

Report 2021-2022

January 2023



**CENTER for INNOVATION,
TECHNOLOGY and POLICY RESEARCH**

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EXECUTIVE SUMMARY

By the end of 2022, IN⁺ hosts 67 researchers, including 24 integrated researchers (12 professors and 12 Doctorate researchers), 38 PhD candidates and junior researchers and 5 affiliated researchers¹, and 2 technical and administrative staff. Although 2021 was a challenging period due to the pandemic situation, IN⁺ did not change its priorities and 2022 can be considered a year of return to “normality”, characterised by the engagement and commitment of the researchers in fostering new opportunities.

Seeking to summarise the main achievements of the 2021-2022 period, this document is divided into four main sections. Section 1 presents an overview of IN⁺, highlighting the global results for the period 2021-2022. Section 2 goes into more detail regarding the composition of each Laboratory team, their activity in selected projects and main outcomes and Section 3 presents the financial overview for the referred period, providing details on the execution of the multi-annual funding. Finally, Section 4 explores the challenges and budgetary framework for the year 2023.

This report shows that while 2021 and 2022 were years of consolidation and exploration of new opportunities, 2023 will be a year of new challenges and growth. The main challenges will be to sustainably grow the team (eventually from 67 to 99 members), implement resource management and financial execution procedures and to increase the visibility of IN⁺, maintaining the values and the mission that IN⁺ envisions.

These challenges come new opportunities and responsibilities that we will address together to affirm 2023 as a year of consolidation of the IN⁺ footprint on the scientific landscape and on its socio-economic impact.

¹ Integrated Researchers – researchers with 20% or more of dedication; Affiliated researchers – researchers with less than 20% of dedication to IN⁺ or integrated in another unit.

1. IN+ OVERVIEW

IN⁺ is established as a cross-disciplinary research centre dedicated to enhance the integration of scientific activities in technology, innovation and policy with applications in industry and society. The research pathways are set with the aspiration of contributing to a sustainable society through cooperation with both industry and the community, fostering the scientific and technological culture in the socio-economic fabric, as well as of encouraging university students and other researchers in discussing challenges and new opportunities for engineering systems and related policy implications.

Acting since 1998 in the domains of **‘Thermofluids, Combustion and Energy Systems’**, **‘Industrial Ecology and Sustainability’** and **‘Technology Management and Policy’**, IN⁺ has been integrating competencies in the different domains, with significant impact in sustainable energy systems and circular economy, technology policy and advanced socio-economic research methods, bringing together researchers from various academic backgrounds.

IN⁺ is coordinated by a **Board of Directors**, gathering one representative of each Laboratory, one representative of the doctorate researchers, one representative of the students and the President, which ensure the high-level management of the Centre. The **Scientific Council**, overviews the performance of IN⁺ and is composed of all doctorate members and headed by a President, as described in [Annex I](#). By the end of 2022, IN⁺ hosted 65 researchers, including 24 integrated researchers (12 professors and 12 Doctorate researchers), 36 PhD candidates and junior researchers and 5 affiliated researchers, as shown in [Annex II](#).

1.1. VISION AND MISSION

IN⁺ aims to excel in promoting scientific research to stimulate new approaches to major societal challenges, bringing together academia, industry, public administration and society. IN⁺ promotes the establishment of innovative tools and approaches for collaborative research and technology development, aimed at urban sustainability and energy transition towards a carbon-neutral society; increasing product value and quality at a global level; reducing development time and life-cycle cost; satisfying the general design requirements of minimum energy consumption, recycling capability and environmental friendliness or technology management and policy. While looking for multidisciplinary approaches and social, environmental and economic impact, IN⁺ leverages the knowledge generated by

its researchers in individual and collaborative projects seeking impact through both value creation and social relevance.

Ethics and Integrity in Research, Social Responsibility, Diversity and Inclusion

IN⁺ institutional culture is founded on the principles of research ethics and integrity, based on rigour, competence, transparency and respect for others, both in research and in management.

Addressing the major societal challenges, IN⁺ activities aim to contribute to a better society, whether by producing basic knowledge or by developing applied research, or by promoting the engagement of researchers and young researchers in specific interactions with and for society, which include raising awareness, promoting scientific literacy among citizens, and policy advise.

IN⁺ also pursues a policy of non-discrimination and equality, establishing that no one shall be privileged, benefited, discriminated, jeopardised or be deprived of any right or exempt of any claim in regard to descendent, age, gender, sexual orientation, marital status, economic situation, origin, social economy, genetic heritage, disability, chronic disease, nationality, ethnicity, territory of origin, language, religion, politics, ideology or union membership.

1.2. ALIGNMENT WITH LARSYS STRATEGIC PRIORITIES

IN⁺ is one of the four members of the Associate Laboratory for Robotics and Engineering Systems² (LARSyS), together with ISR, ITI and MARTEC, which is recognized and funded by the Foundation for Science and Technology (FCT). LARSyS aims at research excellence at the highest international level in Robotics and Engineering Systems, including building-up new knowledge bases with impact in ocean, urban, aeronautics and space, biomedical, and future working environments, as well as to stimulate new industry-science relations and deepen the understanding of network science. Its activities are developed in a team-based research approach oriented to exploit synergies, resources, and competencies of the various centres to explore new frontiers of knowledge in emerging themes and organized in five thematic areas: **Oceans** - Exploration and Exploitation; **Urban** – Sustainability; **Life** - Engineering for and from the Life Sciences; **Interaction** - Cognitive Robots and Human Experience; and, **Air** - Space and Aeronautics. IN⁺ contributes to all the thematic lines of LARSyS, as presented in [Annex III](#).

² Together with Institute for Systems and Robotics (ISR/IST); Interactive Technologies Institute (ITI/IST) and Centre for Maritime Technologies (MARETEC/IST).

1.3. ADVANCED TRAINING

IN⁺ activities include a close collaboration with various international post- graduation programmes in which Instituto Superior Técnico participates (MIT, CMU, Austin University) and national PhD and Master programs running at IST, fostering the integration of young researchers in R&D activities. The list of Master and PhD theses developed with the supervision of IN⁺ researchers under this framework is presented in [Annex IV](#).

IN⁺ have been particularly involved in the creation and consolidation of some of these programmes, of which we may highlight those coordinated by IN⁺ members:

+ DOCTORAL PROGRAMME IN SUSTAINABLE ENERGY SYSTEMS

The objective of the PhD Program on Sustainable Energy Systems is to use a multi-disciplinary approach to educate a new generation of sustainability-aware leaders with expertise in energy systems and economics. A focus on energy systems design and analysis, research, and leadership and entrepreneurship provide graduates with the tools to be at the forefront of sustainable energy systems development. This Doctoral program in Sustainable Energy Systems follows the distinctive model, initially developed under the framework of the Sustainable Energy Systems focus area of the MIT - Portugal Program, of integrating engineering and economics education, to empower students as leaders to design and execute innovative strategies in real world situations to promote Sustainable Energy Systems (SES). The programme curriculum enables this competitive advantage through rigorous coursework and R&D activities with world-class faculty, including MIT participation under the MIT - Portugal framework, challenging experimental learning, and hands-on teamwork and leadership experiences.

Coordination: Paulo Ferrão

+ MASTER PROGRAMME IN ENERGY ENGINEERING AND MANAGEMENT

The Master programme in energy engineering and management offers a cross-cutting programme in the energy field, combining technical specialized knowledge, grounded on a solid scientific basis, with a broader perspective of the interactions with economics, environment and innovation in the energy area. To this programme various departments of IST contribute with their competences recognized both on the national and international levels. The programme combines an approach to sustainable energy systems, in its different economic, environmental and social aspects with specialization areas which are relevant in the energy sector. The students through development of quantitative analytical methods, critical evaluation of solutions and application of modern research techniques and in contact with several

industrial needs, will be capable of dealing with a large range of problems facing society in the field of energy.

Coordination: Edgar Fernandes

1.4. EXTENSION ACTIVITIES

Extension activities represent an important part of the activities implemented by IN⁺. The collaborations developed with public and private entities are implemented through collaborative projects, services and participation in networks, committees and institutions, ensuring a strong connection with the main actors and stakeholders in the centre's main areas of interest. Below, a selection of the networks, committees and institutions in which IN⁺ participates through its members is provided.

Presence in networks, committees, and institutions

IN⁺ researchers are actively involved in various networks, committees, and institutions, which contributes to strengthening collaboration and partnership relations in the centre's main areas of interest. In this context, for the years 2021 and 2022, IN⁺ members were engaged in the following networks, committees and institutions:

- + **EUREKA Association:** Eureka was established in 1985 as an agreement to foster competitiveness and market integration and to encourage R&D cooperation. Currently, Eureka includes the participation of 47 countries (in Europe and beyond) who share the same goals and provide national funding to organisations who apply to Eureka funding programmes. **Paulo Ferrão**, engaged as a member of the Executive Group.
- + **Portuguese Automotive Cluster, Mobinov:** Mobinov is a platform for aggregating knowledge and competence within the automotive industry, with the aim of promoting an increasing enhancement of competitiveness and internationalization of the sector. On the other hand, it aims to contribute to turning Portugal into a reference in research, innovation, design, development, manufacturing and testing of products and services in the automotive industry. **António Luís Moreira**, engaged as member of the Board of Directors.
- + **Environmental Advisory Committee of Rolls-Royce:** External Environment Advisory Committee who independently review and make recommendations on Rolls-Royce products and operational strategies. **Paulo Ferrão**, engaged as member of the Committee.

- + **European Academy of Cancer Sciences (EACS):** The European Academy of Cancer Sciences is an independent advisory body of eminent oncologists and cancer researchers, placing science at the core of policies to sustainably reduce the death and suffering caused by cancer in Europe. Building on the collective work from its members, the EACS joined forces with relevant stakeholders to define common goals for the implementation of a mission-oriented approach to cancer in Horizon Europe. In this context, EACS is committed to support the Cancer Mission and is ready to provide evidence-based advice to underpin policies that allow solutions and inform society of the benefits of research, contributing to reinforce its role towards an evolving research and innovation policy for Europe. **Manuel Heitor**, engaged as Honorary Member.
- + **European Commission Mission “Climate-Neutral and Smart Cities”:** Since climate mitigation is heavily dependent on urban action, this Mission intends to support cities in accelerating their green and digital transformation. The Cities Mission will involve local authorities, citizens, businesses, investors as well as regional and national authorities to deliver 100 climate-neutral and smart cities by 2030, ensure that these cities act as experimentation and innovation hubs to enable all European cities to follow suit by 2050. As foreseen in its implementation plan, the Cities Mission takes a cross-sectoral and demand-led approach, creating synergies between existing initiatives and basing its activities on the actual needs of cities. **Paulo Ferrão**, as the Deputy-Chair.
- + **AIR CENTRE:** The Atlantic International Research Centre (AIR Centre) is an international collaborative organization that promotes an integrative approach to space, climate, ocean and energy in the Atlantic. The AIR Centre is driven by and at the same time supports emerging technological innovations and advances in data science. **Paulo Ferrão**, has been President of the General Assembly from 2021 up to December 2022.
- + **Consortium of Higher Education Researchers (CHER):** CHER aims at developing activities in the field of research on higher education. It wants to stimulate cooperation in research projects and to develop further the internationalisation of higher education research and the development and implementation of an advanced international training programme on higher education in Europe. Currently, CHER counts some 160 members from more than 30 countries, from whom almost a quarter are from outside Europe. **Hugo Horta**, engaged as member of the Board of Governors.
- + **COST Association:** The European Cooperation in Science and Technology (COST) is an EU-funded, intergovernmental framework with currently 41 Members and 1 Cooperating Member, that act as a funding organisation for the creation of research networks, called COST Actions. These

networks offer an open space for collaboration among scientists across Europe (and beyond) and thereby give impetus to research advancements and innovation. **Paulo Ferrão** was engaged as President of the Board from 2019 until 2021.

Participation in Collaborative Laboratories

IN⁺ has been actively participating in the creation and consolidation of Collaborative Laboratories, being particularly involved in three of them – C5LAB, HyLAB and +Atlantic.

+ C5LAB

The C5Lab is a Collaborative Laboratory that operates as a R&D platform for the development of innovative technologies for the sustainable production of cement, mortar and concrete with a reduced CO2 footprint. Based on a holistic approach, the C5Lab addresses the several links of the production chain: alternative raw materials, CO2 capture and reuse, synthetic fuels, energy efficiency, eco-efficient cements, eco-efficient cementitious materials (cements, mortars and concrete), among other. Research activities in the C5Lab follow three main areas: Capture and reuse of CO2; Energy transition and efficiency; Sustainable Cementitious Materials and innovation in manufacturing.

IN⁺ participation: António Luís Moreira - Vice-President and member of the Scientific Council; Paulo Ferrão – member of the Scientific Council.

URL: <https://www.c5lab.pt/index.html>

+ HyLAB

The main goal of the HyLab is to enable the Portuguese swift implementation of green hydrogen production, storage, transport and utilization at competitive costs. The development of competitive technologies will contribute to the global energy transition and decarbonization. Through its operation, the HyLab aims to anticipate by 6 years (2024 vs 2030, reference year of international studies) the breakeven cost between fossil and green hydrogen. This should allow the HyLab and the Portuguese industry to have the robustness necessary to be established as a reference player within the green hydrogen international market.

IN⁺ participation: Edgar Fernandes – Member of the Board and of the Scientific Council.

URL: <https://www.hylab.pt/>

+ +ATLANTIC

The +ATLANTIC CoLAB is a not-for-profit R&D+I Portuguese Collaborative Laboratory that conceives and provides knowledge-based products and services related to various fields of the blue economy, ocean sustainability, marine science, marine ecosystem's health, climate change, ocean literacy, and science communication. +Atlantic is composed of a multidisciplinary team that integrates expertise in numerical modelling, remote sensing, data science, artificial intelligence, and space and ocean technologies to develop such products and services and to partner in national and international projects.

IN⁺ participation: Manuel Heitor – Member of the General Assembly.

URL: <https://colabatlantic.com/>

1.5. AWARDS AND DISTINCTIONS

In recognition of their activities, the IN⁺ researchers were distinguished with the following awards and distinctions:

+ BEST MASTER'S DISSERTATION IN THE AREA OF HYDROGEN TECHNOLOGIES

Agata Sara Horwacik, supervised by **Edgar Fernandes** and **Rui Costa Neto**, was distinguished for the best Master's dissertation in the area of Hydrogen Technologies, by the Foundation for the Development of New Hydrogen Technologies in Aragon, March 2022.

+ DOCTOR *HONORIS CAUSA* IN SCIENCE AND TECHNOLOGY

Manuel Heitor received the Honorary Title of Doctor of Science and Technology by the Carnegie Mellon University, May 2022.

+ TÉCNICO DISTINGUISHED PROFESSOR

Manuel Heitor received the title of Técnico Distinguished Professor, at the solemn session of the celebrations of the 111th anniversary of Técnico, May 2022.

Paulo Ferrão received the title of Técnico Distinguished Professor, at the solemn session of the celebrations of the 110th anniversary of Técnico, May 2021.

+ TIRADENTES MEDAL

Manuel Heitor awarded the Tiradentes Medal by the Legislative Assembly of the State of Rio de Janeiro, June 2022.

+ BEST STUDENT PAPER AWARD

Jihoon Shin won the “Best Student Paper” Award at IAMOT 2022. His Ph.D. was conducted under the CMU Portugal Entrepreneurial Research initiative (ERI) E4 Value, led by **Miguel Amaral** and Granger Morgan, June 2022.

+ BEST PAPER - 16TH INTERNATIONAL CONFERENCE HEFAT-ATE 2022

Pedro Pontes, Iva Gonçalves, **António Luís Moreira**, **Ana Moita**: best paper, awarded at the 16th International Conference HEFAT-ATE 2022, August 2022.

+ ULISBOA/CGD SCIENTIFIC AWARD

Patrícia Baptista received an honourable mention for her research on Environment Engineering and Energy, November 2022.

+ HABILITATION IN ENGINEERING AND MANAGEMENT

Joana Mendonça’s habilitation (Agregação) in Engineering and Management was approved by unanimity by the Jury, December 2022.

2. RESEARCH AREAS AND CORE COMPETENCIES

Research at IN⁺ is structured into three scientific areas/Laboratories, described below, from which emerge a multidisciplinary framework around fundamental and applied projects and experimental facilities, dedicated to address contemporary issues in innovation, technology, and policy, with applications in engineering, science and society.

2.1 THERMOFLUIDS, COMBUSTION AND ENERGY SYSTEMS

In the field of **Thermofluids, Combustion and Energy Systems**, the research activities aim at improving knowledge in advanced fields of strategic technologies with emphasis on the principles of transport and reaction phenomena. The activities of this Laboratory are oriented to optimize energy processes through research on microscale thermal phenomena and multiscale transport phenomena in energy systems, including interfacial transport in view of enhanced heat and mass transfer, fuel/liquid atomization, lean-combustion, burning biomass and gunpowder under unsteady combustion.

Research team

Table 1 presents the LTCES team details. Due to slight increase in the number of PhD candidates, between 2021 and 2022, the team increased from 16 to 19 researchers.

Table 1. LTCES Team 2021-2022

	2021	Members	2022	Members
Integrated Researchers (IST Faculty and Doctorate Researchers)	6	António Luís Moreira; Edgar Caetano Fernandes; Ana Sofia Moita; Sandra Dias; Gonçalo Duarte; Teodoro Trindade.	6	António Luís Moreira; Edgar Caetano Fernandes; Ana Sofia Moita; Sandra Dias; Gonçalo Duarte; Teodoro Trindade.
PhD Candidates and Junior Researchers	9	Alexandre Gamboa; Carlos Diogo; Filipe Quintino; Gonçalo Coutinho; Inês Ferrão; Inês Maia; Pedro Pontes; Elaine Fabre; Bruno Gouveia.	12	Alexandre Gamboa; Bruno Gouveia; Carlos Diogo; Filipe Quintino; Florentin Eckl; Gonçalo Coutinho; Inês Ferrão; Inês Maia; José Eduardo Socha Pereira; Miguel Campino; Pedro Pontes; Tomás Meias.
Affiliated Researchers	1	João Ventura;	1	João Ventura;

Projects

Within the period, the **Thermofluids, Combustion and Energy Systems** research team was involved in the following projects:

+ BIOTERM

Start: 01/12/2016 **End:** 30/11/2021 **PI:** Ana Sofia Moita **Status:** Closed

Description: Development of reversible wetting smart interfaces for the design of biothermofluidic devices.

Funding Program: FCT Researcher | **Total Budget:** 49.732,00€

+ SMART-HEAT

Start: 01/04/2018 **End:** 31/12/2021 **PI:** António Moreira **Status:** Closed

Description: Smart interfaces should adapt to different situations, often requiring opposite wetting regimes. The micro and nano-patterning to achieve these regimes is often obtained by a trial-and-error approach applied to particular experimental conditions, given the variety of surface treatments easily available nowadays. However, this approach is not much efficient. The link between the wetting regimes and the transport phenomena at interfaces is missing. The work proposed here establishes this link in a new method to design smart interfaces, pliable for precise heat and mass transfer control. Instead of a trial-and-error approach, this methodology considers the development of a simulating tool matching the wetting regimes with the most relevant interfacial processes to be controlled (joint work between Jilin University and IN+/IST-ID). Then, particular interfaces are developed at the Jilin University which are further tested and implemented at IN+/IST-ID. The project should produce innovative surfaces for a cooling system prototype.

