

SCIENCE WITH IMPACT, (SMART SPECIALISATION) AND PUBLIC POLICIES

José Manuel Mendonça FEUP-DEGI/INESC TEC





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GREAT CHALLENGES FOR SCIENCE AND SOCIETY

- digital transition
- energy transition

CHALLENGES I - COMMUNICATING

Autonomous Communications Systems – machine-to-machine & other

Communications for Extreme Environments

Obstacle-aware Communications



NESCTE

CHALLENGES II – COMPUTING

Managing the Increasing Complexity of Critical Information Systems

Designing and Deploying Heterogeneous Computing Architectures

Improving Computational Systems for a better Human-Technology Symbiosis



CHALLENGES III - DECARBONIZING

Cost-effective decarbonization and digitalization of energy systems

Evolving and de-centralizing energy-driven business models and markets Resilience and reliability of energy systems



Transitioning Socio-technical systems towards sustainability

- **Developing Responsive and Resilient end-to-end Value Chains**
- Managing Systems under uncertain, complex and dynamic environments
- **Engineering Human-Centred Systems for Sustainability and Resilience**



INESC TEC *Motto*

FROM PERVASIVE INTELLIGENCE

TO GLOBAL COMPREHENSION

RESEARCH AND INNOVATION FOR IMPACT

RESEARCH

Domains behind Excellence in Science

Scientific domains build a **multidisciplinary environment** to optimise resources and maximise synergies

Artificial Intelligence Bioengineering Communications Computer Science and Engineering Photonics Power and Energy Systems Robotics Systems Engineering and Management

INNOVATION

TEC4 Addressing Market Challenges

NEED

AND MARKET

CHALLENGES

CIETAL

ATFORMS

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Strategy driven platforms addressing and impacting great societal challenges and market needs



RESEARCH STRATEGY

From Pervasive Intelligence to Global Comprehension

- Digitally-enabled systems are vital in the modern economy and society
- The opportunities ahead are strongly linked to progress in our core sciences, **interacting with other disciplines** and influencing **multiple application areas**
- The incredible progress has rekindled our ambition to more fully comprehend our world



DIGITAL MODELS

Bring comprehensive, highprecision digital models of physical entities into the lab through the creation of more and more complex **digital twins**.



TRUSTWORTHY TECHNOLOGY

Address the indispensable trustworthiness of digital technologies in light of our increasing dependence and their ever-growing complexity.



TACKLING THE EXTREME

Dare to deal with uncooperative, dangerous, or even hostile natural and industrial environments, highrisk activities, nanosecond decisions, or massive sets of entities or data.



SUSTAINABLE TRANSFORMATION

Prioritise the long-term preservation and improvement of social, economic, and environmental systems in the ongoing **digital**, **energy and green transitions**.

SCIENCE, ENGINEERING AND IMPACT



STAYAWAY Covid

European team that invented the current Apple/Google digital contact tracing algorithm. Portuguese mobile app downloaded by more than 3 million users.



Deep Brain Stimulation for Parkinson's Disease and Epilepsy

Cutting-edge implantable and wearable devices, for real-time disruption and control of epileptic seizures as well as optimised management of Parkinson's Disease symptoms.



World depth record in flooded mines exploration

Creation of an autonomous underwater robot that was able to explore and map a flooded mine up to 450 meters deep.



Digital twinning to design IKEA factories worldwide

Development of simulation and optimisation tools to support the design of 6 IKEA factories (Portugal, Lithuania, Slovakia, Russia e China).



Renewable energy integration made practical

Creation of the PS-MORA software to validate optimal annual plans for security of supply considering large scale renewable energy integration



Improving public policy for rural fires

After the tragic 2017 season, a key role in the recommendations of the Independent Technical Commission, in particular regarding the creation of the Agency for Integrated Rural Fire Management (AGIF) and the ForestWISE CoLAB.

DIGITAL TWIN MANUFACTURING SYSTEMS DESIGN AND OPERATION

Challenge

- Higher efficiency manufacturing of hundreds of different products
- Best layout for a specific product mix

Approach

- Digital twin of the manufacturing system
- Simulation-optimization techniques
- Robust decision-making in dynamic multivariable environments ("what-if" scenarios)

Impact

- Improved production system layout
- Increased capacity
- Better resource utilization
- Stock reduction



IKEA (Portugal, Lithuania, Slovakia, Russia e China), Kyaia, Simoldes, Embraer (Portugal and Brasil), Thyssenkrupp, Amkor

ENERGY

A leading country in RENEWABLE INTEGRATION – smart grids



Pilot for a Smart City: Évora – 33,000 consumers using Smart Grid technology



Metering

Portuguese Technology advanced EMS/DMS (EFACEC), Smart and Smart Grids



Managing the Power System with large scale integration RES: Forecasting, reserve management, stability studies

Wind power forecasting services

Provides short-term forecasts up to 72 hours ahead, 4 times per day 75% of the wind power forecasts in Portugal



> 5100 MW
instaled capacity
in Portugal
(7th in Europe)

World record: over 4 days with 100% renewable electricity - hydro, wind, solar, biomass



2016 Feb - renewables enough to feed all the country load and export during 106 h



Mais um domingo com preços nulos de eletricidade. O tal prenúncio de tempos futuros?



