



UTAustin
Portugal

Charting Future Impact

REPORT FROM THE UT AUSTIN PORTUGAL 2024 COLLOQUIUM



Austin, Texas, September 10-11, 2024

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Executive Summary

The UT Austin Portugal 2024 Colloquium (Colloquium) was held on September 10-11, 2024 in Austin, Texas. More than ninety researchers from UT Austin and several academic institutions, research centers and laboratories, and companies in Portugal gathered in Austin to identify and map out future collaborative research opportunities and intellectual, human capital, economic, and social impacts in four broad areas – Clean Energy, Nanotechnologies, Advanced Computing, and Earth and Space – that will best prepare their respective communities to meet future societal challenges. Representatives from FCT's other two international partnerships, MIT Portugal and CMU Portugal, as well as industry professionals with projects funded by the program, were also invited to participate. (See Appendix for a full list of participants).

This Colloquium is novel in the history of the UT Austin Portugal program in that it engaged the research community to help identify areas of importance to them and to Portugal. With an eye toward impacting and advancing societal, human capital, and economic gains; informed by the UT Austin Portugal Program's network of researchers, programs, and synergies to advance human capital development; and leveraging the unique and complementary capabilities of the partners, the experts focused on four areas of science and technology:

- Addressing climate neutrality through **clean energy**.
- Scaling tools for energy-efficient **advanced computing**.
- Advancing critical materials discovery through **nanotechnology** advancements.
- Exploiting **space** technology and data for applications on **earth**.

Participants were asked to identify questions in each of the four areas important to Portugal's research and economic priorities, where leveraging

dual investment and expertise would uniquely advance scientific and technical understanding, education, and the translation of ideas into practice.

UT Austin researchers saw value in collaborating with Portugal. Specifically, access to common problems (e.g., use of hydrogen, need for AI tools), complementary, interesting, and different challenges (e.g., how to generate and store hydrogen), as well as Portugal's position as an influencer in the EU, which extends the impact of the collaboration. The trust, built over years of experience, allows us to make bold decisions, tackle complex challenges, and quickly move ideas from the lab to real-world applications.

Within the **clean energy** area, three research topics should be prioritized: future energy networks, industrial greening, and climate neutral smart cities. These initiatives have been selected to address critical aspects of the energy transition while aligning with Portugal's strategic priorities. Each Research Priority Topics (RPT) will serve as a framework for more specific actions within its domain, with the aim of prototyping and validating solutions using Portugal as a testbed. To achieve this, open data will need to be made available, leveraging the vast amounts of energy-related data available in the country, while respecting the confidentiality requirements established by law. The Portuguese Energy Living Lab will become a premier space for students to conduct research and develop their theses, as well as a testing ground for startups to test their innovative ideas. This environment will attract both national and international talent, further promoting the concept of Portugal as a "Clean Tech Startup Nation".

Advanced computing and the use of data are critical to all areas of research and society. In the coming years, as industry races to advance AI technology, the research community's desire to use these tools will place increasing pressure on and demand for computing and data resources. UT Austin and Portugal have leading computing and data centers in the Texas Advanced Computing Center (TACC) and the Minho Advanced Computing Center

(MACC). Compute and data centers are huge consumers of energy, putting pressure on power grids. AI algorithms are computationally intensive. Therefore, energy-efficient tools are needed to address some of the increased energy demands. To improve the use and efficiency of MACC and TACC's key partnership facilities for their users, this thrust will focus on greener, more efficient and sustainable AI tools, adapting AI workflows and models for specific industry applications and Public Administration, or exploiting future computing paradigms. In addition to building tools for more efficient use of infrastructure, this collaboration will focus on the need to build the human capacity to harness these new technologies and computing paradigms.

There are significant opportunities to **accelerate materials discovery and the rational design of new critical materials**, particularly in battery technology, semiconductors (e.g. packaging), green hydrogen, and smart textiles. This challenge requires combining nanotechnology knowledge from many fields, including atomistic and molecular materials, structure-property characterization, device fabrication, artificial intelligence and machine learning (AI/ML), and advanced robotics. In addition, progress requires state-of-the-art facilities for fabricating and testing materials and devices, and for running AI/ML models. The combined modeling and experimental programs play to the strengths of researchers and facilities at UT Austin and in Portugal. Further, advances in these areas could position Portugal as a leader in renewable energy technologies, advanced electronics manufacturing, and innovative textiles, fostering long-term economic and industrial growth.

Exploiting and improving **space- and airborne-based observations, sensors, and technologies**, and using, processing and making available the data produced, can help decision makers and the public understand and intervene in the earth-based management of our national resources. Integrated urban resilience models play a critical role in this effort, using real-time data from space and airborne sources to simulate and analyze urban climate impacts, predict vulnerabilities, and strengthen climate adaptation strategies. These

tools enable targeted interventions to protect critical infrastructure, enhance public safety, and support urban planning initiatives to mitigate risks from wildfires, coastal flooding and erosion, and extreme weather events to ensure sustainable development in a changing climate. Opportunities abound in the advancement of terrestrial applications (including decision support tools/digital twins) enabled by space-based observations and sensing, technologies for obtaining solutions from space-based systems, and technologies for enabling space activities and engineering operations.

Colloquium participants identified facilities, expertise, and programs at both UT Austin and Portugal that could be leveraged through collaborations to make progress in these four areas. One example is the H2@UT research cluster, with its H2@Scale demonstration project to develop a first-of-its-kind hydrogen technology proto-hub; with an additional \$1.2 billion [Department of Energy \(DOE\) grant](#), in November 2024, for the creation of a Texas-based hydrogen hub – the Gulf Coast Hydrogen hub, led by HyVelocity. This will be an invaluable asset in advancing the goals of green industries, a Portuguese priority. A second example is the collaboration with TACC, the largest academic supercomputing center in the world, to address critical issues to improve facilities at both TACC and MAAC in Portugal for more effective use of new AI methods for materials discovery by researchers, e.g. for batteries, fuel cells, solar cells, etc.

Participants noted the need to move ideas more quickly from the laboratory to the marketplace. UT has several programs, such as hosting the NSF Innovation Corps (I-Corps) Southwest Region Hub and the Austin Technology Incubator, and many relationships with industry that could be transferred/adapted to ensure a healthy entrepreneurial ecosystem in Portugal for new ideas and to engage newly trained researchers from these collaborations.

Finally, a critical element for future collaborations identified by participants is the trust in the UT Austin Portugal Program partnership that allows for difficult

decisions to be made in support of the broader program. This trust, along with the exciting ideas across four focus areas and concrete collaborations, all with one institution, is an outstanding foundation for the future of this excellent inter-institutional and international collaboration.

This report captures the directions and rationale that emerged from the exciting and engaging discussions. It also highlights the higher-level, mutually beneficial linkages that these collaborations can leverage to make deep and lasting advances in human knowledge, student enrichment, and economic benefit for both partners. These collaborations will help position Portugal within the European Union as a leader in research innovation, entrepreneurship and human capital development. This report will help the research community define high-impact collaborative research projects. We also hope that this report can assist the program's primary sponsor in making policy decisions regarding the future of the UT Austin Portugal program and the other FCT international partnerships as a whole.



Figure 1 - Peter Stone opening the Program's colloquium

1. The Report

From the outset, the event was designed to be a participatory and community-based exercise, with the organizers asking participants to identify areas of focus within these four areas that leveraged and aligned with the unique strengths and priority investments of both UT Austin and Portugal, where collaboration could accelerate progress or produce results that could not be achieved without collaboration. On the first day, participants were divided into smaller teams to brainstorm the future through a series of open-ended questions with the help of facilitators from UT Austin and Portugal; on the second day, they were asked to present and discuss their conclusions and proposals with a broader audience. Two roundtables with leading experts from both sides were formed to discuss how the program continues to transform

and impact Portugal and the transatlantic relationship (considering both US and EU agendas).



Figure 2 - Portuguese delegates on a tour of Texas Inventionworks

This report captures the directions and rationales that emerged from these exciting and engaging discussions. It also highlights the higher-level, mutually beneficial linkages that these collaborations can leverage to make deep and lasting advances in human knowledge, student enrichment, and economic benefit for both partners. This report is intended to inform the broader community of researchers in Portugal and at UT about the opportunities for collaborative research. We also hope that this report can assist the program's primary sponsor in making policy decisions regarding the future of the UT

Austin Portugal program and the other FCT international partnerships as a whole.



Figure 3 - Helena Braga (University of Porto) speaking at the Mulva Auditorium

2. Vision Statement

To contribute to a knowledge-based society and to promote science- and innovation-based companies so that Portugal can better face the challenges of the future.



Figure 4 - Shannon Strank, UT Austin, interacting with other delegates

3. Why Now

Climate, energy and the environment are inextricably linked. Today's society faces a tipping point in climate change and needs secure and sustainable energy for future generations and to drive economic prosperity. Meeting these needs will require scientific advances and transformative industries. There are now unique opportunities to leverage investment and infrastructure across the Portuguese and UT Austin ecosystems to address societal challenges in energy, materials, computing, and earth and space. In addition to advancing our understanding and creating approaches and technologies to address these challenges, additional needs include the development of:

- Human capital, with experience and a new mindset, a new way of thinking about the future;

- Industries and entrepreneurial start-ups to transition technologies into society and provide avenues for human capital to continue their careers in Portugal.

The recent report, *The Future of European Competitiveness*, calls out the innovation gap between the EU and the US and China in areas of advanced technologies and calls for a plan for decarbonization and competitiveness. Portugal is positioned to be an example in key areas of competitiveness, innovation, and decarbonization. A partnership between UT Austin and researchers and entrepreneurs across Portugal in the areas highlighted in this report can assist Portugal in becoming an example for Europe. It can also contribute towards the strengthening of the long-standing alliance between the US and the EU, which finds expression expressions in many forms of joint initiatives and engagements, of which the renewed US-EU Science and Technology Agreement is a prime example.¹ The priorities or areas of common interest identified in this agreement, ranging from information and communication technologies to the environment (including climate research), non-nuclear energy, biomedicine and health, materials sciences and metrology, to name a few, provide an opportunity to deepen transatlantic cooperation for the benefit not only of the US and the EU, but also of the world.

¹ [https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:21998A1022\(01\)](https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:21998A1022(01))



Figure 5 - Paulo Ferrão, IST, at the Mulva Auditorium

4. Why UT Austin and Why Texas

Over the years of the partnership, collaborations with UT researchers have provided access to unique laboratory facilities, enabling testing and prototyping that would otherwise be unavailable to Portuguese researchers (e.g., Texas Advanced Computer Center, Oden Institute for Computational Engineering and Science, and Texas Materials Institute). In addition, working with researchers in Texas has accelerated the progress of joint collaborations through experience (e.g., ANI awards in space). Perhaps more importantly, it has exposed students to different research experiences and cultures. It has also allowed leaders of small and medium-sized enterprises (SMEs) to interact with US researchers, a unique opportunity in the Portuguese research environment.



Figure 6 - Networking moment outside the Mulva Auditorium

In the summaries of the research areas (below), the research value for collaborating with UT is presented. A common theme is UT Austin's investments in labs and infrastructure in areas important to the Portuguese research community. In particular, several of these facilities are at a scale not available at other universities (e.g., [H2@Scale](#), a hydrogen technology protohub R&D facility with multiple forms of renewable hydrogen generation and end users; Horizon, the largest academic supercomputer dedicated to open scientific research; Texas Institute for Electronics, a national center of excellence in 3D heterogeneous integration featuring an open-access R&D and prototyping fabrication facility). Also, UT provides, in one institution, the expertise to engage each of the areas and in ways to strengthen the ties between the areas.



Figure 7 - Paula Vilarinho, University of Aveiro, and Helena Braga, University of Porto, at the H2@Scale demonstration facility (J.J. Pickle Research Campus, UT Austin)

Texas is the [undisputed](#) leading US state in energy production. In 2021, the state provided nearly one-fourth of US domestic produced energy.² Not only is it the top producer of oil and natural gas in the nation, Texas also produces

² US Energy Information Administration, State Energy Data System, Primary energy production – total energy consumption comparison (Last visited Aug. 21, 2023.)

more electricity than any other state in the US “During the past decade, Texas’ fuel mix has changed considerably as renewables have proliferated and more transmission lines bring electricity from remote wind and solar farms to urban market centers”. Home of leading renewable energy companies such as E.ON Climate & Renewables N.A., NextEra Energy Resources, Invenergy, Lincoln Clean Energy, Apex Clean Energy, Pioneer Green Energy, SunChase Power, RES Americas, EDF Renewable Energy, and Tri Global Energy, Texas clean energy business is flourishing. According to the [2023 US Energy and Employment Report](#), Texas accounted for 22% of wind energy generation, and 17% of solar energy production. Currently Texas produces about 26% of all US wind-powered electricity generation, the most of any state. Looking at the decades ahead, data from Texas 2036’s [Future of Texas Energy](#) scenario models suggest that this transition trend to clean energy has an opportunity to continue.

