof systems. This will provide a formal specification of proofs that can be used to represent proofs in existing systems, to specify operations on proofs, and to analyse properties of proof systems.

Quantitative Types for Programming Languages. Following our work on the definition of resource aware semantics for languages with pattern-matching and global state, we aim at exploring quantitative semantics for other language effects such as non-determinism (work in collaboration with IRIF at Université de Paris). We are also using quantitative types to explore open problems related to the linearisation of the lambda calculus and its relation to termination (work in collaboration with Universidade Federal de Goiás).

Cyber Threat Intelligence (CTI). To further develop the CTI sharing proxy, initially developed under the PANDORA project, we will contribute for advanced searchable encryption schemes that are distributed and support multiple sharing groups with different privacy and confidentiality requirements through the ongoing PRIVATEER project.

Privacy. Research results on the privacy implications of Wi-Fi connectivity on tracking users. Privacy protection mechanisms for location data. Blockchain-based mechanisms for distributed authentication and authorisation.

Security. Develop new mechanisms for collecting informed consents for data sharing, in the form of Verifiable Presentation for the European Digital Identity Wallet (EUDIW) and working on the integration of this wallet into the management circuit of authorisations and security policies of the User Managed Access (UMA) protocol. Identify the parts of the security policy management and access management flows of the UMA protocol that need to be compatible with OID4VC (OpenID for Verifiable Credentials), so that a EUDIW can act as a player in the access authorisation management of informed consent circuits.

5.12.2.3 Innovation

CRACS research is applied in several areas. In 2024, the Centre's innovation activities will focus on:

Machine Learning Models (MLMs). Develop innovative indoor localisation methods based on ML. Develop innovative estimation methods for stellar astrophysics based on ML.

Generative AI for microlearning. Explore the application of generative AI for microlearning in scenarios such as: i) adaptive content generation – use generative algorithms to dynamically create personalised microlearning content and dynamic learning paths based on individual learner profiles; ii) natural language generation (NLG) for summarisation – implement NLG techniques to automatically summarise complex concepts or lengthy materials into concise microlearning snippets; iii) generative assessments and feedback – use generative models to generate diverse sets of microlearning assessments and offer automated feedback using generative algorithms to provide corrective guidance.

Network Science. Continuation of previous state-of-the-art work with a focus on the efficient discovery of significant patterns and the development of metrics able to characterise and compare networks from any domain. Application to concrete domains, such as financial, biological, political and sports data.

Time Series. Application of the novel methods to real and complex multivariate data sources, such as smart cities.

Cyber Threat Intelligence (CTI). An efficient CTI sharing tool can minimise the impact of an attack and, in some cases, completely prevent it. The CTI sharing tool to be developed in the PRIVATEER project is planned to have a real societal impact, by improving the cybersecurity capabilities of any entity with a real and open source contribution to the existing toolset of CTI sharing, and to be made available for generic use by any entity.

Nun-Fungible Tokens (NFTs). A Web3 solution that makes use of NFTs to create and support a novel business model for Device-as-a-Service (DaaS) is expected to be specified within the Blockhain.PT project.

Privacy. Public release of an open-source privacy toolkit, implementing several privacy-enhancing technologies that we have developed throughout the years, namely privacy mechanisms for location data and face anonymisation techniques.

Security. Develop extension modules for an Authorisation Server with support for the UMA protocol, such as Keycloak, that implements interfaces with the user and integrate with the EUDIW wallet, allowing users to issue and install informed consents in the form of verifiable credentials.

5.12.3 Main actions planned for 2024

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

Table 5.12 - CRACS – Main planned initiatives and actions

Initiatives	Key Results	Strategic objectives
Prioritise publications in high-impact journals and high-ranked conferences	Increase the overall quality of the publications	C1.1
Increase our involvement in the leadership of scientific initiatives (we estimate the organisation of 6 international events)	Foster a stronger international recognition of our researchers and promote networking	C1.2
Organise advanced training courses on: Big Data analysis using Spark; OpenMP for shared memory parallel programming; MPI for distributed memory parallel programming; and SYCL for heterogeneous computing	Take our expertise to other application areas to unlock new opportunities for collaborations	C1.4
Strengthen existing collaborations in the areas of Biology and Astrophysics	Explore other possibilities for establish continuous multidisciplinary research lines	C1.4
Submit project proposals to national and European calls	Development of new projects and increased funding	C3.5

5.13 HASLAB – High-Assurance Software Laboratory

Coordinators: Alcino Cunha and António Luís Sousa

Assistant to the Centre Coordination: Catarina Leones Fernandes

5.13.1 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 competences such as Human-Computer Interaction, Programming Languages, Mathematics of Computing, or Quantum Computing. Through a multidisciplinary approach that is based on solid theoretical foundations, HASLab aims to provide solutions — theory, methods, languages, tools — for the development of complete ICT systems that provide strong guarantees to their owners and users.

5.13.2 Main objectives for 2024

5.13.2.1 Highlights

In 2024, 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

HASLab will continue to prioritise publications in high-impact conferences and journals, in particular in the context of PhD theses. To achieve this, implement the following initiatives: continue our PhD student mentoring program, focusing on keeping the research plan on track and 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, our goal is to have at least 20 papers submitted to CORE A* and A conferences, or equivalent top-ranked journals, half of them in the context of PhD theses.

C1.6. Increase the international embedment of our community

Excellency in research is many times a by-product of a solid network international collaborations. As such, we intend to increase both the mobility of our researchers (both of senior researchers and graduate students) and the number of incoming international visiting researchers. More specifically, our goal is to have at least 8 visits of senior researchers to international renowned institutions, 4 graduate student internships in international renowned institutions, 2 PhD theses co-supervised by renowned international researchers, and 6 incoming international visiting researchers.

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

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

HASLab economic model is not very sustainable at the moment, in particular when it comes to high margin projects. In particular, we have only a handful of contracts with industry and projects from international competitive research funding, and the fundraising and execution of these projects is centred in a handful of senior researchers. To increase the sustainability and resilience of this economic model we are planning the following initiatives: stabilisation of core development teams around the key senior researchers involved in the fundraising and execution of high margin projects (4 new MSc hirees and 3 new PhD hirees); raise awareness inside the centre for the current imbalance in fundraising among senior researchers, in particular develop a heatmap-like internal assessment mechanism (similar to the one currently use to assess the centres inside INESC TEC) so that the senior researchers can better perceive what is their contribution to the overall centre performance.

5.13.2.2 Research

In 2024, we envision the following research achievements for each of the research areas of the centre:

Software Engineering

HASLab is one of the key international partners involved in the development of the Alloy formal modelling language, first proposed at MIT, as well as educational tools focused on this language (including the http://alloy4fun.inesctec.pt/ web application already used by a few universities around the world). In the upcoming year we will continue to develop extensions to this language, in particular to make it more amenable for specifying quantitative and security requirements, and we will explore its application to new areas, in particular in the formal design of transactional database systems.