Funding Program: FCT PTDC | **Total Budget:** 100,046.40€ | **IN⁺ Budget:** 100,046.40€

Partners: Key Lab Bionic Eng, Jilin University.

+ NFSCOOLINGSYSTEM

Start: 16/08/2018 **End:** 15/08/2022 **PI:** António Moreira **Status:** Closed

Description: In the past decades, significant advances in nanotechnology have led to a new generation of thermofluids known as nanofluids (NFs). This innovative fluid is an engineered colloidal mixture of nanoparticles (NPs) in a base fluid. The introduction of NPs into the base fluids is claimed to enhance significantly its heat transfer performance and as a result has become the object of research for several industrial applications [7,8]. Generally, many research studies have observed a great increase of the NFs

thermal conductivity and convective heat transfer. Despite these reported superior thermophysical properties and decades of research very few NFs were implemented in industrial applications. It is widely accepted that the NFs long term stability is one of the major factors that are slowing down the industrial applications of the NFs. By solving this major problem, it is expected that the NFs can finally start to make a substantial impact as an efficient coolant fluid in a variety of thermal systems. Because microchannel heat sink (MHS) is considered as one of the most promising cooling approaches for high power density devices, in this project, the main objective will be focused on the development of an acoustic MHS system complemented by the use of innovative NFs to enhance its cooling performance. The integration of piezoelectric transducers into the MHS will generate acoustic waves that propagate into the fluid containing suspension of NPs and as a result we believe to enhance the long-term stability of NPs dispersion.

Funding Program: FCT PTDC | **Total Budget:** 236,933.00€ | **IN⁺ Budget:** 49,925.00€

Partners: Universidade do Minho.

+ CARAVELA

Start: 01/06/2020 **End:** 30/06/2023 **PI:** Edgar Fernandes **Status:** Ongoing

Description: Motivated by the emergence of the named movement New Space and by the increase in the number of launches of small satellites, the CARAVELA project is an R&D initiative for the development of building blocks that are part of a multipurpose micro-launcher dedicated to small satellites.

Funding Program: PT2020 | **Total Budget:** 4,032,321.53€ | **IN⁺ Budget:** 215,919.00€ | **Execution:**

Partners: TEKEVER SPACE, Lda (LP), CEIIA, Universidade Nova de Lisboa, Universidade do Porto, ISQ, OMNIDEA, Lda, Aeroclube de Torres Vedras, FHP - Frezite High Performance, Lda., USIMECA METALOMECÂNICA, Lda.

+ COOLSPOT

Start: 04/03/2021 **End:** 03/03/2024 **PI:** António Moreira **Status:** Ongoing

Description: This project compares three main cooling strategies (spray cooling, pool and microchannel flow boiling), providing unique data for the development of more complex models of the integrated cooling system. Innovative micro and additive fabrication solutions will be explored in the fundamental evaluation of the systems cooling performance and then included in a final integrated system, developed for the cooling of thermoelectric generators (TEGs) for the automotive industry, integrating energy recovering strategies. The project contributes to further describe the fundamental transport phenomena governing each of these cooling strategies and how innovative solutions such as surface and liquid

(nanofluids) modification may alter and potentially improve them. The final step is an integrative design project of the best performing cooling solution to be further developed in a more product-oriented project, in the near future.

Funding Program: FCT PTDC | **Total Budget:** 249,952.50€ | **IN⁺ Budget:** 133,340.00€

Partners: LARSyS, Universidade do Minho (MEtRICs and CMEMS).

+ PAC

Start: 01/07/2020 **End:** 30/06/2023 **PI:** António Moreira **Status:** Ongoing

Description: The PAC Project aims to generate new knowledge for the development, testing and demonstration of a new generation of technologies crucial to the positioning of the national automotive cluster in a new vehicle value chain - Tier 0.5 -, addressing the goals of autonomous and connected mobility.

Funding Program: PT2020 | **Total Budget:** 8,049,910.94€ | **IN⁺ Budget:** 129,414.66€

Partners: Simoldes-plasticos, S. A. (LP), Associação CCG/ZGDV - Centro de Computação Gráfica, CEiiA, CeNTITVC, CITEVE, CONTROLAR - Electrónica Industrial e Sistemas, Lda, CRITICAL MANUFACTURING, SA, ERT TÊXTEL PORTUGAL SA, INEGI, INESC TEC, Instituto Politécnico de Leiria, IPN, ISQ, MICROPLASTICOS, S.A., MOBINOV - ASSOCIAÇÃO DO CLUSTER AUTOMÓVEL, Sakthi Portugal, S.A, SCHMIDT LIGHT METAL, FUNDIÇÃO INJECTADA LDA, TMG - Tecidos Plastificados e Outros Revestimentos para a Indústria Automóvel, S.A., TOOLPRESSE, PEÇAS METÁLICAS POR PRENSAGEM LDA, Universidade de Aveiro.

+ M-ECO2

Start: 01/01/2022 **End:** 31/12/2025 **PI:** Rui Costa Neto **Status:** New project

Description: Agenda M-ECO2 - Industrial cluster for advanced biofuel production aims to develop a highly innovative industrial cluster for the production of advanced sustainable biofuels based on green hydrogen and residual raw materials. Production liquefaction and distribution of medical and industrial Oxygen, via electrolysis with renewable energies; Life cycle analysis of the electrolysis process for the production of hydrogen and green oxygen and incorporation of the gases into established processes and markets; Production of methane and methanol as green hydrogen and carbon dioxide.

Funding Program: PRR | **Total Budget:** 101,500,000€ | **IN⁺ Budget:** 2,321,520.00€

+ ECOCERÂMICA E CRISTAL DE PORTUGAL

Start: 01/01/2023 **End:** 31/12/2025 **PI:** Edgar Fernandes **Status:** New project

Description: The ECP Pact assumes itself as an integrative and transversal proposal for the Ceramics and Crystal sectors, oriented towards its critical factors of competitiveness and aiming at an improvement of the international positioning. Focusing on 4 central thematic areas - energy sustainability, circular economy and industrial symbioses, digital transition and capacity building - it focuses on the development of new products, processes and services with high added value, based on new models of cross-sectoral industrial organization, thus ensuring progression in the international value chain and focus on activities with higher added value. The ECP Pact is developed in a strategic sector of the national economy and aims to increase its competitiveness, based on factors of innovation, differentiation and a strong collaborative dynamics and investment in innovation throughout the various segments of the sector's value chain, supported by improving the skills of its assets.

Funding Program: PRR | **Total Budget:** 46,400,000€ | **IN+ Budget:** 849,900.00€

Outcomes

In the period, the **Thermofluids, Combustion and Energy Systems** Laboratory was responsible for the publication of 46 articles in international journals (29 in 2021; 17 in 2022), the supervision of 31 MSc Thesis (21 in 2021 and 10 in 2022) and the participation in 5 international conferences. The group also participated actively in the installation and governance of two Collaborative Laboratories – C5LAB and HyLAB – and was also responsible for the organization of the 20th Edition of the International Symposium on Applications of Laser and Imaging Techniques to Fluid Mechanics, which gathered more than 100 participants.

Below is presented a selection of the most relevant publications in terms of their contribution to the scientific areas in which LTCES operates.

+ ASPECTS OF AND BIOMETHANE INTRODUCTION IN NATURAL GAS INFRASTRUCTURE AND EQUIPMENT

Authors: Filipe Quintino, Nuno Nascimento, Edgar Fernandes

Year of publication: 2021 | **Journal:** Hydrogen

Abstract: The injection of green hydrogen and biomethane is currently seen as the next step towards the decarbonization of the gas sector in several countries. However, the introduction of these gases in existent infrastructure has energetic, material and operational implications that should be carefully looked at. With regard to a fully blown green gas grid, transport and distribution will require adaptations. Furthermore, the adequate performance of end-use equipment connected to the grid must be accounted

for. In this paper, a technical analysis of the energetic, material and operational aspects of hydrogen and biomethane introduction in natural gas infrastructure is performed. Impacts on gas transmission and distribution are evaluated and an interchangeability analysis, supported by one-dimensional Cantera simulations, is conducted. Existing gas infrastructure seems to be generally fit for the introduction of hydrogen and biomethane. Hydrogen content up to 20% by volume appears to be possible to accommodate in current infrastructure with only minor technical modifications. However, at the Distribution System Operator (DSO) level, the introduction of gas quality tracking systems will be required due to the distributed injection nature of hydrogen and biomethane. The different tolerances for hydrogen blending of consumers, depending on end-use equipment, may be critical during the transition period to a 100% green gas grid as there is a risk of pushing consumers off the grid.

DOI: <https://doi.org/10.3390/2030016>

+ TECHNO-ECONOMIC EVALUATION OF TWO HYDROGEN SUPPLY OPTIONS TO SOUTHERN GERMANY: ON-SITE PRODUCTION AND IMPORT FROM PORTUGAL

Authors: Florentin Eckl, Ludger Eltrop, Ana Moita, Rui Costa Neto

Year of publication: 2022 | **Journal:** International Journal of Hydrogen Energy, 47(60)

Abstract: Hydrogen production through electrolysis using renewable electricity is considered a major pathway and component for a sustainable energy system of the future. For this production pathway, a high renewable energy potential, especially in solar energy, is crucial. Countries like Germany with a high energy demand and low solar potential strongly depend on hydrogen import. In the present work, a case study with two alternative hydrogen supply options is conducted to evaluate the economic viability of solar hydrogen delivered to a hydrogen pipeline in Stuttgart, Germany. For both options, hydrogen is generated through an 8 MW alkaline electrolyser, solar powered and supported by grid-based electricity to meet the required load. The first option is based on a hydrogen production system that is positioned in Sines, Portugal, an area with high global radiation and proximity to a deep sea port. The hydrogen is processed by liquefaction and transported to Stuttgart by tanker ship via Hamburg and by truck. The second supply option uses an on-site hydrogen production system in Stuttgart.

The work shows that the production costs in Sines with 2.09 €/kgH₂ (prices in €2021) are, as expected, significantly lower than in Stuttgart with 3.24 €/kgH₂. However, this price difference of 1.15 €/kgH₂ for hydrogen production drops to a marginal difference of 0.13 €/kgH₂ when considering the whole value chain to the delivery point in Stuttgart. If the waste heat from electrolysis is used in a district heating system in Stuttgart, the price difference is down to 0.03 €/kgH₂. The first supply option is dominated by

costs for processing, especially liquefaction. These costs would need to be reduced to fully exploit the cost advantage of solar hydrogen production in Portugal. Also, a fundamental switch to pipeline transport of gaseous hydrogen should be considered. Both investigated hydrogen supply options show the potential to provide the pipeline in Stuttgart with hydrogen at lower costs than by using the alternative technology of steam reforming of natural gas.

Contribution: This paper evaluates green hydrogen production from solar sources and performs a techno economic evaluation of production vs transportation.

DOI: <https://doi.org/10.1016/j.ijhydene.2022.05.266>

+ THE PRESSING NEED FOR GREEN NANOFLUIDS: A REVIEW

Authors: José E. Pereira, Ana S. Moita, António L.N. Moreira

Year of publication: 2022 | **Journal:** Journal of Environmental Chemical Engineering, 10

Abstract: Possessing the same efficacious thermophysical properties as their conventional counterparts, the green nanofluids are prepared by facile, cost-effective, safe, clean, and eco-friendly synthesis processes that entail minimal hazardous implications on public health and surrounding environment. This work of review intends to offer a general overview of the biosynthesis methods of preparation of these bio-friendly heat transfer fluids, their fundamental properties, and main potential fields of application. Also, this survey highlights the urgent necessity to adopt the development and use of green nanofluids and correspondent environmentally benevolent methods of preparation. This trend will mitigate the risks and threats posed by the conventional nanofluids and their physical and chemical manufacturing methods to human health and environment, especially in the actual era where the carbon dioxide emissions and other discharged hazards loads to the atmosphere and climate change are continuously increasing worries. There is no doubt about the paramount importance of adopting novel green nanomaterials and breakthrough green technologies as soon as possible. Particularly, the synthesis of bio-friendly nanofluids, using bioactive compounds present in abundant and renewable natural extracts, and the use of this novel class of heat transfer fluids in thermal management systems will undoubtedly constitute a major benefit to the public and to the preservation of the environment.

Contribution: This paper critically revises the processes for the production and use of the so called green nanofluids presenting new alternatives.

DOI: <https://doi.org/10.1016/j.jece.2022.107940>

+ THE IMPACT OF CLAY AS WALL MATERIAL ON THERMOELECTRIC POWER GENERATION AND FLAME-WALL INTERACTION

Authors: Diogo M.G. Almeida, Sandra I.G. Dias, Edgar C. Fernandes

Year of publication: 2022 | **Journal:** Applied Thermal Engineering

Abstract: The use of clay as the combustor wall material for direct heat-to-electricity conversion using a Thermoelectric generator (TEG) was evaluated in a side-wall configuration burner. The influence of different fuel blends (Methane, Biogas and Biogas + H₂) and flame work conditions in TEG power and efficiency are discussed. Flame–wall interaction (FWI) of the laminar side-wall quenching (SWQ) premixed V-flame was investigated. Heat release rate (HRR) and quenching distances were analysed with the chemiluminescence of excited OH* and CH* radicals. The gases velocity field was studied with Particle Image Velocimetry (PIV). For comparison, a galvanized steel (GS) plate was used in the same working conditions. We found that the efficiency (η_{TEG}) and electrical power (P_{TEG}) losses between materials increases with flame temperature. Quenching distances (δ) were larger in the flame clay wall interaction. Flame quenching was governed by heat losses independently of the wall but the impact of convection was more significant when using the clay wall.

DOI: <https://doi.org/10.1016/j.applthermaleng.2022.118414>

2.2. INDUSTRIAL ECOLOGY AND SUSTAINABILITY

Research activities in **Industrial Ecology and Sustainability** aim to improve the design of complex sustainable systems by understanding and modelling relationships between population dynamics, energy and materials use, ecosystem services, environmental impacts of human activities and economic growth. The activities of the Industrial Ecology and Sustainability Laboratory are oriented towards the development of cities, considering the complex interactions between people, technology, policy and urban infrastructures, to create “sustainable cities”, through an improved urban metabolism, particularly focusing on supporting decision-making in energy and waste management systems.

Research team

Table 2 shows the detail of Industrial Ecology and Sustainability Laboratory team in 2021 and 2022. As it can be seen, the most significant fact to highlight is the integration of Patrícia Baptista as IST professor. By the end of 2022, the team is composed of 28 researchers.

Table 2. Industrial Ecology and Sustainability Laboratory Team 2021-2022

	2021	Members	2022	Members
Integrated Researchers (IST Faculty and Doctorate Researchers)	10	Carlos Santos Silva; Fernanda Margarido; Filipe Mendes; Paulo Ferrão; Diana Neves; Mexitli Reyes; Patrícia Baptista; Ricardo Gomes; Rui Costa Neto; Catarina Rolim	12	Carlos Santos Silva; Fernanda Margarido; Filipe Mendes; Marta Abrantes; Patrícia Baptista; Paulo Ferrão; Diana Neves; Mexitli Reyes; Ricardo Gomes; Rui Costa Neto; Sónia Cunha; Francisco Costa.
PhD Candidates and Junior Researchers	12	Diana Fernandes; Fabíola Pereira; Gonçalo Araújo; Joana Fernandes; Monica Shenouda; Naim Majdalani; Olga Savchuk; Ricardo Robles; Rui Semeano; Sónia Cunha; Tatiana Silva; João Santos.	14	Diana Fernandes; Fabíola Pereira; Glaucio Silva; Gonçalo Araújo; Jaime Sierra; Joana Fernandes; Monica Shenouda; Naim Majdalani; Olga Savchuk; Ricardo Robles; Rui Semeano; Tatiana Silva; João Santos; Rui Pereira.
Affiliated Researchers	2	Melissa Bacatelo; Francisco Capucha.	2	Melissa Bacatelo; Francisco Capucha.

Projects

Within the period, the **Industrial Ecology and Sustainability** Laboratory, was involved in the following projects:

+ SHARING CITIES

Start: 01/01/2016 **End:** 31/12/2021 **PI:** Carlos Santos Silva **Status:** Closed

Description: Sharing Cities was a major international smart cities project that addressed some of the most pressing urban challenges facing today's cities such as energy use, low carbon transport and buildings, and harnessing data for the good of the city. The programme was officially completed in December 2021.

Funding Program: H2020 | **Total Budget:** 28,045,835.00€ | **IN⁺ Budget:** 451,412.50€

Partners: Greater London Authority (LP), Royal Borough of Greenwich, Mastodon C LTD, Danfoss A/S, Kiwi Power LTD, Transport for London, CML, Lisboa E-Nova, Reabilita Ida, Ceiiia, E-Redes, Altice labs SA, Comune di milano, Politecnico di milano, CEFRIEL SOCIETA CONSORTILE A RESPONSABILITA LIMITATA, Poliedra, Legambiente Associazione onplus, Ricerca sul sistema energetico - RSE SPA, NHP srl, Teicos UE SRL, A2A SPA, Siemens SPA, Ville de Bordeaux, Obshtina Burgas, Miasto stoleczne Warszawa, Instytut Energetyki, Eurocities ASBL, Future cities catapult, Imperial College of Science Technology and Medicine, Urban DNA solutions LLP, Siemens PLC, Municipia SPA.

+ IMPROVEMENT

Start: 01/10/2019 **End:** 2023 **PI:** Carlos Santos Silva **Status:** Ongoing

Description: IMPROVEMENT aims to solve the challenge of integrating renewable energy systems (RE) and energy efficiency (EE) in public buildings (EPs) in the SUDOE region, where due to their application area, the quality and continuity of supply have to be considered as fundamental aspects (Hospitals, Research Centers and Universities, Military Buildings, Transport Stations). These buildings have a high energy consumption in heating and cooling, but also in electrical appliances that are extremely sensitive to electrical power disturbances. The project proposes the conversion of these EPs into Zero Energy Balance Buildings (nZEB) through the implementation of micro-networks for the combined generation of cold, heat and electricity with active control of the neutral and use of hybrid energy storage systems (ARM).

Funding Program: SUDOE | **Total Budget:** 2,501,926.27€ | **IN⁺ Budget:** 143,889.03€

Partners: Centro Nacional del Hidrógeno (LP); Universidad de Castilla la Mancha; École nationale supérieure de mécanique et d'aérotechnique ; Laboratorio Nacional de Energía e Geología; Secretaría General de Industria; Energía y Minas de la Junta de Andalucía; Universidad de Córdoba; Agencia Andaluza de la Energía; Universidad de Perpignan Via Domitia.

+ BUILDING HOPE

Start: 02/07/2020 **End:** 30/06/2023 **PI:** Carlos Santos Silva **Status:** Ongoing

Description: The Building HOPE project will develop a tool to redefine buildings energy management practices in the context of smart urban environments. The HOPE platform will be tested in relevant contexts: industrial, office and retail buildings, demonstrating the novelty of its features and its impact in the energy management, in order to become a unique energy management platform for buildings in the next decade.