CHALLENGES FOR AÇORES

Use of renewables (geothermic, wind and solar PV) for electricity production

- **Storage of energy produced by renewables**
- **Electric mobility**
- **Maritime electric transport**
- Sea port electrification (offshore power supply)
- Security of supply

Robustness of exploitation and stability of island power grids

GRACIÓLICA HYBRID POWER STATION



- Dynamic Simulation Studies
- 65-70%

renewable energy In electricity production



Battery storage





IDENTIFICATION OF *SCENARIOS* FOR EVs INTEGRATION

- Night charging of EV avoids wind power cuts, ensures E-mobility and supply to the grid in peak hours



SÃO MIGUEL WINTER LOAD BALANCE

• Typical day regarding load and wind regime: storage increase needed



SEA



TEC4

TEC4SEA aims to become a Centre of Excellence in Ocean Research and Engineering, recognized worldwide.

TEC4SEA aims at bringing the energy transition, autonomous and digital worlds to a sustainable sea economy by inducing R&D activities in a market-pull innovation process targeting both established and emerging sectors





TEC4 MAIN INNOVATION SERVICES

- Development of optical and biosensors
- Broadband communications solutions
- Heterogeneous data integration and management
- Development of virtual and augmented reality solutions
- Offshore RES and multiple energy vectors integration

- Digital Twins and logistic optimization solutions
- Mission oriented robotic platforms
- On-board processing solutions and optimization
- Perception solutions, 3D mapping and data fusion
- Underwater positioning systems and navigation algorithms



CAPTURE OF LOST FISHING NETS



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Prevent Pos 2 Pos 3 Fishers as guardians of the ocean Tag locator Marker buoy Tag locator (SLU) Detection and removed of NET**TAG**⁺ Avoid location Fishing sears location Fishing sears locations Tagged gear acoustic release capabilities (releasing marker buoys) Robotic recovery assistance



AUTONOMOUS AERIAL INSPECTION PIONEER INITIATIVES

- Aerial robots developed for inspection of power assets
- Cooperation with Portuguese power utility company EDP
- LIDAR based navigation
- Onboard image processing (visible, IR, hyperspectral)
- Autonomous takeoff, landing and recharging







Inspeção de torres eólicas

Veículo autónomo aéreo

Penela





ENVIRONMENTAL MONITORING GLIDERS & AUVS BROAD DATA COLLECTION TO FEED DIFFERENT MODELS

Conventional AUVs and Gliders

Baseline data gathering

Continuous data gathering

Impact assessment

Measurements in the water column

Automation of processes

Water parameters

Acoustic monitoring

Biological data







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HYBRID AUVS SUPPORTING DETAILED INSPECTION AND SURVEY

EVA

- Developed initially for real-time bathymetry and perception in open pit mines (VAMOS project)
- Medium size (180 Kg), 2000m depth rated
- Autonomous, semi autonomous and ROV modes
- Advanced sensor payload capabilities

IRIS

- small size hybrid ROV/AUV (27 kg), 100m depth rated
- 5 DOF motion control
- Vision, imaging scanning sonar
- Multibeam profiling sonar



IRIS



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DEEP SEA AUTONOMOUS ROBOTIC LANDERS PLATFORMS FOR RESIDENT UNDERWATER ROBOTS

TURTLE

- Hybrid lander / AUV
 - Long term permanence on bottom (lander)
 - Autonomous locomotion for positioning/ re-positioning (AUV)
- Efficient vertical ascent/dive
 - Variable buoyancy system
- Acoustic communications
- Custom developed pressure tolerant batteries
- Autonomous navigation
 - INS
 - DVL
 - USBL/LBL acoustic positioning when in range
 - Multibeam sonar
- On board processing



PERMANENCE AT SEA AN ECOSYSTEM OF COMPLEMENTARY PLATFORMS

- TURTLE landers provide docking and energy charging to AUVs
- Surface buoy provides charging to landers
- Surface vessel for maintenance and deployment
- Robotic landers can be mobile observation nodes (ex. env. monitoring)
- Data transfer to control centers (on land)



ROOTICS IN EU-SCORES PAVE THE WAY FOR BANKABLE MULTI-SOURCE OFFSHORE PARKS

Environmental monitoring + Operations and maintenance



AGRO-FOOD

TEC4 AGRO-FOOD INESC TEC Platform for Agro-food and Forest

Co-creating the digital revolution



EC4 GRO-FOOD

INTELLIGENT PRECISION AGRICULTURE

DEMETER - Building an Interoperable, Data-Driven, Innovative and Sustainable European Agri-Food Sector <u>h2020-demeter.eu/</u>



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ROBOTICS FOR AGRI-FOOD

agROBOfood - Business-Oriented Support to the European Robotics and Agrifood Sector, towards a network of Digital Innovation Hubs in Robotics agrobofood.eu/



SRO-FOOD

INTELLIGENT PRECISION AGRICULTURE AND FOOD SAFETY

NOVATERRA - Integrated Novel Strategies for Reducing the Use and Impact of Pesticides, Towards Sustainable Mediterranean Vineyards and Olive Groves https://www.novaterraproject.eu/

News

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Stakeholders

Deliverables



Reducing the negative impact of pesticides through innovation in Mediterranean olive groves and vineyards.