Distributed Systems

In the upcoming year, HASLab will continue to contribute data management technology in the context of multiple national and international research projects, aiming at deliver results at multiple levels ranging from data replication and polyglot querying techniques to data spaces middleware and applications. HASLab will also focus on storage systems, aiming at delivering results from the collaboration with Jepsen LLC on distributed testing and results on optimisation of storage systems for HPC and ML workloads.

Cybersecurity

HASLab is a key partner in involved in the development of Libjade, a cryptographic library written in jasmin, with computer-verified proof of correctness and security in EasyCrypt. The primary focus of libjade is to offer high-assurance software implementations of post-quantum crypto primitives. Libjade is being developed within the Formosa Crypto project, which federates several initiatives in machine-checked cryptography and high-assurance cryptographic engineering under a single banner, to better support developers and users. 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.

5.13.2.3 Innovation

In 2024, one of the main projects HASLab will be involved in is ATRACT. In essence, the project aims at digital transformation through solutions based on HPC and AI, presented in the form of a service to industry. Our aim is to use these contacts to strengthen relationships and promote the transfer of innovation.

Also, HASLab's work in the InterConnect project will result in the publication the Wattchr mobile app for Android and iPhone platforms. This app aimed at the general public has a server backend that leverages research in data spaces to integrate data that feeds a prediction algorithm to recommend actions to individual consumers towards energy efficiency.

5.13.2.4 Complementary advances

Jointly with these key advances, in 2024, 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.

C1.5. Provide innovative learning experiences

HASLab will continue to invest in attracting and providing an innovative learning experience for MSc students to conduct thesis in R&D projects in the centre, as MSc students are key to ensure the sustainability of our team. In particular, in 2024 we aim to have 60 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.

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

In the context of ATTRACT project we aim to achieve 2 new research contracts with industrial players.

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

In the upcoming year we will try to engage with other domains inside INESC TEC to establish new partnerships to apply for international competitive research funding. HASLab already has a strong partnership with the Power and Energy Systems domain, but other domains also have close connections with our R&I, for example the Robotics and Artificial Intelligence domains.

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

C4.3. Expand the diversity of our community

HASLab aims to attract and cultivate a diverse and balanced team, in particular in terms of gender equality. While at the graduate student level the centre has made considerable progress in this respect in the past years (currently 9/22 PhD students are female), that progress still had no counterpart in the team of hired and senior researchers (only 1/8 of the former and 3/30 of the latter are female). To increase the gender balance at the senior ranks we expect to hire 3 new PhD female researchers in 2024.

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

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

In 2024, 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, next year HASLab will have a new meeting room at UMinho, 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.

5.13.3 Main initiatives planned for 2024

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

Table 5.13 - HASLab – Main planned initiatives and actions

Initiatives	Key Results	Strategic Objectives
Continue with the PhD mentoring plan; Encourage disclosure of paper submission plans	20 submissions to CORE A* and A conferences or equivalent top-ranked journals	C1.1
Increase researcher mobility	8 outgoing visits; 4 outgoing student internships; 6 incoming visits	C1.6
Stabilise core development teams	4 new MSc hirees and 3 new PhD hirees	C5.1
Attract MSc students	15 grants for MSc students; 60 concluded MSc thesis	C1.5
Capitalise on the ATTRACT DIH project	2 new research contracts with industry	C2.3
Establish partnerships with new domains	2 EU project proposals in partnership with new domains	C3.1
Increase gender equality at senior ranks	3 new female PhD hirees	C4.3
Improve infrastructures	1 new meeting room	C5.3

6 RESEARCH AND TECHNOLOGY INFRASTRUCTURES

INESC TEC maintains more than twenty 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 2024 of a selection of those research and technology infrastructures are presented below in this Section.

6.1 CLOUDinha Laboratory

6.1.1 Mission and positioning

The laboratory provides computational support to research and development activities of INESC TEC and University of Minho, providing bare metal, virtualisation capabilities, containers and security features such as trusted hardware.

The cluster is composed of different generations of hardware namely, Sandy Bridge, Ivy Bridge, Haswell and Kaby Lake. It is currently composed of 100 machines based on commodity hardware with Intel Core i3 CPUs, 16 GB 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.

The heterogenous hardware nature of the cluster is important for supporting different research projects that may require specific hardware features (e.g., different storage or network technologies, access to trusted hardware capabilities).

6.1.2 Main objectives and actions planned for 2024

As in previous years, the main goal of the laboratory is to continue supporting research and development, by providing the necessary computational resources, for key computer science areas such as:

- Distributed systems and data management
- Storage systems, databases and AI frameworks
- Privacy and security
- Blockchain and Internet of Things
- Software engineering

The later objective is aligned with the Strategic Objective **of Building stronger knowledge-based and multidisciplinary R&I ecosystems.**

As another objective, the laboratory will continue to provide access to bare metal servers, where virtualised resources can also be deployed on (e.g., virtual machines, containers), according to the need of the research work being conducted. Also, we plan to continue updating the cluster, by introducing new servers, if the demand for these is justified. The use of virtual resources and the upgrade of hardware resources and services based on the needs of users is key for the Strategic Objective of *improving the quality, management and usage of our infrastructures.*

6.2 EMSO-PT Research Infrastructure

6.2.1 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 ultimate goal of EMSO-PT is to organise the Portuguese contribution to the EMSO-ERIC network, a large-scale European Research Infrastructure, networking fixed point, deep sea multidisciplinary observatories, with the scientific objective of real-time, long-term monitoring of environmental processes related to the interaction between the geosphere, biosphere, and hydrosphere.

It is a geographically distributed infrastructure at key sites in European waters, spanning the Arctic, the Atlantic, and the Mediterranean, up to the Black Sea. It will be in place by the end of the decade.

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.

6.2.2 Main objectives and actions planned for 2024

The main objectives for 2024 are the following:

- **Deployment of the Turtle node with an EGIM system** – In the line of relocatable nodes, in 2024 will be further improved the Turtle energy system, and longer deployments will be tested during the year. Longer terms deployments in the northern Portuguese coast and in Setubal canyon will be performed.
- **Deployment of a glider network** – two operational gliders equipped with payload sensors will be deployed in cooperation with EMSO-PT partners to conduct several experiments.

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.

6.3 iiLab - Industry and Innovation Laboratory

6.3.1 Mission and positioning

To disclose and disseminate the state-of-the-art in advanced production technologies through the demonstration of research results, experimentation, and advanced training. iiLab supports technology-based innovation in public and private organisations, thus contributing to the development of their skills in the development, adoption and implementation of advanced production technologies, leading to a sustainable competitiveness in the circular economy context.

- Demonstration of concepts and advanced technologies in the areas of robotics, automation, industrial cyber-physical systems (Internet of things) in the form of a show-room;
- Dissemination of INESC TEC's expertise through the industry and the community in general;
- Experimentation and prototyping space for technological companies;
- Tailor-made training for senior managers and senior executives of industrial companies.