Funding Program: PT2020 | **Total Budget:** 1,502,597.43€ | **IN⁺ Budget:** 308,208.26€

+ BEE2WASTE CRYPTO

Start: 01/05/2020 **End:** 30/04/2023 **PI:** Paulo Ferrão **Status:** Ongoing

Description: The Bee2WasteCrypto project aims to develop a differentiating and intuitive IT tool, which, based on high resolution data on waste production, allows Regional Waste Management Units (RWMUs) to design and manage optimal decentralised solutions for each region, and promotes more sustainable waste production and separation behaviours.

Funding Program: PT2020 | **Total Budget:** 1,999,491.05€ | **IN⁺ Budget:** 490,619.20€

Partners: COMPTA- Emerging business, S.A (LP), 3 Drivers, Engenharia, Inovação e Ambiente, Lda., UNL - Universidade Nova de Lisboa.

+ C-TECH

Start: 01/04/2020 **End:** 31/03/2023 **PI:** Paulo Ferrão **Status:** Ongoing

Description: C-Tech aims at researching, developing and pilot-scale a digital smart city platform for urban modelling and planning which, based on a three-dimensional representation of the city and its combination with multiple data from different data sources (from domains such as weather, energy and water consumption, mobility and, most of all, user's behavior as determined by their mobile phone use), will allow to simulate scenarios regarding energy-efficiency of buildings, green structures, creation and urban mobility, empowering local authorities to identify and tackle specific environmental issues, overcome the global challenge of decreasing urban carbon footprint and fostering the transition to a net-zero ecosystem.

Funding Program: PT2020 | **Total Budget:** 2,889,933.89€ | **IN⁺ Budget:** 631,324.41€

Partners: NOS COMUNICAÇÕES, S.A. (LP), NOVA IMS, Lisboa E-Nova, CEIIA

+ REVALER

Start: 01/08/2020 **End:** 30/07/2022 **PI:** Paulo Ferrão **Status:** Ongoing

Description: The MAFRA Reciclar a valer + project aims to create a living laboratory of incentive systems, which tests different technological solutions and monitors their results, contributing to increase the knowledge about these systems and promote their effectiveness and economic efficiency, in order to prepare the implementation of the deposit system.

Funding Program: EEA Grants | **Total Budget:** 840,000.00€ | **IN⁺ Budget:** 39,600.00€

Partners: Município de Mafra (LP), Novo Verde, Entidade Gestora de Resíduos de Embalagens, S.A., Electrão, Tratolixo, 3 Drivers, Engenharia, Inovação e Ambiente, Lda.

+ RELIABLE

Start: 02/02/2020 **End:** 02/12/2022 **PI:** Carlos Santos Silva **Status:** Ongoing

Description: The objective of the RELIABLE project is to develop a public dashboard with real-time and high spatial resolution information about the health risks of building occupants during extreme weather

events - heat waves and cold. This dashboard will improve current alert systems in two dimensions: 1) improve current risk forecasting models, integrating new sources of public data processed with machine learning algorithms; 2) increase the spatial and temporal resolution of warnings, if possible to the statistical subsection level (BGRI).

Funding Program: FCT PTDC | **Total Budget:** 239,538.25€ | **IN⁺ Budget:** 159,791.25€

Partners: Agência Regional para o Desenvolvimento da Investigação, Tecnologia e Inovação - Associação (ARDITI), Instituto Nacional de Saúde Dr. Ricardo Jorge (INSARJ).

+ BATERIAS 2030

Start: 01/07/2020 **End:** 30/06/2023 **IN+ participation:** Fernanda Margarido **Status:** Ongoing

Description: The project Batteries 2030 focuses on the development of technologies applied to batteries of the future and their transfer to the urban environment. The project strategic goal is based on disruptive solutions, reliable, sustainable, easily scalable, capable of being integrated throughout the value chain and accessible to the consumer.

Funding Program: PT2020 | **Total Budget:** 8,270,716.59€ | **IN⁺ Budget:** n.a.

Partners: DST SOLAR, S.A. (LP), 3 Drivers, Engenharia, Inovação e Ambiente, Lda., AddVolt, S.A., AMNIS PURA, LDA, bysteel fs SA, CEIIA, CeNTITVC, CHARGE2C - NEWCAP LDA, DOMINGOS SILVA TEIXEIRA, SA, EFACEC ENERGIA - MÁQUINAS E EQUIPAMENTOS ELÉCTRICOS, S.A., INESC Microsistemas e Nanotecnologias, INESC TEC, INNOVATION POINT - INVESTIGAÇÃO E DESENVOLVIMENTO, SA, LABORATÓRIO IBÉRICO INTERNACIONAL DE NANOTECNOLOGIA, LNEG, Omniflow, S.A., SECIL - COMPANHIA GERAL DE CAL E CIMENTO, S.A., Universidade do Minho, Universidade do Porto, VISBLUE PORTUGAL, UNIPESSOAL LDA, WATT-IS, LDA, ZEEV, LDA.

+ BE.NEUTRAL

Start: 01/04/2022 **End:** 31/12/2025 **PI:** Paulo Ferrão **Status:** Ongoing

Description: BE.Neutral Agenda aims to position the Portuguese cities and the Industry in the future of mobility from a new generation of products and services oriented towards carbon neutrality, having a transformational effect on the economy, the environment and society.

Funding Program: PRR | **Total Budget:** 221,376,867.63€ | **IN⁺ Budget:** 2,162,399.22€

Partners: NOS COMUNICAÇÕES, S.A. (LP), 3Drivers - Engenharia, Inovação e ambiente, Lda, Almadesign - conceito e Desenvolvimento de Design, Lda, Armis - Sistemas de Informação, Lda, Associação C.C.G/ZGDV - Centro de Computação Gráfica, DTx, PIEP, Associação Porto Digital, AYR NEUTRAL, Lda, BENUS, S.A,

BOSCH CAR Multimédia Portugal, S.A, BRIGHTCITY, S.A., CAETANO AERONAUTIC, S.A., CAETANOBUS - Fabricação de Carraçarias, S.A, CEiiA, CeNTItvc, CITEVE, CTT, DMS - Displays&Mobility solutions, Limitada, Edmtech, Lda, EDP Comercial - Comercialização de energia, S.A, EDP Inovação, S.A, EVIO - Electrical Mobility, Lda, GUIMOCIRCUITO - Circuitos Impressos, Lda, HFA - Henrique, Fernando & Alves, S.A, IBÉRICA - Indústria de Componentes Metálicos, S.A, INEGI, INL, Mind Over Body, Unipessoal Lda, MOBINOV, NOS TECHNOLOGY - Conceção, Construção e Gestão de Redes de Comunicações, S.A, Omnidea, Lda, OPT - Optimização e Planeamento de Transportes, S.A, OVAL - Gabinete de Arquitectura, Planeamento e Engenharia, Lda, Siemens, S.A, Simoldes Plásticos, S.A, Smart Energy LAB, TMG - Tecidos Plastificados e Outros Revestimentos para a Indústria Automóvel, S.A, Toyota Caetano Portugal S.A, Universidade do Minho, Universidade NOVA de Lisboa, WITHUS - Inovação e Tecnologia, Lda.

+ SYNTECS

Start: 2023

End: 2025

PI: Paulo Ferrão

Status: New project

Description: SYNTECS (Sustainably aNd digiTally driven hiErarchical laser texturing for Complex Surfaces) brings together a consortium of industry leaders and academic and research organisations that are at the forefront of laser-based processing. SYNTECS is designed to tackle the multiple challenges experienced with current chemical and mechanical surface treatments. The overall aim of SYNTECS is to develop and demonstrate a digital and green laser texturing approach to generating complex multifunctional surfaces.

Funding Program: Horizon Europe | **Total Budget:** 4,481,812.50€ | **IN⁺ Budget:** 225,125.00€

Partners: Fraunhofer (LP), Laser Engineering Applications S.A., Fusion Bionic, Farplas Otomotiv, 3-Drivers, Centro Ricerche FIAT, Deputy Ireland, The manufacturing Technology centre Limited, The University of Birmingham, ICONIQ Innovation.

Outcomes

In the period 2021-2022, **Industrial Ecology and Sustainability** Laboratory was responsible for the publication of 2 chapters in books and 42 articles in international journals (23 in 2021; 19 in 2022), and the supervision of 66 thesis (44 in 2021; 22 in 2022). In addition, LEIS team participated in 18 conferences (15 international; 3 national) and was responsible for 31 dissemination actions, including appearances in the media, organization of workshops and participation (speaker) in seminars.

Below is presented a selection of the most relevant publications in terms of their contribution to the scientific areas in which LEIS is active.

+ A FRAMEWORK TO ANALYZE THE DYNAMICS OF THE SOCIOECONOMIC METABOLISM OF COUNTRIES: A PORTUGUESE CASE STUDY

Authors: Sónia Cunha, Paulo Ferrão

Year of publication: 2021 | **Journal:** Journal of Industrial Ecology

Abstract: Socioeconomic metabolism dynamics are relevant to identify (un)sustainable development pathways in different economies, particularly if the evolution of resource productivity of critical economic sectors can be quantified. This paper offers a four-step methodological framework to quantify these dynamics for an economy in a way that can be replicated for a series of years and countries. This methodological framework is based on the compilation of economic and physical flows in the form of input-output tables in a time series, making use of publicly available data. The data download and processing were automatized using Python, creating an expedited analysis process. The results characterize the flows through and within a country and allow the user to identify structural changes in the economy by tracking both monetary and physical flows for 17 material groups and up to 37 economic sectors. The application of the methodological framework is illustrated in a case study covering the 2008 economic crisis in Portugal, in which the socioeconomic metabolism, the underlying structural changes, and the corresponding environmental impacts are characterized. The use of this information for the design of decoupling policies is discussed, in view of promoting sustainable dematerialization during periods of economic prosperity.

Contribution: This paper offers a pioneer four-step methodological framework to quantify the socioeconomic metabolism dynamics of countries for any economy in a way that can be replicated for a series of years and countries. This innovative approach is instrumental to evaluate the sustainability pathways of nations.

DOI: <https://doi.org/10.1111/jiec.13184>

+ DESIGNING A DISTRICT ENERGY INFRASTRUCTURE - A CASE-STUDY IN LISBON

Authors: Alexandre Jewell, Nils Schöler, Sébastien Cajot, Ricardo Gomes, Carlos Santos Silva and Francois M. A. Marechal

Year of publication: 2022 | **Journal:** Frontiers in Sustainable Cities, Volume 43

Abstract: The paper describes a case study on the design of district energy infrastructure for the green-field project of the Vale de Santo António (Lisbon, Portugal). The methodology is based on a novel framework built on the sequential integration of three software tools: QGIS, City Energy Analyst (CEA) and Urbio. QGIS is used to define the building database (construction solutions, uses and schedules); CEA is

used to model the neighborhood energy services (heating, cooling, domestic hot water and electricity, including for EVs); and Urbio is used to design the energy infrastructure to supply the neighborhood in an optimal manner. The study illustrates the high impact of building renovation on heat demand and the existing potential for a two-layout network to minimize pumping demand and heat distribution loss. Moreover, a sensitivity analysis with regard to future carbon tax changes and electricity greening concludes that an electricity-based heating mix is optimal.

DOI: <https://doi.org/10.3389/frsc.2022.863787>

+ METAEXPLORER: COLLABORATIVE DEVELOPMENT OF URBAN METABOLISM PLATFORM FOR DECISION MAKING SUPPORT

Authors: Diana Neves, Patrícia Baptista, Ricardo Gomes, Sónia Cunha, Mexitli Sandoval-Reyes, Diana Vieira Fernandes, Catarina Rolim, Carlos A.Silva

Year of publication: 2023 | **Journal:** Energy Strategy Reviews, Volume 45

Abstract: Cities need to improve sustainability levels demanded by climate change mitigation efforts. The use of big data analytics is crucial for understanding its dynamics and deploying solid public policies. Nevertheless, data availability poses great challenges, being difficult to produce reliable analyses. Delivering trustable cross-sectorial energy datasets with high spatial and temporal resolution is thus critical to provide valuable insights for informed policymaking. This paper describes the MetaExplorer, a GIS-platform, which gathers trustable energy-related datasets, at municipal level for Portugal, providing a user-friendly georeferenced visualisation tool that can be used to derive statistical models, and support policymaking. Publicly available data was collected and cleaned, divided on five thematic areas: energy demand, buildings, mobility, waste management, and socio-economic, while a visualisation tool was developed to provide the possibility to further explore relations between indicators and support the energy transition at local level, delivering customised analyses with a global perception.

DOI: <https://doi.org/10.1016/j.esr.2022.101041>

2.3. TECHNOLOGY MANAGEMENT AND POLICY

The IN⁺ research agenda for Technology Management and Policy aims at policy analysis, through multidisciplinary activities, namely in terms of science, technology and industry policy formulation and the need to secure sustainable development. The conditions for the social construction of technological

systems in both developed and developing societies are addressed in terms of their impact on the emergence of new social realities, and their potential as factors of economic and social change and development on a global scale. Case studies are developed worldwide, particularly in Portugal and Europe. The emphasis is on issues in which the interaction of technology, humans, and institutions is of importance to foster quality of life. The current objectives for this research area are to:

- Derive science and technology policies and innovation strategies in terms of socioeconomic development.
- Develop and apply advanced research methodologies for the analysis of technoeconomic systems.
- Promote the exchange of knowledge in advanced technologies.
- Promote the management of technology and innovation for the optimisation of industrial processes.

Research team

Table 3 shows the detail of Technology Management and Policy Laboratory team in 2021 and 2022. As it can be seen, the most significant fact to highlight is the integration of Hugo Silva as IST professor and the return of Manuel Heitor to the team. By the end of 2022, the team is composed of 18 researchers.

Table 3. Technology Management and Policy Laboratory team 2021-2022

	2021	Members	2022	Members
Integrated Researchers (IST Faculty and Doctorate Researchers)	5	Miguel Amaral; Joana Mendonça; Miguel Torres Preto; Catarina Seco Matos; Hugo Horta;	6	Miguel Amaral; Hugo Silva; Manuel Heitor; Miguel Torres Preto; Hugo Horta; Inês Nunes.
PhD Candidates and Junior Researchers	11	Afonso Amaral; Benjamin Meindl; Cristian Ruiz; David Silva; Helena Costa; Maria Eugénia Leitão; Nádia Costa; Paulo Loureiro; Rodrigo Santos Lapa; Rudolph Caballero Santarromana; Diogo Silva.	10	Afonso Amaral; Benjamin Meindl; Cristian Ruiz; David Silva; Helena Costa; Maria Eugénia Leitão; Nádia Costa; Paulo Loureiro; Rodrigo Santos Lapa; Rudolph Caballero Santarromana.
Affiliated Researchers	2	Gonçalo Brás; Maria João Rodrigues	2	Gonçalo Brás; Maria João Rodrigues

Projects

Within the period, the **Technology Management and Policy Laboratory** research team was involved in the following projects:

+ PORT XXI

Start: 30/11/2020 **End:** 30/11/2021 **PI:** Joana Mendonça **Status:** Closed

Description: PORT XXI aims to identify and evaluate the deployment of transformative environmental monitoring and management services that could help ports minimize their environmental impact, while keeping operational costs contained by taking advantage of EARTH OBSERVATION, SATCOM and SAT NAV infrastructures, in combination with information gathered from other sources such as CCTV, data repositories, in situ sensors, mobile sensors, using autonomous robotic solutions and incorporating Big Data and AI techniques for automatic knowledge extraction.

Funding Program: ESA | **Total Budget:** 200,000.00€ | **IN⁺ Budget:** 24,053.00€

Partners: INESCTEC; Portos dos Açores; Amberjack Solutions; Moniport; The Climate impact; AIR CENTRE.

+ TECHSKILLS

Start: 01/10/2018 **End:** 30/09/2021 **PI:** Miguel Preto **Status:** Closed

Description: The introduction of new products and new production processes by firms affects the demand for workers' skills. The recent trends in the labor market show that the increased demand for high-skilled workers performing more complex tasks goes along with decreased demand for middleskilled workers performing routine tasks, as well as worse employment and pay conditions for large sections of the low-skilled. This project aims to study these issues considering the different dimensions at which skills can be measured - a complex combination of formal education, various forms of labor experience, and the task content of each occupation. The analysis also has to take into account the complementarity of skills with different forms of technology and knowledge intensity observed in firms' activities.

Funding Program: FCT PTDC | **Total Budget:** 209,349.40€ | **IN⁺ Budget:** 209,349.40€

Partners: n.a.

+ BEYOND.ADDICTIVE

Start: 01/06/2019 **End:** 01/03/2022 **PI:** Joana Mendonça **Status:** Closed

Description: Beyond.Additive focuses on 2nd generation R&D of TLM technology for additive manufacturing of large parts complex dimensions and/or geometries, filling current gaps in terms of control and process monitoring and thus allowing the processing of new materials.

Funding Program: PT2020 | **Total Budget:** 966,649.13€ | **IN⁺ Budget:** 70,182.32€

Partners: Adira - Metal Forming Solutions, S.A. (LP), CEiiA.

+ AEROS CONSTELLATION

Start: 30/06/2020

End: 30/06/2023

PI: Miguel Preto

Status: Ongoing

AEROS Constellation (AEROS) project intends to develop a nanosatellite platform as a precursor of a future constellation to leverage the Space/Ocean scientific and economic synergies. The project is formed by a consortium of Portuguese companies, research institutes and universities. It shall develop Portuguese technologies and competencies to monitor and value the ocean, by combining national and international know-how to build the AEROS nanosatellite constellation. Managed from Portugal, AEROS is an integrated system of assets and capabilities including different existing, improved, and new platforms operating in the Ocean and Space, equipped with state-of-the-art sensors and technologies, all connected through a communication network linked to a data gathering, processing and dissemination system.

Funding Program: PT2020 | **Total Budget:** 2,786,748.78€ | **IN⁺ Budget:** 167,995.00€

Partners: EDISOFT - Empresa de Serviços e Desenvolvimento de Software, S.A. (LP); IMAR; CEiiA; AIR CENTRE; SPINWORKS, S.A; DSTELECOM, S.A; +ATLANTIC; Universidade do Minho; Faculdade de Ciências da Universidade do Porto; Universidade do Algarve; MIT.

+ MAGAL CONSTELLATION

Start: 01/07/2020

End: 01/07/2023

PI: Hugo Silva

Status: Ongoing

Description: The “MAGAL Constellation” project aims to research and develop a network of RADAR Altimeters for monitoring the oceans, with regard to their phenomena and climate change, which are integrated into a network of small Satellites and cohabiting with other data systems (temperature, salinity, etc., of the oceans), allows obtaining global, coherent and continuous information on these phenomena.

Funding Program: PT2020 | **Total Budget:** 1,184,540.39€ | **IN⁺ Budget:** 134,435.41€

Partners: Efacec Energia – Máquinas e Equipamentos Elétricos, S.A. (LP), CEiiA, Omnidea LDA, CIIMAR – Centro Interdisciplinar de Investigação Marinha e Ambiental, Instituto de Telecomunicações, Universidade da Beira Interior, +ATLANTIC, UT Austin.

+ K4P ALLIANCES

Start: 04/2022

End: n.a.

PI: Manuel Heitor

Status: Ongoing

Description: New international joint venture promoting the inclusive development of the Global South, with emphasis on Africa and Latin America, through the mobilization of pilot projects aiming to foster sustainable and healthier societies and reduce inequalities in the digital age. The goal is to help accomplish the target of greening our economies and promoting Sustainable and Healthy Territories, together with achieving carbon neutrality, or “net zero”, by 2050, through a network of data centres and collaborative projects in Latin America and Africa and, eventually in the Indo-Pacific, providing capacity building and fostering new jobs through community-based participatory research and innovation.