Complementary to this growth in clean energy activity in the state, there are a number of large-scale programs being developed at UT Austin that may be of relevance to the present and future of the UT Austin Portugal program. For instance, in the clean energy technology area, led by the [Energy Institute](#), the [H2@UT](#) research cluster was created with the “mission to help enable a hydrogen economy”, with participants across campus. Also in the hydrogen field, the [H2@Scale](#) demonstration project is developing a first-of-its-kind hydrogen technology proto-hub with multiple forms of renewable hydrogen generation and end users. Just last year, in 2023, UT Austin became a major part of a large-scale award from the Department of Energy, a \$1.2 billion program dedicated to creating a hydrogen hub, HyVelocity. Also recently, UT received a substantial award from the Electrified Processes for Industry without Carbon (EPICX) Institute to lead research and development in electrification for industrial processes to decarbonize some of the more energy-intensive parts of the US economy.



Figure 8 - Brian Korgel, UT Austin, and João A. Peças Lopes, University of Porto, presenting the vision for Clean Energy at the Mulva Auditorium

In the nanotechnology area, UT Austin's research contributions are vast and diverse. Among several other examples is the progress in the use of nanotechnology for the microelectronics industry and how that has evolved over the years. For many years UT Austin led a program funded by the National Science Foundation (NSF) that developed an engineering research center called [NASCENT](#). This center developed techniques that enabled UT Austin – as part of the growth enabled by the [CHIPS and Science Act](#) – to receive over \$500 million in the state of Texas to build a facility to devise next-generation chips via three-dimensional heterogeneous integration (3DHI), a semiconductor fabrication technology that integrates diverse materials and components into microsystems using precision assembly technologies. This led to the foundation of the [Texas Institute for Electronics](#) (TIE), which in July

2024 was awarded a \$840 million [grant](#) from [DARPA](#) over the next five years to innovate in this space. This is the single largest grant in the University of Texas System awarded to a single school. Again, the scale of UT Austin's capabilities in nanotechnology is extremely ambitious, as the university aims to leapfrog the technology of advanced packaging in the microelectronics industry in a way that gives the United States a chance to get back to a strong position in this important area of industry, where currently it only comprises 3% of worldwide production. Additionally, by working closely with industry through Austin-based companies such as Silicon Labs, ARM, Applied Materials, and Samsung Semiconductor, UT Austin aims to really move these capabilities forward. And the impact of these developments in nanotechnology will enable critical impacts in energy, electronics, computing, and many other important fields.



Figure 9 - Dmitri Petrovykh, INL, speaking at the Mulva Auditorium

In advanced computing, another field where UT Austin is a powerhouse, we've witnessed huge evolution of systems at the [Texas Advanced Computing Center \(TACC\)](#), the largest and most capable academic supercomputing center in the world. The Frontera system came online in the recent past as the number one academic supercomputer in the United States, and has now been complemented by Vista, which is a more AI-forward computational system. But it does not stop here, as TACC is currently developing a next-generation system – Horizon – which is the next large-scale Track 1 machine³ for US academic research, which will come online in about two years (more details [here](#)). AI occupies such an important position at UT Austin that President Hartzell has declared 2024 as the “[Year of AI](#)”. The University is therefore an integral part of the national AI and research infrastructure and has been making major investments in developing not only hardware but also software for AI research. The [Institute for the Foundations of Machine Learning](#), the [Machine Learning Laboratory and its Center for Generative AI](#), for example, are key partners in the pursuit of advancing the basic research in artificial intelligence and machine learning. TACC has been a major player in the UT Austin Portugal program over many years, which is a unique and differentiating asset of this partnership.

³ A Track 1 supercomputer is a classification that refers to the fastest and most powerful supercomputers in the world, specifically those capable of achieving performance levels in the range of 1 exaFLOPS (one quintillion floating-point operations per second) or higher. This category represents a significant milestone in high-performance computing, marking the transition to exascale computing.



Figure 10 - Dan Stanzione, TACC, and Rui Oliveira, UT Austin Portugal, presenting the main takeaways of the session on Advanced Computing

Texas is home to several leading earth-space initiatives. For instance, located in Houston, [the Johnson Space Center](#) is considered “The Hub of Human Spaceflight”, as it is the home of mission control and astronaut training. Also in Texas is the headquarters of [SpaceX](#) (Space Exploration Technologies Corp.) in Brownsville, along with the Starbase launch site in Boca Chica, and the Rocket Development and Test Facility in McGregor. Another example is [Firefly Aerospace](#), an Austin-based end-to-end space transportation company. The research and business capabilities in Texas are immense, and UT Austin plays a significant role in producing knowledge and training professionals in the field of science and engineering for space and earth observation (see the [Center for Space Research](#), the [Department of Aerospace Engineering and Engineering Mechanics](#), the [Institute of Geophysics](#), the [Oden Institute](#), and the [Jackson School of Geosciences](#), just to name a few).



Figure 11 - Presentation of the Earth-Space group's vision by Ana Pires, INESC TEC, and Srinivas Bettadpur, UT Austin

This combination of laboratory investments, often on a scale that is unparalleled and valuable for practical application, of all disciplines at one institution, and of integration and interaction across disciplines, represents a unique opportunity for Portuguese researchers. Finally, broad-based research initiatives and faculty-led research programs helped UT Austin exceed \$1 billion in research expenditures for 2023, demonstrating that the infrastructure and ecosystem for research scholarship and discovery at the highest level are in place and available to support partnership initiatives.



Figure 12 - Delegates taking notes on Day 2 at the Mulva Auditorium

5. Why Portugal

“What starts here changes the world,” proclaimed across the UT Austin campus, guides UT and helps it prioritize investments. UT welcomes partnerships with academic institutions, local and state governments, and start-ups to established industries to broaden the research and discovery beyond its campus. International partnerships help it expand that impact globally.

Portugal originally approached UT Austin to collaborate in building Portuguese human capital. The nearly eighteen years of mutually beneficial collaborations have established and grown trust between the partners. Thanks to this robust and enduring partnership, Portugal has come a long way (please refer to the section *The Foundation for Realizing UT Austin Portugal Vision and Goals Beyond 2024*).

Portugal's increasing strengths in research and innovation and its prominent role in EU priority initiatives such as decarbonization or the development of a European HPC supercomputer network make it a natural partner of UT Austin and a country from which Europe can draw inspiration when it comes to fostering (successful) long-term knowledge-based international cooperation.

Looking ahead, UT sees commonality and complementarity with many Portuguese challenges (e.g., complementarity in hydrocarbon-based energy: abundance in one and scarcity in another, with a common goal of increasing renewable energy; commonality in issues of coastal erosion, fires, drought, and natural disasters). In addition, Portugal is seen as a bridge to Europe, as demonstrated in advanced computing through a transfer of equipment that leveraged EU funding, literally putting Portugal on the EU computing map and demonstrating UT Austin's commitment to research and innovation as embodied in its official motto, "What Starts Here Changes the World". UT values this trusted relationship, the alignment of priorities, and the Portuguese ability and willingness to expand joint collaborations.

Therefore, the program can provide a complementary pathway for Portugal, through close collaboration with UT Austin, to successfully achieve its goals of decarbonizing the economy and society, contributing to the mitigation and prevention of climate change, enabling the inclusive and trusted digital empowerment of society, thereby accelerating the country's rise in the European digitalization ranking and economic growth and societal prosperity.



Figure 13 - Teresa Ponce Leão, LNEG, commenting on the Clean Energy group's presentation at the Mulva Auditorium

6. Key Opportunity Areas

The colloquium participants explored four broad areas. Three of these areas – Nanotechnologies, Advanced Computing, and Space & Earth – are part of the current UT Austin Portugal Program. A fourth area, Clean Energy, emerged from more than two years of deliberate discussions with the scientific project leaders, the community at the program's annual conferences, and the external review committee.

And why these areas?

Let's start with a focus on nanotechnology and advanced computing. As Key Enabling Technologies (KETs), they cut across a wide range of application areas and have the potential to address societal challenges, from fighting cancer to tackling climate change. In the green energy transition, for example, nanomaterials are paving the way for a new generation of batteries with the

potential to accelerate a climate-neutral future. Similarly, as we move toward more powerful supercomputing in modern economies, we need to accelerate innovation to make computing more sustainable and, therefore, less energy-intensive. Advancing computing power without compromising the green transition is one of the challenges the program could address, building on its legacy of collaboration and success, and leveraging its talent pool and advanced research infrastructures.

Nanotechnologies is a long-standing area of the program. Introduced in 2013 as an emerging technology, it was intended to advance a collaborative vision in nanotechnology research, education and training, and to explore common interests in technology commercialization. In Phase 3, it established itself as the area with the highest number of applications and funded research projects and exchanges, with promising results for sectors ranging from health to energy. In terms of advanced computing, the program's ongoing collaboration with UT Austin's Texas Advanced Computing Center (TACC) has been instrumental in placing Portugal at the forefront of research and innovation in the European HPC landscape. The \$1 million BOB supercomputer donated to Portugal by TACC under the umbrella of UT Austin Portugal consisted of twenty Stampede 1 racks, including 20 cabinets and 40 nodes. Stampede 1 was one of the most powerful machines in the world for open science research, operated by TACC between 2013 and 2018. The BOB system, which allowed Portugal to join the European High-Performance Computing Joint Undertaking and host Deucalion, a world-class EuroHPC green supercomputer, has so far provided more than 34 million CPU hours to more than 300 Portuguese research groups from 37 institutions. This even more powerful (and green) supercomputer (Deucalion) is expected to push the limits of Portugal's computing capabilities.

Although Space-Interactions was only added to the Program in 2018, the groundwork for turning it into a core scientific area started years before, when

UT Austin Center for Space Research (CSR) and UT El Paso led a joint feasibility assessment study on creating a spaceport in the Azores islands. With the view to promoting synergies across scientific areas as much as possible, the Space-Earth area can primarily benefit from research cooperation with Nanotechnologies and Advanced Computing and will contribute to the vision of the US and the EU – and therefore of Portugal – of an “Atlantic Ocean that is healthy, resilient, clean, safe, transparent, predictable, productive, understood and treasure to promote the well-being, prosperity and security of present and future generations through the sustainable exploration of its living and no-living resources.”⁴

Clean energy emerged as a potential focus for the program almost two years ago. It has grown to the status of a key area because of the Portuguese efforts and strategic interest on green hydrogen and the batteries value chain (e.g. New Generation Storage, NGS). Not only is clean energy a critical research and innovation area, but two main arguments for a Program’s focus, unique contributions, and involvement in this area are to (1) draw on the connections, human capital, and trust that the program has successfully built over the years in advanced computing, nanotechnology, and earth and space, and (2) mobilize complementary expertise and research infrastructures and societal goals at UT Austin and in Portugal.

The US and Europe are working together at the diplomatic level to build a just and clean energy future, focusing on developing and promoting green technologies, diversifying energy supplies, and increasing energy security. Portugal stands out in the European landscape as a leading country in the transition to clean energy, especially through the integration of electricity from renewable sources. In fact, under the theme "Energy", hydrogen has emerged as a convergent topic between UT Austin and Portugal, more specifically. Hydrogen is an integral part of Portugal's overall energy transition strategy. The

⁴ https://ec.europa.eu/info/research-and-innovation/strategy/strategy-2020-2024/europe-world/international-cooperation/united-states_en

dedicated approach to hydrogen reflects a vision to create an H2 ecosystem, from research and innovation to production and infrastructure scale-up, that will contribute to decarbonization and climate change mitigation. Likewise, UT and Texas are well-positioned to take advantage of the hydrogen push: the state is experiencing a surge in renewable energy deployment; it has energy expertise (arguably the energy university), world-class research institutions, abundant renewable energy, enough space for storage, and priority projects such as Texas's H2@Scale program - integrating commercial hydrogen production, distribution, storage, and use. One of the pilots includes providing clean, reliable power to the Texas Advanced Computing Center (TACC) and a feasibility study for scaling up hydrogen production and use at the Port of Houston. Of note, UT has declared 2025 the 'Year of Energy', which is another indicator that the University will prioritize initiatives in this area in the near future.

First, Clean Energy mobilizes complementary scientific competencies in Portugal and at UT Austin in areas such as sustainable energy systems, energy market modeling and simulation, advanced simulation of cyber-physical systems, and reliability analysis of energy systems. Second, the program's proposed framework - where education, research, and innovation support activities are intertwined - would allow both sides to combine their unique expertise and experience to contribute to making clean energy affordable, reliable, sustainable, and accessible to all, a goal that is at the forefront of several national and international cooperation agendas. In particular, UT Austin is uniquely positioned to be a partner in clean energy and hydrogen, due to its increasing use of renewable energy, outstanding energy expertise, world-class research institutions, abundant renewable energy, ample space for storage, and priority projects. Similarly, Portugal has played a leading role in the transition to clean energy, particularly in the integration of renewable electricity, and is one of the first countries in the world to set carbon neutrality targets for 2050.



Figure 14 - John Ekerdt, UT Austin Portugal, wrapping up the colloquium on Day 2

Out of the colloquium, some key opportunities emerged.

