APPENDIX A – TECHNOLOGY PROPOSALS PoC ENEA 2025

The ENEA 2025 PoC technology proposals are divided according to the possible areas of application of the technology covered by the project, as listed below. Please note that the same technology may be present in different sectors.

Technological proposals applicable to both the "Open" and "Challenges" calls

- Aerospace
- Agri-food
- Materials

Technological proposals applicable only to the "Open" call

- Cultural heritage
- Technologies for smart communities
- Transportation - Vehicles and systems for land and sea mobility
- Energy
- Chemistry (green)
- Life sciences and health applications
- Smart factory - capital goods for industry and services
- Technologies for the environment and the circular economy
- Computer science & information technologies
- Innovative approaches and technologies for Made in Italy industries (fashion, wood-furniture-home furnishings, goldsmithing, etc.)
- Blue economy
- Construction, monitoring, and infrastructure safety technologies

Technological proposals applicable to both the "Open" and "Challenges" calls

Aerospace (applicable to both the "Open" and "Challenges" calls)		
NUC202501	ECOnductors	Efficient current generation in superconductors
NUC202506	SPRING	Perovskite scintillators for imaging ionising radiation
NUC202507	GRAFEMI	Graphene-based protective coatings for protection against electromagnetic interference (EMI shielding)
NUC202509	RADLIF	Lithium fluoride-based optical ionising radiation detectors for applications in dosimetry, radiotherapy, radiobiology and cosmic radiation
NUC202516	SPAZIO-MIRA	Early Monitoring of Musculoskeletal Alterations in Orbit Based on MIRcroRNA and AI
NUC202521	SCHERM-GA	Screens optimised with Genetic Algorithms – Experimental Validation of Multilayer Screens Optimised with Genetic Algorithms for Protection against Ionising Radiation
NUC202522	ILLUMINA	Innovative Led Lamp for Ultraviolet Material Irradiation and Next-generation Applications
NUC202523	IMDT	Improved Data Trasmission sub-GHz - Innovative prototype for the detection and transmission of environmental and biometric data using the LoRa protocol
SSPT202522	RFB	Functional Coatings for Bioplastics
SSPT202524	OPTIMA-3D	Optical ProtoType for Imaging, Measurements & Analysis – 3D
SSPT202526	ECOWELD	Enhanced Compatibility of Optimized WELDing for Dissimilar
SSPT202528	MACETE	Materials with high Electrical and Thermal Conductivity
SSPT202531	UV-ORBITSIM	Device and method for the simulation of ultraviolet radiation in Earth orbit
SSPT202532	MaCPro-SiSiC	CVI-Assisted Method for the Production of 3D Composites in SiSiC
TERIN202509	OPTIM-H_2	OPTical sensing for Intelligent Monitoring of H_2 storage

Agri-food (applicable to both the "Open" and "Challenges" calls)		
NUC202504	AGIN	Agriculture of functionalised hydrogels of natural origin
NUC202513	SLAM	Portable LIBS instrument for elemental analysis of solid materials and trace samples
NUC202514	HARPD	Hazelnut Reflectometric Pathogen Detection - Detection of pathogens in hazelnuts using reflectometry techniques
NUC202515	AGROLIBS	Detection of heavy metals and/or pesticides in food matrices using laser-induced breakdown spectroscopy (LIBS)
NUC202517	FLACS	Laser photoacoustic for security checks
NUC202519	THZMAT	THZMAT Terahertz for materials research - Development of a prototype broadband THz-TDS spectrometer for measurements on materials and biological samples
NUC202522	ILLUMINA	Innovative Led Lamp for Ultraviolet Material Irradiation and Next-generation Applications
NUC202523	IMDT	Improved Data Transmission sub-GHz - Innovative prototype for the detection and transmission of environmental and biometric data using the LoRa protocol
NUC202524	Q-NUT MM	Quality of NUTs via Millimetric wave Methods - Millimetre wave device for determining the quality of dried fruit
NUC202525	Digital BPM	Development of digital Beam Position Monitor (BPM)
SSPT202502	PROCHIT-CRAB	Integrated Process for Extracting Chitin from Blue Crab Shells
SSPT202503	Carliros-Whey	Bioprocesses for the production of carotenoids from red yeasts using dairy waste
SSPT202505	S.O.LI.D	Optimised Freeze-Drying Systems for Ready-Made Sauces Dry
SSPT202506	ECO-FUN	Eco-sustainable Agri-food Technologies for the Development of the Italian Mushroom Industry
SSPT202507	k-BREAD	Biotechnological evolution of Koji from fermented bran for the development of innovative and functional baked goods