Partners: AIR Center, Bureau Veritas, CEIIA, Ciência Viva, CNPq – National Council for Scientific and Technological Development, CONFAP (National Council of State Research Funding Foundations), Fundação Oswaldo Cruz, GMES & Africa Program; Science and Technology Division; Human Resources, Science and Technology Department | African Union Commission, Institute for Prospective Studies, INPA – “Instituto Nacional de Pesquisas da Amazônia”, MPEG – “Museu Paraense Emílio Goeldi”, NOSI, Rio de Janeiro Federal University, COPPE - The Alberto Luiz Coimbra Institute for Graduate Studies and Research in Engineering, Future’s Institute (“Instituto do Futuro”, “Colégio Brasileiro de Altos Estudos da UFRJ”), SANSa - South Africa Space Agency, SENAI - National Service for Industrial Apprenticeship, Tiniguena, Vrije Universiteit Amsterdam, +Atlantic.

Outcomes

In the period 2021-2022, the Technology Management and Policy Laboratory was responsible for the publication of 28 articles in international journals (18 in 2021; 10 in 2022), supervision of 12 thesis (1 of them PhD) and 3 participations in international conferences. Below is presented a selection of the most relevant publications in terms of their contribution to the scientific areas in which Technology Management and Policy Laboratory is integrated.

+ TECHNOLOGY FORGIVENESS: WHY EMERGING TECHNOLOGIES DIFFER IN THEIR RESILIENCE TO INSTITUTIONAL INSTABILITY

Authors: Jaime Bonnín Roca, Parth Vaishnav, Granger M. Morgan, Erica Fuchs, Joana Mendonça

Year of publication: 2021 | **Journal:** Technological Forecasting and Social Change, Volume 166

Abstract: Long-term public support may encourage the diffusion of emerging technologies by coordinating the generation of knowledge and providing patient funding, but unexpected policy changes

may hinder private investment and even lead to situations of technology lockout. Leveraging archival data; insights from 45 interviews across academia, industry, and government; and 75 hours of participant observations, we develop insights about why institutional instability in Portugal affected the adoption of Polymer Additive Manufacturing (PAM) and Metal Additive Manufacturing (MAM) differently. In both cases, Portugal invested in the technology relatively early. While PAM has been widely adopted, including increasingly in high-tech applications, MAM adoption has been modest despite MAM's potential to greatly improve the performance and competitiveness of metal molds. From the comparison between PAM and MAM, we generate theory about technological and contextual factors that affect 'technological forgiveness', defined as the resilience of a new technology's adoption to institutional instability.

DOI: <https://doi.org/10.1016/j.techfore.2021.120599>

+ THE PORTO EUROPEAN CANCER RESEARCH SUMMIT 2021

Authors: Ulrik Ringborg, Anton Berns, Julio E. Celis, Manuel Heitor

Year of publication: 2021 | **Journal:** Molecular Oncology

Abstract: The effective implementation of the EU cancer research strategy has been the focus of the European Cancer Research Summit, which took place in Porto in May 2021 and mainly discussed the requirements for distributed and interconnected infrastructures needed to support research on cancer therapeutics, care, and prevention. The European Cancer Summit and the resulting Porto Declaration on cancer research stemmed from the previous "Europe: Unite against Cancer" Declaration that was signed by the consecutive German, Portuguese and Slovenian EU presidencies in October 2020, with the aim to outline future directions for cancer research and care throughout Europe (3). This initiative prepared the grounds for European organizations and stakeholders to determine a common strategy for effectively delivering equal care to European cancer patients.

Manuel Heitor stressed that the Porto Declaration on Cancer Research of May 2021 calls for a collective action throughout Europe towards a comprehensive translational cancer research approach focused on personalized and precision medicine and covering the entire cancer research continuum. Specific actions are required to strengthen a network of well-distributed and interconnected high-quality infrastructures for translational research, clinical and prevention trials and outcomes research, to ensure that science-driven and social innovations benefit patients and individuals at risk across the healthcare systems in the European Union (EU). The declaration has been framed by the discussion that such a European-wide deployment of high-quality infrastructures has the potential to achieve in 2030 a 10-year cancer-specific survival for 75% of patients diagnosed in EU member states with a well-developed healthcare system.

In this context, the European Cancer Research Summit emphasized that broadening the social basis for knowledge-based activities in cancer treatment and prevention, and strengthening the research system producing new knowledge and excellence, should be combined with fostering intermediaries with society and the economy at large. This will require a focusing on the continuous skill development for researchers, clinicians and teaching staff throughout the entire education, research, and health care systems. In addition, establishing close links between professionals and the society will be a continuous process based on a clear understanding of science-society relationships, and expanding beyond the currently dominating policies that consider science only through short-term, demand-driven economic development issues.

DOI: <https://doi.org/10.1002/1878-0261.13078>

+ EFFECTS OF ABSORPTIVE CAPACITY AND INNOVATION SPILLOVER ON MANUFACTURING FLEXIBILITY

Authors: José Pinheiro, Luis Filipe Lages, Graça Miranda Silva, Alvaro Lopes Dias, Miguel T. Preto

Year of publication: 2021 | **Journal:** International Journal of Productivity and Performance Management

Abstract: Shifting demand and ever-shorter production cycles pressure manufacturing flexibility. Although the literature has established the positive effect of the firm's absorptive capacity on manufacturing flexibility, the separate role of the innovation competencies of exploitation and exploration in such a relationship is still under-investigated. In this study, the authors examine how these competencies affect manufacturing flexibility. The authors use survey data from 370 manufacturing firms and analyse them using covariance-based structural equation modelling (CB-SEM). The results indicate that absorptive capacity has a strong, positive and direct effect on exploitative and exploratory innovation competencies, proactive and responsive market orientations, and manufacturing flexibility. The authors' findings also demonstrate that the exploitative innovation competencies mediate the relation between responsive market orientation and manufacturing flexibility. Essentially, these exploitative innovation competencies produce a direct positive effect on manufacturing flexibility while simultaneously being a vehicle for absorptive capacity's indirect effects on it. An exploration innovation strategy does not significantly affect manufacturing flexibility. This study contributes by combining key strategic features of firms with manufacturing flexibility, while providing new empirical evidence of the mediation of the exploitative innovation competencies in the relation between responsive market orientation and manufacturing flexibility.

DOI: <https://doi.org/10.1108/IJPPM-04-2020-0156>

+ THE FOUR SMARTS OF INDUSTRY 4.0: EVOLUTION OF TEN YEARS OF RESEARCH AND FUTURE PERSPECTIVES

Authors: Benjamin Meindl, Néstor Fabián Ayala, Joana Mendonça, Alejandro G. Frank

Year of publication: 2021 | **Journal:** Technological Forecasting & Social Change

Abstract: The Industry 4.0 literature has exponentially grown in the past decade. We aim to understand how this literature has evolved and propose future research opportunities. We focus on four smart dimensions of Industry 4.0: Smart Manufacturing, Smart Products and Services, Smart Supply Chain, and Smart Working. We perform a machine learning-based systematic literature review. Our analysis included 4,973 papers published from 2011 to 2020. We conducted a chronological network analysis considering the growth of these four dimensions and the connections between them. We also analyzed keywords and the main journals publishing on these four smart dimensions. We show that the literature has mainly been devoted to the study of Smart Manufacturing, although attention to the other smart dimensions has been growing in recent years. Smart Working is the less explored dimension, with many opportunities for future research. We show that research opportunities are concentrated in the interfaces between the different smart dimensions. Our findings support the vision of Industry 4.0 as a concept transcending the Smart Manufacturing field, thus creating opportunities for synergies with other related fields. Scholars can use our findings to understand the orientation of journals and gaps that can be fulfilled by future research.

DOI: <https://doi.org/10.1016/j.techfore.2021.120784>

+ THE STRUGGLE OF SMALL FIRMS TO RETAIN HIGH-SKILL WORKERS: JOB DURATION AND THE IMPORTANCE OF KNOWLEDGE INTENSITY

Authors: Hugo Castro-Silva, Francisco Lima

Year of publication: 2022 | **Journal:** Small Business Economics

Abstract: In the knowledge economy, skilled workers play an important role in innovation and economic growth. However, small firms may not be able to keep these workers. We study how the knowledge-skill complementarity relates to job duration in small and large firms, using a Portuguese linked employer-employee data set. We select workers displaced by firm closure and estimate a discrete-time hazard model with unobserved heterogeneity on the subsequent job relationship. To account for the initial sorting of displaced workers to firms, we introduce weights in the model according to the individual propensity of employment in a small firm. Our results show a lower premium on skills in terms of job duration for small firms. Furthermore, we find evidence of a strong knowledge-skill complementarity in large firms, where the accumulation of firm-specific human capital also plays a more important role in

determining the hazard of job separation. For small firms, the complementarity does not translate into longer job duration, even for those with pay policies above the market. Overall, small knowledge-intensive firms struggle to retain high skill workers and find it harder to leverage the knowledge-skill complementarity.

DOI: <https://doi.org/10.1007/s11187-022-00602-z>

+ DOES R&D TAX CREDIT IMPACT FIRM BEHAVIOUR? MICRO EVIDENCE FOR PORTUGAL

Authors: Alexandre Paredes, Joana Mendonça, Fernando Bação, Bruno Damásio

Year of publication: 2022 | **Journal:** Research Evaluation, Volume 31

Abstract: In this study, we use panel data to analyse the impact of an R&D tax credit on R&D personnel, particularly the impact on Ph.D. holders allocation, comparing low R&D intensity firms with medium-high and high R&D intensity firms. The results show that, in medium-high and high R&D intensity firms, the R&D tax credit had a significant impact on allocating Ph.D. holders in firms after 3 years of participation in the tax incentive scheme. We use a database covering 7,710 firms that performed R&D at least once in Portugal over the 23-year period 1995 to 2017, provided by the official business R&D survey data and a database of firms that applied for tax credit incentives at least once in the same period. Based on the estimation of impulse-response functions by local projections, we assess the impact of introducing the tax incentive scheme for corporate R&D in firms from different R&D intensity sectors.

DOI: <https://doi.org/10.1093/reseval/rvac002>

In terms of extension activities, the Technology Management and Policy Laboratory team also contributed to:

- Support the organization of 2022 “Encontro da Arrábida”;
- Design the concept and negotiate the terms of the future Cabo Verde Innovation Centre for Green and Blue Growth (CAVIC);
- Support the New Space Portugal mobilizing agenda;
- Support the 1st Edition of José Mariano Gago Prospective Analysis Award;
- Establishment of 3 new collaboration protocols between IN+ and JUNITEC, +Atlantic and Ciência Viva;
- Participation as speaker/moderator in 13 workshops and seminars.

3. GLOBAL INDICATORS

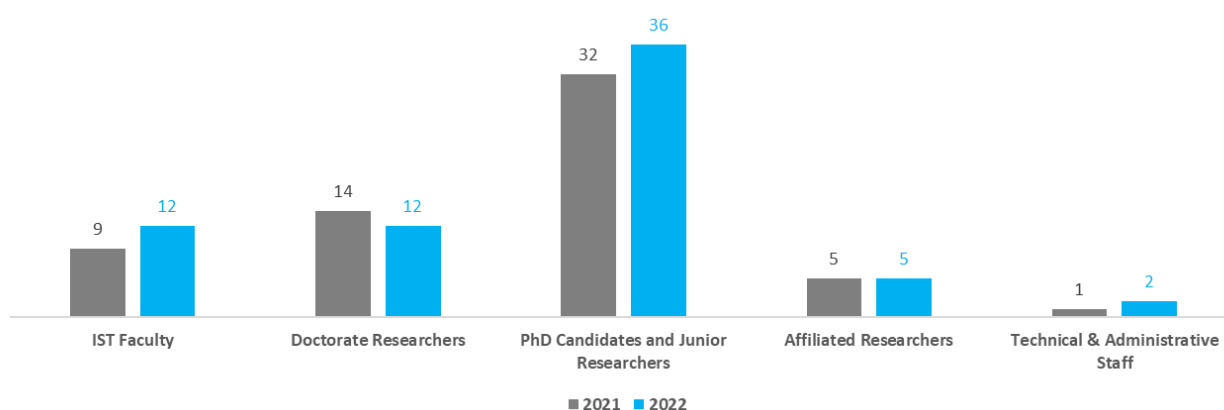
2021-22

This section presents a short summary of the results IN⁺ achieved in the period 2021-2022, including highlights of the activity and the main indicators for human resources, activity in projects, scientific publications, and dissemination. The following sections of the document include detailed information for each Laboratory.

Human resources

IN⁺ team is composed of a multidisciplinary team, integrating researchers with different scientific backgrounds and experience. **Figure 1** shows the breakdown of Human Resources by type of institutional relation with IN⁺ and its evolution from 2021 to 2022. By the end of 2021, the team included a total of 59 researchers, from which 23 integrated researchers (9 professors and 14 Doctorate researchers) and 32 PhD candidates and junior researchers. In 2022, the total number of researchers increased to 65 and the technical and administrative team was reinforced, but overall, the total number of human resources remained relatively stable between 2021 and 2022.

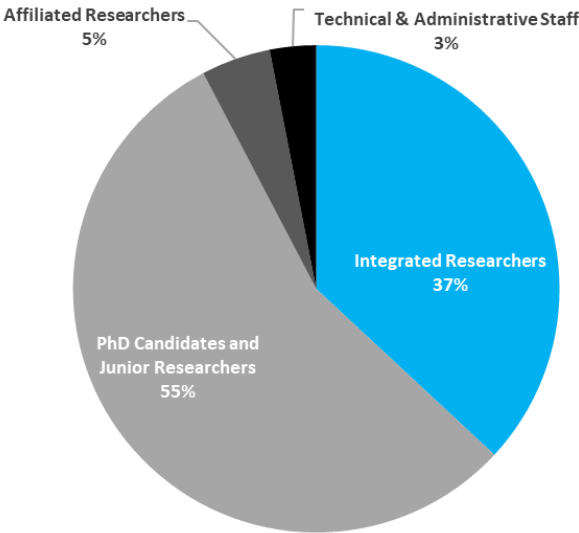
Figure 1. IN⁺ Human Resources (2021-2022)



[Annex II](#) shows the detail of the team members considered in each category.

The PhD candidates and junior researchers represent the largest group of human resources (55%), as illustrated in **Figure 2**, followed by Integrated Researchers (37%), including IST Faculty and Doctorate researchers.

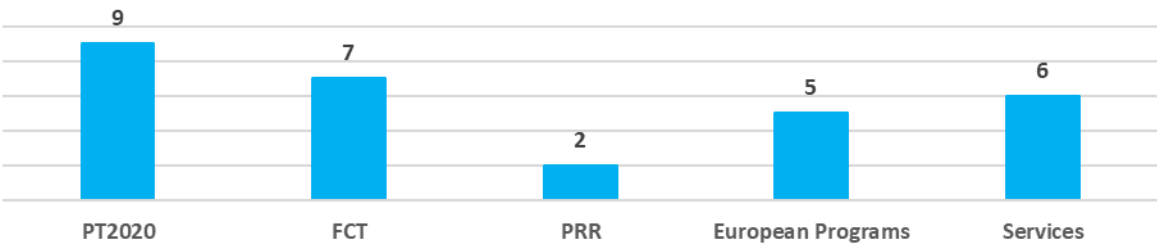
Figure 2. IN⁺ Human Resources 2022



Activity in Projects

IN⁺ research activities are the result of a strong involvement in researchers in projects, which provide not only the necessary external funding but also the opportunity to connect with industry and society. It should be noted that more than 86% of the projects developed in the period 2021-2022 have a collaborative nature, mainly funded through PT2020, FCT and services provision. The projects funded through European Programs (H2020; EEA Grants; Interreg) represented 17% of the projects developed within the period, while services correspond to 21%. **Figure 3** shows the distribution of projects per type of funding source.

Figure 3. IN⁺ projects by type of funding source 2021-2022

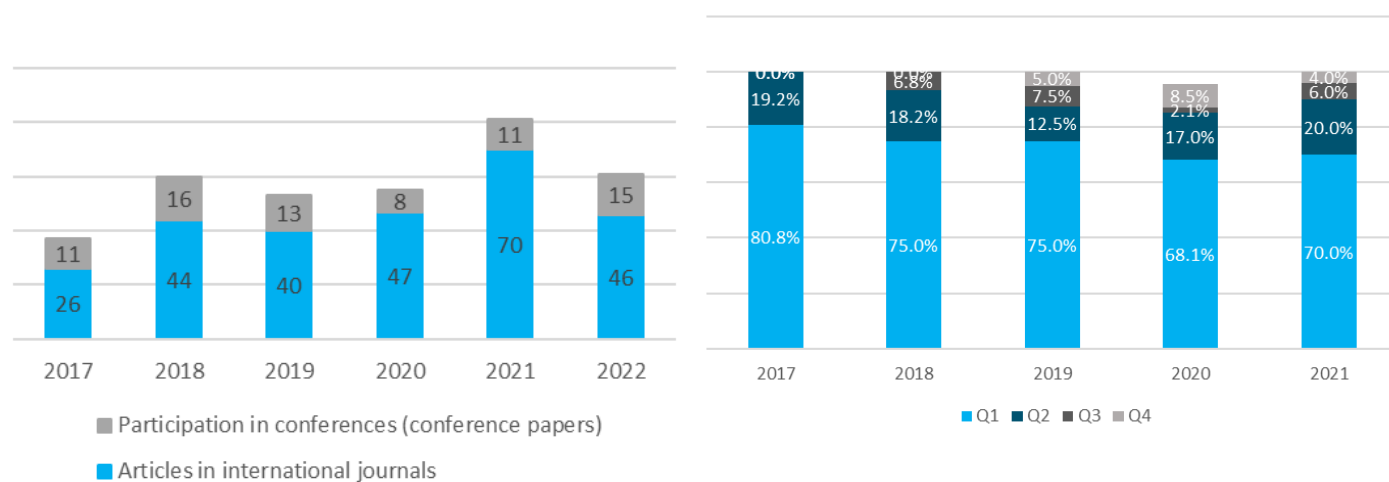


From the 29 projects developed in the period, 8 ended during 2021 and 7 during 2022. By the end of 2022, IN⁺ was involved in 15 ongoing projects and is at the contracting phase of 5 new projects (PRR).

Publications

During 2021 and 2022, IN⁺ published almost 200 articles in international journals, participated in more than 20 conferences and supervised more than 100 thesis (3 of them PhD thesis). Regarding the evolution of the publications indexed by Scopus, **Figure 4** shows the distribution of publications per year and [Annex V](#) provides the complete list of publications produced by IN⁺ in the period.

Figure 4. Evolution of IN⁺ publications indexed by Scopus and articles by source quartile



Analysing the publications per subject area, it is possible to verify in **Table 4** that 40.2% of the publications within the period 2017-2021 are aligned with the 'Engineering' domain, followed by 'Energy' with 32.3%, 'Social Sciences' with 26.8% and 'Environmental Science' with 23.4% of the publications.