6.3.2 Main objectives and actions planned for 2024

1. **Excel and innovate across the missions of academia, harnessing the collective strength of our community:**
    - Raise de Contribution and visibility of our research: Promote the use of iiLab by INESC TEC R&D projects, with special emphasis on those that involve carrying out PhDs in cooperation with industry, thus contributing to increasing the number of PhD students, as well as increasing scientific publications in high-ranked journals and conferences;
    - Develop closer and deeper relations with our innovation partners and broader community: Organise promotion sessions and visits to iiLab for industrial companies, contributing to the possible establishment of new R&D contracts or the sale of services by INESC TEC or even provide new challenges and needs from industry. / Organise several technology experimentation/demonstration sessions for industrial companies;
    - Provide innovative learning experiences: Design and implement a training roadmap to guide individuals and companies through the complexities of digital transition and empower the companies' workforce with the skills needed to thrive in the digital age. At least two executive and senior training programmes with a strong practical component based on the research results;
    - To develop, implement and present a showcase for visitors and trainees: some research results in areas such as advanced planning model, planning and scheduling, simulation and optimisation, digital twin, automation, collaborative robotics, IoT platform, augmented reality, and quality control with AI will be integrated into a real-world complex manufacturing process, enabling seamless data exchange and interoperability. These integrations contribute to the evolution of smart manufacturing practices.
2. **Make an impact on the toughest challenges of our time in science, technology, and society, through bold creativity and transformative action:**
    - Better align and deliver R&I with Industry's needs: Host at iiLab INESC TEC projects carried out in cooperation with industry, both at national and international level;
    - As contributions to the communication of scientific and technological achievements, the iilab intends to organise open days (at least one) to disseminate research and innovation advancements among academia and companies in general.
3. **Increase our relevance by closely integrating across science and innovation, disciplines, and ecosystems:**
    - Develop better linkages between knowledge production, development, and market uptake: Organise and carry out for industry demonstration projects resulting from previous research projects. / Focus on the design, development and demonstration of 6 pilot cases in the scope of the NOS 5G & Digital Transformation TestBed, in close collaboration with technology companies. Industry will be invited to

special show cases that will be organised to demonstrate benefits of digital technologies in manufacturing scenarios. / Support the licensing to industry of technology-based products and services;

- Increase our international networking, leadership and competitiveness: Organise or participate in the organisation of at least one high-visibility international event. / Provide laboratory support to several EU-funded or other international projects. / Promote the connection to, at least, one other international Industry Laboratory.

4. **Strike for a sound, sustainable and effective operational model:**

- Improve quality, management, and usage of our infrastructures: Seek financing to continue investment in iiLab infrastructures. / Promote licensing of INESC TEC technology to technology companies using iiLab as a facilitator to demonstrate and validate these technologies in relevant scenario.

6.4 Laboratory of Communications

6.4.1 Mission and positioning

The Communications Laboratory (ComLab) 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 ComLab, 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.

ComLab 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 an electrically large anechoic chamber (1.2 m x 0.6 m x 0.6 m) designed for evaluating different source 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, 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.

6.4.2 Main objectives and actions planned for 2024

The main objective of the ComLab is to support the experimental evaluation and testing of next generation communications, localisation and sensing solutions in a controlled environment, after they are evaluated in simulation and before they are tested in the real world. Toward this goal, the following actions are planned for 2024, grouped by the following strategic objectives:

Improve quality, management and usage of our infrastructures

- Deploy a vision-aided large intelligent surface and mobile base station/user equipment, including the assembly of a multi-camera testbench suitable to test computer vision algorithms;
- Develop and test new Wi-Fi and 5G-based backup communications solutions for emergency/disaster management scenarios, considering different backhaul links (e.g., fibre and LEO satellite);
- Expand the recently established biological tissues optical characterisation testbed;
- Extend the laboratory facilities to a complementary room enabling research on 5G/6G solutions in cooperation with a mobile operator.

Provide innovative learning experiences

- Organise a training session to instruct researchers on how to use the tools and instruments associated to vision-aided communications;
- Foster the use of ComLab in the context of research activities involving students, such as the CTM Summer Internships and BSc Curricular Internships.

Better align and deliver R&I with Industry's needs

- Promote the use of the improved ComLab infrastructures, in close cooperation with mobile operators and other industrial partners, for R&D&I activities addressing the needs of real-world application scenarios.

6.5 Laboratory of Microfabrication

6.5.1 Mission and positioning

The Laboratory of Microfabrication does fundamental research on laser direct writing microfabrication using a femtosecond laser and develops solutions in integrated optics, optofluidics, etc. The laboratory also provides fabrication services to other areas of research within the Centre of Applied Photonics (CAP).

6.5.2 Main objectives and actions planned for 2024

This microfabrication laboratory explores non-traditional microfabrication techniques based on femtosecond laser direct writing processes, ranging from high resolution tridimensional localised 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 sensing heads that will lead to the development of better and more reliable sensing heads.

- 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;
- Micromachining and laser welding of glasses;
- Machining and waveguiding writing in Ultra Low Expansion (ULE) glasses;
- Exploration of glass poling techniques for the fabrication of active devices fabricated by femtosecond;
- 3D metallic electrode fabrication.
- Fabrication of microfluidic and optofluidic devices using FLICE techniques for sensing applications;
- Fabrication of Bragg and long period gratings (first and higher order structures); improve the currently fabrication set-up.
- Explore the creation of nitrogen vacancies centres on diamond.

The fabrication capabilities are complemented with equipment available at CEMUP – MNTEC. The cleanroom is a service providing laboratory managed by University of Porto that was supported since its creation by INESCTEC which made its micro/nanofabrication equipment available on this infrastructure for widespread use.

6.6 TRIBE - Laboratory of Robotics and IoT for Smart Precision Agriculture and Forestry

6.6.1 Mission and positioning

The Laboratory of Robotics and Internet-of-Things (IoT) for Smart Precision Agriculture and Forestry, called TRIBE, was established in 2013.

This laboratory has the mission to research and develop robotics, automation, and IoT based solutions, to improve the levels of smart precision ("right time, right amount, right place") agriculture and forestry, profitability, and automation in three main environments: Permanent Crops (such as steep slope vineyards, olive groves, tree fruits), Forest biomass harvesting, Protected Cultivation (conventional and urban).

6.6.2 Main objectives and actions planned for 2024

Table 6.1 - TRIBE – Main actions planned

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
Increase the numbers of patents produce under TRIBE context	Increase the numbers of patents to make easier the technology transfer.	C1.3
Maintain 1 Horizon project coordinated by TRIBE team	Coordinate a very competitive proposal to HORIZON framework for agriculture/forest.	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
Keep organising 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
Promote the creation of a Start-up with TRIBE 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

6.7 Neuro-Engineering Lab – BRAIN Lab

6.7.1 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: Brain imaging (&signals); Man-machine symbiosis with edge-AI (e.g. Brain-Computer Interfaces); Quantified Movement multimodal analysis in neurological diseases; Neurosurgery Aiding Systems; and from Macro-to-nano bio-neuro-sensing.

We operate several heavy R&D equipment of which our unique f-MRI simulator fully equipped with new 64ch video-EEG medical systems and a neurophotonics micro&nano sensing workbench under installation.

BRAINLab research group in the last academic year of 2022/2023 counted with 9 MSc Thesis and 5 ongoing PhD thesis and 1 concluded PhD.