SSPT202508	BAMP	Bio-Active Material for Packaging
SSPT202509	Be-Yeast-PRO	BEer by-product YEAST-derived PROtein (food & nutra) - High-Pro functional ingredients from spent brewery yeast
SSPT202510	PlantAb	Peroxidase labelled antibodies and biomolecules
SSPT202512	FAST- BREED	High-efficiency speed breeding platform for horticultural species
SSPT202513	BIOGLUSAFE-3	Integrated BIOtechnological approach for the development of flours with high technological properties with celiac disease-SAFE -3 GLUTINE proteins
SSPT202521	ELPIS	Electrochemical Learning sensor for PFAS Intelligent Surveillance
SSPT202522	RFB	Functional Coatings for Bioplastics
SSPT202524	OPTIMA-3D	Optical ProtoType for Imaging, Measurements & Analysis – 3D
SSPT202525	EtIMoBenD	Smart Labels for Perishable Goods Tracking
SSPT202529	DE-MOF	MOF-based desiccant device for the sustainability of dehumidification processes
TERIN202501	OLI.D.IN.	Use of by-products from fermentation processes for the production of fuel oils for green diesel by means of an insect bio factory
TERIN202510	BIOFIDS 2.0	Photobioreactor for BIOlogical Desulfurization of biogas
TERIN202504	RODIM	Robot for Mechanized Deweeding

Materials (applicable to both the "Open" and "Challenges" calls)		
NUC202502	TITAN	FeCh-based superconducting tapes and titanium nitride buffers
NUC202504	AGIN	Agriculture of functionalised hydrogels of natural origin
NUC202507	GRAFEMI	Graphene-based protective coatings for protection against electromagnetic interference (EMI shielding)
NUC202513	SLAM	Portable LIBS instrument for elemental analysis of solid materials and trace samples

NUC202519	THZMAT	THZMAT Terahertz for materials research - Development of a prototype broadband THz-TDS spectrometer for measurements on materials and biological samples
SSPT202508	BAMP	Bio-Active Material for Packaging
SSPT202517	RE-SiBAT	Silicon Recovery for Batteries
SSPT202518	DEGREE-PV	GREEn Delamination for the efficient recycling of end-of-life photovoltaic panels
SSPT202522	RFB	Functional Coatings for Bioplastics
SSPT202523	DECAMERON	DErived CArbon MatERials Realized for Optical Nanodevices
SSPT202524	OPTIMA-3D	Optical ProtoType for Imaging, Measurements & Analysis – 3D
SSPT202528	MACETE	Materials with high Electrical and Thermal Conductivity
SSPT202529	DE-MOF	MOF-based desiccant device for the sustainability of dehumidification processes
SSPT202530	GLAM WIND	Green and Low environmental impact design solutions by Additive Manufacturing for mini WIND turbines
SSPT202531	UV-ORBITSIM	Device and method for the simulation of ultraviolet radiation in Earth orbit
SSPT202532	MaCPro-SiSiC	CVI-Assisted Method for the Production of 3D Composites in SiSiC
TERIN202506	CEM0+	CEMENT AT KM 0 +
TERIN202507	GECOplus	Advanced Green Ecolight Cement mOrtar
TERIN202508	MAT-ENE	Development of monitoring techniques on advanced materials for energy applications
TERIN202511	BIOINK	Sustainable conductive water-based inks from biomass biochar for energy, sensor and flexible electronics applications
TERIN202512	NAVE	Anti-Counterfeiting and Efficient Verification Nanostructures