Table 4. IN⁺ publications per subject area

Subject Area (Top 10)	%
Engineering	40.2
Energy	32.3
Social Sciences	26.8
Environmental Science	23.4
Chemical Engineering	12.4
Physics and Astronomy	12.0
Business, Management and Accounting	9.3
Computer Science	9.3
Mathematics	8.6
Chemistry	5.2

4. FINANCIAL OVERVIEW

The year 2021 was still significantly affected by the effects of the Covid-19 pandemic on work routines, while the year 2022 is characterised by a return to “normality”. In fact, as can be observed in the detailed distribution of expenses by spending item – **Table 5**, the financial overview reflects an increase of 28% in expenditures in 2022 when compared to 2021.

Table 5. Distribution of expenses by items 2021-2022

	2021	2022	Weight in total 2021-2022 (%)
Human Resources³	863,259 €	1,056,124 €	77.9
IST Faculty ⁴	333,957 €	413,044 €	
Doctorate Researchers - Working contracts	328,877 €	316,240 €	
PhD Candidates - Studentships	146,613 €	243,898 €	
MSc Researchers - Fellowships	8,597 €	16,136 €	
Post Doc or other - Fellowships	21,384 €	28,949 €	
Technical and Administrative staff - Working contracts	23,832 €	37,857 €	
Missions	862 €	15,339 €	0.7
Travel, Accommodation and Missions	862 €	15,339 €	
Goods and Services	61,396 €	94,371 €	6.3
Website Maintenance	5,424 €	5,535 €	
IT Support	13,284 €	13,284 €	
General Office Expenses	654 €	1,842 €	
Materials, Supplies & Maintenance Services	40,365 €	72,146 €	
Other Services	1,669 €	1,564 €	
Communication and Dissemination	2,393 €	31,483 €	1.4
Conferences	2,393 €	31,483 €	
Equipment	16,529 €	70,777 €	3.5
Acquisition	6,481 €	63,703 €	
Software	10,048 €	7,074 €	
Overheads⁵	135,390 €	116,995 €	10.2
Overhead contributions to IST	135,390 €	116,995 €	
TOTAL	1,079,830 €	1,385,089 €	

³ [Annex II](#) show the detail of the Human Resources.

⁴ Considers the salaries of IST professors listed in [Annex II](#) in the proportion they are dedicated to IN⁺, typically, 50% FTE.

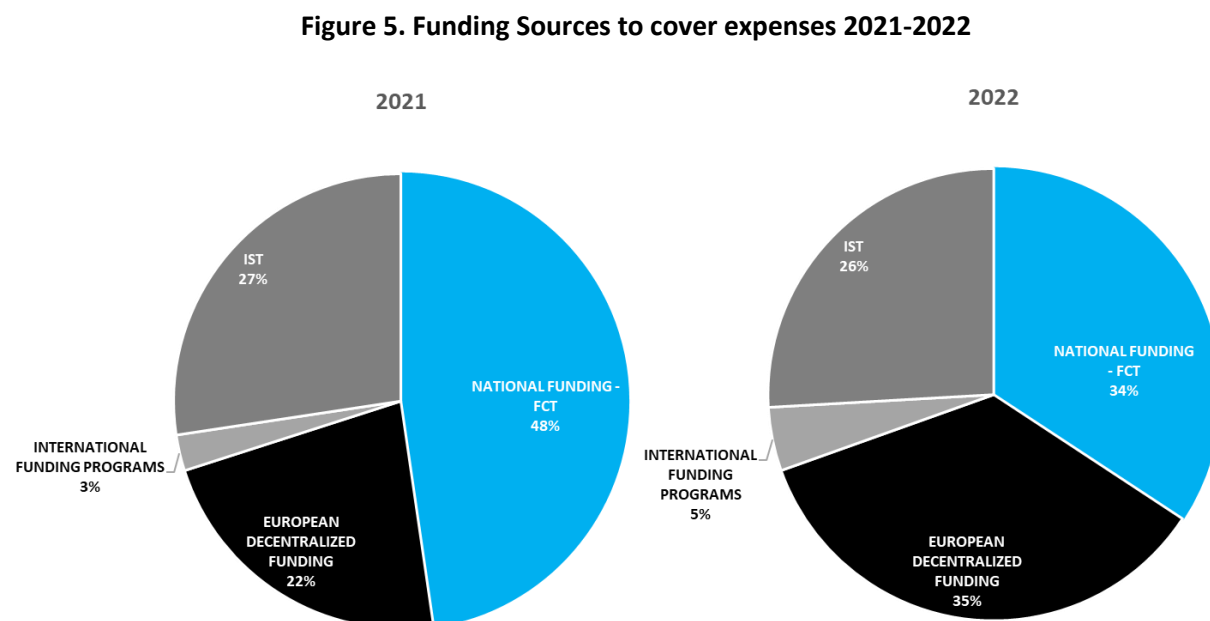
⁵ Provisional data.

Human Resources are often characterised in terms of Full-Time Equivalent (FTE), and typically IST academic staff have a 50% FTE, while Doctorate researchers and grant holders have typically a FTE corresponding to 100%. Affiliated researchers are considered if contributing with less than 20% or if integrated in another research units.

Considering the period 2021-2022, 'Human Resources' represented 77.9% of global spending, while 'Goods and Services' represented 6.3% and Equipment 3.5%. It should be highlighted that the data referring to overhead contributions are preliminary.

In 2021, the expenditure items most impacted by the limitations imposed by the pandemic were travel, accommodation, and missions due to the limitations in-person participation in meetings and conferences and equipment, materials and supplies as a consequence of the constraints caused in experimental activities. In turn, considering the return to "normal" work routines, 2022 reveals an increase in these expenditure items. The financial outlook for 2022 should be understood as the most common framework for a typical year.

The presented expenses were covered by different sources coming from national funding programs (48% in 2021; 34% in 2022), European Decentralized Funding (21% in 2022; 35% in 2022) and IST contributions through the payment of IST Faculty salaries, representing 27% of the funding sources in 2021 and 26% in 2022 - **Figure 5**.



In **Table 6** it is possible to see in more detail the funding sources mobilised to cover the incurred expenditure in 2021 and 2022.

Table 6. Funding Sources to cover expenses 2021-2022

	2021	2022
NATIONAL FUNDING - FCT	589,380 €	567,149 €
Base Funding	93,605 €	149,036 €
Programmatic Funding	53,081 €	73,455 €
Associate Laboratory	- €	12,836 €
Researcher FCT Program	164,438 €	139,355 €
PhD Studentships	264,696 €	148,720 €
Research Projects - PTDC	13,561 €	43,747 €
EUROPEAN DECENTRALIZED FUNDING	276,251 €	584,548 €
PT2020	276,251 €	554,740 €
PRR	- €	29,807 €
INTERNATIONAL FUNDING PROGRAMS	31,612 €	75,421 €
H2020/HEurope	23,784 €	24,031 €
INTERREG	7,828 €	40,751 €
Other	- €	10,639 €
IST	338,388 €	428,791 €
PI Research Funds	4,431 €	15,748 €
IST Contribution - Faculty Salaries	333,957 €	413,044 €
TOTAL	1,235,630 €	1,655,908 €

4.1. MULTI-ANNUAL FUNDING

The multi-annual funding of IN⁺ is divided into three components: Base funding and Programmatic funding for the period 2020-2023 and the Associated Laboratory (AL) funding for the period 2022-2025.

As agreed by the Board of Directors, the funding was distributed among the three Laboratories as shown in **Table 7**. This distribution considered the dimension of each laboratory and the need to include a budget to cover general expenses (which includes current expenses not covered by projects, salaries of the administrative team and salary of a PhD researcher) and strategic expenses. The table shows the detailed distribution of the funding by each group and the respective execution until the end of 2022.

Table 7. Multi-annual funding and execution 2020-2022⁶

		TOTAL FUNDING DISTRIBUTION	EXECUTION 2020-22			EXECUTION (%)
			2020	2021	2022	
General Expenses		451,947 €	101,687 €	125,040 €	133,144 €	79.6
Strategic		48,710 €	7,716 €	736 €	4,445 €	26.5
LTCES	IN+ (2020-23)	68,768 €	17,341 €	4,041 €	47,333 €	58.5
	LTCES LAB (2020-23)	48,710 €				
		AL (2022-25)	304,124 €			105 €
LEIS	IN+ (2020-23)	68,768 €	2,709 €	5,723 €	26,080 €	50.2
	Waste L. (2020-23)	31,996 €	- €	44 €	- €	0.14
		AL (2022-25)	304,124 €			12,732 €
LTMP	IN+ (2020-23)	35,339 €	3,903 €	11,102 €	11,281 €	39.0
	SILAB (2020-23)	31,996 €	- €	- €	- €	0.0
		AL (2022-25)	115,857 €			- €
TOTAL		1,510,339 €	133,356 €	146,685 €	235,119 €	34.1

In the period 2020-22, the base funding (2020-23) has an execution rate of 61%, the programmatic funding (2020-23) of 68% and the Associate Laboratory (2022-25) of 2%.

In addition, considering the budget already committed to 2023-2025 and that is related to salaries of the human resources allocated to multi-annual funding, **Table 8** presents the detail of the global execution (budget executed in the period 2020-2022 and budget already committed to 2023-2025), corresponding to 52.3%.

⁶ The base and programmatic funding were separated in two components: funding to the general activities of the group (referred as IN⁺ in the table) and funding to the experimental facilities (referred as LTCES LAB; WASTE L. and SILAB in the table). AL refers to the Associate Laboratory funding.

Table 8. Multi-annual funding committed 2023-2025

		BUDGET COMMITTED 2023-25 (€)			EXECUTED 2020-22 + COMMITTED 2023-25 (€)	GLOBAL EXECUTION (%)
		2023	2024	2025		
General Expenses		69,150 €	- €	- €	429,021 €	95.0
Strategic		- €	- €	- €	12,897 €	26.5
LTCES	IN ⁺ (2020-23)	- €	- €	- €	68,714 €	58.5
	LTCES LAB (2020-23)					
	AL (2022-25)	38,072 €	38,072 €	43,001 €	119,250 €	39.2
LEIS	IN ⁺ (2020-23)	6,725 €	- €	- €	41,282 €	41.0
	Waste L. (2020-23)	- €	- €	- €	44 €	0.14
	AL (2022-25)	79,581 €	- €	- €	92,313 €	30.4
LTMP	IN ⁺ (2020-23)	- €	- €	- €	26,285 €	39.3
	SILAB (2020-23)	- €	- €	- €	- €	0.0
	AL (2022-25)	- €	- €	- €	- €	0.0
TOTAL		193,529 €	38,072 €	43,001 €	789,969 €	52.3 %

The budget available per laboratory for the period 2023-2025 is indicated in **Table 9** and the detailed execution per multi-annual funding component, expenditure item and Laboratory will follow in next sections.

Table 9. Budget available for the period 2023-2025

	LTCES	LEIS		LTMP		GENERAL EXPENSES	STRATEGIC
		LEIS	Waste L.	LTMP	SILAB		
BASE+ PROGRAMMATIC	48,764 €	27,529 €	31,952 €	8,846 €	31,996 €	22,926 €	35,814 €
ASSOCIATE LABORATORY	184,875 €	211,812 €		115,857 €		--	--
TOTAL	233,639 €	271,293 €		156,699 €		22,926 €	35,814 €

Base Funding

The total amount of Base Funding for the period 2020-2023 is 586,294 euros and the global execution corresponds to 73.1%, including the committed expenses for 2023. As presented in **Table 10**, 'Human

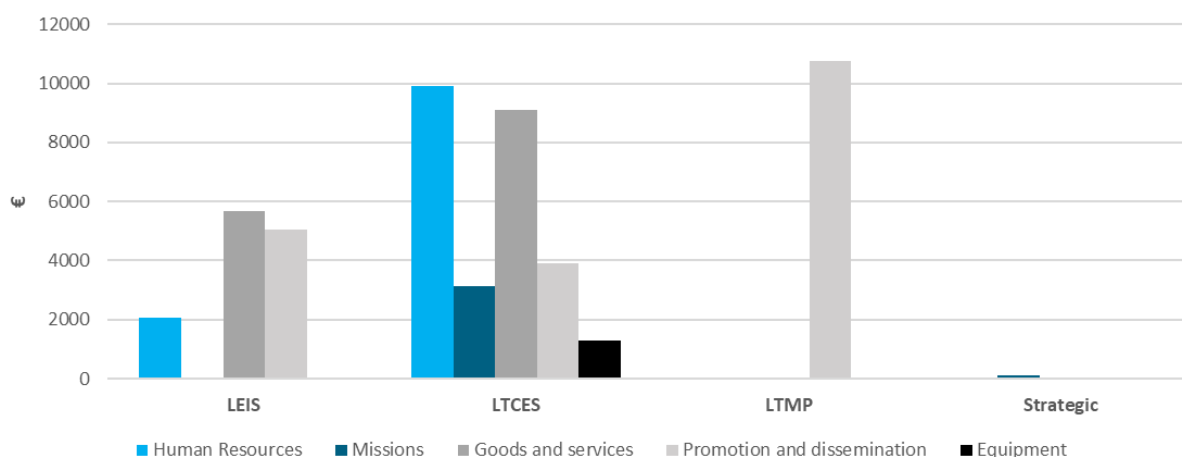
Resources' is the budgetary line with the highest level of expenditure (301,413 euros), representing 70.2% of the global expenditure, followed by Goods and services acquisition with 15.4%.

Table 10. Base Funding – Global Execution (2020-2023)

	PLANNED BUDGET (€)	AMOUNT EXECUTED (€)	WEIGHT ON GLOBAL EXECUTION (%)
Human Resources	351,614 €	301,413 €	70.2
Missions	20,967 €	3,275 €	0.76
Goods and Services	73,057 €	66,276 €	15.4
Promotion and dissemination	20,939 €	19,796 €	4.62
Equipment	2,458 €	1,307 €	0.30
Overheads	117,259 €	36,708 €	8.56
TOTAL	586,294 €	428,774 €	

Figure 6 presents the breakdown of the expenses incurred by each Laboratory by type of expenditure.

Figure 6. Base Funding - Breakdown of the expenses incurred by each Laboratory



Programmatic Funding

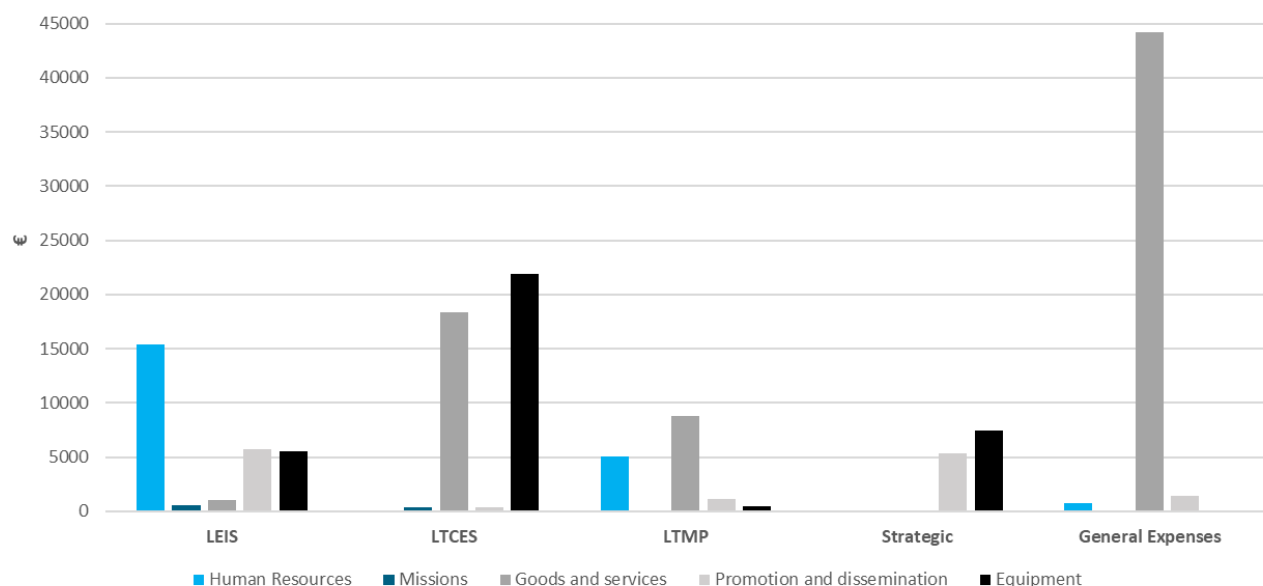
The total amount of Programmatic funding for the period 2020-2023 is 199,940 euros and the global execution corresponds to 71.8%. As presented in **Table 11**, 'Goods and services' acquisition is the budgetary line with the highest level of expenditure, representing 5.3% of the global expenditure, and is followed by 'Equipment' which accounts for 24.6%.

Table 11. Programmatic Funding – Global Execution

	PLANNED BUDGET (€)	AMOUNT EXECUTED (€)	WEIGHT ON GLOBAL EXECUTION (%)
Human Resources	46,600 €	21,125 €	14.7
Missions	14,000 €	834 €	0.6
Goods and Services	73,840 €	72,363 €	50.4
Promotion and dissemination	25,825 €	13,942 €	9.7
Equipment	37,400 €	35,359 €	24.6
Internal Allocations	2,275 €	- €	0.0
Total	199,940 €	143,623 €	

Figure 7 presents the breakdown of the expenses incurred by each Laboratory by type of expenditure.

Figure 7. Programmatic Funding - Breakdown of the expenses incurred by each Laboratory



Associate Laboratory

The total amount of Associate Laboratory Funding for the period 2022-2025 is 724,105.68 euros and the global execution corresponds to 29.2%. As presented before, this execution refers to 12,836€ executed in 2022 and 198,726€ committed to Doctorate researchers' salaries in the period 2023-2025. LEIS is responsible for the execution of 92,313 euros, while LTCES accounts for 119,250 euros.

5. PLANNING 2023 – A YEAR OF GROWTH

The year 2023 will bring several challenges to IN⁺ in three main domains.

- + Increase of the intensity of IN⁺ research activities, namely under the recently approved projects in the ‘Recovery and Resilience Plan’ → Challenges in terms of resource management and implementation control.
- + Growth of the team: Within the scope of the projects running in 2023, it is foreseen to hire at least 14 Doctorate researchers and 22 students (PhD, MSc, and Post Doc grants) → Challenges in terms of talent attraction, human resources management and valorisation.
- + Reinforce external relations, namely in terms of awareness about IN⁺ and strengthening national and international collaborations through new projects, training offers and events → Challenges in terms of international positioning, coherence with ongoing projects and initiatives and communication and awareness.

5.1. ACTIVITY IN PROJECTS

During 2023, IN⁺ will have at least 18 ongoing projects, 15 of which are under execution (as presented in section 2) and 3 will be contracted in the beginning of the year under the PRR. The description of these new projects – Aliança para a Transição Energética, New Generation Storage and H2GreenValley – is presented below.

To ensure better management of the technical, human and financial resources necessary for the development of activities, IN⁺ will implement some management procedures to assist researchers, such as hours allocation control and monitoring of financial execution.

+ ALIANÇA PARA A TRANSIÇÃO ENERGÉTICA

Start: 01/01/2023 **End:** 31/12/2025 **PI:** Paulo Ferrão/Virginia Infante **Status:** New project

Description: The Alliance for Energy Transition aims to strengthen the competitiveness and resilience of companies in the energy sector as a result of the creation of innovative products and solutions of export

nature, based on technology and know-how developed and consolidated in the sector, placing Portugal at the forefront of decarbonisation and enabling an effective energy transition. IN+ will be involved in the development of an ultra-fast, universal modelling system for energy management in buildings and recommendation of efficiency measures.