- Within nanomaterials science and technology, there are opportunities to advance the discovery of critical materials in areas of battery technology, semiconductors, and green hydrogen.
- Within the area of advanced computing, an opportunity identified is the scaling of tools for energy-efficient computing, for example, in greener, more sustainable AI tools focusing on efficiency and translational AI to other areas.
- And within Earth and Space, there is a critical need for a seamless integration of data acquire from different platforms and sensors to manage and model the flood of data into usable and management means to improve understanding, decision support and information

dissemination for the prevention of forest fires, coastal flooding and erosion, hazard mitigation, and climate change.

- Ocean and space technologies and data are significant and have high potential for monitoring the large Portuguese Exclusive Economic Zone.
- The area of clean energy sees a common challenge of climate neutrality, with foci on climate neutral cities, greening industry, and future energy systems.

Many more ideas are presented below in the section *Future Opportunity Research Areas*.

7. Goals of a Future Collaboration

The participants see numerous achievable goals from a collaboration between the Portuguese and UT Austin communities in these targeted areas. A few are listed here.

Research Impacts: Joint papers and external funding to

- Position Portugal as a global leader in clean energy research
- Provide more efficient and greener computational infrastructure
- Accelerate material discovery pipelines
- Utilize space-based systems to responsibly manage environmental factors impacting the human and natural condition

Education and Training: Produce the next generation of thought leaders in Portugal in each area

Public Literacy: Communicating the latest advances in clean energy technologies, and practical uses of space-based data to the people of Portugal

Economic Development: Innovate to catalyze the creation of new business opportunities in Portugal, either via start-up creation or entrepreneurship in established energy, materials, or computing companies or governments.



Figure 15 - Networking moment

8. The Foundation for Realizing UT Austin Portugal Vision and Goals Beyond 2024

To realize our vision, we start from a foundation of trust built and nurtured through shared experience. We need to go back nearly eighteen years to understand how far this partnership has come and why its path to date best positions it for the future.

When the partnership was created in 2007, the Portuguese government's primary goal was to expose Portuguese researchers to internationalization through regular collaboration with top US universities in areas where the country needed to develop talent and research-based companies. At the time, UT Austin was chosen for its unquestioned scientific expertise in digital media, advanced computing, applied mathematics, and technology transfer and entrepreneurship. The program's core areas have changed over the years to remain relevant to the nation's science-based challenges, leveraging UT Austin's strengths and thought leadership in areas such as nanotechnology and space and earth observation.

The first two phases, from 2007 to 2017, established connections between researchers on the UT Austin campus and throughout the Portuguese research community. These phases also established administrative mechanisms to successfully carry out the program's activities through coordination, research facilitation, education, and exchange. The research component focused on digital media, advanced computing, applied mathematics, and emerging technologies, areas considered strategic for Portuguese interests and of mutual interest to UT Austin, taking into account Portugal's unique assets, and with benefits for the participants, Portuguese society, and the world at large. As for the third phase (2018-present), the program aimed to build Portuguese intellectual capital through sustained international collaborations, through the implementation of joint exploratory and industry-led research projects capable of leveraging additional funding, even outside the program; research exchanges; and advanced training programs in targeted knowledge (research) areas of societal challenges: space-earth interactions, medical physics, nanotechnologies, and advanced computing.

Interestingly, but not surprisingly, much of the program's path coincides with the improvement of Portugal's technology balance of payments (BOP). Negative until 2007, the BOP has since followed an upward trend, growing from €750 million in 2015 to €1.3 billion in 2021 (equivalent to 0.6% of GDP), driven mainly by exports of information technology services (which will be worth around €3 billion in 2024). To some extent, this can be attributed to projects and initiatives undertaken as part of the FCT's international partnerships with US universities, of which the UT Austin Portugal program is a prime example. The significant growth in R&D spending in the business sector - up about 85% since 2015, and accounting for about 1% of GDP in 2021 (up from 0.58% in 2015) - can also be linked to some extent to the partnerships' industrial affiliation programs, with UT Austin focusing on digital media and emerging technologies.

Particularly impactful at the entrepreneurial and business levels has been the program's University Technology Transfer Network (UTEN) instrument, institutionally managed under the partnership with UT Austin, but also serving the other two partnerships. UTEN, a hallmark of the Program's commitment to science-based knowledge transfer and valorization, has had a profound and significant economic and social impact on Portugal through training and business development activities. In fact, UTEN's work has resulted in most Portuguese universities, associated laboratories and research institutions facilitating specialized technical support to promote science-based technology transfer and commercialization. In addition, thanks in large part to the program's innovation arm, Portugal has produced an outsized number of fast-growing startups and unicorns, such as Feedzai, Sword Health, or other emerging tech companies. As we chart future impacts, Portugal can continue to learn from Austin's emergence as a leading US hub for high-tech start-ups and giants to leverage, energize, and rapidly bring to market and society the results of the program's research investments, and to close the (still wide) gap between research produced in academia and the marketplace.

Through the last seventeen years, researchers and administrations of the UT Austin Portugal ecosystem have been working together to:

- Develop human capital,
- Create and accelerate research results,
- Establish infrastructure in Portugal,
- Enable the transition of results to new companies.

Furthermore, trust in this partnership has enabled:

- A community of minds with complementary resources,
- Rapid coalescing of teams to respond to opportunities,
- A track record in shortening the gap between research and innovation,
- Flexibility in responding to unanticipated challenges (often from budgets and Covid).

- Exploiting and creating new opportunities to advance the partnership beyond what was envisioned, for example, in the transfer of equipment from UT to Portugal that resulted in a successful EU award to enhance facilities at MACC.

Thus, not only will we succeed, but we will be sprinting from the start.



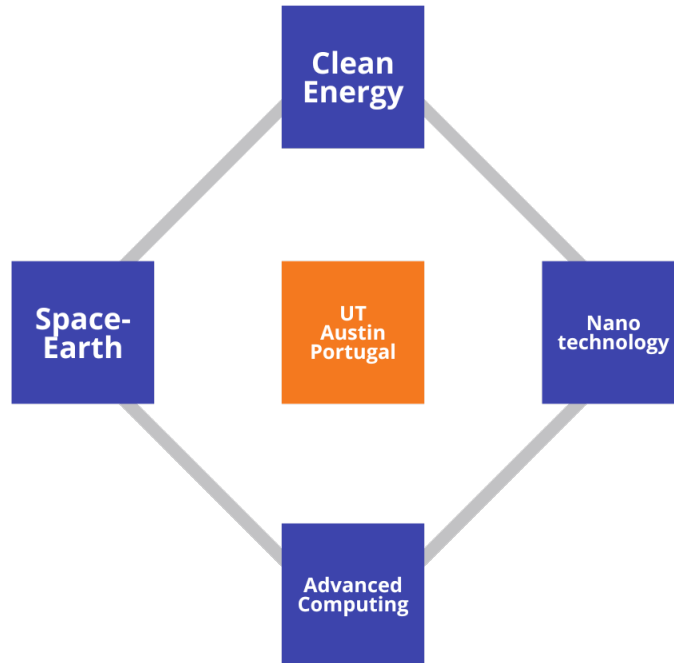
Figure 16 - Burke Fort, UT Austin, and José Manuel Mendonça, UT Austin Portugal, chatting at the end of Day 2

9. The Future Opportunity Research Areas

In this section, we reflect on the discussions of the four thematic breakout groups. Many ideas were discussed, reflecting a wide and deep pool of opportunities for partnerships between UT Austin and Portugal.

For each area, we provide a rationale for the focused themes, key challenges, specific reasons for UT Austin and Portugal to collaborate, and elaborate on a

specific research topic to support these themes. A more detailed presentation of the topics for four themes follows.



9.1. Clean Energy: Addressing Climate Neutrality

Summary

The world's demand for energy is growing - and it needs to be produced reliably and affordably, accessible to all, and used at scale. At the same time, greenhouse gas (GHG) emissions must be reduced to mitigate climate impacts, and industry, government and community leaders have made significant commitments and investments to transition away from carbon-intensive energy sources. Creating the availability of low carbon intensity (LCI) hydrogen is fundamental to achieving these environmental priorities and long-term energy sustainability for transportation, power and heat, agriculture, and

critically, industry. More than 30% of global greenhouse gas emissions are associated with industrial processes. This includes the production of chemicals, cement, steel, glass, ceramics: sectors with emissions that are difficult to reduce because they require processing at very high temperatures and the processes themselves (e.g. steel and cement production) generate significant GHG emissions. The combined use of process electrification with renewable energy and LCI hydrogen provides a roadmap for reducing GHG emissions associated with industrial processes. LCI hydrogen can also be used to significantly reduce emissions across the transportation sector, providing fuel for medium- and heavy-duty vehicles, heavy equipment, marine and air transportation modalities that are difficult to decarbonize through electrification alone.

At present, there are significant technological gaps in the large-scale production of clean hydrogen at a reasonable cost. New technologies are needed to achieve large-scale production, storage, transportation, and end-use of hydrogen, i.e., the entire hydrogen supply chain. The barriers to the emergence of a clean hydrogen economy range from fundamental knowledge gaps in chemistry and materials science, to pilot scale-up of laboratory-proven technologies, to commercial implementation of systems in the hydrogen supply chain at scale - combined with a poor understanding of the economic viability of these emerging technologies in the supply chain.

The UT Austin Portugal program has the potential to address fundamental knowledge gaps in the development of economically viable, large-scale hydrogen technologies. Through collaboration, researchers at UT Austin and in Portugal could develop a digital twin-enabled framework for analyzing, predicting, optimizing, and controlling a set of critical hydrogen systems to enable transformative engineering advances that would positively impact the entire hydrogen supply chain (i.e., the "engineered system"). This hydrogen supply chain could be considered an engineered system. UT Austin could use its unique Hydrogen Proto-Hub research facility as an at-scale research

testbed to develop and ultimately implement digital twins of hydrogen systems to significantly advance hydrogen-related technologies, such as the state of the art in catalysts, membranes, materials, process design, instrumentation, and fundamental engineering understanding of LCI hydrogen systems.

The UT Austin Portugal program could be a catalyst for large-scale deployment of LCI hydrogen infrastructure and electrification of industrial processes. This would stimulate regional economic development in Portugal and contribute to the emissions-related goals of both Portugal and the United States. In addition to the economic impact, the environmental and sustainability benefits would be enormous and global.

The development of a new LCI hydrogen market and manufacturing sector would lead to employment and training opportunities in the energy and manufacturing sectors throughout Portugal. The creation of digital twins for the hydrogen supply chain would help modernize more traditional industries such as steel, glass, and ceramics, which is essential for Portugal's continued economic competitiveness. These research efforts would position the UT Austin Portugal program to train the next generation of multidisciplinary, inclusive workforce to address the climate and sustainability challenges ahead in Portugal. Taken together, these initiatives are essential to ensure economic prosperity, energy sufficiency, and clean air and water, while strengthening Portugal's leadership in energy and manufacturing and creating new jobs.



Figure 17 - Clean Energy Session Room

Proposed Research Topics

The working group has identified Climate Neutrality as the grand challenge to tackle, given that:

- Europe has declared to become climate neutral by 2050 and the Biden Administration of the US has also set 2050 as a target for net zero emissions from the energy sector.
- These shared goals set the stage for a fruitful collaboration between UT Austin and the Portuguese research and innovation ecosystem.
- UT Austin and Portugal both have world-recognized research and education programs in clean energy.

Through these shared strengths and interests, the UT Austin Portugal program shall aim to help achieve this grand challenge of Climate Neutrality.

Furthermore, this partnership brings a unique framework to address the societal challenges facing Climate Neutrality:

- Portugal has become a global reference for how to decarbonize the energy sector, with nearly 65% of its electricity production coming from renewable energy sources. Very ambitious targets have been defined for the coming years, namely for 2030 where a global target of 51% for the share of renewable energy in gross final energy consumption was defined. To do so a reinforcement of the exploration of renewable energy potential between 2025 and 2030 is foreseen, with a focus on onshore/offshore solar and wind technologies (with an increase in onshore wind from 6.3 GW to 10.4 GW and the growth in offshore wind from 0.03 GW to 2 GW), and through the increase in solar power from 8.4 GW to 20.8 GW. By 2030, more than 80% of electricity consumption will be assured by renewable power sources. To stress that all this will happen simultaneously with a re-industrialization of the economy due to the new industries that are expected to be installed in Portugal (like H₂ and NH₃ plants, battery plants, green steel industries, data centers, etc.), taking profit of the potential of renewable and cheap electricity production that can be achieved. In addition to its deep commitment to the decarbonization of its economy, Portugal also brings a deep talent pool of faculty, researchers, students, practitioners and industry members in the energy field.
- UT Austin also has world-renowned research and education programs in energy and strong public-private partnerships with industry leaders in the energy sector. It will bring its full research capacity, student and faculty talent pool and pilot-scale lab infrastructure to provide new approaches and application-level research and development opportunities to students, faculty and practitioners in the UT Austin Portugal program.

- This partnership will leverage these unique and complementary strengths and translate them to the “living laboratory” settings of Portuguese industry, cities and communities.

Within the framework of “**Portugal as a Living Lab,**” the participants identified three Priority Research Topics (PRT) to prototype and validate solutions to address pivotal societal challenges:

PRT #1: Climate Neutral Cities

With a large proportion of the population (45%) living in cities (in Portugal), which produce a significant proportion of CO₂ emissions, understanding and managing demand will improve the health and livelihoods of the population and reduce emissions.