This last year of 2023, BRAIN as also became the first Portuguese research infrastructure to be part of EBRAINS, a European Infrastructure that is part of ESFRI. This membership will continue into 2024 and new interaction will start to happen to strength our connection with other members and pursuit new research projects.

6.7.2 Main objectives and actions planned for 2024

BRAINlab strategy defined for 2023 was a success with scientific and internationalisation achievements, mainly concerning high impact publication that increased our visibility and partnership with several European research groups and organisations that endorsed our international Network. For the next year of 2024, we aim to continue this effort aligned with INESC TEC strategic objectives:

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

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 the University of Plymouth namely with the Brain Research & Imaging Centre (BRIC) will also lead to possible project and joint research.

C2.2. Better align and deliver R&I with industry's needs

Jointly with our start-up InSignals Neurotech implement clinical trials in 3 international clinical 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. One more new start-up will be created resulting from IP of our lab (not disclosable at this moment).

C1.5. Provide innovative learning experiences

The creation of a new Laboratory at FEUP and the enhancement of the new Lab at INESC TEC will provide more resources and learning capabilities to students and researchers to conduct their research and achieve high scientific impact findings. BRAIN Lab will also receive two international students from the US (Stanford and Rice Universities) for 6 months internships that is a result of our internationalisation efforts for attracting the best world students to our lab.

C5.2. Improve quality, management and usage of our infrastructures

INESC TEC research programs jointly with EBRAINS and new possible funding opportunities is allowing to improve our infrastructure to have high-quality system in a more organised and structured way.

6.8 Robotics and Autonomous Systems Laboratory

6.8.1 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 as well as advanced education programs. In fact, as a research lab in an academic environment it fosters undergraduate research, supports multiple engineering courses and academic activities.

The Centre for Robotics and Autonomous Systems is also managing the TEC4SEA infrastructure in Leixões, an area dedicated to support sea operations and logistics. In the case of larger R&D projects, the Centre is also renting temporary laboratory space to support local development at supervision.

6.8.2 Main objectives and actions planned for 2024

The main objectives of the Robotics and Autonomous Systems Laboratory for 2024 are the following:

- Upgrading laboratory working conditions – The laboratory infrastructure needs to have some upgrades to improve the working conditions in the open space, to address the harsh working conditions in extreme weather and some aging of the office equipment.
- Upgrading laboratory equipment and tools – the growing R&D activity and the expansion to new application areas requires up to date laboratory equipment and tools. Investments planned for 2024 will contribute to the maintenance and update of development equipment, make available fast prototyping equipment, as well as high performance systems allowing for the conduction of field experiments.
- Training of technical staff – in order to allow researchers to be more focused on innovation and research activities, an effort will be pursued on the training technical staff to support the conduction of experimental activities.
- Consolidation of the technical support team – Given the planned activities for 2024 there will be a strong demand for technological developments therefore there will be need to continue the efforts to increase the support team.
- Integration with R&D Infrastructures – take advantage of some of the services provided by the infrastructures (eg. TEC4SEA) to optimise logistics, simplify outsourcing, and accelerate development and testing of equipment.

6.9 Smart Grids and Electric Vehicles Laboratory (SGEVL)

6.9.1 Mission and positioning

SGEVL mission is to make it possible to put into practice the concepts, algorithms, and scientific knowledge generated by the Power and Energy Systems domain. This implementation ranges from elementary prototypes/proof of concept to complete demonstrators installed in the field. Besides this, SGEVL aims to support the creation and transference of scientific knowledge in cooperation with industry, as well as provide technical training and education for industrial partners and academia.

Currently, SGEVL has four main working fields: smart grids, electric mobility, energy management, and power electronics, supported not only by the permanent I&D staff working at SGEVL but also by senior researchers from academia working in close cooperation with Power and Energy Systems domain and graduating students which choose SGEVL to develop their work.

6.9.2 Main objectives and actions planned for 2024

Consolidate human resources and testing infrastructures considering the areas of energy storage, hydrogen, EV charging, hybrid AC/DC distribution grids, synthetic inertia, and real-time simulation, and reinforce SGEVL infrastructure to improve its capabilities in supporting research activities in INESC TEC, provide services to industry, training and educational activities in accordance with CPES guidelines.

Among other sources, the laboratory infrastructure will be reinforced next year 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 SGEVL human resources.

- **Energy Storage**: Increase energy storage capacity to expand the microgrid testbed, funded by the PRR project Next Generation Storage (NGS).
- **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).
- **EV charging**: Continue the development of EV smart charging laboratory scale testbed, integrating EVSE (Electric Vehicle Supply Equipment) with V2G capabilities (H2020 POCITYF and HE GreenDataAI projects), enabling the development of pre-certification services of EV smart charging appliances and the development of new solutions ensuring interoperability between EVSE and other household/building appliances (initiated in H2020 InterConnect project), and integrating a virtual domain suited to test edge AI algorithms for electrical mobility integrated in low voltage grids and Energy Data Spaces.
- **Hybrid AC/DC distribution grids**: Expand the laboratory scale hybrid AC/DC microgrid initiated in the scope of P2020 SmartGlow project, using the PRR funding.
- **Synthetic inertia**: 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 (new area for the infrastructure):** The infrastructure will be expanded to integrate a target of 30 domestic consumers, located in the area operated by *Cooperativa Eléctrica do Vale d'Este* (CEVE), a small distribution system operator, with energy meters (aggregated and individually controllable loads) and sensors to monitor in-house comfort levels (temperature, humidity, CO2). The goal is to offer a data-centric testing infrastructure for energy efficiency and management, local energy communities, and the operation of low-voltage grids. The data will be integrated with a Data Space implementation from the HE ENERSHARE project.

Promote the exploitation of CPES research results with the creation of new added-value services for industry, namely functional testing and experimental validation of solutions for EV charging, hydrogen electrolysis, grid protection, synthetic inertia, and DC grids, but also the construction of a data generating and storage infrastructure to make data available for industry actors. Also, continue the efforts to increase the dissemination activities and international collaboration with other scientific partners to attract new clients and strategic partners based on the list of developed services, disseminate SEGVL website, and produce support material.

6.10 Tec4sea Research Infrastructure

6.10.1 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 enable full validation and evaluation of technological solutions designed for the ocean environment, allowing researchers to evolve from simulation/lab experiment 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 businesses players.

6.10.2 Main objectives and actions planned for 2024

The main objectives for 2024 are the following:

- **Validation of services** – the definition of services was finalised at the end of the implementation phase. Some validation tests were already conducted, but others are still needed, as new services are offered to the community.
- **Increase the number of services** – Continue the divulgation of the TEC4SEA resources and services for different stakeholders and potential users to increase the number of contracted services in 2024.
- **Upgrading the infrastructure** –Upgrades to the infrastructure assets are planned.
    - In 2024 will start the process for adding dynamic positioning system to Mar Profundo.
    - Adding a side pole for underwater sensors mounting in IPESEA rigid inflatable boat.
- Building on the experience from the first implementation phase, 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, and establishing priorities for the second implementation phase, to ensure a successful transition to the operational phase.