Funding Program: PRR | **Total Budget:** 342.6M€ | **IN+ Budget:** 578,640.00 €

Lead Partner: Efacec Energia – Máquinas e Equipamentos Elétricos, S.A.

+ NEW GENERATION STORAGE

Start: 01/01/2023 **End:** 31/12/2025 **PI:** Fernanda Margarido **Status:** New project

Description: The New Generation Storage (NGS) Innovation Pact is completely aligned with the European Union's energy transition strategy until 2040, and the challenge for the complete electrification of mobility by 2035. Based on a model structured in 8 Work Packages that cover the entire value chain of component production, battery packs and recycling, it proposes to add value to each stage of the process, culminating in a common goal: the creation of a new technological ecosystem in the area of batteries that will make the national industry stand out in the global market. Through the cooperation of 54 entities (30 companies and 24 ENESII), the aim is to structurally transform the national productive fabric, creating the necessary conditions - at the technological level and human resources - for an industrial ecosystem capable of mass production of innovative technologies, and a complete value chain that allows the management of end-of-life of world reference.

Funding Program: PRR | **Total Budget:** 239.2 M€ | **IN+ Budget:** 1,324,925 €

Lead Partner: DST SOLAR, S.A.

+ H2GREENVALLEY

Start: 01/01/2023 **End:** 31/12/2025 **PI:** Edgar Fernandes **Status:** New project

Description: The H2 Green Valley Agenda brings together a set of complementary projects in the green hydrogen (H2) value chain focused on the development of transmission, storage and distribution infrastructures, in order to create, in a coordinated, scalable and innovative way, the first green H2 hub in Sines. Producers and consumers interconnected in a common infrastructure, allowing cost sharing and the development of innovative services, accelerating the energy transition to a green economy.

The Agenda will develop a green H2 transmission infrastructure, an injection and mixing system in the gas network, adaptation of the Sines gas distribution network and develop equipment to implement a pilot to convert domestic consumers to H2, as a demonstrator for a 100% green future. The Agenda will create

4 new services and 8 products, reduce national CO2 emissions by 1% by 2027 and 2% by 2030, and decrease external energy dependence by 2% by 2030.

Funding Program: PRR | **Total Budget:** 28.5 M€ | **IN⁺ Budget:** 1,177,935.00 €

Lead Partner: REN, GÁS, S.A.

5.2. GROWTH OF THE TEAM

With the information currently available, it is possible to see that the expected increase of the team in 2023 will be at least from 67 to 99 members. As presented in **Table 12**, the team will be composed of 13 professors (+1 than 2022, as Ana Sofia Moita will become IST professor), 28 doctorate researchers (+16 than in 2022, funded through PRR projects), 53 PhD candidates and Junior researchers (+17 than in 2022, funded through the ongoing projects), 5 affiliated researchers and 2 administrative staff.

Table 12. IN⁺ team expected in 2023

		2022	2023
Integrated Researchers	IST Faculty	12	13
	Doctorate Researchers	12	28
PhD Candidates and Junior Researchers		36	53
Affiliated Researchers		5	5
Technical and Administrative Staff		2	2
TOTAL		67	99

In order to overcome the main challenges brought by this abrupt increase – talent recruitment, human resources management and researchers valorisation, IN⁺ will invest in improving its practices in three areas: offering attractive conditions and promoting widely the job offers in order to attract the best talent, implementing human resources management procedures and applying measures to reward and valorise the performance of researchers.

5.3. REINFORCE EXTERNAL RELATIONS

In terms of external relations, IN⁺ will focus on three main areas of intervention:

- + Improving pre-award support making it easier for researchers to identify new partners and opportunities for collaboration through co-financed projects, for example through Horizon Europe, or services.

- + Raising awareness about IN⁺ competencies, projects and initiatives, through the design and implementation of a communication plan;
- + Organisation of an annual IN⁺ Conference dedicated to “Global Challenges and Emerging Technologies”;
- + Creating new training offers in the field of Hydrogen, Urban analytics/Digital Twins, Energy Planning and Space Systems.
- + Strengthening the connection with LARSyS, by promoting joint monthly events dedicated to explore collaboration opportunities.
- + Implementing a IN⁺ 25 years celebrations program, including (but not limited to):
 - Organisation of a “25+ Global Challenges competition”;
 - Organisation of an Urban Data Hackathon;
 - Edition of an IN⁺ 25years book;
 - “IN⁺ goes to school” – Thematic visits of IN⁺ researchers to primary and/or secondary schools;
 - Organisation of cultural initiatives (concert and exhibition)
 - Consolidation of IN⁺ community through the organisation of thematic workshops and team building initiatives.

5.4. FINANCIAL PLANNING

Considering the aforementioned increase of team members and activities foreseen for the year, IN⁺ will also observe an increase in its expenses. In fact, in comparison to 2022, the expenditure will almost double (from 1,385,089 euros to 2,652,250 euros), increasing 91.5%. However, it should be noted that the referred growth will be fully covered by the projects in execution during the year.

Table 13 presents the detail of the budget planned for the year. As in previous years, ‘Human resources’ represents the largest share of total expenditure (69%), followed by ‘Equipment’ (13%) and ‘Goods and services’ (4%).

Table 13. Budget planned for 2023

	2023
Human Resources⁷	1,842,593 €
IST Faculty ⁸	491,265 €
PhD Researchers – Working contracts	776,646 €
PhD Researchers – Fellowships	389,821 €
MSc Researchers – Fellowships	51,647 €
Post Doc or other – Fellowships	61,295 €
Technical and Administrative staff – Working contracts	71,919 €
Missions – Travel and Accommodation	43,824 €
Travel, Accommodation and Missions	43,824 €
Other	- €
Goods and Services	102,416 €
Website Maintenance	6,000 €
IT Support	13,284 €
General Office Expenses	3,000 €
Subcontracts	6,000 €
Materials, Supplies & Maintenance Services	74,132 €
Communication and Dissemination	70,000 €
Publications	20,000 €
Conferences	50,000 €
Equipment	339,834 €
Equipment Acquisition	339,834 €
Software	0 €
Overheads	253,582 €
	2,652,250 €

6. FINAL REMARKS

This report shows that while 2021 and 2022 were years of consolidation and exploration of new opportunities, 2023 will be a year of new challenges and growth. The main challenges will be to sustainably grow the team (eventually from 67 to 99 members), implement resource management and financial execution procedures and increase the visibility of IN⁺, maintaining the values and the mission that IN⁺ envisions. These challenges come new opportunities and responsibilities that we will address together to affirm 2023 as a year of consolidation of the IN⁺ footprint on the scientific landscape and on its socio-economic impact.

⁷ As described in [section 4.2](#).

⁸ Considers the salaries of IST professors, as described in [Annex II](#) and [section 4.2](#)., in the proportion they are dedicated to IN⁺, typically, 50% FTE.

ANNEX I – GOVERNANCE STRUCTURE

By the end of 2022, the Board of Directors was composed by the following members:

- + Paulo Ferrão, [President of the Board of Directors](#)
- + Edgar Fernandes, [Representative of Thermofluids, Combustion and Energy Systems Laboratory](#)
- + Carlos Santos Silva, [Representative of Industrial Ecology and Sustainability Laboratory](#)
- + Manuel Heitor, [Representative of Technology Management and Policy Laboratory](#)⁹
- + Ricardo Gomes, [Representative of Doctorate Researchers](#)
- + Afonso Amaral, [Representative of Students](#)

The **Scientific Council**, overviews the performance of IN⁺ and is composed of all doctorate members and headed by a President, as follows:

- + Fernanda Margarido, [President of the Scientific Council](#)

Doctorate members:

- | | |
|--------------------------------------|--|
| + Ana Sofia Oliveira Henriques Moita | + Manuel Frederico Tojal Valsassina Heitor |
| + António Luís Moreira | + Maria João Rodrigues |
| + António Miguel Areias Dias Amaral | + Marta Abrantes |
| + Carlos Augusto Santos Silva | + Mexitli Eva Sandoval Reyes |
| + Catarina Seco Matos | + Miguel Simões Torres Preto |
| + Diana Pereira Neves | + Patrícia de Carvalho Baptista |
| + Edgar Caetano Fernandes | + Paulo Manuel Cadete Ferrão |
| + Filipe Mendes | + Ricardo Manuel Anacleto Gomes |
| + Gonçalo Nuno de Oliveira Duarte | + Rui Pedro da Costa Neto |
| + Gonçalo Nuno Rodrigues Brás | + Samuel Pedro de Oliveira Niza |
| + Hugo Duarte Alves Horta | + Sandra Isabel Godinho Dias |
| + Joana Serra da Luz Mendonça | + Teodoro José Pereira Trindade |
| + João Miguel Pires Ventura | |

Acting transversally, the **technical and administrative team** supports the Board of Directors and the Scientific Council activities in the following areas: Organisation and Management, External Relations and Communication, and Technical Support. This team is composed by Sandra Dias, a member of the Scientific Council and two other members, as follows:

- + Ana Gonçalves
- + André Gonçalves

⁹ Joana Mendonça, from January-May 2021; Miguel Amaral, from May 2021-April 2022; Manuel Heitor since April 2022.

ANNEX II – HUMAN RESOURCES 2021-2022

		2021	Members	2022	Members
Integrated Researchers	IST Faculty	9	António Luís Moreira; Miguel Amaral; Carlos Santos Silva; Edgar Caetano Fernandes; Fernanda Margarido; Filipe Mendes; Joana Mendonça; Miguel Torres Preto; Paulo Ferrão	12	António Luís Moreira; Miguel Amaral; Carlos Santos Silva; Edgar Caetano Fernandes; Fernanda Margarido; Filipe Mendes; Hugo Silva; Manuel Heitor; Marta Abrantes; Miguel Torres Preto; Patrícia Baptista; Paulo Ferrão
	Doctorate Researchers	14	Ana Sofia Moita; Catarina Seco Matos; Diana Neves; Hugo Silva; Mexitli Reyes; Patrícia Baptista; Ricardo Gomes; Rui Costa Neto; Sandra Dias; Elaine Fabre; Catarina Rolim; Gonçalo Duarte; Hugo Horta; Teodoro Trindade.	12	Ana Sofia Moita; Diana Neves; Mexitli Reyes; Ricardo Gomes; Rui Costa Neto; Sandra Dias; Sónia Cunha. Inês Nunes; Francisco Costa; Gonçalo Duarte; Hugo Horta; Teodoro Trindade.
PhD Candidates and Junior Researchers		33	Afonso Amaral; Alexandre Gamboa; Benjamin Meindl; Carlos Diogo; Cristian Ruiz; David Silva; Diana Fernandes; Fabíola Pereira; Filipe Quintino; Francisco Costa; Gonçalo Araújo; Gonçalo Coutinho; Helena Costa; Inês Ferrão; Inês Maia; Joana Fernandes; Júlia Pereira; Maria Eugénia Leitão; Monica Shenouda; Nádia Costa; Naim Majdalani; Olga Savchuk; Paulo Loureiro; Pedro Pontes; Ricardo Robles; Rodrigo Santos Lapa; Rudolph Caballero Santarromana; Rui Semeano; Sónia Cunha; Tatiana Silva; Diogo Silva; Bruno Gouveia; João Santos.	36	Afonso Amaral; Alexandre Gamboa; Benjamin Meindl; Bruno Gouveia; Carlos Diogo; Cristian Ruiz; David Silva; Diana Fernandes; Fabíola Pereira; Filipe Quintino; Florentin Eckl; Glaucio Silva; Gonçalo Araújo; Gonçalo Coutinho; Helena Costa; Inês Ferrão; Inês Maia; Jaime Sierra; Joana Fernandes; José Eduardo Socha Pereira; Maria Eugénia Leitão; Miguel Campino; Monica Shenouda; Nádia Costa; Naim Majdalani; Olga Savchuk; Paulo Loureiro; Pedro Pontes; Ricardo Robles; Rodrigo Santos Lapa; Rudolph Caballero Santarromana; Rui Semeano; Tatiana Silva. Tomás Meias; João Santos; Rui Pereira.
Affiliated Researchers		5	Gonçalo Brás; João Ventura; Maria João Rodrigues; Melissa Bacatelo; Francisco Capucha.	5	Gonçalo Brás; João Ventura; Maria João Rodrigues; Melissa Bacatelo; Francisco Capucha.
Technical & Administrative Staff		1	André Gonçalves	2	Ana Gonçalves; André Gonçalves

ANNEX III – IN+ CONTRIBUTION TO LARSYS THEMATIC LINES

Thematic Line	Activities	Objectives	IN+ Contribution
OCEAN	Modelling	Simulate and forecast physical and biogeochemical tridimensional processes in coastal and open waters at different scales, as well as estuaries and watersheds, using an integrated modelling philosophy.	<ul style="list-style-type: none"> - Development of advanced systems for ocean modelling and exploration with a view to challenging scientific, commercial, and societal applications.
	Acoustic remote sensing	Monitor the state of the ocean, including the mapping and measurement of anthropogenic noise and evaluate its impact on marine life and biodiversity.	
	Cooperative marine/aerial robotics	Scientific and commercial tools to sample the ocean adaptively, inspect critical offshore structures for ocean farming and energy harvesting, map vast extensions of the deep ocean, monitor marine protected areas, and secure harbour installations.	
	Sensor networks	Understand migratory routes and movements of marine megafauna in selected areas using bio-tagging devices.	
	Ocean Literacy	Deepen the knowledge on ocean among the society.	
URBAN	Metabolism	Model and forecast the interactions between multiple urban systems.	<ul style="list-style-type: none"> - Integration of machine learning algorithms in the urban data sets that support the models and improve their capabilities. - Development of new solutions and algorithms for data acquisition and processing. - Development of sustainable energy systems with the increasing integration of renewables, smart grids and the increasing participation of end users and citizens. - Optimization of other natural resources as water and food and its integration with the energy models. - Development of new combustion technologies for appliances and vehicles. - Analysis of new business models and societal impacts with a strong focus on the Socio Technical Systems perspective.
	Informatics	Develop platforms to collect and store data and generate information to feed models and support the development of decision-making tools for citizens, municipalities and governmental agencies.	
	Systems	Design new technologies, services and products and policies for urban environment.	
LIFE	Neurologic diseases	From the classical diagnosis based on medical imaging and fundamental or applied research in	

	Cancer and Rehabilitation	neurosciences to robotic human-machine interaction systems applied in rehabilitation, social robots in active and healthy life supporting systems or new biomicrofluids lab-on-chip solutions.	<ul style="list-style-type: none"> - New technologies to assist citizens to improve their life quality in urban environments. - Lab-On-Chip Cancer Diagnosis: developing new diagnostic methods based on mechanophenotyping characterization and on adapted constitutive models relating specific flow properties.
INTERACTION	Cognitive Robots and Systems	Design of Cognitive Robots and Systems (CRS) capable of interacting routinely with humans in different application contexts, e.g. manufacturing, homes, services and public spaces.	<ul style="list-style-type: none"> - Analysis of business opportunities and employment implications of the developed technologies and identify industry needs.
AIR	Propulsion	<p>Competence building and technology adoption in supply chain management, namely Metal Additive Manufacturing and Aircraft Interiors;</p> <p>Development of micro turbine engines and hybrid-electric propulsion systems for UAVs;</p> <p>Development of robots for collaborative tasks with astronauts inside a space station environment, as the ISS;</p> <p>Improvement of mass centre and inertia estimation techniques and motion control of single and multiple aerial vehicles, namely using image based visual servoing;</p> <p>Development of a low-cost modular satellite platform with a suite of remote-sensing and communication systems;</p> <p>Development of methods for integration of field data, proximal sensing and remote sensing (UAV and satellite based) for environmental monitoring</p>	<ul style="list-style-type: none"> - Analysis of new business models and societal impacts with a strong focus on the Socio Technical Systems perspective.

ANNEX IV – LIST OF MASTER AND DOCTORAL THESES

PhD Theses

Manuel Betancourt Schwarz, Energy, ***Economic and Quality of Service assessment using Dynamic Modelling and Optimization for Smart Management of District Heating networks***, Universidade de Lisboa, IMT Atlantique/IST - Universidade de Lisboa, 15/02/2021. **Supervisors:** Bruno Lacarrière; Carlos Augusto Santos Silva.

Francisco Pires Costa, ***Cognitive Urban Building Energy Modeling: A New Data Science-Based Approach, for Energy Management at the Urban Level***, IST, Universidade de Lisboa, 14/02/2022. **Supervisor:** Carlos Santos Silva. <https://scholar.tecnico.ulisboa.pt/records/DVsEpD3jSqRes83DuQ5zxxLRQtFNz9acmWrD>

Benjamin Meindl, ***Contributions towards Navigating the Fourth Industrial Revolution - Technology trends, research directions, workforce implications***, IST, Universidade de Lisboa, 06/05/2022. **Supervisor:** Joana Mendonça. <https://scholar.tecnico.ulisboa.pt/records/Q8gSo3S5Cc3xJl4tc8MkRHK4xGHsGrlyOi>

Sónia Cunha, ***Analysis of the Socioeconomic Metabolism of Nations: Methods and Applications***, IST, Universidade de Lisboa, 30/05/2022. **Supervisor:** Paulo Ferrão https://scholar.tecnico.ulisboa.pt/records/BV6hiMQeWIP0cqvaVF_zXzlrPftabZJUQ_GK

Master Theses

2021

Afonso Maria Cordeiro da Silva, ***Green Hydrogen and Oxygen Economy developments in Portugal***, ISTS, UL, Dezembro 2021. **Supervisor:** Rui Costa Neto. <https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344781>

Agata Sara Horwacik, ***Technological and economical assessment on energy conversion systems based in Gas Turbines***, Outubro 2021. **Supervisors:** Edgar Fernandes, Rui Costa Neto. <https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1128253548922452>

Alexandre Ferreira Teixeira, ***Avaliação das condições críticas para a ocorrência de ebulição em permutadores de calor líquido/gás***, IST, UL, Dezembro 2021. **Supervisors:** Ana Sofia Moita, António Luís Moreira. <https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1972678479055051>

Alexis Phillips, ***Unleashing a solar irrigation pump revolution for smallholder farmers in Myanmar***, IST, UL, Janeiro 2021. **Supervisor:** Rui Costa Neto. <https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/846778572212932>

André Cacilhas Machado, ***"Estudo paramétrico de otimização da geometria de tubos corrugados para maximização da transmissão de calor em escoamentos internos"***, MSc in Mechanical Engineering, IST, Universidade de Lisboa, Janeiro 2021. **Supervisor:** Ana Sofia Moita.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/846778572212837>

André Henrique Alves Carneiro, **Modelling job promotion in a consulting company by a logistic regression**, IST, UL, Janeiro 2021. **Supervisors:** Miguel Preto, Hugo Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/846778572213008>

Andy Nicolas Leren, **MODELLING OF A MICROGRID IN A PUBLIC BUILDING**, IST, UL, Janeiro 2021. **Supervisor:** Carlos Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/846778572212933>

António Maria Jácome Morgado, **Determinants of technology-based firms' survival in Portugal**, IST, UL, Novembro 2021. **Supervisor:** Miguel Amaral.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/1128253548922988>

António Maria Maia Marques Líbano Monteiro, **Development of a Powertrain System for a Shell Eco-marathon Fuel Cell Electric Vehicle**, IST, UL, Outubro 2021. **Supervisor:** Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/565303595502759>

Bernardo Dias Macara, **Impact of Flame Temperature in the Chemiluminescence of Enriched Biogas**, IST, UL, Dezembro, 2021. **Supervisors:** Edgar Fernandes, Filipe Quintino.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/565303595502907>

Bruno Miguel Grosso Marques Ferreira, **Gestão Automática de Iluminação em Salas de Aula do IST**, IST, Universidade de Lisboa, Outubro 2021. **Supervisor:** Carlos Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344874>

Carlos Manuel De Bastos Ribeiro, **Análise Numérica e Experimental de Bombas Ejetoras para sistemas de queima com Metano e Hidrogénio**, IST, UL, Outubro 2021. **Supervisor:** Edgar Caetano Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344869>

Carlos Miguel Da Rocha Lourenço, **Promoção de Medidas de Eficiência Energética em Dormitórios Académicos**, IST, UL, **Supervisor:** Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1691203502344863>

Carmen Margarida Fernandes Machado, **Renovation Passport towards a Near Zero Energy Building**, IST, UL, Janeiro 2021. **Supervisor:** Paulo Ferrão

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1128253548922352>

Carolina Sofia Carvalho Ribeiro Belga, **Desempenho Energético, Ambiental e Económico para Deslocações Urbanas Multimodais em Diferentes Gamas de Distância**, IST, UL. **Supervisors:** Patricia Baptista, Gonçalo Duarte.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1691203502344861>

Catarina Semedo, **O impacto das tecnologias de automação no emprego: o caso dos serviços**, IST, UL, Setembro 2021. **Supervisor:** Miguel Preto.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/846778572213489>

Daniel Joaquim Fernandes, **Techno-economic and environmental assessment of Portugal's potential to produce and upgrade biogas from anaerobic digestion of manure**, IST, UL, Dezembro, 2021. **Supervisor:** Edgar Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1972678479055096>

Daniela Oliveira Silva, **Industrial and Laboratory Processing of Spent Li-ion Batteries for Efficient Materials Recovery**, Mestrado Integrado Engenharia de Materiais (IST). **Supervisors:** Fernanda Margarido e Carlos Nogueira.