PRT #2: Greening the Industry

While Portugal has achieved incredible success in the overall use of renewable energy to produce electricity, this is not uniform across the economy, especially in the industrial sector. Several key industries (oil refining and petrochemicals, cement, glass, ceramics, iron and steel production) still emit large amounts of CO₂ and have specific needs for emission reduction, especially when they involve high temperature industrial processes (e.g. cement, glass, ceramics). In these "hard to abate" sectors, alternative approaches need to be explored, such as the electrification of process heating and the use of hydrogen.

PRT #3: Future Energy Networks & Systems

With energy demand projected to double in the next decade and the desire for a near-zero carbon energy system, ensuring that energy is clean, transported efficiently and available when needed is critical. This is essential for human health, economic prosperity and sustainable development. Ensuring reliable, resilient and secure energy systems is therefore paramount.



Figure 18 - Energy experts from UT Austin and Portugal working on a vision for the Clean Energy area under the Program

Collaboration synergies

For each PRT, a table is presented with a list of the most relevant research areas within each area, together with an identification of the competencies available at UT Austin and in Portuguese institutions, in order to show the synergies between the partners.

PRT #1: Climate Neutral Cities

Domains of Research	UT Austin	Portuguese Institutions
Energy Communities	Energy Institute, Civil Architectural & Environmental Engineering Department, Jackson School of Geosciences	INESC TEC, FEUP, INESC ID
Sensing/Sensors, IoT, Sensor Materials	Civil Architectural & Environmental Engineering Department, Texas Materials Institute, EPIXC, Energy Institute, Integrative Biology	INESC TEC, FEUP, IST, INESC MN
Embodied Carbon in Building Materials	School of Architecture, Civil Architectural & Environmental Engineering Department, Texas Materials Institute, EPIXC, O'Donnell Institute, Energy Institute	INEGI, FEUP, IST, LNEG
Territorial Needs & Matching Constraints	Jackson School of Geosciences, Petroleum & Geosystems Engineering Department, Energy Institute	INEGI, LNEG
Digital Twins of Buildings & Mobility	Energy Institute, O'Donnell Institute, Aerospace and Engineering Mechanics Department, Jackson School of Geosciences, Energy Institute	IST, INESC TEC, INESC ID
Coordinated Transportation & Logistics	Civil Architectural & Environmental Engineering Department, Electrical & Computer Engineering Department, Energy Institute	IST, FEUP, INEGI, INESC ID

PRT #2: Greening the Industry

Domains of Research	UT Austin	Portuguese Institutions
Hydrogen (Production, Transport & Use)	Center for Electromechanics, Bureau of Economic Geology, Energy Institute, Cockrell School of Engineering, Center for Electrochemistry	INESC TEC, INEGI, IST, FEUP, UTAD, LNEG
Electrification	EPIXC, Energy Institute, Electrical & Computer Engineering Department	INESC TEC, FEUP, IST, LNEG, INESC ID
Circularity & Value Chain Evaluation	Energy Institute, Jackson School of Geosciences, Mechanical Engineering Department, Operations Research and Industrial Engineering, LBJ School of Public Affairs, McCombs School of Business	INEGI, FEUP, IST, LNEG
Algae & Biofuels	Chemical Engineering, Energy Institute, UTEX Culture Collection of Algae, Dept of Molecular Biosciences	FEUP, IST, LNEG
Sustainable Aviation Fuels (SAFs)	Chemical Engineering Department, Center for Electromechanics, Energy Institute	IST, FEUP, LNEG

Domains of Research	UT Austin	Portuguese Institutions
High Temperature Applications (Ceramics, Glass, Cement, Steel)	EPIXC, Center for Electromechanics, Energy Institute, O'Donnell Institute	INEGI, FEUP; IST, LNEG
Fertilizer and Agriculture	Energy Institute, Jackson School of Geosciences	FEUP, IST, UTAD
Ammonia	Center for Electromechanics, Bureau of Economic Geology, Energy Institute, Mechanical Engineering Department	FEUP, IST, LNEG
Carbon capture combined with hydrogen (methane, methanol, etc.)	Bureau of Economic Geology, Chemical Engineering Department, Petroleum & Geosystems Engineering Department, Energy Institute	FEUP, IST, LNEG; UTAD
Critical minerals	Bureau of Economic Geology, Petroleum & Geosystems Engineering Department, Energy Institute, LBJ School of Public Affairs, Mechanical Engineering Department	FEUP, IST, LNEG
Thermal storage	Mechanical Engineering Department, Energy Institute	IST, LNEG

PRT #3: Future Energy Networks & Systems

Domains of Research	UT Austin	Portuguese Institutions
Risk Assessment for Future Power Systems	Energy Institute, Mechanical Engineering Department	INESC TEC, FEUP, IST, INESC ID
AI and IT in Energy Systems	O'Donnell Institute, Cockrell School of Engineering, Jackson School of Geosciences, College of Natural Sciences, Energy Institute	INESC TEC, FEUP, IST, INESC ID
Fast stability assessment and new solutions for stability improvement	Chemical Engineering Department, Energy Institute	INESC TEC, FEUP, IST, INESC ID
Security of Supply	LBJ School of Public Affairs, Cockrell School of Engineering, Energy Institute	FEUP, INESC TEC, IST, INESC ID
Sustainable Aviation Fuels (SAFs)	Chemical Engineering Department, Center for Electromechanics, Energy Institute	IST, FEUP, LNEG, INEGI, UTAD
Energy and Ancillary Service Markets	McCombs School of Business, Energy Institute, Operations Research and Industrial Engineering	INESC TEC, FEUP; IST, INESC ID
Renewable energy communities	Energy Institute, Civil Architectural and Environmental Engineering Department	INESC TEC, FEUP, IST,

Domains of Research	UT Austin	Portuguese Institutions
		UTAD, INESC ID
Storage systems	Cockrell School of Engineering, Bureau of Economic Geology Energy Institute	FEUP, IST, LNEG, INESC ID
Multi-energy systems	Energy Institute, Chemical Engineering Department, Mechanical Engineering Department	INESC TEC, FEUP, IST, LNEG, INESC ID
Sector coupling	Energy Institute	INESC TEC, FEUP, IST, UTAD, INESC ID
Managing flexibility	Chemical Engineering Department, EPIX, Energy Institute	INESC TEC, IST, INESC ID
Power Electronics	Electrical and Computer Engineering Department, Energy Institute	FEUP, IST; INESC TEC, INESC ID
GIS Mapping	Jackson School of Geosciences, Energy Institute	INESC TEC, INEGI, LNEG
Carbon Capture and Storage	Bureau of Economic Geology, Chemical Engineering Department, Petroleum & Geosystems Engineering Department, Energy Institute	INEGI, LNEG
Batteries	Cockrell School of Engineering, Center for Electrochemistry, Energy Institute	FEUP, IST, LNEG, INESC ID
Digital Twins	O'Donnell Institute, Aerospace and Engineering Mechanics Department, Energy Institute	INESC TEC, IST, INESC ID
Exploitation of geothermal resources	Petroleum & Geosystems Engineering Department, Bureau of Economic Geology, Energy Institute	LNEG
Planning the grid connection of data centers	Energy Institute	INESC TEC, INESC ID
Electric mobility	Civil Architectural & Environmental Engineering Department, Electrical & Computer Engineering Department, Energy Institute	INESC TEC, FEUP, IST, INESC ID
Offshore energies	Mechanical Engineering Department, Energy Institute	LNEG, INESC TEC, IST, FEUP

Additionally, the recently created [Iberian Energy Storage Research Center](#) (CIIAE) in Cáceres, Spain, is expected to become a major partner in these endeavors.



Figure 19 - Debrief session of the Clean Energy group

9.2. Nanotechnology: Advancing Materials Discovery

Summary

Within nanomaterials, there are significant opportunities for rapid discovery and rational design of new materials, particularly in battery technology, semiconductors, green hydrogen and smart textiles. In battery technology, nanomaterials can increase energy density, improve recharge cycles, and enable the development of solid-state batteries and alternative ion technologies such as sodium-ion batteries, which offer sustainable alternatives to lithium-based systems.

Fuel cells and electrolyzers are the underlying technologies for the green hydrogen energy vector. Nanomaterials are key enablers for more efficient and sustainable oxygen redox reactions, currently fully relying on expensive and scarce Platinum and Ruthenium.

In semiconductors, nanotechnology is opening the door to heterogeneous integration and more efficient semiconductor packaging, leading to smaller, faster and more energy-efficient devices - critical for applications in telecommunications, AI and high-performance computing. In green hydrogen, nanomaterials are playing a critical role in developing more efficient catalysts for hydrogen production, reducing reliance on rare earth metals, and improving the efficiency of electrolytic hydrogen production and storage.

Meanwhile, in smart textiles, nanotechnology can be used to create fabrics with embedded sensors, conductive fibers and responsive properties, opening up applications in wearable health monitoring, sports performance tracking, protective clothing and military applications. These advances could position Portugal as a leader in renewable energy technologies, advanced electronics manufacturing and innovative textiles, fostering long-term economic and industrial growth.



Figure 20 - José Manuel Mendonça, UT Austin Portugal, addressing the Nanotechnologies breakout group

Proposed Research Topics

To meet this challenge, advancing materials discovery requires combining knowledge from many fields, including atomistic and molecular materials, structure-property characterization, device fabrication, artificial intelligence and machine learning (AI/ML), and advanced robotics. In addition, state-of-the-art facilities for fabricating and testing materials and devices and for running AI/ML models are needed to make progress.

A unique advantage of partnering with UT Austin is its focus on rapid materials discovery, which brings together robotics, AI, and advanced characterization techniques in a single facility. Combined with machine learning (ML) and AI, robotics has immense potential to automate repetitive experiments and characterization processes, significantly reducing the need for human intervention. This integration can greatly accelerate the materials discovery process, improving both the speed and consistency of experimental results.

The working group identified five PRT with high potential for impact in nanotechnology:

PRT #1: Advanced batteries

From nanomaterials and structural design to the electrode and pouch cell level, including solid state and alternative ions to Li (e.g. Na). Battery designs can be "bespoke" with different chemistries, electrode configurations and packaging to meet the specific needs of various applications, from nano-devices and microelectronics to electromobility, smart textiles and large-scale grid storage.

In addition, there are opportunities to develop non-toxic, disposable or biodegradable battery technologies for use in small IoT devices and wearable electronics in textiles, emphasizing sustainability and recyclability in future battery innovations.

PRT #2: Green H₂ economy

By developing alternative nanocatalysis to reduce the use of rare earth materials in fuel cells and electrolyzers which is coupled to the robust operation of electrodes; and H₂ storage, especially high-density storage for mobile/decentralized applications.

PRT #3: Advanced environmental technologies

Water treatment: for example, the development of nanomaterials for membrane-based RO (reverse osmosis) and desalination (RO for high ionic conductivity and stability), or the recycling or upcycling of critical minerals.

Advanced sensing technologies that enable individuals and households to easily monitor water quality.

Technologies for separating oil and water to facilitate seawater cleaning following oil spills.

PRT #4: Semiconductor packaging

With the emergence of heterogeneous integration as a critical part of advanced semiconductor packaging, Portugal has a strong foundation on which to build. Expanding its role in this area, particularly in collaboration with leading companies such as Amkor and the renowned research capabilities at UT Austin, could position Portugal as a leader in specialized semiconductor packaging in Europe. To further develop its semiconductor packaging sector, Portugal would benefit from continued investment in R&D, workforce training and advanced manufacturing technologies. Collaboration with European and global partners could also help enhance the country's capabilities in this growing sector.

PRT #5: Smart textiles

Key players in Portugal, such as CITEVE, are exploring innovations in nanotechnology-enabled fabrics for applications in healthcare, sports and fashion. Smart textiles can incorporate functionalities such as sensors, moisture control, and temperature regulation, making them valuable for protective clothing as well as for wearable health monitoring and performance tracking.

While challenges remain, such as cost and seamless integration of electronics into fabrics, Portugal's focus on sustainability and

nanotechnology provides a unique opportunity to lead in this growing market. In addition, smart fabrics can be designed with energy-efficient wireless capabilities, combining advances in energy storage and semiconductor technologies.

Expanding collaborations with international partners could accelerate commercialization and solidify Portugal's role in high-tech textiles, especially in areas where energy, semiconductors and textiles intersect.



Figure 21 - Paula Vilarinho, University of Aveiro, and Helena Braga, University of Porto, participating in the Nanotechnologies breakout session

Collaboration synergies

A collaboration between researchers at UT Austin and Portugal will be able to take advantage of unique existing infrastructure, at scale, at UT Austin, the

expertise of the collaborators, and the opportunities provided by existing or growing industries in Portugal. Examples of infrastructure and facilities at UT Austin, many at a scale beyond a single laboratory, include:

- Battery manufacturing center (battery materials synthesis, large cell fabrication and assembly, in-line testing)
- Center for Electromechanics (testing of large-scale electrolyzers and fuel cells).
- Semiconductor packaging facility (in the Texas Institute of Electronics, TIE).
- DOD Microelectronics Manufacturing Center at TIE.
- Semiconductor nanofabrication (Microelectronics Research Center)—state-of-the-art lithography and etching technologies.
- Core nano-characterization facilities (Texas Materials Institute).
- High-performance computing for modelling using AI/ML (Texas Advanced Computer Center).
- Facility to help build autonomous machines (Texas Robotics Institute).