Technological proposals applicable only to the "Open" call

Cultural heritage (applicable only to the "Open" call)		
NUC202507	GRAFEMI	Graphene-based protective coatings for protection against electromagnetic interference (EMI shielding)
NUC202510	SOAP	Advanced optical sensors based on biocompatible quantum dots and smart polymers
NUC202511	LOCATE	LED Optics for Crime Analysis and Trace Evidence
NUC202512	IRIS	Integrated time-Resolved Imaging Spectroscopy
NUC202513	SLAM	Portable LIBS instrument for elemental analysis of solid materials and trace samples
NUC202518	MICONDEXRIC	Microwaves for material recycling - Creation of a microwave prototype for rapid analysis of materials for separation and recycling
NUC202524	Q-NUT MM	Quality of NUTs via Millimetric wave Methods - Millimetre wave device for determining the quality of dried fruit
SSPT202520	FACILE	Facilitate local Land incorporation in Environmental applications
SSPT202524	OPTIMA-3D	Optical ProtoType for Imaging, Measurements & Analysis – 3D
SSPT202525	EtIMoBenD	Smart Labels for Perishable Goods Tracking
TERIN202512	NAVE	Anti-Counterfeiting and Efficient Verification Nanostructures

Technologies for smart communities (applicable only to the "Open" call)		
DUEE202501	BIOFITO	Biogas production and integrated phytoremediation from domestic wastewater
DUEE202502	DOCCIA	Demand Optimization for Controlled Consumption in ACS
NUC202501	ECOnductors	Efficient current generation in superconductors
NUC202507	GRAFEMI	Graphene-based protective coatings for protection against electromagnetic interference (EMI shielding)
NUC202523	IMDT	Improved Data Transmission sub-GHz - Innovative prototype for the detection and transmission of environmental and biometric data using the LoRa protocol
SSPT202515	NasusDS	Device for the assessment of personal exposure to air pollutants
SSPT202516	SentinAir	Air Quality Monitoring Platform

SSPT202520	FACILE	Facilitate local Land incorporation in Environmental applications
SSPT202521	ELPIS	Electrochemical Learning sensor for PFAS Intelligent Surveillance
TERIN202509	OPTIM-H_2	OPTical sensing for Intelligent Monitoring of H_2 storage

Transportation - Vehicles and systems for land and sea mobility (applicable only to the "Open" call)		
SSPT202522	RFB	Functional Coatings for Bioplastics
SSPT202530	GLAM WIND	Green and Low environmental impact design solutions by Additive Manufacturing for mini WIND turbines
NUC202508	WISE-Joint	Weigh-In-motion Sensing Expansion Joint

Energy (applicable only to the "Open" call)		
DUEE202502	DOCCIA	Demand Optimization for Controlled Consumption in ACS
NUC202501	ECOnductors	Efficient current generation in superconductors
NUC202502	TITAN	FeCh-based superconducting tapes and titanium nitride buffers
NUC202520	ALAST	Highly efficient laminate architecture for tritium production in hybrid systems - Proof of concept of high-efficiency multilayer blanket for tritium production in hybrid fusion-fission reactors
NUC202521	SCHERM-GA	Screens optimised with Genetic Algorithms – Experimental Validation of Multilayer Screens Optimised with Genetic Algorithms for Protection against Ionising Radiation
NUC202523	IMDT	Improved Data Transmission sub-GHz - Innovative prototype for the detection and transmission of environmental and biometric data using the LoRa protocol
SSPT202517	RE-SiBAT	Silicon Recovery for Batteries
SSPT202518	DEGREE-PV	GREEn Delamination for the efficient recycling of end-of-life photovoltaic panels

SSPT202530	GLAM WIND	Green and Low environmental impact design solutions by Additive Manufacturing for mini WIND turbines
TERIN202501	OLI.D.IN.	Use of by-products from fermentation processes for the production of fuel oils for green diesel by means of an insect bio factory
TERIN202503	SStoBioMethane	Production of biomethane from sewage sludge and organic wastewater
TERIN202508	MAT-ENE	Development of monitoring techniques on advanced materials for energy applications
TERIN202509	OPTIM-H_2	OPTical sensing for Intelligent Monitoring of H_2 storage
TERIN202510	BIOFIDS 2.0	Photobioreactor for BIOlogical Desulfurization of biogas
TERIN202511	BIOINK	Sustainable conductive water-based inks from biomass biochar for energy, sensor and flexible electronics applications