<https://fenix.tecnico.ulisboa.pt/cursos/mem/dissertacao/1128253548922855>

David Carreira Martins, **Impacts of EV transition in municipal fleet**, IST, UL, Outubro 2021. **Supervisors:** Patrícia Baptista, Catarina Rolim.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344140>

Diogo Filipe de Deus Vozzone, **Flashback and Blowoff Stability Analysis of Hydrogen Enriched Natural Gas using Bunsen Flames**, IST, UL, Outubro 2021. **Supervisor:** Edgar Caetano Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344871>

Diogo Manuel Gervásio de Almeida, **Effect of Different Wall Materials in Thermoelectric Electricity Production**, IST, UL, Outubro 2021. **Supervisors:** Edgar Caetano Fernandes, Sandra Dias.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344870>

Duarte Morais das Neves Franco, **Additive Manufacturing as an alternative to traditional technologies in the ongoing Manufacturing Paradigms**, IST, UL, Janeiro, 2021. **Supervisors:** Paulo Miguel Nogueira Peças, Afonso Soares Branco Cardoso do Amaral

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/846778572212951>

Duarte Pinto Ascensão Pardal Monteiro, **100% Renewable Energy System for the Autonomous Region of Madeira in 2050**, IST, UL, Janeiro 2021. **Supervisor:** Carlos Augusto Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1128253548922335>

Ewa Pazdur, **Transition Towards Carbon Free Electricity - Developing CO2 Emission Assessment Software For Corporate Use**, IST, UL. **Supervisor:** Carlos Augusto Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1691203502344864>

Francisca Duarte Ferreira, **Techno-economic assessment on energy conversion systems for the Pulp and Paper and Metallurgical industries**, IST, UL, Dezembro 2021. **Supervisor:** Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344718>

Francisco João Martins Sequeira, **Innovation in services: how different from innovation in manufacturing?**, IST, UL, Setembro 2021. **Supervisor:** Miguel Preto.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/1972678479055225>

Francisco Maria da Silva Passos Moita, **Can Small Firms Be the Leaders of Innovation? Finding the Determinants of Product and Process Innovation**, IST, UL, Janeiro 2021. **Supervisor:** Hugo Castro Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/1128253548922206>

Francisco Mendes Veiga, **Metals Recovery from Spent Li-ion Batteries by Hydrometallurgy**, Mestrado Integrado Engenharia de Materiais (IST). **Supervisors:** Fernanda Margarido e Carlos Nogueira.

<https://fenix.tecnico.ulisboa.pt/cursos/mem/dissertacao/1128253548922921>

Francisco Miguel Belchior Calado da Silva, **Analysis of fat droplets dynamics in water columns**, IST, UL, Dezembro 2021. **Supervisors:** Edgar Fernandes, Sandra Dias

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1972678479055105>

Francisco Xavier Penha Gonçalves Belmar da Costa, **Design and modelling of renewable energy communities as tool for low-carbon energy systems**, IST, UL, Outubro 2021. **Supervisors:** Patrícia Baptista, Diana Neves.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344098>

Gonçalo Costa, **Avaliação do potencial do uso de hidrogénio verde para fornecer serviços de sistema ao sistema eléctrico nacional**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, **Supervisors:** Diana Neves, Carlos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344807>

Gonçalo Nuno Fernandes Madeira, **CH₄+H₂ Flame stabilization using direct current (DC) electric fields**, IST, UL, Dezembro 2021. **Supervisors:** Edgar Fernandes, Sandra Dias

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1128253548922704>

Guilherme da Silveira Ribeiro Bruges Armas, **Experimental and computational evaluation of the thermohydraulic performance of compact, gravity-driven, closed-loop thermosyphon cooling systems**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** António Luís Moreira.

<https://fenix.tecnico.ulisboa.pt/cursos/meq/dissertacao/1128253548922249>

Inês Gonçalves de Brito Fernandes, **Avaliação de medidas de eficiência energética numa frota de transportes coletivos urbanos**, IST, UL, Janeiro 2021. **Supervisors:** Patrícia Baptista, Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/283828618790540>

Javier Pollos Ezquerro, **Analysing the competitiveness of offshore -wind production models**, IST, UL, Janeiro 2021. **Supervisor:** Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1972678479054934>

Joana Dias Fonseca, **The Vanadium Redox Flow Battery - Electrochemical Impedance Characterization**, IST, UL, Janeiro 2021. **Supervisor:** Rui costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1972678479054940>

Joana Nunes Nicolau Baptista da Silva, **Cooperative and interactive Learning to estimate Human Behaviours for Energy Applications**, IST, UL, Setembro 2021. **Supervisor:** Carlos Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1691203502344138>

João Afonso Vicente Silva, **Estudo paramétrico de otimização da geometria de tubos corrugados com fluidos complexos para maximização da transmissão de calor em escoamentos internos**, IST, UL, Dezembro 2021. **Supervisors:** Ana Moita, António Luís Moreira.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344115>

João De Matos Espadinha, **Assessing the value proposition of P2P energy markets for decarbonization by 2050**, IST, UL. **Supervisors:** Diana Neves, Patrícia Baptista.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344761>

João Pedro Madeira da Silva, **Value co-creation and innovation: the case of Portuguese firms**, IST, UL, Janeiro 2021. **Supervisors:** Miguel Preto, Hugo Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/846778572213006>

João Pedro Nunes Marques, **Avaliação energética de soluções de mobilidade alternativas numa frota de distribuição postal**, IST, UL, Outubro 2021. **Supervisor:** Patrícia Baptista.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344866>

Jóni André Santo Bernardo, **Plataforma de gestão de Energia para Edifícios do Exército**, IST, UL, Março 2021. **Supervisor:** Carlos Augusto Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/846778572212931>

José Francisco Proença Mendes, **Técnicas de Pós-processamento de imagem para métodos experimentais em termografia**, IST, UL, Dezembro 2021. **Supervisor:** Ana Sofia Moita.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/565303595502914>

José Pedro Rocha Maia, **Portugal's Energy System in 2050: The Role of Transportation**, IST, Universidade de Lisboa, Janeiro 2021. **Supervisor:** Carlos Augusto Santos Silva.

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Karan Ramesh Narayan, **-Powered Long-Distance Transportation for Portugal**, IST, UL, Janeiro 2021. **Supervisors:** Rui Costa Neto, Paulo Ferrão.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/846778572212854>

Karolina Elżbieta Serafin, **Optimization of the Electrical and Thermal Microgrids for a nearly Zero-Energy Building located in Lisbon**, IST, UL. **Supervisor:** Carlos Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1691203502344129>

Lidia Garcia Garcia, **Development of an energy management model for a heating and cooling microgrid in a public building**, IST, UL, Janeiro 202. **Supervisor:** Carlos Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1128253548922334>

Luiz Fernando Teixeira da Silveira, **European Potential of Solar Technologies for Electricity Generation under Project Drawdown Framework**, IST, UL, Janeiro 2021. **Supervisor:** Carlos Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1691203502344223>

Manuel Bruno da Costa Coimbra Fernandes, **The Impact of Macroeconomic Shocks on Global Supply Chains**, IST, UL, Janeiro 2021. **Supervisor:** Hugo Castro Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/846778572212755>

Marcello Avanzini, **Unveiling the social costs of fuel poverty in Lisbon public housing**, IST, UL, Janeiro 2021. **Supervisor:** Ricardo Gomes.

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Marcos Diogo de Almeida Freitas de Araújo, **Relationship between marketing innovation and other innovation types: an empirical analysis of Portuguese firms**, IST, UL, Janeiro 2021. **Supervisor:** Miguel Preto.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/846778572213009>

Marek Utracki, **Modeling thermal comfort in residential buildings in Portugal**, IST, UL. **Supervisors:** Carlos Santos Silva, Ricardo Gomes.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1691203502344137>

María Lauroba Cebrián, **Feasibility assessment of distribution**, IST, UL, Outubro 2021. **Supervisor:** Edgar Caetano Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/283828618790724>

Maria Oliveira Dias, **Análise termodinâmica a uma central geotérmica**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, Janeiro 2021. **Supervisor:** Edgar Caetano Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/846778572212796>

Maria Teresa Tavares Louro Correia Ramalho, **Impacte energético e económico de medidas de eficiência energética numa frota de veículos pesados de mercadorias**, IST, UL, Janeiro 2021. **Supervisors:** Rui Costa Neto, Patrícia Baptista.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344226>

Mário João Carvalho de Pinto Balsemão, **Definição de Estratégias Para Produção e Consumo de Combustíveis Sustentáveis Para a Aviação em Portugal**, IST, UL, Outubro 2021. **Supervisor:** Paulo Ferrão.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1128253548923065>

Michał Jan Rabiej, **Design of solar cooling system**, IST, UL, Junho 2021. **Supervisor:** Carlos Santos Silva

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/1409728525633131>

Miguel Patrik Jyllilä Sanches, **Characterization of heat transfer in nanofluid spray cooling of a solid heated surface**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, Janeiro 2021. **Supervisors:** Ana Sofia Moita, António Luís Moreira.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/846778572212835>

Miguel Varela Pereira da Costa, **Optimal Location of Public Charging Stations for Electric Vehicles: A Model Based on Vehicle Travel Patterns**, IST, Universidade de Lisboa, Janeiro 2021. **Supervisor:** Carlos Augusto Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344224>

Nuno Almeida, **Modelling high-education buildings: A top-down modelling approach to disaggregate end-uses**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, **Supervisors:** Diana Neves, Carlos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344808>

Patrícia Alexandra Varela Pinto, **Modelling and experimental validation of an alkaline electrolysis cell for production**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, Janeiro 2021. **Supervisors:** Ana Moita, Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/846778572212872>

Pedro Filipe Caldeira Rosa, **Assessment of the potential deployment of energy communities based on GIS approach**, IST, UL, Dezembro 2021. **Supervisors:** Diana Neves, Patrícia Baptista.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344751>

Pedro Miguel Que Ye, **CH₄ + H₂ Flames Anchored on Perforated Plates A Thermoacoustic Analysis**, IST, UL, Dezembro 2021. **Supervisor:** Edgar Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1691203502344747>

Rafael Prata Afonso, **Life-cycle assessment of material and end-of-life scenarios for passenger cars**, IST, UL, Outubro 2021. **Supervisors:** Patrícia Baptista, Fernanda Margarido.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1128253548922426>

Ricardo Cortinhas Rita Santos, **The Impact of Alumina Nanofluids on Pool Boiling Performance**, IST, UL, Outubro 2021. **Supervisors:** António Luís Moreira, Ana Moita.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/565303595502760>

Ricardo João Capote Coelho, **Otimização energética de uma unidade hospitalar**, IST, UL, Janeiro 2021. **Supervisors:** Rui Costa Neto, António Luís Moreira.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/283828618790541>

Ricardo Júlio Ruas Pessoa Dinis, **Promotion of Energy Efficiency Measures in SIBS Forward Payment Solutions**, IST, UL, Janeiro 2021. **Supervisors:** António Luís Moreira, Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/283828618790539>

Ricardo Matias Moreno, **Análise energética e modelação técnico-económica da integração de painéis fotovoltaicos numa plantação em estufa no Baixo Alentejo**, IST, UL, Outubro 2021. **Supervisors:** Carlos Augusto Santos Silva, Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1409728525632962>

Ricardo Oliveira, **Implementing blockchain technology for P2P energy trading and evaluation on users' adoption on energy communities**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, **Supervisors:** Diana Neves, Catarina Rolim.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/565303595502905>

Rodrigo Miguel Vaz dos Santos, **Eco-innovation determinants in Portuguese companies**, IST, UL, Setembro 2021. **Supervisor:** Miguel Preto.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/1972678479055171>

Rúben Alexandre Páscoa Ezequiel, **Caracterização experimental da transferência de calor em escoamento interno para misturas de água e etilenoglicol**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, Janeiro 2021. **Supervisors:** Ana Moita, António Luís Moreira.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/846778572212836>

Salomé Cunha Costa, **Introduction of Mycelium-Based Composites in the Portuguese Industry**, Mestrado Integrado Engenharia e Gestão Industrial. **Supervisor:** Fernanda Margarido.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/1128253548922975>

Surya Venkatesh Pandiyan, **NILM Methods for low-frequency smart meter data**, IST, UL. **Supervisor:** Carlos Santos Silva

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/283828618790529>

Vasco Aires Barros Monteiro, **The Role of Absorptive Capacity in the Relationship Between Different Cooperation Partners and Innovation**, IST, UL, Setembro 2021. **Supervisor:** Miguel Preto.

<https://fenix.tecnico.ulisboa.pt/cursos/megi/dissertacao/846778572213369>

Xavier Calvão Borges Antunes Ferreira, **Phase Change Materials in a Hybrid Solar Thermal/Photovoltaic Energy Storage System for a Residential House**, IST, Universidade de Lisboa, Janeiro 2021. **Supervisors:** Carlos Augusto Santos Silva, Rui Costa Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec/dissertacao/1409728525632963>

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Ana Beatriz Soares Mendes, **Integrated Energy management systems of thermal and power networks in buildings**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 24/06/2022. **Supervisor:** Carlos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503575>

António Gonçalves, **Utilização do CEA na Gestão de Energia dos Edifícios do Exército Caso de Estudo: Aquartelamento da Academia Militar da Amadora**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisors:** Carlos Santos Silva

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/1128253548923294>

Bárbara Pereira Oliveira, **Energy efficiency measures for a NZEB single family household**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 24/06/2022. **Supervisor:**

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503576>

Beatriz Caeiro Rosa Carrasco, **Energy impacts of alternative scenarios for adopting electric mobility at the building scale**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisors:** Patrícia Baptista, Ricardo Gomes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503351>

Candela Marín Martínez, **WASTE TO FUELS PATHWAYS. A CASE STUDY OF WASTE TO HYDROGEN IN PORTUGAL**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 13/07/2022. **Supervisor:** Paulo Ferrão.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503627>

David Miguel Afonso Santos, **Retrofitting of an Off-Road Capable Passenger Vehicle with a Hydrogen-Electric Powertrain**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** Patrícia Baptista.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572214051>

David Silva Carvalho, **Study of the geometry of microchannels based heat sinks to cool high-concentrated photovoltaic cells**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 29/06/2022. **Supervisor:** António Luís Moreira.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503569>

Diogo Bezold Rosner Fragoso, **Increasing RES penetration through H₂ technologies on Flores island, Azores: a techno-economic analysis**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** Edgar Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/1128253548923138>

Duarte Miguel Niza Meira Jesus, **Metodologia para avaliação dos efeitos da degradação de fluido arrefecedor em permutadores de calor para automóveis**. **Supervisors:** Antonio Moreira, Ana Moita.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/1128253548923191>

Eduardo Maria Soares Rodrigues, **Interchangeability Analysis of a Domestic Cooktop Burner**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 06/07/2022. **Supervisor:** Edgar Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572214336>

Francisco Leite Garcia da Cruz Morais, **Forecasting energy prices using machine learning**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** Carlos Santos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503398>

Francisco Pereira Courela, **Assessing building envelope retrofitting solutions according to extreme events response**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisors:** Carlos Silva, Ricardo Robles.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572214089>

Gonçalo Santos Lucas Camões Gato, **Design of a Solar Cavity Absorber for a Calcium-Looping Fluidised Bed Calcination Reactor**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** Carlos Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572214101>

Inês Alves Silvestre, **Power Losses in Natural Gas and Hydrogen Transmission in the Portuguese High-pressure Network**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** Rui C. Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503187>

Irene Mansó Borràs, **Using urban building energy simulation tools and geographic information systems to define energy communities**, MSc in Industrial Engineering, University of Valencia, 07/09/2022. **Supervisors:** Ricardo Gomes, Diana Neves.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572214096>

Iva Andrea Alvarinho Gonçalves, **Escoamento Multifásico em Microcanais: Estudo para aplicação a um sistema de refrigeração de painéis fotovoltaicos de alta concentração**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 29/06/2022. **Supervisor:** António Luís Moreira.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503572>

Joana Alexandra Costa Faria, **Green Hydrogen and Oxygen Developments in Portuguese Economy in the Context of Vehicle Refuelling Stations**, MSc in Engineering and Energy Management, IST, Universidade de Lisboa, 07/07/2022. **Supervisor:** Rui C. Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/565303595503607>

João David Ferreira da Silva e Sá, **A Study on the Influence of Variable Geometry Evaporators in Organic Rankine Cycle Waste Heat Recovery of a Heavy-Duty Truck**. **Supervisors:** Duarte Valerio, Ana Moita.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/1972678479055475>

José Maria Falcão Trigo Vacas de Carvalho, **Análise do potencial energético de sistemas de carregamento wireless para veículos elétricos**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisors:** Patrícia Baptista, Gonçalo Duarte.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503253>

Luís Miguel Barbosa Pires, **Energy Efficiency and Sustainability in Healthcare Diagnostics**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisors:** Carlos Augusto Silva.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572213627>

Maria Leonor Trindade de Oliveira Rodrigues Pereira, **Analysis of energy communities as means to reduce fuel poverty on social neighbourhood**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** Ricardo

Gomes. <https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/1972678479055395>