7 SUPPORT SERVICES

7.1 Legal Support Service

Manager: Rita Barros

7.1.1 Presentation of the Service

Legal Support ensures the conformity of the activity carried out by INESC TEC with the national and European legal system, seeking to follow best practices within the various areas of its intervention, which includes human resources, international relations, public procurement and data protection, but also matters of tied contracts, such as those related to intellectual property or commercial and business law. In its vast activity, the Legal Support Service always seeks to defend the Institution's best interests, by proposing a solution that is capable of integration the strategic interests of INESC TEC and the obligations imposed on it, above all, taking into account its nature.

7.1.2 Service catalogue

- Support to the acquisition of goods, services and works, subject to public procurement, as well as the respective contractual execution (e.g: modifications to the contractual relationship or termination of the contract).
- Support to the negotiation of various types of contracts, such as services, consortium agreements, collaboration protocols, licence agreements, Non-Disclosure Agreement, Data Protection agreement, Memorandum of Understanding, etc.
- Support in drafting and revising Grant Contracts, Labour Contracts, Services Agreements and related Documents.
- Dissemination and awareness-raising on applicable legislation.
- Support to the participation and creation of other entities.
- Litigation (legal practice).

7.1.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2024:

- **Improve the base conditions for technology commercialisation**
    - Ensuring compliance with the highest quality standards in the drafting of legal acts that reflect the degree of commitment between legal requirements and the strategic interests of the Institution, placing them at the service of the Institution in order to promote the closest partnerships, ensuring the necessary legal context in the dialogue with the market and in relationships with it, particularly in terms of technology transfer and preservation, but also the dissemination of results to society.
- **Develop closer and deeper relationships with our innovation partners and the broader community**
    - Improve negotiation instruments, pursuing to arm the Institution's R&D Centres with tools that allow a closer approach to the industry, by participating *ad initium* in discussions with stakeholders, in order to ensure the simplicity of the negotiation process.
    - Develop awareness-raising actions with the aim of clarifying internal procedures, assisting in the image that INESC TEC intends to project to the market and the society, ensuring that the focus remains on R&D&I, reducing legal and bureaucratic obstacles to the relationships being developed.

- **Contribute to digitalisation of public administration**
    - Presence in initial discussions promoted by the research centres that aim to execute projects related to digitalisation of public services, seeking, from a legal point of view, to provide the best tools, taking into account national and European frameworks, seeking to avoid setbacks and additional bureaucracy, thus ensuring the fluidity of the research and promoting synergy between the parties involved.
- **Promote our proactive participation in R&I agenda-setting at regional, national and EU level**
    - Monitoring legislative developments, pursuing to participate in public consultations that are of interest to the Institution, support and participation in national and international working groups, evaluation studies on public policies, but also on other major themes that guide the Institution, seeking to contribute to the construction of a legislative framework capable of responding to the challenges of Science and Technology, capable of monitoring its evolution and ensuring the necessary synergies to guarantee the transmission of knowledge to society.
- **Increase our international networking, leadership and competitiveness**
    - Study the best international practices, in order to place Law at the service of knowledge, technology and innovation, guaranteeing the know-how in the area, in order to ensure adequate responses that provide and encourage greater and better participation of INESC TEC in international initiatives.
- **Improve attraction and retention of world-class talent**
    - Support the contracting activity of the Human Resources Service, assisting in the search for the legal instrument best suited to the needs of the Institution, compliant with the applicable legislation, providing the balance necessary to attract and maintain human resources of high scientific potential.
- **Strengthen our commitment to independence and compliance research with ethical principles**
    - Raise awareness in matters of ethics, prevention of corruption and protection of personal data, through training actions, as well as the construction of legal instruments and tools translated into proposals and agreements established by the Institution, compatible with legal requirements and the national and European highest standards.
- **Promote and contribute to environmental sustainability**
    - Compliance with national and European best practices and recommendations promoting green and social public procurement, ensuring that public contracts fulfil ecological parameters and promote better social conditions, such as gender equality.

7.2 Accounting and Finance Service

Manager: Paula Faria
Assistant Manager: Libânia Caetano

7.2.1 Presentation of the Service

The Accounting and Finance Service is responsible for coordinating and executing the accounting activities, for fulfilling all fiscal obligations, managing INESC TEC´s cash flow and ensure the availability of enough funds to meet the payments due time. In this context, the service acts as a mediator between the institute and external parties, according to the guidelines provided by the Board. From an administrative perspective, it is also responsible for the purchasing and travel processes and for managing the institute insurances and fixed assets.

7.2.2 Service catalogue

The Accounting and Finance department provides a wide range of services to a number of recipients both internal and external to the organisation:

- Purchasing Process;
- Travel Process;
- Procurement Process;
- Invoicing R&D Services and collecting payments;
- Tax and Reporting Obligations;
- Accounting records;
- Financial Management;
- Fixed Asset Management;
- Insurance Management.

7.2.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the main objectives and actions planned for 2024 by the Accounting and Finance include:

- Strengthen the sustainability and resilience of our economic model
    - Reinforce continuous improvement activities and practices;
    - Improve the procurement process;
    - Increase efficiency on Fixed Assets Management;
    - Participate in the identification of requirements, procurement and implementation of a new ERP system;
    - Improve logistics for organising events;
    - Hire an additional member of staff to cope with the increase in activity.
- Promote and contribute to environment sustainability
    - Consolidate the digital archive process.

7.3 Management Control Service

Manager: Vanda Ferreira
Assistant Manager: Bárbara Maia

7.3.1 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.

7.3.2 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 the HR of the institution;
- 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.

7.3.3 Main objectives and initiatives planned for 2024

For 2024 the Service selected some Strategic Objectives and defined the following initiatives for 2024:

- Strengthen the sustainability and resilience of our economic model
    - Participate in the search, selection and implementation of a new ERP
    - Planning available funding and resources for the next five years
    - Continue to develop and implement management guidelines and internal procedure guidelines
    - Automate the consolidation of information to support the preparation of payment requests
    - Implementation of new and appropriate internal management tools, based on Power BI or others
- Increase our international networking, leadership and competitiveness
    - Review of the workflow associated with proposals register and subsequent cost centre opening
    - Reinforce the team in the area of European Projects to support the increasing number of coordinated projects
    - 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”

7.4 Human Resources Service

Manager: Luís Seca
Assistant Manager: Margarida Gonçalves

7.4.1 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.

7.4.2 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.

7.4.3 Main objectives and actions planned for 2024

Activities in the Strategic Development Area

In detail, during the year 2024 the following activities will take place:

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

- **Approve and implement the job descriptions and competencies policy**: implement the job descriptions and competencies policy, as well as the job catalogue for all the positions and the respective competency directory.
- **Implement and communicate the career policy**: integrate EC (Executive Committee) feedback on strategic guidelines; adjust (in accordance with the job descriptions and competencies policy) and implement the career policy.
- **Implement and communicate the performance appraisal policy**: integrate EC (Executive Committee) feedback on strategic guidelines; adjust (in accordance with the job descriptions and competencies policy) and implement the performance appraisal policy.
- **Remodel and implement the new welcoming and onboarding policy**: conduct a new and revised onboarding process based on the novel developed contents and materials.