In Portugal, there are quite a few laboratories and university departments and research groups that are extremely competent in this field. For example, it is expected for the [International Iberian Nanotechnology Laboratory](#) (INL) to continue playing a leading role in this focus area of the program. Academic institutions such as the University of Aveiro and the New University of Lisbon host the largest Portuguese Associated Laboratories in the area of materials and nanomaterials (CICECO and i3N).

A collaboration between researchers at UT Austin and Portugal will take advantage of the unique existing infrastructure at UT Austin, the expertise of faculty at both UT and Portugal, and the opportunities presented by existing or growing industries in Portugal.



Figure 22 - Debrief session of the Nanotechnologies breakout group

9.3. Advanced Computing: Scaling tools for energy-efficient computing

Summary

The rapid adoption of artificial intelligence has created an unprecedented need for computing power. Organizations are using AI in multiple areas, from analyzing data to improving customer service, transforming technology, and driving innovation. The projected economic impact of the widespread use of AI by 2030 is estimated to exceed \$9-15 trillion, based on an analysis of various sectors and market trends.

To understand the scale of demand for these energy-intensive tasks, the International Energy Agency recently predicted that data centers will double their power consumption by 2026 compared to 2022, to more than 1,000 TWh, equivalent to Japan's annual electricity consumption and more than 20 times the consumption of Portugal.

Both energy and water consumption pose significant sustainability challenges for high-end computing, and the rate at which this resource consumption and environmental impact will grow in the coming years will depend on the pace of adoption, the range of efficiency improvements, and scientific breakthroughs.



Figure 23 - Advanced Computing breakout room

Proposed Research Topics

With sustainability in mind, the group has identified four PRT aimed at balancing performance and resource efficiency in high-end computing systems and applications:

PRT #1: Exploit low-precision hardware built for AI for scientific computing problems

AI-oriented hardware, such as GPUs and custom ASICs, is often designed for low-precision computations, which may be sufficient for many scientific computing tasks. When low-precision is not sufficient, participants agreed to look for effective and efficient applications by training low-precision models with high-precision data (surrogate models and preconditioners), optimizing algorithms through a sequence of low-precision operations for high-precision results, or using mixed-precision operators.

PRT #2: Greener, more efficient, and sustainable AI tools

Directly address the growing concern about the environmental impact of AI and large-scale computing. The general consensus of the group was to create more comprehensive benchmarks and measurements of AI products, improve algorithmic efficiency, and improve tools for deploying, scheduling, and using AI pipelines. Key topics include:

- Reducing energy consumption of AI workloads by developing greener algorithms and combining these with infrastructure-level optimizations for energy reduction, without affecting user experience.
- Making HPC infrastructures more cost-effective and energy-efficient by improving the usage and consolidation of HPC's computational, network, and storage resources through novel deployment, scheduling, and resource management tools.
- Building better benchmarking and monitoring tools that can realistically simulate distinct AI workloads (DL, LLMs)

and observe key metrics such as performance and resource consumption (including energy).

PRT #3: Translational AI Research

Bridging the gap between theoretical AI advances and practical applications in different domains by adapting AI workflows and models for specific industrial applications and public administration.

Particularly relevant were the discussions on how to handle large language models for Portuguese language applications, and the privacy, security, and compliance challenges of implementing AI in sensitive domains, as highlighted by the participants. Key topics include:

- Providing secure execution environments for companies to run their AI workloads while ensuring the privacy of datasets and models while at rest, in transit, and during execution.
- Enhancing security guarantees for critical data stored at HPC infrastructures against common threats (e.g., data leakage, ransomware).

PRT #4: Future Computing Paradigms

Explore new technologies and methods that can transform the high-end computing environment. For example, combine quantum and neuromorphic devices with traditional supercomputers, test RISC V-based AI accelerators, and create and improve algorithms and new applications to meet the growing needs of AI and scientific applications.

Collaboration Synergies

From the foregoing, Sustainable Advanced Computing, which focuses on advancing efficient large-scale computing for artificial intelligence and scientific discovery, emerged as a natural, overarching challenge for the participants in this discussion group. At scale, the technologies for AI and traditional high-end scientific computing are indistinguishable, and the latter has been an area of major impact for the program since its inception:

- The Minho Advanced Computing Center was recently established in Portugal, with the advent of “BOB”, a supercomputer built with a donation from TACC at UT Austin.
- Based on the success of BOB, the MACC won funding for the current supercomputer “Deucalion” through the EU Joint Undertaking in High Performance Computing (20M).
- The BigHPC project has been focused on the development of scalable system software tools with the company WaveCom in Portugal.
- Funding in Quantum Ray Tracing from Intel sprang from the collaboration of TACC and Luis Peixoto Dos Santos (which included funding for multiple summers in Austin)
- Though interrupted by the pandemic, 13 students in Advanced Computing spent a semester in Austin at TACC.

It is therefore expected that this research area will build on the existing close collaboration between the Texas Advanced Computing Center and the Minho Advanced Computing Center (Deucalion), involving researchers from across Portugal and UT Austin.



Figure 24 - Nuno Castro, University of Minho & LIP, speaking at the Advanced Computing breakout room

9.4. Space-Earth: Exploiting Satellite Technology and Data for Earth Applications

Summary

The Space-Earth Interaction (SEI) Theme encompassed a range of interdisciplinary topics, including the exploration of space, the use of space-based solutions, and Earth observation techniques. The working group concluded that the primary objective of this Theme should be the use of Earth-based applications and interests to address challenges on Earth in the context of space exploration.

The importance of the Portuguese space and marine economy was extensively discussed, as well as the issue of commercialization. From the initial discovery phase to the marketplace, this issue was reflected in the discussions and how

an initiative called "UT Austin PT Booster" could facilitate the transition of technology to the marketplace, thereby increasing the impact of the program. Discussion also included the creation of a "UT-PT WebPortal" that would facilitate the dissemination of information and allow investigators to connect with experts in relevant fields.

It is important to note that the potential overlap between the different thematic areas is not coincidental. Rather, they are inherently interrelated.

A review of the future opportunities for these research areas reveals a common need for advanced energy solutions, nanotechnology, and computer science. This observation suggests a natural connection between the four proposed scientific fields of the future: Clean Energy, Nanotechnology, Advanced Computing, and Space-Earth.



Figure 25 - Space-Earth breakout room

Proposed Research Topics

During the Earth-Space thematic breakout sessions, three PRT and sub-Key Topics (KT) were identified:

PRT #1: Terrestrial Applications Enabled by Space

This challenge addresses how space-based technologies address terrestrial challenges, from urban planning and hazard assessment to natural resource management. Applications include urban heat island monitoring, risk analysis, and using AI for data insights to support sustainability in areas such as water, energy, and biodiversity conservation. These technologies highlight the critical role of space in solving terrestrial problems. Key topics of focus include:

- Decision Support and Analysis through Space-Based Technologies and Digital Twins
- Urban Heat Islands
- Hazard Analysis and Risk Assessment: Utilizing remote sensing, GIS mapping, spatial analysis, and sustainability frameworks to support hazard detection and mitigation efforts.
 - Development of SAR-based land deformation sensing services tailored for the Atlantic Islands.
- Agriculture and Environmental Management:
 - Addressing water and energy needs, soil contamination, and sustainable land management practices.
- Coastal Evolution, Preservation, and Resilience

- Monitoring contamination, managing flood risks, and strategies to tackle erosion to enhance resilience in coastal regions.
- Ocean Monitoring, Preservation and New Opportunities:
 - Monitoring activity in the recently expanded Marine Protected Areas.
 - Monitoring surface properties and contamination.
- Forestry and Ecosystem Services
 - Biomass assessment, vegetation monitoring, fire hazard evaluation, and carbon cycle analysis.
- Biodiversity Conservation
 - Protecting biodiversity across land, coastal, and ocean ecosystems.
- Extreme Events and Hazard Management
 - Analyzing the impacts of extreme events, such as flooding, and addressing cross-cutting environmental and social issues.
- Defense and Security:
 - Addressing geospatial and environmental factors in defense and security contexts.
- Exclusive Economic Zone (EEZ) and Continental Shelf Extension
 - Supporting the assessment and management of resources within the EEZ and continental shelf areas.
- Artificial Intelligence in Space-based Applications
 - Leveraging AI for advancements in space exploration, data analysis, and Earth observation and prediction.

PRT #2: Technology for Sensing and Solutions in Space

This theme focuses on space sensing technologies, including CubeSats, GNSS, and precision tools for Earth and space monitoring. Rapid development cycles and modular payloads increase mission adaptability, with research conducted in environments such as microgravity and the ISS. Other areas include advanced sensing for improving data accuracy, space resource utilization for long-duration missions, and geotechnologies for Earth and space exploration. KT of focus include:

- Space Technology
 - Focus areas include nanosatellites, high-precision GNSS, accelerometers, monitoring prototypes, to detect gravity field variations and Earth's seasonal changes.
 - Emphasis on prioritizing rapid development lifecycles encompassing design, fabrication, testing, and deployment.
 - Use of modular payloads for adaptable and flexible missions.
 - Testing and research in environments such as microgravity, suborbital flights, and the International Space Station (ISS).
- Sensing Engineering
 - Development of advanced sensing technologies to improve data accuracy and functionality in space environments.
- Space Resources
 - Exploration and utilization of space resources to support long-term missions and space industry sustainability.
- Space Geotechnologies

- Application of geotechnologies for spatial analysis and monitoring, supporting both Earth observation and extraterrestrial exploration efforts.

PRT #3: Technology for Enabling Space Activities and Engineering Operations

This initiative encompasses a range of technologies essential to advancing space exploration and facilitating engineering operations in extraterrestrial environments. The following areas represent the intersection of space technology innovation and its potential applications both in space and on Earth, driving advances in exploration, resource management, and sustainable practices. KT of focus include:

- Space Exploration and Robotics: Technologies that support the exploration of space and the development of robotic systems to assist in remote or autonomous operations in space environments.
- In-Situ Resource Utilization (ISRU): Techniques for utilizing local resources on the Moon, Mars, and other celestial bodies to support construction and ongoing operations, reducing dependency on Earth-supplied resources.
- Ground-Tested Space Technologies with Terrestrial Impact: Innovations designed for space that can be tested on Earth and offer applications with significant benefits on the ground, such as advancements in vertical farming.
- Autonomy in Space Operations: Development of autonomous systems capable of managing tasks

independently, crucial for long-duration missions where real-time human control is limited.

- **Navigation in Outer Space:** Advanced navigation technologies to enable precise Positioning & Timing, movement, and coordination of assets in the vast, uncharted regions of outer space.
- **Sustainable Use of Space Assets:** Strategies for the responsible and sustainable utilization of space assets, ensuring longevity and minimizing waste in space-based operations.



Figure 26 - Ana Pires, INESC TEC, and Marco Bravo, UT Austin Portugal, interacting with delegates from the Space-Earth breakout group

Collaboration Synergies

Portugal Space, CEiiA, Universities and research laboratories.



Figure 27 - Ana Pires, INESC TEC, wrapping up the Space-Earth breakout session

10. Human Capital Development

The initial inspiration for the partnerships was to strengthen, broaden, increase and elevate the talent pool in Portugal.

Throughout the program's history, talent creation has remained central to its mission, with additional tools and goals. Students not only learn about technologies and improve their skills, but also build a new network of colleagues for their careers. More subtly, they are exposed to different ways of doing research, thinking about innovation, and collaborating. These soft skills are key to building the leaders of the future.

But building human capital is not enough. There must be opportunities for them to apply their experiences, whether in academia, government, or industry. This requires a focus on expanding these opportunities to retain the talent that Portugal has created.



Figure 28 - Networking moment

11. Innovation

The program has an opportunity to leverage specific UT Austin activities and experience in interacting with companies. It is important to note that this discussion highlighted both the commercialization of a new technology and the training of researchers to understand how to test ideas in a marketplace and, in some cases, lead to new companies.

One concrete discussion at the meeting is to help train students and researchers on how to test their innovation ideas based on customer

discovery. This concept is based on a US government program called Innovation Corps (I-Corps). UT Austin's experience in other countries (Mexico, South Korea, India, and many other countries around the world) not only trained researchers on how to test the market for their concepts, but also led to the development of additional government programs to help turn tested ideas into reality.



Figure 29 - Round table on research commercialization in the spotlight with Marco Bravo, UT Austin Portugal; [John Cesar](#) (UT Austin); Karol Lang (UT Austin) and [Weston Waldo](#) (SWICORPS)

What does it take for the program to serve as a cross-cutting platform that leverages, energizes, and rapidly brings to market and to society the innovations that emerge from all of its research investments? If you think about clean hydrogen, there is still a long way to go to ensure the successful integration of hydrogen into energy-intensive industries such as steel, cement and glass. A cross-cutting field like TIE is essential to catalyze strategic

partnerships between academia, industry, government, philanthropy, and investors.