Chemistry (green) (applicable only to the "Open" call)		
NUC202510	SOAP	Advanced optical sensors based on biocompatible quantum dots and smart polymers
NUC202513	SLAM	Portable LIBS instrument for elemental analysis of solid materials and trace samples
NUC202515	AGROLIBS	Detection of heavy metals and/or pesticides in food matrices using laser-induced breakdown spectroscopy (LIBS)
SSPT202502	PROCHIT-CRAB	Integrated Process for Extracting Chitin from Blue Crab Shells
SSPT202522	RFB	Functional Coatings for Bioplastics
SSPT202525	EtIMoBenD	Smart Labels for Perishable Goods Tracking
TERIN202501	OLI.D.IN.	Use of by-products from fermentation processes for the production of fuel oils for green diesel by means of an insect bio factory

TERIN202502	AGRO HI-GREEN	Valorization of agri-food waste and biochar by Hermetia illucens for the production of high value-added lipids useful in Green-Chemistry and a soil conditioner for carbon storage
TERIN202511	BIOINK	Sustainable conductive water-based inks from biomass biochar for energy, sensor and flexible electronics applications

Life sciences and health applications (applicable only to the "Open" call)		
NUC202503	SmartTBox	Smart Tent for real-time gamma radiation measurement
NUC202509	RADLIF	Lithium fluoride-based optical ionising radiation detectors for applications in dosimetry, radiotherapy, radiobiology and cosmic radiation
NUC202510	SOAP	Advanced optical sensors based on biocompatible quantum dots and smart polymers
NUC202516	SPAZIO-MIRA	Early Monitoring of Musculoskeletal Alterations in Orbit Based on MIRcroRNA and AI
NUC202520	ALAST	Highly efficient laminate architecture for tritium production in hybrid systems - Proof of concept of high-efficiency multilayer blanket for tritium production in hybrid fusion-fission reactors
NUC202521	SCHERM-GA	Screens optimised with Genetic Algorithms – Experimental Validation of Multilayer Screens Optimised with Genetic Algorithms for Protection against Ionising Radiation
NUC202525	Digital BPM	Development of digital Beam Position Monitor (BPM)
SSPT202501	MATISSE	Smart Asian Tiger Mosquito Sexing
SSPT202503	Carliros-Whey	Bioprocesses for the production of carotenoids from red yeasts using dairy waste
SSPT202510	PlantAb	Peroxidase labelled antibodies and biomolecules
SSPT202511	GREEN-PULSE	Targeted cancer therapy using electroporation of a plant-derived immunoconjugate

SSPT202513	BIOGLUSAFE-3	Integrated BIOtechnological approach for the development of flours with high technological properties with celiac disease-SAFE -3 GLUTINE proteins
SSPT202514	BOB-TMS	Characterization and Calibration of Flat and Angled BOBine TMS
SSPT202515	NasusDS	Device for the assessment of personal exposure to air pollutants
SSPT202516	SentinAir	Air Quality Monitoring Platform
SSPT202522	RFB	Functional Coatings for Bioplastics
SSPT202523	DECAMERON	DErived CArbon MatERials Realized for Optical Nanodevices
SSPT202525	EtIMoBenD	Smart Labels for Perishable Goods Tracking
SSPT202527	DO. SI.	Safe dosimetry
SSPT202531	UV-ORBITSIM	Device and method for the simulation of ultraviolet radiation in Earth orbit
SSPT202529	DE-MOF	MOF-based desiccant device for the sustainability of dehumidification processes

Smart factory - capital goods for industry and services (applicable only to the "Open" call)		
DUEE202502	DOCCIA	Demand Optimization for Controlled Consumption in ACS
NUC202503	SmartTBox	Smart Tent for real-time gamma radiation measurement
NUC202505	RAPERIN	Detector for ionising radiation and particles based on inorganic perovskites
NUC202510	SOAP	Advanced optical sensors based on biocompatible quantum dots and smart polymers
NUC202513	SLAM	Portable LIBS instrument for elemental analysis of solid materials and trace samples
NUC202517	FLACS	Laser photoacoustic for security checks
NUC202519	THZMAT	THZMAT Terahertz for materials research - Development of a prototype broadband THz-TDS spectrometer for measurements on materials and biological samples