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INTELLIGENT PRECISION AGRICULTURE AND FOOD SAFETY

SCORPION - Cost effective robots for smart precision spraying https://scorpion-

OBJECTIVE



h2020.eu/

Coordination INESC TEC, Portugal Spraying in agriculture represents a societal challenge due to its negative impact in human and animal health and in environment. SCORPION's objective is to develop a safe and autonomous precision spraying tool integrated into a modular unmanned tractor (robotics platform) to increase spraying efficiency, while reducing human and animal exposure to pesticides, water usage and labour costs. The project will focus on steep slope vineyards but with impact in other high-value permanent crops (olive groves and fruticulture). SCORPION' will consider Global Navigation Satellite System (EGNSS) receiver (triple frequency, PPP, OS-NMA, HAS) fused with other sensors, to increase the solution reliability, accuracy and safeness, and to enable autonomous ultraviolet light treatments (to eliminate partial need of phytopharmaceuticals) and to allow high precision spraying in permanent crops.

SUBSCRIBE TO NEWSLETTER

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SRO-FOOD

INTELLIGENT PRECISION AGRICULTURE

INTELLIGENT FERTILYSING SYSTEM



- Spraying precision
- Environmental protection
- Improved and increased production
- Right quantity, right moment, right place
- Compatible with ISOBUS
 tractors
- European standards

Made by Herculano



INESCTE

Powered by



RO-FOOD

TEC4AGRO-FOOD PARTNERSHIPS



EC4 **GRO-FOOD**

SUPPORTING PUBLIC POLICIES

SUPPORT TO PUBLIC POLICIES CASE 1 - EMERGENCY SITUATIONS



- Consultancy related to the SIRESP response during the Pedrogão's fires
 - Fire policy management, information systems for fires, and communications for first responders
- EVA underwater robot in Borba's marble quarry disaster
 - EVA requested by the Portuguese Navy to detect submersed vehicles
- Response to COVID-19 Pandemic
 - STAYAWAY COVID App Official Portuguese digital contact tracing application

Successful Demonstration of ?VAMOS! Underwater Mining Technology in UK



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SEARCH AND RESCUE IN A CATASTROPHE SCENARIO Borba Road Collapse - 2018 November 19th

- Underwater mining technology
- Two vehicles missing in a marble quarry flooded pit
- Support to the Portuguese Navy







SUPPORT TO PUBLIC POLICIES CASE 2 - ELECTRICAL ENERGY AREA



- Technical requirements, factors of preference and organisation of a 1.400 MW wind power public auction leading to a local industrial cluster – 2006
 - March 2018: 100% country's electrical energy from renewable sources
- Architecture to manage municipal Low Voltage networks concessions
- Specific technical requirements of Madeira's grid / Azores Graciosa Green Island
- Technical requirements (generation/storage) for solar generation auctions (2019)
- Future architectures of Iberian Electricity Markets, HVDC connections with Africa



- Portuguese industry
 - Mature sectors and SMEs from 200 M€ to 2.000 M€ in footwear exports
 - Emerging intervention in agro-industry and forestry
 - Long-lasting work supporting modernisation and digital transformation
- Active role in definition of National/European innovation agendas on industry
 - RIS3 (Smart Specialisation Strategies), MANUFUTURE ETP VISION 2030, Made in Europe PPP
- Support or leading part in National/European collaborative strategies
 - PRODUTECH, 12 CoLABs, CIT, VANGUARD initiative, iMAN Norte, DIHs

WHERE IS THE KNOWLEDGE FOR POLICY ADVICE?



- Who will offer the best advice on the location of a new airport, the huge investments on hydrogen, the complex smart grid regulations, the fiscal policy for electrical vehicles, underwater mining licenses, the 5G, ... and on all the public health issues raised by the pandemic?
 - The assessors of the ministers and secretaries of state?
 - The big 4 consulting companies?
 - Individual scientists, much too often real prima donnas?
 - Chief Technology Offices? Advisory Committees?
- Sound in-depth knowledge, integrity, transparency, multidisciplinarity, freedom of opinion, reasonable scientific consensus, etc. are imperative to advise on alternatives and options, but are hard to find all together

THANK YOU FOR YOUR

ATTENTION!



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WE ARE SCIENCE. WE ARE TECHNOLOGY. WE ARE INNOVATION. WE ARE INNESCIEC.

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