Figure 30 - Round table I panelists on Day 2

12. Implementation

Each breakout group discussed how to implement activities. There are strong overlaps in many ideas and specific suggestions depending on the community.

Research Collaboration: to develop new approaches and overcome existing barriers to progress, and to interact with other thrusts, through

- Interdisciplinary UT Portuguese Teams working jointly, harnessing the unique expertise and infrastructure

- Student and Fellowship Exchange to strengthen collaborations (a couple of weeks to three months in some cases)
- Faculty visits to exchange ideas, monitor progress, and plan next steps

Education: to develop human capital for future scientific frontiers and entrepreneurship

- Develop joint academic programs with co-taught courses and instructor exchanges.
- Specific opportunities in
 - Advanced computing: Leverage MS in EU Master4HPC programs (e.g. U Minho) or the Aerospace programs in Lisbon, Aveiro, Minho, and Porto, and leverage the UT Austin Computational Engineering major.
- Develop online learning
- Conduct Maymester-style courses, taken between spring and summer terms, for rigorous academics with cultural immersion

Future Workforce for Portugal

- Develop Advanced courses and credentials

Build an Innovation Ecosystem: to assist in creating lab-to-market know-how

- Entrepreneurial Courses, Accelerators, Prizes
 - Several technology-to-market booster (US Austin PT booster)
- Start-Up Incubators

Networking Events or Mechanisms: to grow a community and translate results

- Connecting Academia, Industry and Policy Makers
- Leverage Existing Events
- Web portals



Figure 31 - John Ekerdt, UT Austin Portugal; Roger Bonnecaze, UT Austin and João Claro, INESC TEC, exchanging views

13. Conclusion

This report outlines opportunities in targeted areas that are important and strategically aligned with priorities in Portugal and at UT Austin. It highlights potential areas of collaboration in science, education, and innovation that can help build transatlantic ties and make significant contributions to pressing societal challenges. Because it is grounded through a participatory, broad-based community exercise, it is intended to inform the development of a proposal to renew the partnership.

Within each target area, the research communities of Portugal and UT have proposed specific foci and goals that draw on the complementary strengths of the participants, that arguably could only be accomplished through this

partnership, and that contribute to Portugal's research, social, and economic priorities and to UT Austin's motto, "What starts here, changes the world".

If renewed, this partnership would leverage world-class experts, advance research, strengthen human capital and the future workforce, and develop ways to move ideas from the lab to the marketplace to improve society.

After all, the track record of trust is a strong foundation for moving forward quickly.

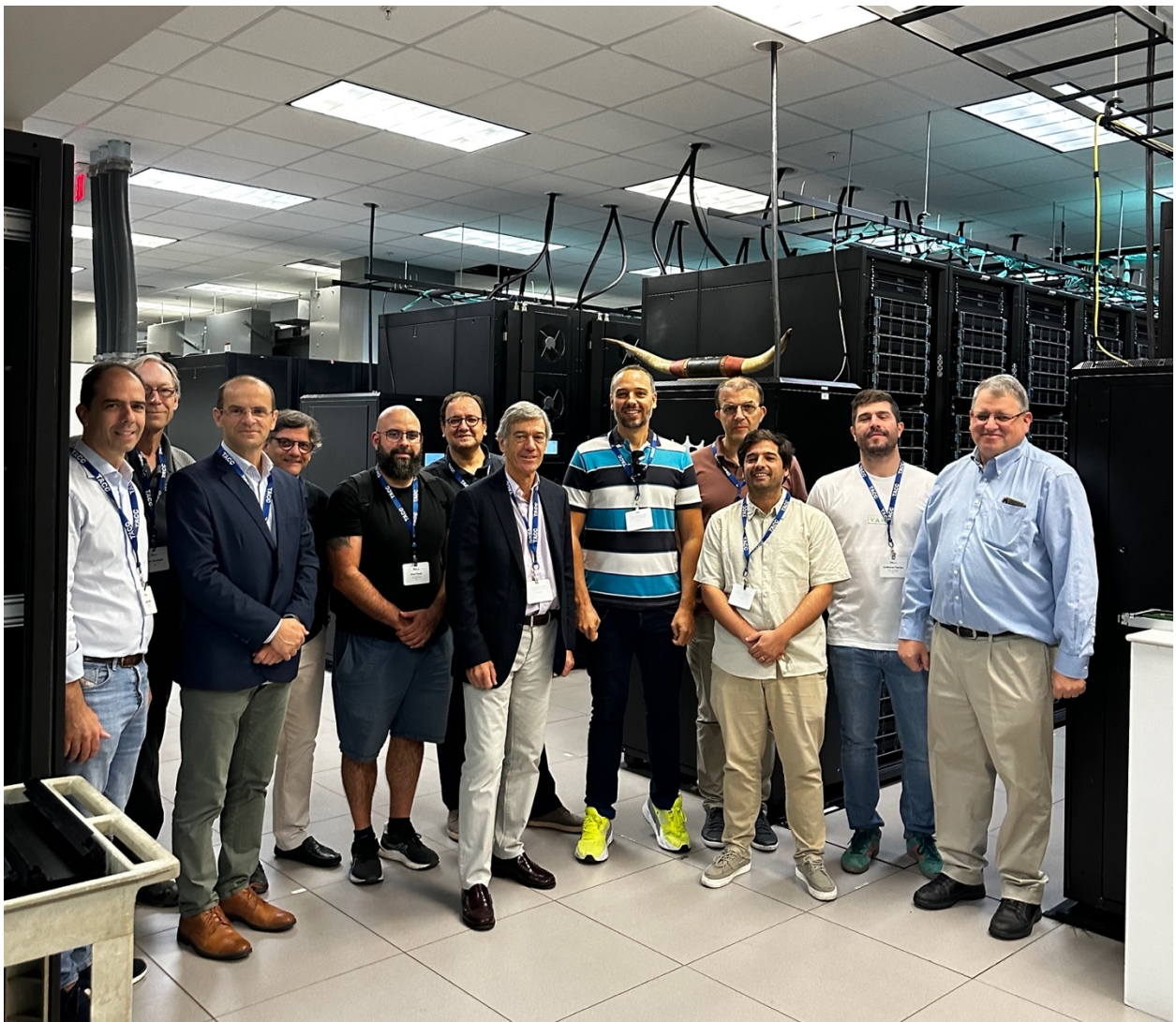


Figure 32 - Portuguese delegation, along with Peter Arzberger, External Review Committee, at TACC, hosted by Dan Stanzone

14. Appendix 1: Colloquium Agenda

DAY1 (Tuesday, 09/10/2024)

8:00 a.m.	Welcome breakfast with Daniel T. Jaffe , Vice President for Research	EER 2.518 Texas Innovation Center								
9:00 a.m.	Intro: Program Background Information + Success Stories + Vision and Goals of the Colloquium + Q&A (Marco Bravo)	EER 0.904 Mulva Auditorium								
9:30 a.m.	Keynote on the Future: Peter Stone Discussion	EER 0.904 Mulva Auditorium								
10:00 a.m.	Thematic Breakout Rooms	EER rooms TBC								
<table><tr><td>#1 Clean Energy</td><td>#2 Nanotech</td><td>#3 Advanced Computing</td><td>#4 Earth-Space</td></tr><tr><td>Facilitators: Brian Korgel João Peças Lopes</td><td>Facilitators: Guihua Yu Killian Lobato</td><td>Facilitators: Dan Stanzione Rui Oliveira</td><td>Facilitators: Srinivas Bettadpur Ana Pires</td></tr></table>			#1 Clean Energy	#2 Nanotech	#3 Advanced Computing	#4 Earth-Space	Facilitators: Brian Korgel João Peças Lopes	Facilitators: Guihua Yu Killian Lobato	Facilitators: Dan Stanzione Rui Oliveira	Facilitators: Srinivas Bettadpur Ana Pires
#1 Clean Energy	#2 Nanotech	#3 Advanced Computing	#4 Earth-Space							
Facilitators: Brian Korgel João Peças Lopes	Facilitators: Guihua Yu Killian Lobato	Facilitators: Dan Stanzione Rui Oliveira	Facilitators: Srinivas Bettadpur Ana Pires							
12:00 p.m.	Networking Lunch	EER 2.518 Texas Innovation Center								
1:00 p.m.	Thematic Breakout Rooms	EER rooms TBC								
<table><tr><td>#1 Clean Energy</td><td>#2 Nanotech</td><td>#3 Advanced Computing</td><td>#4 Earth-Space</td></tr><tr><td>Facilitators: Brian Korgel and João Peças Lopes</td><td>Facilitators: Guihua Yu and Killian Lobato</td><td>Facilitators: Dan Stanzione and Rui Oliveira</td><td>Facilitators: Srinivas Bettadpur and Ana Pires</td></tr></table>			#1 Clean Energy	#2 Nanotech	#3 Advanced Computing	#4 Earth-Space	Facilitators: Brian Korgel and João Peças Lopes	Facilitators: Guihua Yu and Killian Lobato	Facilitators: Dan Stanzione and Rui Oliveira	Facilitators: Srinivas Bettadpur and Ana Pires
#1 Clean Energy	#2 Nanotech	#3 Advanced Computing	#4 Earth-Space							
Facilitators: Brian Korgel and João Peças Lopes	Facilitators: Guihua Yu and Killian Lobato	Facilitators: Dan Stanzione and Rui Oliveira	Facilitators: Srinivas Bettadpur and Ana Pires							
4:00 p.m.	From science to commercialization, a UT Austin Portugal – I-Corps™ journey Moderator: Marco Bravo Panelists: Karol Lang (PI), John Cesar (TL), Weston Waldo (SWICORPS)	EER 0.904 Mulva Auditorium								
5:00 p.m.	Tour of the Texas Inventionworks, with Scott Evans	EER 1.608								

7:00 p.m. Networking dinner

The Otis Hotel

DAY 2 (Wednesday, 09/11/2024)

8:00 a.m.	Breakfast with Roger Bonnacaze , Dean Cockrell School of Engineering	EER 2.518 Texas Innovation Center
8:30 a.m.	Debriefing from breakout groups: #1 Clean Energy #2 Nanotech #3 Advanced Computing #4 Earth-Space	<i>EER 0.904 Mulva Auditorium</i>
10:30 a.m.	Coffee-break	<i>EER Atrium</i>
11:00 a.m.	Roundtable I “What societal grand challenges can the program tackle?” “How could the program foster economic growth?” <i>Moderator:</i> Fernanda Leite <i>Panelists:</i> João Claro , António Vidigal , Paulo Quental , Dmitri Petrovykh , Anabela Oliveira , Helena Braga , Tiago Hormigo , Juan Sanchez <i>Plenary discussion</i>	<i>EER 0.904 Mulva Auditorium</i>
11:45 a.m.	Roundtable II “How will impact be achieved and measured?” “Which activities should the program focus on?” <i>Moderator:</i> Fernanda Leite <i>Panelists:</i> Paulo Ferrão , Teresa Ponce de Leão , André Dias , João Pinelo , Paula Vilarinho , Peter Arzberger , Robert A. Peterson , Woodrow Winchester III <i>Plenary discussion</i>	<i>EER 0.904 Mulva Auditorium</i>
12:30 p.m.	Wrap-up (John Ekerdt and José Manuel Mendonça) Plenary discussion	<i>EER 0.904 Mulva Auditorium</i>
1:00 p.m.	Networking Lunch (EER)	EER 2.518 Texas Innovation Center