NUC202523	IMDT	Improved Data Transmission sub-GHz - Innovative prototype for the detection and transmission of environmental and biometric data using the LoRa protocol
NUC202524	Q-NUT MM	Quality of NUTs via Millimetric wave Methods - Millimetre wave device for determining the quality of dried fruit
NUC202525	Digital BPM	Development of digital Beam Position Monitor (BPM)
SSPT202507	k-BREAD	Biotechnological evolution of Koji from fermented bran for the development of innovative and functional baked goods
SSPT202523	DECAMERON	DErived CArbon MatERials Realized for Optical Nanodevices
SSPT202524	OPTIMA-3D	Optical ProtoType for Imaging, Measurements & Analysis – 3D
SSPT202526	ECOWELD	Enhanced Compatibility of Optimized WELDing for Dissimilar
SSPT202529	DE-MOF	MOF-based desiccant device for the sustainability of dehumidification processes
SSPT202530	GLAM WIND	Green and Low environmental impact design solutions by Additive Manufacturing for mini WIND turbines
SSPT202532	MaCPro-SiSiC	CVI-Assisted Method for the Production of 3D Composites in SiSiC
TERIN202509	OPTIM-H_2	OPTical sensing for Intelligent Monitoring of H_2 storage
TERIN202512	NAVE	Anti-Counterfeiting and Efficient Verification Nanostructures

Technologies for the environment and the circular economy (applicable only to the "Open" call)		
DUEE202501	BIOFITO	Biogas production and integrated phytoremediation from domestic wastewater
NUC202503	SmartTBox	Smart Tent for real-time gamma radiation measurement
NUC202504	AGIN	Agriculture of functionalised hydrogels of natural origin
NUC202505	RAPERIN	Detector for ionising radiation and particles based on inorganic perovskites

NUC202510	SOAP	Advanced optical sensors based on biocompatible quantum dots and smart polymers
NUC202511	LOCATE - LED	LED Optics for Crime Analysis and Trace Evidence
NUC202513	SLAM	Portable LIBS instrument for elemental analysis of solid materials and trace samples
NUC202515	AGROLIBS	Detection of heavy metals and/or pesticides in food matrices using laser-induced breakdown spectroscopy (LIBS)
NUC202517	FLACS	Laser photoacoustic for security checks
NUC202518	MICONDEXRIC	Microwaves for material recycling - Creation of a microwave prototype for rapid analysis of materials for separation and recycling
SSPT202504	SPHINGOCOSO	SPHINGObacterium for the biological management of soil contaminants
SSPT202506	ECO-FUN	Eco-sustainable Agri-food Technologies for the Development of the Italian Mushroom Industry
SSPT202507	k-BREAD	Biotechnological evolution of Koji from fermented bran for the development of innovative and functional baked goods
SSPT202509	Be-Yeast-PRO	BEer by-product YEAST-derived PROtein (food & nutra) - High-Pro functional ingredients from spent brewery yeast
SSPT202515	NasusDS	Device for the assessment of personal exposure to air pollutants
SSPT202516	SentinAir	Air Quality Monitoring Platform
SSPT202517	RE-SiBAT	Silicon Recovery for Batteries
SSPT202518	DEGREE-PV	GREEn Delamination for the efficient recycling of end-of-life photovoltaic panels
SSPT202519	GUSCI	Shells for Structural, Circular and Innovative Uses
SSPT202520	FACILE	Facilitate local Land incorporation in Environmental applications
SSPT202521	ELPIS	Electrochemical Learning sensor for PFAS Intelligent Surveillance
SSPT202532	MaCPro-SiSiC	CVI-Assisted Method for the Production of 3D Composites in SiSiC

TERIN202501	OLI.D.IN.	Use of by-products from fermentation processes for the production of fuel oils for green diesel by means of an insect bio factory
TERIN202502	AGRO HI-GREEN	Valorization of agri-food waste and biochar by Hermetia illucens for the production of high value-added lipids useful in Green-Chemistry and a soil conditioner for carbon storage
TERIN202503	SStoBioMethane	Production of biomethane from sewage sludge and organic wastewater
TERIN202505	WILD-SAFE	Intelligent multi-sensor acoustic network for early detection of forest fires and safety in natural areas
TERIN202506	CEM0+	CEMENT AT KM 0 +
TERIN202507	GECOplus	Advanced Green Ecolight Cement mOrtar
TERIN202510	BIOFIDS 2.0	Photobioreactor for BIOlogical Desulfurization of biogas
TERIN202511	BIOINK	Sustainable conductive water-based inks from biomass biochar for energy, sensor and flexible electronics applications