Mervyn Muthukumar, **Building energy simulation for assessing heating from co-generation hydrogen fuel cell**, MSc in Energy Engineering and Management, IST, Universidade de Lisboa. **Supervisors:** Ricardo Gomes, Rui Costa Neto. <https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/846778572214062>

Miguel Alexandre Sobral Piçarra, **Life-cycle assessment of an electric passenger vehicle considering alternative materials, the use phase and end-of-life scenarios**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisors:** Patricia Baptista, Fernanda Margarido. <https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503075>

Miguel Constantino Carmo Sousa, **Smart Computer Cooling with Nanofluids**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 29/06/2022. **Supervisor:** António Luís Moreira. <https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572214288>

Paula Sofia Ferreira Cunha, **Parametric Design of an End-winding Cooling Method for a Permanent Magnet Synchronous Motor**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 14/10/2022. **Supervisor:** António Luís Moreira. <https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503840>

Pedro Alexandre Arieira Lima, **Reabilitação de edifícios devolutos: impacto energético nos edifícios e em mobilidade**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** Patrícia Baptista, Ricardo Gomes. <https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503352>

Pedro Gil de Lima Mayer Beltrão, **Feasibility of Hydrogen Production**, MSc in Engineering and Energy Management, IST, Universidade de Lisboa, 11/07/2022. **Supervisor:** Edgar Fernandes. <https://fenix.tecnico.ulisboa.pt/cursos/mege/dissertacao/565303595503610>

Pedro Manuel Machado Venceslau, **Estratégias para reabilitação de um edifício visando um balanço energético nulo: aplicação a um caso de estudo**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 06/07/2022. **Supervisor:** Paulo Ferrão, Ricardo Gomes. <https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595502856>

Ricardo da Silva Ribeiro, **Modelação de injeção de hidrogénio nas redes de distribuição de gás natural**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 06/07/2022. **Supervisor:** Edgar Fernandes. <https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503497>

Ricardo Jorge Falcão Santos, **Development of a combustion chamber for nanofuels**. **Supervisors:** Miguel Mendes, Ana Sofia Moita. <https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503603>

Tomás De Almeida Carvalho, **Modelling and experimental validation on gas-liquid separators, with application to an oxygen-water mixture from electrolyzer in a hydrogen production unit**, MSc in Mechanical Engineering, IST, Universidade de Lisboa. **Supervisor:** Rui C. Neto.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503642>

Tomás de Sousa Machado Mendes, **Nanofuel single droplet combustion**. **Supervisors:** Miguel Mendes e Ana Moita.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/565303595503589>

Vasco Duarte Caetano Deyrieux Centeno, **Hydrogen enriched Methane flames anchoring on a multi-hole burner**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 13/07/2022. **Supervisors:** Sandra Dias, Edgar Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572214337>

Vasco Van Mourik Guerra de Zoio Reis, **Modelling and experimental validation of an alkaline ammonia electrolysis cell for hydrogen production**, MSc in Mechanical Engineering, IST, Universidade de Lisboa, 27/06/2022. **Supervisors:** Rui Costa Neto, Edgar Fernandes.

<https://fenix.tecnico.ulisboa.pt/cursos/memec21/dissertacao/846778572214285>

ANNEX V – LIST OF PUBLICATIONS

Book Chapters

- Costa F.P., Silva C.A.S. (2021) **Urban Modeling and Analytics in a Smart Context**. In: Ploix S., Amayri M., Bouguila N. (eds) Towards Energy Smart Homes. Springer, Cham. https://doi.org/10.1007/978-3-030-76477-7_1
- Silva C.A.S., Amayri M., Basu K. (2021) **Characterization of Energy Demand and Energy Services Using Model-Based and Data-Driven Approaches**. In: Ploix S., Amayri M., Bouguila N. (eds) Towards Energy Smart Homes. Springer, Cham. DOI: https://doi.org/10.1007/978-3-030-76477-7_7

International Journals

2021

- A. Gamboa, L.M. Marques, E.C. Fernandes, **Electric Field Assisted Mass Production of Carbon Nanotubes on 303L Stainless Steel**, Diamond and Related Materials, 2021, 108274, ISSN 0925-9635. <https://doi.org/10.1016/j.diamond.2021.108274>
- Abrantes, B.F., Preto, M.T. and António, N. (2021), "**Toward a dynamic capabilities' diffusion model for international business headway of SMEs: evidence from the metallurgic and metal-mechanic (MMI) sectors**", Review of International Business and Strategy, Vol. ahead-of-print No. ahead-of-print. <https://doi.org/10.1108/RIBS-10-2020-0125>
- Afonso Amaral, Paulo Peças, **SMEs and Industry 4.0: Two case studies of digitalization for a smoother integration**, Computers in Industry, Volume 125, 2021. <https://doi.org/10.1016/j.compind.2020.103333>
- Alessandro Giordano, H. Scott Matthews, Patrícia Baptista, Paul Fischbeck, **Impacts of topography and weather barriers on commercial cargo bicycle energy using urban delivery crowdsourced cycling data**, Sustainable Cities and Society, 2021, 103326, ISSN 2210-6707. <https://doi.org/10.1016/j.scs.2021.103326>
- Amaral A, Peças P. A **Framework for Assessing Manufacturing SMEs Industry 4.0 Maturity**. Applied Sciences. 2021; 11(13):6127. <https://doi.org/10.3390/app11136127>
- Ana Oliveira, António Lopes, Ezequiel Correia, Samuel Niza, Amílcar Soares, **An urban climate-based empirical model to predict present and future patterns of the Urban Thermal Signal**, Science of The Total Environment, Volume 790, 2021. <https://doi.org/10.1016/j.scitotenv.2021.147710>
- Ana Sofia Cabeça, Carla Oliveira Henriques, José Rui Figueira, Carlos S. Silva, **A multicriteria classification approach for assessing the current governance capacities on energy efficiency in the European Union**, Energy Policy, Volume 148, Part A, 2021. <https://doi.org/10.1016/j.enpol.2020.111946>

- Barbón, A., Ayuso, P. F., Bayón, L., & Silva, C. A. (2021). **A comparative study between racking systems for photovoltaic power systems**. Renewable Energy, 180, 424-437. <https://doi.org/10.1016/j.renene.2021.08.065>
- Benjamin Meindl, Néstor Fabián Ayala, Joana Mendonça, Alejandro G. Frank, **The four smarts of Industry 4.0: Evolution of ten years of research and future perspectives**, Technological Forecasting and Social Change, Volume 168, 2021, 120784, ISSN 0040-1625. <https://doi.org/10.1016/j.techfore.2021.120784>
- Bot K, Aelenei L, Gonçalves H, Gomes MdG, Silva CS. **Performance Assessment of a Building-Integrated Photovoltaic Thermal System in a Mediterranean Climate—An Experimental Analysis Approach**. Energies. 2021; 14(8):2191. <https://doi.org/10.3390/en14082191>
- Brais Armiño Franco, Patrícia Baptista, Rui Costa Neto, Sofia Ganiilha, **Assessment of offloading pathways for wind-powered offshore production: Energy and economic analysis**, Applied Energy, Volume 286, 2021, 116553, ISSN 0306-2619 <https://doi.org/10.1016/j.apenergy.2021.116553>
- Brás, G. R. (2021). **Awarding PhD Powers to Polytechnics: An Academic Trap?** SAGE Open <https://doi.org/10.1177/21582440211020743>
- Brás, G.R. and Dowley, K.M. (2021), "**Impact of demographic, political and financial factors on municipal transparency: a dynamic panel approach**", International Journal of Public Sector Management, Vol. 34 No. 2, pp. 101-117. <https://doi.org/10.1108/IJPSM-11-2019-0289>
- Brás, G.R., Preto, M.T., Daniel, A.D., Teixeira, A.A.C., **Dimensions of the Entrepreneurial University and its Role in The Perception of Regional Competitiveness** [Dimensões da Universidade Empreendedora e o Seu Papel na Perceção de Competitividade Regional1] (2021) Revista Portuguesa de Estudos Regionais, (58), pp. 29-47. <https://www.scopus.com/inward/record.uri?eid=2-s2.0-85107689077&partnerID=40&md5=5963162dab8d3668087ddf4607f1d6bf>
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International Conferences

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Pontes P., Moita, A. S., and Moreira, A. L. N., ***Design Optimization Of Microchannel Geometry Using A Genetic Algorithm Parallel With Openfoam***, Proceedings of the 15th International Conference On Heat Transfer, Fluid Mechanics And Thermodynamics - Applied Thermal Engineering, HEFAT, 26 July, PP. 1054-1059, ISBN 978-1-77592-216-2.

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Hugo Castro Silva, "***Juggling Product and Process Innovation: The role of firm size in Innovation Performance***" DRUID21, Copenhagen, Denmark, October 18-20, 2021.

Pedro Pontes, Lourenco Martins, Iva Goncalves, Ana S. Moita, Antonio L. N. Moreira, "***Thermographical study of geometry and phase change influence on PDMS Microchannel liquid cooling devices***", 18th edition of the European Thermal Sciences Conference, EURO THERM2021, 19-23 September, 2021, Lisbon, Portugal

Tatiana Bruce da Silva, "***The use of alternative fuels to mitigate climate change impacts in the transportation sector in Rio de Janeiro, Brazil***", The 24th Euro Working Group on transportation meeting, EWGT21, 8-10 of September 2021, Virtual Event.

Hugo Castro Silva, "***The Struggle of Small Firms to Retain High-Skill Workers: Job Duration and the Importance of Knowledge Intensity***", INFER 2021, 23rd Annual Conference, 8-10 of September 2021, Lisbon, Portugal.

Patricia Baptista, "***Assessment of EV Powertrain Performance with Integrated PV***", PV in Motion 2021, Conference & Exhibition on Solutions for Vehicle Integration, 6-8 December, Virtual.

Paulo Ferrão, ***Research on Renewable Energies in Portugal***, World Renewable Energy Congress, Lisbon, 26-20 July 2021

Diogo Gonçalves, Rui Costa Neto, José Marques, Paula Figueiredo, Paula Carreira, Maria Orquídia Neves, ***Ground Source Heat Pumps (GSHP) in heating and climatization of the Military Academy (Portugal): Amadora Quartering case study***, World Renewable Energy Congress, Lisbon, 26-30 July 2021

Karol Bot, Laura Aelenei, Maria da Glória Gomes, Carlos Santos Silva, ***Building Integrated Solar Energy Systems (BI-SES) for façades – a literature review***, World Renewable Energy Congress, Lisbon, 26-30 July 2021.

2022

Diana Neves, Patricia Baptista, Pedro Rosa, "***Development of an assessment tool for improving energy communities' deployment***", World Sustainable Energy Days, Wels, Austria, 6-8 April 2022 (Oral).

Gonçalo Araújo, Ricardo Gomes, António Leitão, Luís Santos "***AD-Based Surrogate Models for Simulation and Optimization of Large Urban Areas***", 27th International Conference of the Association for Computer-Aided Architectural Design Research in Asia, CAADRIA 2022, Post Carbon, 9 -15 April 2022, Sydney, Australia (on-line).

Paulo Ferrão, "***The role of Buildings Digital Twin Models in Designing Carbon Neutral Cities***", CIAR 2022, LNEC, 5 de maio, 2022 (oral).

I. Silva, Bruno Gouveia, A. Azevedo, Edgar Fernandes, Elizabeth Duarte, "***A synchronized methodology to understand the environmental advantages of sewage ...***", 5th South East European conference on sustainable development of energy, water and environment systems, Vlore, Albania, 22-26 May 2022 (Oral).

David Martins, Catarina Rolim, Gonçalo Duarte, Patricia Baptista, "***The role of municipalities in the adoption of electric mobility: case study from Lisbon, Portugal***", EVS35 Symposium, Oslo, Norway, June 11-15, 2022.

Patricia, Baptista, "***Assessing EV energy consumption of real world trips based on origin and destination: proof-of-concept in Lisbon, Portugal***" EVS35 Symposium, Oslo, Norway, June 11-15, 2022.

Fernandes, Joana Bastos; Ferrão, Paulo Cadete; Silvestre, José Dinis; Costa, António Aguiar; GÖSWEIN, Verena, "***Advancing Circular Economy in the Existing Building Stock: a methodology to support building characterisation for sustainable refurbishment design***", Central Europe towards Sustainable Building 2022, CESB22, Praga, Republica Checa, July 4 -6, 2022.

Pontes, P., Gonçalves, I., Moreira, A.L.N., Moita, A.S., "***Bubble Dynamics and Heat Transfer in Microchannel Flow Boiling: Detailed Study on Bubble Dynamics under Controlled Bubbly Flow Conditions***", 16Th International Conference on Heat Transfer, Fluid Mechanics and Thermodynamics and the editorial board of applied Thermal Engineering, HEFAT-ATE 2022, Amsterdam, Países Baixos, August 8-10, 2022. (on-line).

Cunha, Sónia, Ferrão, P. 14th ISIE SEM Conference, "***Transforming socio-economic metabolism in times of multiple crises***", Vienna, Austria, 19-21 September 2022.

Carlos Santos Silva, "***Smart energy management in netzero energy buildings: case study in Lisbon Portugal***", World Renewable Energy Congress XXI, WREC2022, Murdoch University, Perth, Australia, 4-9 December.

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Mendes, T. S. M., Ferrão, I. A., Mendes, M. A. A., Moita, A. S., Silva, A. R. R. (2022) ***The impact of high particles concentration in a biofuel droplet combustion***. 31st Conference on Liquid Atomization and Spray Systems, 6-8 September 2022 (Virtual Conference).

Moita, A.S., Quinto, L., Lucena, R., Antunes, W., Moreno, L., Pontes, P., Moreira, A.L.N. (2022) ***Thermal management of CBRN equipment using PDMS microchannels based heat sinks with nanofluids***, 3rd WORLD CONFERENCE ON ADVANCED MATERIALS FOR DEFENSE, AUXDEFENSE 2022, 6-8 July, Guimarães, Portugal (and online).

Coutinho, G., Rossi, M., Moita, A.S., Moreira, A.L.N. (2022) ***3D particle tracking velocimetry applied to platelet-size particles in red blood cells suspensions flows through squared microchannels***. 20th

International Symposium on Applications of Laser and Imaging Techniques to Fluid Mechanics, 11-14 July, Lisbon, Portugal.

Gonçalves, I.M., Pinho, D., Zille, A., Kaji, H., Minas, G., Lima, R., Sousa, P., Moita, A. (2022) ***A simple method to modify the PDMS surface wettability for biomicrofluidic applications***. 20th International Symposium on Applications of Laser and Imaging Techniques to Fluid Mechanics, 11-14 July, Lisbon, Portugal.

Sanches, M., Moita, A.S. O. H., Panão, M. R. O. (2022) ***Potential contamination of high-speed dental handpiece by spray impact on the mouth surface***. 20th International Symposium on Applications of Laser and Imaging Techniques to Fluid Mechanics, 11-14 July, Lisbon, Portugal.

Ferrão, I., Mendes, M. A. A., Moita, A. S. O. H., Silva, A. R. R. (2022) ***Experimental investigation of disruptive burning phenomena on nanofuel droplets***. 20th International Symposium on Applications of Laser and Imaging Techniques to Fluid Mechanics, 11-14 July, Lisbon, Portugal.

Moita, A.S., Gonçalves, I., Varelas, J., Moreira, A. L. N., Lima, R. (2022) ***Biomimetic fluid flow in microchannels with complex geometries***. 9th Word Congress in Biomechanics, 10-14 July 2022, Taipei, Taiwan (and online).

Carvalho, V., Gonçalves, I., Rodrigues, R. O., Sousa, P., Moita, A., Minas, G., Teixeira, S., Lima, R. A. (2022) ***Visualization of a blood analogue flowing in an organ-on-a-chip platform***. 9th Word Congress in Biomechanics, 10-14 July 2022, Taipei, Taiwan (and online).

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Moita, A., Gonçalves, I., Varelas, J., Lima, R., Moreira, A. L. (2022) ***Fluid flow of biomimetic fluids in complex microchannels for microcirculation studies***. IX International Conference on Computational Bioengineering – ICCB 2022, 11-13 April, 2022, Lisbon, Portugal.

Gonçalves, I., Madureira, M., Miranda, J., Schutte, H., Moita, A. S., Minas, G., Grassmann, S. Lima, R. (2022) ***Separation microfluidic devices fabricated by different milling processes***. 15th International Conference on Biomedical Electronics and Devices, BIODEVICES 2022, 9-11 February 2022 (Virtual conference).

National Conferences

2022

- Patrícia Baptista, Helena Monteiro, Maria Gonçalves, Fernanda Margarido, António Moreira, "**Portugal Autocluster for the future**", GET2022, Portuguese Research Group in Mobility and Transportation, Porto, 4th March (Oral).
- Catarina Rolim, Patricia Baptista, "**Sharing Cities: Analysis of the impacts of EV transition in the Lisbon Municipal Fleet**", GET2022, Portuguese Research Group in Mobility and Transportation, Porto, 4th March (Oral).
- Rui Costa Neto, **Em busca de Eficiência - Combustíveis alternativos e fontes de energia (Painel)**, Air Summit, Aerodromo de Ponte de Sor, 12-15 October.
- Fernandes, M., Mendes, M. A. A., Moita, A.S. Moita, A.S. (2022) **Sistema de arrefecimento corporal no uso de fatos de protecção nuclear, biológica, química e radiológica - NBQR**. 4º Encontro de I&D em Ciências Militares. Academia da Força Aérea, 16 Novembro 2022.
- Moita, A.S., Torres, J., Quinto, L., Chambel, E., Pontes, P., Moreira, A.L.N. (2022) **Sistema de arrefecimento da componente eletrónica e baterias em veículos militares não tripulados**. 4º Encontro de I&D em Ciências Militares. Academia da Força Aérea, 16 Novembro 2022.
- Moita, A.S., Quinto, L., Lucena, R., Antunes, W., Moreno, L., Pontes, P., Moreira, A.L.N. (2022) **Thermal management of CBRN equipment using microchannels based heat sink**. International Society of Military Sciences ISMS Conference, 10-13 October 2022.
- Nobrega, G.T.V., Barbosa, F.M., Soares, F., Palha, R., Souza, R., Ribeiro, J.E.P., Moita, A.S., Lima, R. (2022) **Cooling performance of an acrylic serpentine with a rectangular cross section**. Submitted to be presented at the International Workshop on Additive Manufacturing and STEAM Education IWAM, 30th September, Braga, Portugal (and online).
- Camilo, F., Moita, A. S., Quinto, L., Chambel, E. (2022) **Development of a modular thermal management system for CBRN equipment by additive manufacturing using stereolithography**. International Workshop on Additive Manufacturing and STEAM Education IWAM, 30th September, Braga, Portugal (online).
- Gomes, J., Chambel, E., Machado, C., Quinto, L., Moita, A.S., (2022) **Desenvolvimento de uma mascara de protecção individual de baixo custo por estereolitografia**. International Workshop on Additive Manufacturing and STEAM Education IWAM, 30th September, Braga, Portugal (online).
- Gonçalves, I. M., Pinho, D., Zille, A., Kaji, H., Minas, G., Lima, R., Sousa, P. C., Moita, A. (2022) **A simple method to modify the wettability of the PDMS surface for biomedical applications**. International Workshop on Additive Manufacturing and STEAM Education IWAM, 30th September, Braga, Portugal (and online).