- **Design, elaborate and implement the new recruitment and selection policy**: ensure planning and resource forecasting in a more integrated way; consider improvements on attraction mechanisms; rethink and elaborate the recruitment and selection process.

Strategic objective – providing innovative learning experiences

- **Implement the training policy:** implement the new training planning for 2024 based on the diagnosis of training needs and contribution from the relevant stakeholders.

Strategic objective – provide a more dynamic and fulfilling working environment

- **Develop wellbeing and occupational health actions and promote the existing support line:** 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 2024 the following activities will take place:

- **To be seen as a strategic partner** and not just a service;
- **Looking for the best practices (benchmarking),** to identify new trends to improve our processes / results;
- **Implementation of a new RH Management Software;**
- **Systematisation of benefits** offered to employees and their dissemination on the intranet;
- **Creation of a user guide for Multicare Health Insurance** and its dissemination;
- **Start the application Cards (App)** to create and read employee cards;
- **Provide a training registration module** for employees and start the training plan that is being prepared;
- **Continuous Improvement of HR processes** on internal platforms such as: automatic alert to new employees of the need to sign their contracts; Creation of new fields in PHC and IRIS (birthplace, origin institution…); the submission of lecturing activities' requests (generate automatic reminders to let the different intervenient know that an action is required such as submit, approve/validate and attach missing documentation); Process internal reorganisation; Providing personal documents on IRIS so that employees can consult it (contracts, addenda, edicts, receipts, training certificates...);
- **Increase/improve institutional relations with IES** regarding the operationalisation of tuition fee payments;
- **Increase/improve automation in the tuition fee** payment process;
- **Continuous update of HR documents available on the intranet and website**, including the creation of the HR Guide and FAQs;
- **Reduce contract drafting time to 3 days.**

7.5 Management Support

Manager: Isabel Macedo

7.5.1 Presentation of the Service

The Management Support Service facilitates effective decision-making in several governing bodies of INESC TEC. In addition to its operational focus, it also 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.

7.5.2 Service catalogue

- Prepare and operationalise decision-making processes at multiple levels;
- Support internal initiatives of the Board and monitor organisational priorities, goals and metrics;
- Assist in institutional reports/responses and 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.

7.5.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2024:

- Raise the contribution and visibility of our research
    - The Service will endeavour to strengthen the comprehensive implementation of Open Science practices at INESC TEC, namely through the availability of intranet content and workshops held on the topic;
    - New approaches and analyses will be explored in terms of bibliometrics reports to provide INESC TEC´s researchers and management with new perspectives on its R&D. Furthermore, the Service will support the Board in its involvement in international initiatives focused on new ways to assess research, such as CoARA – Coalition for Advancing Research Assessment and EARTO Collective studies;
    - The AG team will strongly support INESC TEC's application in the FCT R&D Units Evaluation 2023/2024 process, ensuring the articulation in information compilation and data quality.
- Develop impactful research and innovation aligned with the SDGs
    - Plans, reports and analyses of INESC TEC research will consider the alignment with SDGs, with the implementation of new internal points of collection of this information and steps to ascertain and demonstrate the institution's positioning.
- Strengthen the distinctive aspects of our institutional model
    - A revision of the document management policy will take place to include a procedure for the digitalisation of records and new information management aspects will be added, namely access to information requirements framed within security accreditations;
    - General assessment of the quality of data made available on INESC TEC's different platforms and curation of new information databases to be developed (e.g. related entities);
    - Boost the area of continuous improvement towards business processes analysis and improvement, fostering cross-service actions and collaboration;
    - Support the Board in developing INESC TEC Strategic Plan towards 2030 and aligning INESC TEC structures to it.
- Strengthen our commitment to independence and compliance of research with ethical principles
    - Further integration of the INESC TEC´s open science services with the OPENAIRE and EOSC ecosystems.

7.6 Secretarial Coordination

Managers: Ana Isabel Oliveira and Grasiela Almeida

7.6.1 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 17 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.

7.6.2 Service catalogue

- **Team Coordination:**
    - Promotion of training and coaching sessions, in order 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.

7.6.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Secretarial Coordination team selected some Strategic Objectives, and it is prioritising the following initiatives in 2024:

- Strengthen the distinctive aspects of our institutional model
    - Promotion of training in the areas of event organisation, Microsoft Excel Advanced, and also training actions yet to be identified in the Training Needs Diagnosis, led by the HR Service;
    - Design and Implementation of a new process focused on the event organisation;
    - Recruitment process to reinforce the team's capacity in order to better respond to the challenges of 2024;
    - Awareness actions towards the use and advantages of the CRM as the institutional contacts database.
- Provide a more dynamic and fulfilling working environment
    - Show & Tell workshop with external expert aimed at sharing best practices with the purpose of implementing improvements in our daily tasks, relations within the team and others, resulting in a stronger and more engaged team.

7.7 Funding Opportunities Office

Manager: Marta Barbas

7.7.1 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.

7.7.2 Service catalogue

- Search and identify the most suitable funding opportunities;
- Monitor and support the preparation and submission of proposals to the different funding programs and support the contracting process of approved proposals;
- Institutional contact point with funding entities;
- Follow-up of the registration of proposals on the Intranet;
- Compilation and dissemination of indicators.

7.7.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2024:

- Increase our international networking, leadership and competitiveness
    - Recruitment of a new resource to reinforce the European Funding team in order to increase the number of EU projects approved in coordination role and other international projects, and to increase revenue in EU projects;
    - Organisation of tailormade workshops to present funding opportunities to specific groups of researchers (junior researchers; researchers from different INESC TEC Polos; …) or to specific calls or programmes (p.e. ECTenders).
- Strengthen the sustainability and resilience of our economic model
    - Regular analysis on the results of proposals, in order to design a set of dedicated workshops that allow researchers to improve the quality of their proposals;
    - Improvement of "proposals workflow" together with SIG;
    - Evaluation of the new area in the internal website for funding opportunities through a questionnaire to users.

7.8 Technology Licensing Office

Manager: Daniel Marques de Vasconcelos

7.8.1 Presentation of the Service

The INESC TEC Technology Licensing Office (TLO) aims **to maximise the societal impact of the R&D results** generated at the institution. In 2024, the TLO will continue its transformation into a Knowledge Transfer Office strengthening its position as a key player at national and European levels. By leveraging **world-class practice in Intellectual Property (IP) Strategy and Technology Transfer, the TLO will contribute to the development of the regional and national innovation ecosystem.**

7.8.2 Service catalogue

- **Scouting and registration of new R&D results**
    - Systematic monitoring of strategic projects, 2) Technology disclosure, and 3) IP awareness and training.
- **Intellectual Property Strategy**
    - Holistic IP strategy, 2) support for IP rights registration, 3) market-oriented portfolio management.
- **Knowledge valorisation and technology transfer**
    - Customer discovery & industry liaison, support to the negotiation of IP exploitation, license monitoring;
    - Support deep-tech spin-offs and venturing.