Computer science & Information Technologies (applicable only to the "Open" call)		
SSPT202520	FACILE	Facilitate local Land incorporation in Environmental applications

Innovative approaches and technologies for Made in Italy industries (fashion, wood-furniture-home furnishings, goldsmithing, etc...) (applicable only to the "Open" call)		
SSPT202522	RFB	Functional Coatings for Bioplastics
TERIN202512	NAVE	Anti-Counterfeiting and Efficient Verification Nanostructures

Blue economy (applicable only to the "Open" call)		
NUC202511	LOCATE - LED	LED Optics for Crime Analysis and Trace Evidence

NUC202515	AGROLIBS	Detection of heavy metals and/or pesticides in food matrices using laser-induced breakdown spectroscopy (LIBS)

Construction, monitoring, and infrastructure safety technologies (applicable only to the "Open" call)		
NUC202503	SmartTBox	Smart Tent for real-time gamma radiation measurement
NUC202505	RAPERIN	Detector for ionising radiation and particles based on inorganic perovskites
NUC202508	WISE-Joint	Weigh-In-motion Sensing Expansion Joint
NUC202511	LOCATE - LED	LED Optics for Crime Analysis and Trace Evidence
NUC202513	SLAM	Portable LIBS instrument for elemental analysis of solid materials and trace samples
NUC202515	AGROLIBS	Detection of heavy metals and/or pesticides in food matrices using laser-induced breakdown spectroscopy (LIBS)
SSPT202521	ELPIS	Electrochemical Learning sensor for PFAS Intelligent Surveillance
TERIN202506	CEM0+	CEMENT AT KM 0 +
TERIN202507	GECOplus	Advanced Green Ecolight Cement mOrtar
TERIN202509	OPTIM-H_2	OPTical sensing for Intelligent Monitoring of H_2 storage

DUEE202501 – BIOFITO - Biogas production and integrated phytoremediation from domestic wastewater

Description of the technology
System capable of combining the purification of grey and black water, the disposal of organic waste, the production of biogas for domestic use or small commercial businesses, and the production of fertilizer. The main components of the proposed system are an Imhoff tank (currently the standard system for wastewater treatment in the absence of a connection to the sewer system), suitably modified to optimize and exploit biogas production, and a Phyto purification tank capable of treating grey water and excess digestate until the purified water can be released into the environment.
Possible applications
The proposed system primarily targets areas and individual buildings that are disconnected from sewerage and natural gas networks. In these situations, the greatest benefit is achieved by combining biogas production with wastewater treatment. In Italy, approximately 20% of residents live in such conditions. The system is also particularly suitable for developing countries.
Main advantages
Compared to a traditional Imhoff tank, the proposed system: • Allows the biogas produced to be recovered, reducing methane emissions and supplying energy to the system • Reduces the concentration of pollutants in wastewater, limiting soil and water pollution • Reduces sludge accumulation, resulting in less need for emptying and a consequent reduction in costs

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

DUEE202502 - DOCCIA- Demand Optimization for Controlled Consumption in ACS

Description of the technology
The technology transforms the heat production system into a 'smart storage' system to increase photovoltaic self-consumption. When PV production exceeds household consumption, the control automatically adjusts the heating power (on an electric boiler or heat pump) to store excess energy in the form of heat. The adjustment is made via a smart controller. The use of reinforcement learning allows it to adapt to user habits and adjust to weather forecasts. Thus, the energy that would be fed into the grid or wasted is made available in the following hours or when photovoltaic availability is low, reducing consumption and bills. Can be applied to new or existing systems.
Possible applications
Heat production optimising electricity consumption. Maximisation of electricity self-consumption, reduction of withdrawals and feed-in from the grid with a view to reducing bills. Stabilisation of the electricity grid outside urban areas. Reduction of unused photovoltaic energy. Suitable for houses, apartment buildings and small businesses, both in urban and isolated contexts.
Main advantages
• Adaptive control, rather than on/off control, regulates the power of the system in order to maximise PV production. • The possibility of implementing AI and reinforcement learning logic allows production to be adapted according to both consumption habits and weather forecasts. • The use of thermal storage reduces the need for chemical batteries and therefore system costs.