15. Appendix 2: List of Participants

#	Name	Home Institution	Home Institution Country	Webpage	Thematic Area
1	José Manuel Mendonça	INESC TEC	Portugal	https://utaustinportugal.org/participants/jose-manuel-mendonca/	Nomad
2	Andreia Passos	INESC TEC	Portugal	https://utaustinportugal.org/participants/andreia-passos/	Nomad
3	Vera Pinto	INESC TEC	Portugal	https://utaustinportugal.org/participants/vera-pinto/	Nomad
4	Peter Arzberger	UT Austin Portugal	USA	https://utaustinportugal.org/participants/peter-arzberger/	Nomad
5	João Claro	INESC TEC	Portugal	https://utaustinportugal.org/participants/joao-claro/	Nomad
6	Deliana Ernst	MIT	USA	https://global.mit.edu/our-team/	Nomad
7	Daniel T. Jaffe	UT Austin	USA	https://research.utexas.edu/ovpr	N/A
8	Roger Bonnecaze	UT Austin	USA	https://cockrell.utexas.edu/about/leadership/about-the-dean	N/A
9	John Ekerdt	UT Austin	USA	https://utaustinportugal.org/participants/john-g-ekerd/	Nomad
10	Fernanda Leite	UT Austin	USA	https://www.cae.utexas.edu/people/faculty/faculty-directory/leite	Nomad
11	Marco Bravo	UT Austin	USA	https://utaustinportugal.org/participants/marco-bravo/	Nomad
12	Luz Vargas	UT Austin	USA	https://utaustinportugal.org/participants/luz-vargas/	N/A
13	Peter Stone	UT Austin	USA	https://www.cs.utexas.edu/~pstone/	N/A
14	Robert Peterson	UT Austin	USA	https://www.mcombs.utexas.edu/faculty-and-research/faculty-directory/robert-peterson/	Nomad
15	Juan Sanchez	UT Austin Portugal	USA	https://www.theatlas.org/index.php?option=com_content&view=article&layout=edit&id=273	Nomad
16	Konavis Smith	UT Austin	USA	https://executive.engr.utexas.edu/about/120-konavis-smith	Nomad
17	Woodrow Winchester III	UT Austin	USA	https://executive.engr.utexas.edu/about/87-woodrow-w-winchester-iii	Nomad
18	Ashley Jennings	UT Austin	USA	https://texasinnovationcenter.utexas.edu/about/our-team/ashley-jennings	Nomad
19	Courtney Link	UT Austin	USA	https://mcombs.utexas.edu/execed/about-us/staff/	Nomad
20	Gaylen Paulson	UT Austin	USA	https://mcombs.utexas.edu/execed/about-us/staff/	Nomad
21	Scott Evans	UT Austin	USA	https://designcreativetech.utexas.edu/scott-evans	N/A
22	Karol Lang	UT Austin	USA	https://ph.utexas.edu/component/cobalt/item/18-physics/442-lang-karol?Itemid=1264	N/A
23	Weston Waldo	UT Austin	USA	https://ati.utexas.edu/waldo-w_400x400/	Nomad
24	João Peças Lopes	University of Porto	Portugal	https://sigarra.up.pt/feup/en/FUNC_GERAL.FORMVIEW?p_codigo=208769	Clean Energy
25	Brian Korgel	UT Austin	USA	https://utaustinportugal.org/participants/brian-korgel/	Clean Energy
26	António Vidigal	UT Austin Portugal	Portugal	https://utaustinportugal.org/participants/antonio-vidigal/	Clean Energy
27	Hugo Morais	University of Lisbon	Portugal	https://sites.google.com/tecnico.ulisboa.pt/hmorais	Clean Energy
28	Vasco Amorim	University of Trás-os-	Portugal	https://www.inesctec.pt/pt/pessoas/vasco-amorim	Clean Energy

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#	Name	Home Institution	Home Institution Country	Webpage	Thematic Area
		Montes and Alto Douro			
29	Paulo Ferrão	University of Lisbon	Portugal	https://in3.dem.ist.utl.pt/team/members/paulo-ferrao/	Clean Energy
30	André Pacheco	University of Algarve	Portugal	https://www.cima.uaig.pt/pt/equipa/andre-miguel-duarte-pacheco	Clean Energy
31	Teresa Ponce de Leão	National Laboratory of Energy and Geology	Portugal	https://www.linkedin.com/in/teresaleao	Clean Energy
32	Shannon Strank	UT Austin	USA	https://cem.utexas.edu/content/shannon-m-strank	Clean Energy
33	David Allen	UT Austin	USA	https://che.utexas.edu/people/faculty/allen	Clean Energy
34	Kent Zheng	UT Austin	USA	https://che.utexas.edu/people/faculty/zheng	Clean Energy
35	Javad Mohammadi	UT Austin	USA	https://www.caee.utexas.edu/people/faculty/faculty-directory/mohammadi	Clean Energy
36	Venkat Subramanian	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/subramanian	Clean Energy
37	David Mitlin	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/mitlin	Clean Energy
38	Joaquin Resasco	UT Austin	USA	https://www.che.utexas.edu/people/faculty/resasco	Clean Energy
39	Killian Lobato	University of Lisbon	Portugal	https://ciencias.ulisboa.pt/en/perfil/klobato	Nanotechnology
40	Guihua Yu	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/yu	Nanotechnology
41	Helena Braga	University of Porto	Portugal	https://sigarra.up.pt/feup/en/FUNC_GERAL.FORMVIEW?p_codigo=320005	Nanotechnology
42	Senen Lanceros	University of Minho	Portugal	https://www.cf-um-up.pt/index.php/people/12-effective-members/52-senentxu-lanceros-mendez	Nanotechnology
43	Filipe Figueiredo	University of Aveiro	Portugal	https://www.ciceco.ua.pt/?tabela=peessoaIdetail&menu=219&user=417	Nanotechnology
44	Paula Vilarinho	University of Aveiro	Portugal	https://www.ciceco.ua.pt/?tabela=peessoaIdetail&menu=218&user=477	Nanotechnology
45	Dmitri Petrovykh	International Iberian Nanotechnology Laboratory	Portugal	https://www.linkedin.com/in/etrovykh/?originalSubdomain=pt	Nanotechnology
46	Emma Fan	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/fan	Nanotechnology
47	Jamie Warner	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/warner	Nanotechnology
48	Yuebing Zheng	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/zheng	Nanotechnology
49	Deji Akinwande	UT Austin	USA	https://www.ece.utexas.edu/people/faculty/deji-akinwande	Nanotechnology
50	Delia Milliron	UT Austin	USA	https://che.utexas.edu/people/faculty/milliron	Nanotechnology
51	Filippo Mangolini	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/mangolini	Nanotechnology
52	Michael Cullinan	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/cullinan	Nanotechnology
53	Wennie Wang	UT Austin	USA	https://che.utexas.edu/people/faculty/wang	Nanotechnology
54	Rui Oliveira	INESC TEC	Portugal	https://utaustinportugal.org/participants/rui-oliveira-2/	Advanced Computing
55	Dan Stanzione	UT Austin	USA	https://utaustinportugal.org/participants/dan-stanzione/	Advanced Computing

#	Name	Home Institution	Home Institution Country	Webpage	Thematic Area
56	Nuno Castro	University of Minho	Portugal	https://utaustinportugal.org/participants/nuno-castro/	Advanced Computing
57	Jaime Cardoso	University of Porto	Portugal	https://web.fe.up.pt/~jsc/	Advanced Computing
58	José Orlando Pereira	University of Minho	Portugal	https://jopereira.github.io/	Advanced Computing
59	João Tiago Paulo	University of Minho	Portugal	https://gsd.di.uminho.pt/members/jtpaulo.html	Advanced Computing
60	Paulo Quaresma	University of Évora	Portugal	https://orcid.org/0000-0002-5086-059X	Advanced Computing
61	Guilherme Farinha	Alfredo AI	Portugal	https://www.linkedin.com/in/guilhermeafarinha	Advanced Computing
62	Mário Gamas	Alfredo AI	Portugal	https://www.linkedin.com/in/mariogamas	Advanced Computing
63	Omar Ghattas	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/ghattas	Advanced Computing
64	Krishna Kumar	UT Austin	USA	https://www.cae.utexas.edu/people/faculty/faculty-directory/krishna-kumar	Advanced Computing
65	George Biros	UT Austin	USA	https://www.me.utexas.edu/people/faculty-directory/biros	Advanced Computing
66	John Cazes	UT Austin	USA	https://tacc.utexas.edu/about/staff-directory/john-cazes/	Advanced Computing
67	Keshav Pingali	UT Austin	USA	https://www.cs.utexas.edu/people/faculty-researchers/keshav-pingali	Advanced Computing
68	Lain Mustafaoglu	UT Austin	USA	https://oden.utexas.edu/people/directory/Zelal-Su-Mustafaoglu/	Advanced Computing
69	Per-Gunnar Martinsson	UT Austin	USA	https://oden.utexas.edu/people/directory/Per-Gunnar-Martinsson/	Advanced Computing
70	Vijay Chidambaram	UT Austin	USA	https://www.cs.utexas.edu/~vijay/	Advanced Computing
71	Feliciano Giustino	UT Austin	USA	https://oden.utexas.edu/people/directory/Feliciano-Giustino/	Advanced Computing
72	Ana Pires	INESC TEC	Portugal	https://www.inesctec.pt/en/people/ana-cristina-pires	Space-Earth
73	Srinivas Bettadpur	UT Austin	USA	https://www.csr.utexas.edu/faculty-and-staff/bettadpur/	Space-Earth
74	Burke Fort	UT Austin	USA	https://sites.utexas.edu/fort/	Space-Earth
75	Luísa Bastos	University of Porto	Portugal	https://utaustinportugal.org/participants/luisa-bastos/	Space-Earth
76	Anabela Oliveira	National Laboratory of Civil Engineering	Portugal	https://www.lnec.pt/instrumentacao-cientifica/en/team/anabela-de-oliveira/	Space-Earth
77	André Dias	CEiiA	Portugal	https://www.ceia.com/space	Space-Earth
78	João Pinelo	AIR Centre	Portugal	https://www.aircentre.org/joao-pinelo/	Space-Earth
79	Paulo Qental	Azores Mission Structure for Space	Portugal	https://portal.azores.gov.pt/en/web/ema-espaco/biografia	Space-Earth
80	Slavka Carvalho Andrejkovicová	University of Aveiro	Portugal	https://www.ua.pt/en/p/80305742	Space-Earth
81	Fernando Lau	University of Lisbon	Portugal	https://fenix.tecnico.ulisboa.pt/homepage/ist13198	Space-Earth
82	Gustavo Dias	University of Minho	Portugal	https://www.linkedin.com/in/gustavo-rodrigues-dias-9436218/	Space-Earth

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#	Name	Home Institution	Home Institution Country	Webpage	Thematic Area
83	Tiago Hormigo	Spinworks	Portugal	https://www.linkedin.com/in/tiago-hormigo/	Space-Earth
84	Luis Sentis	UT Austin	USA	https://www.ae.utexas.edu/people/faculty/faculty-directory/sentis	Space-Earth
85	Brandon Jones	UT Austin	USA	https://sites.utexas.edu/bajones/	Space-Earth
86	Zong-Liang Yang	UT Austin	USA	https://www.jsg.utexas.edu/researcher/zong-liang_yang/	Space-Earth
87	Jingyi Ann Chen	UT Austin	USA	https://www.ae.utexas.edu/people/faculty/faculty-directory/chen	Space-Earth
88	Lori Magruder	UT Austin	USA	https://www.ae.utexas.edu/people/faculty/faculty-directory/magruder	Space-Earth
89	Gordon Wells	UT Austin	USA	https://www.csr.utexas.edu/about-csr/faculty-and-staff/	Space-Earth
90	Kelley Crews	UT Austin	USA	https://liberalarts.utexas.edu/geography/faculty/kac2869	Space-Earth
91	Dev Niyogi	UT Austin	USA	https://www.jsg.utexas.edu/researcher/dev_niyogi/	Space-Earth

16. Appendix 3: Breakout Presentation Slides

16.1. Clean Energy: Addressing Climate Neutrality

The Grand Challenge of Climate Neutrality

- Europe has declared to become climate neutral by 2050 and the Biden Administration of the U.S. has also set 2050 as a target for net zero emissions from the energy sector.
- These shared goals set the stage for a fruitful collaboration between UT Austin and the Portuguese research and innovation ecosystem.
- UT Austin and Portugal both have world-recognized research and education programs in clean energy.
- Through these shared strengths and interests, the UT|Portugal program aims to help achieve the grand challenge of Climate Neutrality.

“Portugal as a Living Lab”

The UT|Portugal program will create **three flagship initiatives** to address pivotal societal challenges:

- Climate Neutral Cities
- Greening the Industry
- Future Energy Networks



Flagship Initiative #2

Greening the industry

Key UT & Portugal strengths for research & development

- Hydrogen (Production, Transport, Storage & Use)
- Electrification
- Circularity & Value Chain Evaluation
- Accountability
- Algae & Biofuels
- Sustainable Aviation Fuels (SAFs)
- Ceramics, Glass, Cement, Steel (high temperature applications)
- Fertilizer and Agriculture
- Ammonia
- Carbon capture combined with hydrogen (methane, methanol, etc)
- Digital Twins
- Critical Minerals



Grand Challenge: Climate Neutrality

Flagship Initiatives:

Climate Neutral Cities, Greening the Industry, Future Energy Networks

Program Goals:

Research Impacts: joint papers & external funding to position Portugal as a global leader in Clean Energy research

Education and Training: produce the next generation of thought leaders in Portugal in the energy sector

Energy Literacy: communicating the latest advances in Clean Energy technologies to the people of Portugal

Economic Development: innovate to catalyze the creation of new business opportunities in Portugal, either via start-up creation or intrapreneurship in established energy companies

UT|Portugal brings a unique framework to address the societal challenges facing Climate Neutrality.

- Portugal has become a global reference for how to decarbonize the energy sector, with nearly 65% of its electricity production coming from renewable energy sources. In addition to its deep commitment to the decarbonization of its economy, Portugal also brings a deep talent pool of faculty, students, practitioners and industry in the energy field.
- UT Austin also has world-renowned research and education programs in energy and strong public-private partnerships with industry leaders in the energy sector. It will bring its full research capacity, student and faculty talent pool and pilot-scale lab infrastructure to provide new approaches and application-level research and development opportunities to students, faculty and practitioners in the UT|Portugal program.
- This partnership will leverage these unique and complementary strengths and translate them to the “living laboratory” settings of Portuguese industry, cities and communities.