7.8.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2024:

- **Raise the contribution and visibility of our research**
    - Fine-tune the systematic follow-up of strategic INESC TEC projects by developing new rules and tools to ease the identification of new R&D results, the organisation of these R&D results in a database, and their valorisation in future projects and business opportunities;
- **Improve the base conditions for technology commercialisation**
    - 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.
- **Increase our international networking, leadership, and competitiveness**
    - Intensifying the participation in international tech fairs and contribution to leading organisations such as TTO Circle, EARTO, and PATLIB.
- **Improve attraction and retention of world-class talent**
    - Consolidation of the current team of two IP and tech managers by supporting international training and dedicated and close follow-up. Education and training of new tech transfer executives.
- **Develop closer and deeper relationships with our innovation partners and the broader community**
    - New Knowledge Transfer and IP Intelligence initiative – open sessions to present real success cases powered by the smart use of IP, allowing didactic hands-on training and disclosing high-tech and cutting-edge strategies among the community.

- Consolidate the relationship between the tech managers and coordinators and PI´s of their respective domains;

- **Build stronger knowledge-based and multidisciplinary R&I ecosystems**
  - Fine-tuning of the new Spin-off Committee for active spin-offs and entrepreneurial projects and consolidating the technical support to the Seed Project – Commercial Proof-of-Concept.

7.9 International Relations Service

Manager: Andreia Passos

7.9.1 Presentation of the Service

The service mission is to assist the INESC TEC Board of Directors and R&D Centres in maximising global opportunities, reach and reputation through tailored support to international mobility, to develop high-level international partnerships and to promote intercultural awareness and understanding. The service turns four years old in 2024 and continues its walk towards its consolidation in the organisational chart amid challenges. The main challenge is how to continue being a proximity service if internal demand grows and the size of the core team remains the same. Indeed, since its creation, the service has struggled to retain newly hired staff in the core team. Additionally, with the recent extinction of SEF and the transfer of its former responsibilities to seven different bodies, the support of foreign newcomers and other foreign staff residing in Portugal for some time now is expected to be affected – to what extent, we do not know - by the uncertainty that comes along with profound restructuring processes such as this one. Coping with this uncertainty represents another challenge to the service in 2024.

7.9.2 Service catalogue

The SRI service portfolio includes the following:

- Inbound and outbound mobility advisory services;
- Management of INESC TEC International Visiting Researcher Programme;
- Support to MoU negotiation, drafting, signing, implementation, and evaluation;
- Support to international delegations and high-level visitors;
- Management of International S&T Partnerships (special projects);
- Information services on International Relations (e.g., monitor sources that may shed light on the S&T landscape and the political and socio-economic context of geographies where INESC TEC plans to operate (either through partnerships or an office setup; liaise with actors who may help us access cooperation opportunities and networks in markets abroad (e.g., embassies, consulates-general, trade associations) or market knowledge (e.g., local culture, regulations, policies, potential partners)).

7.9.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Service selected some Strategic Objectives and is committed to developing the following initiatives in 2024:

- **Increase the international embedment of our community:**
    - Encourage international engagement of our staff to enhance existing partnerships and forge new relationships. To this end, the SRI will continue looking for international mobility programmes and funding schemes supporting inbound and outbound mobility to improve the organisation's exposure to internationalisation and support staff in their efforts to participate in such programmes.
    - Monitor and assess the implementation of the second edition of the INESC TEC International Visiting Researcher Programme and prepare for the launch of a third edition.
    - Produce regular reports to inform the BoD of outcomes and the expected impact of staff international mobility engagement.
- **Increase our international network, leadership, and competitiveness:**
    - Continue assisting the organisation in bilateral and multilateral cooperation, taking advantage of individual initiatives that may leverage international agreements in areas deemed strategic for the institution and strengthening existing international institutional partnerships through regular interactions with champions.

- Support the organisation in the conduction and negation of international or multilateral initiatives rooted in national agendas of strategic relevance to Portugal's international standing as an S&T and Innovation hub (e.g., assistance in the negotiation of the UT Austin Portugal partnership renewal; development of a semiconductor international research and innovation ecosystem).
- Work with SCOM to design and produce institutional promotional material for the international area.

- **Expand the diversity of our community:**
  - Work closely with HR to help the institution onboard and retain new hires from other countries, nurturing a *proximity service* culture.
  - Have a broader offer of workshops and courses on interculturality to help staff navigate cultural differences successfully when participating in or conducting negotiation processes with foreign partners / interacting with foreign staff.

7.10 Communication Service

Manager: Joana Coelho
Assistant Manager: Sofia Maciel

7.10.1 Presentation of the Service

The Communication Service (SCOM) is responsible for the design and implementation of the institution's internal and external communication actions. The internal communication initiatives aim to promote a greater knowledge of INESC TEC activities among its community and promote a greater interaction between the employees - through internal events. Concerning external communication, SCOM focuses on promoting the institutional image at various levels, towards consolidating INESC TEC's prestige, also working together with researchers to promote and disseminate the science and innovation activities carried out at the institution.

7.10.2 Service catalogue

The Communication Service encompasses five main areas: content production, design and multimedia, organisation of events, support and/or leadership of the dissemination and communication activities of European and/or national projects and translation. The communication tools used by SCOM follow an integrated marketing communication perspective and they are: 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). The communication activities are strategically divided between external and internal actions.

7.10.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Service selected some Strategic Objectives (SO), and it is prioritising the following initiatives in 2024:

- **EXTERNAL**
    - The deployment of the new institutional website (a process initiated throughout a diagnosis in 2023), aligned with the SO "communicate scientific and technological achievements and their impacts".
    - Continue and expand our science communication capability, with the maintenance of some formats (videocast, podcast, long written articles), but also the launch of new contents, aligned with the SO "engage in direct dialogue with the public", contributing to a greater scientific literacy of the society.
    - Continue to evolve our communication capabilities among different stakeholders, from scientific to innovation, policy makers and even future employees, throughout different communication tools, from digital marketing (social media, website), to public relations (events, press relations), advertising (videos, brochures), direct marketing (newsletters), etc, based on different objectives and, therefore, established KPIs, aligned with the SO "communicate scientific and technological achievements and their impacts".
- **INTERNAL**
    - The development of an internal communication strategy, based on a diagnosis of activities, channels and needs, to address critical topics such as culture awareness and engagement, sense of belonging, and talent retaining, contributing to meeting the SO "Improve attraction and retention of world-class talent".
    - In line with the SO "Build stronger knowledge-based and multidisciplinary R&I ecosystems", set up new internal communication activities, such as events to discuss science and promote collaboration opportunities between researchers.
    - The improvement of existing internal communication channels, such as the Intranet and the weekly agenda, stimulating the community's engagement, in line with the SO "Provide a more dynamic and fulfilling working environment".

7.11 Networks and Communications Service

Manager: Gil Coutinho

7.11.1 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 datacentre resources, network equipment, videoconferencing solutions, etc.

7.11.2 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' datacentres, 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.