Flagship Initiative #1

Climate neutral cities

Key UT & Portugal strengths for research & development

- Energy Communities
- (Portugal as a) Living Lab
- Sensing/Sensors/Sensor Networks/Internet of Things (IoT)/Sensor Materials
- Embodied Carbon in Building Materials
- Territorial Needs & Matching Constraints
- Digital Twins of Buildings & Mobility
- Coordinated Transportation & Logistics



Flagship Initiative #3

Future Energy Networks

Key UT and Portugal strengths for research & development

- Power Systems
 - Resilience
 - Risk Assessment
 - Energy + AI & IT
 - Stability issues
 - Security of Supply
 - Energy Markets
 - Renewable communities
 - Storage Systems
 - Multi-energy Systems
 - Sector Coupling
 - Flexibility
 - Power Electronics
 - Advanced Computer Solutions
- GIS Mapping
- Direct Air Capture (DAC)
- Carbon Capture & Storage (CCS)
- Batteries: chemistry & modeling
- Digital Twins
- Sensing/Sensors and Sensor Networks
- Trading
- Geothermal
- Thermal Storage
- Water
- Data Centers



Tools for Program Implementation (1/2)

Research Collaboration

- Interdisciplinary Teams
- Student Exchange
- Faculty visits

Education

- Developing joint academic programs with co-taught courses
- On-line learning
- Maymester-style courses



Tools for Program Implementation (2/2)



Future Energy Workforce for Portugal

- Advanced courses and credentials

Build an Energy Innovation Ecosystem

- Entrepreneurial Courses, Accelerators, Prizes
- Energy Start-Up Incubator

Networking Events

- Connecting Academia, Industry and Policy Makers
- Leverage Existing Events

Cross-Sector Collaboration Activities with Nanotechnology and Advanced Computing

16.2. Nanotechnology: Advancing Critical Materials Discovery



UT Austin - Portugal Colloquium

Nanotechnology Theme

Facilitator: Killian Lobato, Guihua Yu, Jamie Warner



Key Discussion Summary

Accelerated Material Discovery (AMD) for Rational Design.

- Nanotechnology: **predictive nanomaterial design** coupled with AI/ML (Texas Advanced Computing Centre): from atomistic to molecular materials, structure-property characterization, device fabrication/testing, to industrial application.
- Advanced semiconductor technology: nanoscale interface/material to emergent properties, unique leverage with TIE, TMI, TQI.

Why? UTA has focused and pioneered on rapid material discovery bringing together robotics, AI and characterisation.
Recent high performance computing allows for predictable design approach.

- Textiles - a emerging school/centre at UTA – could be synergistic with established PT textile industry.
- What is “nanotechnology” – discussion of a new definition of area?

3



Technological Impacts

Potential high growth industries in Portugal

- Advanced batteries: nano-material/structure design, to electrode level, to pouch cell level, from nanomaterial level to battery pack, leveraging unique Texas Battery Center, TMI, and top battery companies in Austin
- Green H2 economy: nanocatalysts, nanoscale interfaces, H2 storage
- Advanced **environmental** technologies: nanomaterials design for membrane-based RO / desalination, recycling/upcycling/circular of critical minerals etc..

Examples of currently established industries in Portugal which directly apply nano.

- Semiconductor packaging
- Smart textiles.

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Discussion & Networking

Proposed Material

- Nanotechnology: from discovery to impact/commercialization
Leveraging key UT strength: Texas Materials Institute, Texas Institute for Electronics (TIE), Texas Quantum Institute, INL, INESC TEC,
- Nanotech synergies with other thematic areas:
Clean energy: energy conversion and storage (advanced batteries and green hydrogen), energy-water nexus (desalination, water purification and harvesting).....
Advanced computing: nano-electronics, -optoelectronics, quantum computing... Space-earth: advanced sensors for monitoring,
- AI/ML, nanomaterials design, technological impacts

2



Facilities/Infrastructure @UT Austin

- Battery manufacturing centre
- Centre for electromechanics (testing of large scale electrolyzers and fuel cells)
- Semiconducting packaging facility (Texas Inst. of Electronics TIE)
- Semiconductor nanofabrication (microelectronics research centre) – lithography and etching technologies.
- Texas Materials Inst. – core nanocharacterisation facilities
- Texas advanced Computer Centre – high performance computing for modelling using AI/ML.
- Texas robotics – help build autonomous machines – a requirement for high throughput material discovery.

SCALE

4



Economy opportunities

- Advanced Batteries
 - Solid state batteries
 - Alternatives ions to Li (e.g. Na)
 - Bespoke design for specific application
 - Design for recyclability
 - Design for durability/stability

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Economy opportunities

- H2 generation of and use in fuel cells
 - Alternative nanocatalysts to reduce use rare earths
 - Robust functioning of electrodes (temp, power densities)
- H2 storage
 - High density storage for mobile/decentralised applications

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Economy opportunities

Semiconducting Packaging

- Taking advantage of Texas Institute for Electronics (TIE) development both in state-of-the-start facilities as well as educational resources (master courses)

Advanced semiconductor nanomaterials
quantum technology, nanoelectronics

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Paula Vilarinho Notes
vision for the future UT Austin – FCT 2025
onwards

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FCT – UT Austin

- Large synergy overview platform on the full value chain of materials, from the atomistic based discovery to the system (product)
- Combining the needed expertise to tackle the future of materials and the future of advanced materials for the industry (European initiative)
- Unique Infrastructure and people

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Examples

- Ex1 nanotec in the production of green H2
- Ex2 "electronics" recycling
- Ex3 scaling up nanotechnologies
- Ex4 autonomous production at the lab scale

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Economy opportunities

Environmental

The emerging energy-water nexus.

- Water desalinisation
 - Membranes for RO for high ionic conductivity and stability
- Water purification, water treatment/reuse.
 - Photocatalysis treatment for the removal of harmful bioactive material (e.g. ibuprofen)
 - Solar desalination

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Economy opportunities

- Smart added value textiles.

These require:

- Power generation capabilities (photoelectric, electromechanical, thermoelectric)
- Energy storage (emebbed super capacitors, or batteries)

- This is a high added value industry.

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Nanotechnologies?

Possible new title (designation)

Accelerating materials discovery for new (energy) markets

Or

Accelerating materials discovery for efficient new energy
markets

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Science	Industry	Education
Accelerating materials discovery for new (energy) markets	Batteries	- Design Thinking
AI	Batteries / electronics / solar panels	- Master on line AI
Energy	Recycling start up	
Water	Enabling technologies: Energy Water Food Textile plastics	
Data curation		

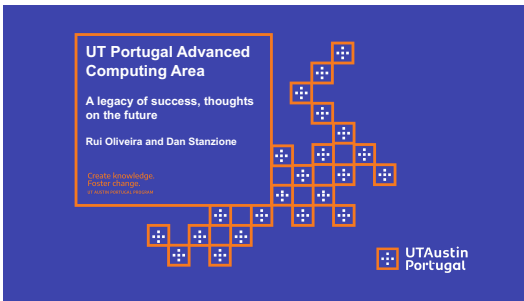
14

Key words

- Nanotec
- AI
- Integration
- Systems
- Batteries
- Semiconductors
- Hydrogen
- Solar panels
- Data curation

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16.3. Advanced Computing: Scaling Tools for Energy-Efficient Computing



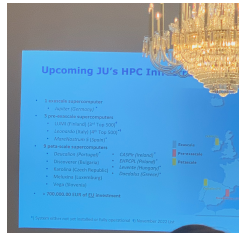
Advanced Computing Focus Area Why is it important?

- You perhaps have heard something about this thing called "AI"
- Estimated \$9T global industry by 2030?
- Impact across maybe half of all jobs.
- At scale, technologies for AI and traditional High End Scientific Computing are indistinguishable.
 - Advanced Computing research made modern AI possible, and now they inevitably advance together.

2

Advanced Computing – What have we Achieved through this project?

- This program has helped put Portugal on the Advanced Computing Map within Europe.
- There has been substantial return in external funding, and in improved computing infrastructure for Portuguese researchers.



3

Tangible Outcomes



Advanced Computing – So what do we do now?

- The next phase of advanced computing research will focus on HPC and AI in:
 - Building capacity (particularly human capacity)
 - Using that capacity effectively to get return.
 - Aligning with US and EU funding initiatives

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Structure of the New Program

- Build capacity in training and education.
 - This is where we started in phase 1, and the connections made have sustained this part of the project
 - Focus initially on the new MS in Advanced Computing at Minho
 - And the new Aerospace programs in Porto and Lisbon.
 - The UT-Austin Computational Engineering major is hosted in our Aerospace engineering department – with many courses taught by our advanced computing staff.
 - Joint course offerings, instructor exchanges, etc.
 - Grow to other programs in support of the other areas.
 - Continue our successful Fellowship/Exchange programs.

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Structure of the New Program

- Use Capacity. - the call for Research Proposals
- Both basic and translational research, with two main goals:
 - Innovations in Portugal to support the broader HPC/AI ecosystem
 - Funding for people through these programs to jumpstart their research careers.
 - Early Career support – preference to people who have been through the programs, and land in academia?
 - Start up support for those who go the entrepreneur route?

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Possible Topics for Research Projects

- Theme: Exploit low precision hardware built for AI for scientific computing problems.
 - Use of surrogate models (low precision models trained on high precision data).
 - Surrogate preconditioners
 - Mixed precision algorithms
 - Chaining low precision ops for high precision results.
 - Scalable Examples of Neuro Operators
- Theme: Greener, more sustainable AI Tools.
 - Improve algorithmic efficiency
 - Create more holistic benchmarks, measurements of AI products.
 - Improve tools for deployment, scheduling, utilization of AI pipelines.

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Possible Topics for Research Projects

- Theme: Translational AI Research:
 - Use of AI in Public Administration
 - LLMs for Portuguese Language applications
 - AI workflows supporting other project areas
- Theme: Future Computing Paradigms
 - Coupling Quantum devices with traditional supercomputers.
 - Evaluating RISC-V-based AI Accelerators.



16.4. Space-Earth: Exploiting Satellite Technology and Data for Earth Applications



BREAKOUT SESSION #4

AREAS OF INTEREST WERE IDENTIFIED AND FUTURE ACTIVITIES PROPOSED

- More events like this one, to bring other Portuguese stakeholders and meet the UT Austin Ecosystem
- Cooperation between PIs (Austin-PT)
- Educational different mechanisms for students were discussed
- Creation of a ROAD-MAP and cross-section cooperation between other areas (nanotech + clean energy + advanced computing)
- White paper contribution from Space-Earth Interaction Group will describe in detail all the proposals and possible strategies discussed, as well as recommendations
- Discussion about showing the value and impact of the program in Portugal

MORE THOUGHTS

- Discussed tangible projects for each class identified
- **Missions / Expeditions (Space, Land, Ocean)** - a proposal for real missions with the "seal" of UT Austin Portugal Program and other partners
 - ◆ 2 Possible Space Missions
 - ◆ 1 Possible Mission from Land or 1 Expedition
 - ◆ 1 Possible Expedition to Antarctica

BY THE END OF FIRST SESSION (MORNING)

What do you expect of the outcomes of this session and workshop?

42 responses



BY THE END OF SECOND SESSION (AFTERNOON)

Which of the following topics or themes is more important to develop your research?



PROBLEM CLASS 1 - DECISION SUPPORT USING SPACE-BASED TOOLS / DIGITAL TWIN

- Urban heat islands (pilot project or seed project defined by Niyogi and Anabela Oliveira)
 - Hazard, remote sensing, GIS mapping, spatial analysis, pilot project (experimental field), sustainability
 - Health, health, energy, water
- Agriculture
 - Water and energy
 - Soil contamination
 - Management
- Coastal evolution and resilience
 - Contamination
 - Flooding
- Forestry, biomass, vegetation, fire hazard, carbon
- Biodiversity
- Extreme events, flooding, cross-cutting
- Defense and security
- Exclusive Economic Zone (Continental Shelf Extension)
- AI in Space

2024 UT Austin Portugal Colloquium
Charting Future Impact

PROBLEM CLASS 2 - TECHNOLOGY FOR SENSING AND SOLUTIONS IN SPACE

- Space Technology
 - *Cubesats, satellites (project by Spinworks and Jones) – high precision GNSS, accelerometer, monitoring prototype, how things in gravity change, seasonal changes on Earth monitor (NASA technology development calls, could be possibility)*
- RFP can ask for mission concept development, whose flight opportunity can follow from independent funding sources
 - *Be mindful of balance between industry and science funding – we do not yet know enough about that balance.*
 - *Prioritize rapid life cycle of development, fabrication, testing, and deployment.*
 - *Modular payloads*
 - *Microgravity, suborbital flights, ISS, testing*
 - *Santa Maria Spaceport*
- Sensing Engineering
- Space Resources
- Space Geo-technologies

PROBLEM CLASS 3 - ENABLING ACTIVITY IN SPACE

- o Space exploration, robotics
- o ISRU – in-situ resource utilization, construction, operation on moon, mars
- o Technology connected with working with space that can be tested or proven on ground, and also has an impact on ground (vertical farming, for example)
- o Autonomy, navigation
- o Sustainable use of assets in space

WORD CLOUD WITH SOME OF OUR INITIAL THOUGHTS AND IDEAS...



details to follow...