7.11.3 Main objectives and initiatives planned for 2024

Towards the strategic objective to **improve quality, management and usage of our infrastructures**, the Networks and Communications Service is prioritising the following initiatives in 2024:

- Enhance INESC TEC's cybersecurity maturity by:
    - Further tuning and streamlining cybersecurity processes like detection, tracking and event response;
    - Elaborating contingency plans and defining resiliency tests with failure simulations;
    - Formally constituting a Computer Security Incident Response Team (CSIRT) integrated within the national network of CSIRTs.

7.12 Management Information Systems Service

Manager: José Carlos Sousa

7.12.1 Presentation of the Service

The Management Information Systems Service oversees the development and maintenance of INESC TEC's management information system.

7.12.2 Service catalogue

- **IRIS - INESC TEC Research Information System**: Members, Conflicts of interest, Teaching Accumulation, HR reports, Projects, Publications, Theses, 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, Electronic invoicing, Resource booking.
- UOneCONNECT – 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.

7.12.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2024:

- Improve quality, management, and usage of our infrastructures:
    - Prepare the current ERP system renewal and bulk data migration;
    - Complete the integration of timecards management with IRIS;
    - Reengineering of the Project Proposals process, enhancing the user experience and better integration with CRM/Project databases;
    - Development of middleware for a new website;
    - Interoperability IRIS – SIGARRA (UP academic information system);
    - Automate the generation of contracts in Human Resources processes;
    - Implement a complete redesign booking system for internal resources.

7.13 System Administration Service

Manager: Jaime Dias

7.13.1 Presentation of the Service

The System Administration Service manages servers, computer systems and common applications, 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.

7.13.2 Service catalogue

SYSTEM ADMINISTRATION

- Setup, configuration, and management of computation, virtualisation and storage infrastructures.
- Backup of critical services, virtual machines and personal computers. Critical data is copied to tape and transported off-site for robust disaster recovery measures.
- Set up and manage authentication infrastructures, specifically the INESC TEC Directory and the federated Identity Provider, to enable seamless authentication across INESC TEC resources and resources on FCCN, as well as other eduGAIN partner institutions.
- Hosting of websites.
- Management of the email mailbox service, powered by a cluster of Exchange servers distributed between the headquarters' datacenters and the disaster recovery site for enhanced data resilience.
- Provision of various file-sharing and collaboration application services.
- Administration of the INESC TEC Microsoft 365 tenant and other Software as a Service (SaaS) subscriptions.
- Purchase and management of software volume licenses, such as Microsoft, Adobe, and MathWorks.
- 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.
- Administration of staff computers.

END-USER SUPPORT

- Helpdesk.
- Desktop support.
- Support for available services.
- Assistance in the installation and configuration of systems/applications.

DATA PROTECTION

- Recommendation and evaluation of computer systems' security and privacy to ensure compliance with GDPR regulations.

7.13.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Systems Administration Service selected the following Strategic Objective and is prioritising the following initiatives in 2024:

- Improve quality, management and usage of our infrastructures.
    - With the increased R&D activity related to Machine Learning and Artificial Intelligence, SAS will continue expanding and improving its computing and storage infrastructures. It will also set up

an MLOps (Machine Learning Operations) platform to provide a set of practices and tools to streamline and automate the end-to-end machine learning lifecycle and maximise the usage efficiency of the resources.

- SAS will Improve cybersecurity by enforcing multi-factor authentication and fostering the utilisation of securely strong password managers.
- SAS will foster the integration of the INESC TEC and the University of Porto identity and authentication infrastructures.

7.14 Infrastructure Management Service

Manager: Jorge Couto

7.14.1 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 2024 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 iiLab and Vila Real facilities in UTAD.

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.

7.14.2 Service catalogue

- General maintenance of INESC TEC buildings, including the ones in the associates;
- Organise 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.

7.14.3 Main objectives and initiatives planned for 2024

Aligned with INESC TEC's Strategic Objectives, the Service selected some Strategic Objectives, and it is prioritising the following initiatives in 2024:

- Increase the number of solar panels to increase electricity production capacity, and continue to replace lighting with LEDs;
- Organise a training session for intervention teams on self-protection measures;
- Carry out a fire drill to test the self-protection measures and associated teams;
- 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 vehicles;
- Repair or possibly replace the air conditioning water cooling chiller;
- Reduce the heating costs of main building by replacing the boiler burner in building A;
- Renewal of the cafeteria spaces (in both buildings) to increase comfort and efficiency for co-workers;
- 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 air conditioning and a raised floor to increase working space.

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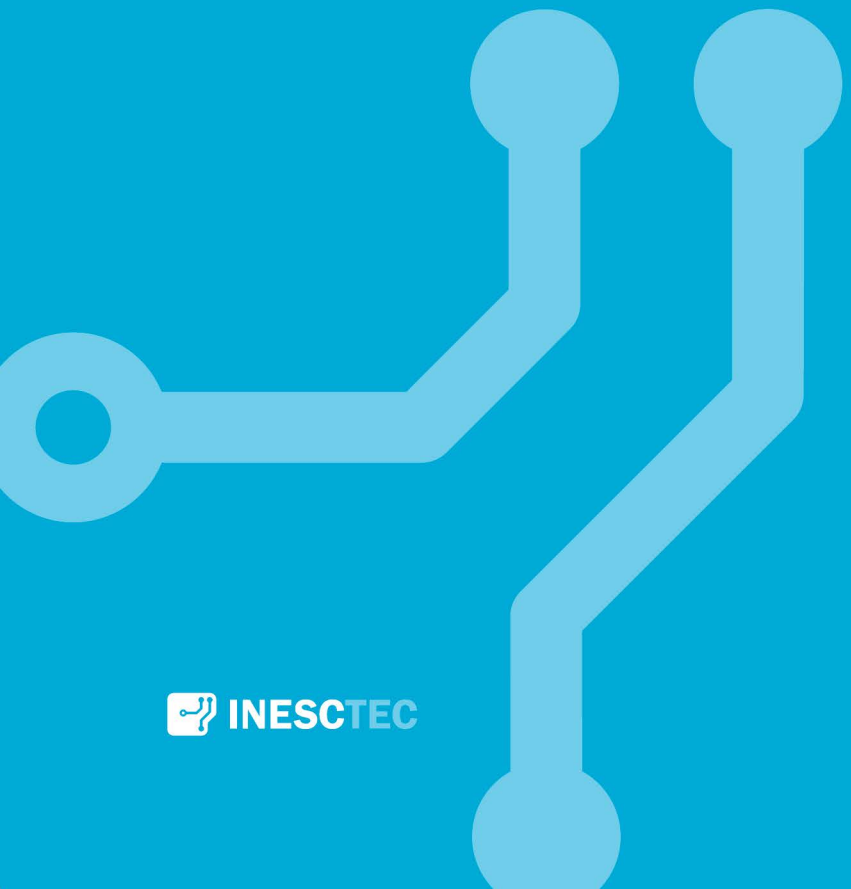
WE ARE TECHNOLOGY
WE ARE INNOVATION
WE ARE INESCTEC



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