Technology Readiness Level	**Industrial Property**
TRL 4	-

NUC202501 – ECOnductors - Efficient current generation in superconductors

Description of the technology
Superconductors are capable of sustaining high currents and magnetic fields with ideally zero losses. For this reason, they have found use in various fields and are considered enabling technologies for a range of applications. The extraordinary properties of superconductors are currently limited by the need to generate their current at room temperature and to introduce transitions to the very low temperatures (below -200 °C) at which they operate. The proposed technology, based on particular interactions between magnetic fields and new families of superconductors (HTS), allows very high currents (even tens of thousands of amperes) to be induced without physical contact with the outside world. This makes it possible to fully exploit the enormous potential of superconductivity.
Possible applications
Current main applications include magnetic resonance imaging, Maglev trains and virtually all large research infrastructures (CERN, ITER, Fermilab, DTT). The technology would accelerate the production of energy from magnetic fusion, enable space applications of superconductivity (such as propulsion and shielding) and impact electricity transmission.
Main advantages
• Reduce losses, achieving efficiencies close to 100% • Reduce the initial investment costs (CAPEX) and operating costs (OPEX) of superconducting systems. • Reduce the size and weight of the systems (the only way to use them in satellites). • Reduce transitions between different temperatures. • Reduce current fluctuations. • Lower operating voltages.

Technology Readiness Level	**Industrial Property**
TRL 3	-

NUC202502 – TITAN - FeCh-based superconducting tapes and titanium nitride buffers

Description of the technology
Innovative structure of superconducting ribbons based on Fe(Se,Te), the simplest compound in the IBS family, deposited on a metal substrate with a conductive TiN interlayer using laser ablation (PLD). TiN promotes epitaxial growth and electrical continuity, contributing to thermal stability. The resistivity of the ribbon in the normal phase corresponds to that of the substrate and, at 22 K, is ~37 μΩ·cm, almost two orders of magnitude less than ribbons with insulating interlayers. Critical currents, $>10^5$ A/cm^2 at 4.2 K up to 17.5 T, are almost isotropic. The structure, simpler than solutions already implemented on metric lengths, reduces complexity and production costs. The PoC tests the process on lengths of tens of centimetres, with a view to larger-scale developments.
Possible applications
Iron-based superconducting tapes are flexible conductors that combine a metal substrate with superconducting materials from the Iron-Based Superconductors (IBS) family, known for their good tolerance to strong magnetic fields. They operate at low temperatures (<20K) and can be used in high-field magnets, NMR and nuclear fusion reactors.
Main advantages
• Elimination of complex insulating buffers. • Introduction of a conductive buffer. • Improved electrical and thermal stability. • Compact architecture and process simplification. • Potential reduction in manufacturing costs. • Reliable performance in high magnetic fields.

Technology Readiness Level	**Industrial Property**
TRL 4	Patent n. PCT/IB2024/057564 dated 05/08/2024 priority IT102023000016830A

NUC202503 – SmartTBox - Smart Tent for real-time gamma radiation measurement

Description of the technology
The smart inspection tent incorporates innovative portable gamma detectors to monitor radiation in real time. The system locates sources and measures their activity, ensuring operator safety (ALARA principle). This technology transforms an ordinary tent into an advanced radiological laboratory, enabling rapid decisions and immediate protection in the field within minutes.
Possible applications
Real-time monitoring of the location and radioactivity of materials containing gamma-emitting radionuclides, even in cases of accidental contamination. Application during environmental monitoring campaigns, emergency response operations, nuclear inspections by national experts and international organisations, e.g. IAEA, CTBTO, EURATOM, ESARDA.
Main advantages
• Portability of the smart tent. • Ability to intervene in emergencies and accidents, even in remote areas. • Operator safety. • Portability of detectors. • Easy integration into the smart tent structure. • Flexibility of detectors.

Technology Readiness Level	**Industrial Property**
TRL 6	-

NUC202504 – AGIN - Agriculture of functionalised hydrogels of natural origin

Description of the technology
The integration of bio-inspired hydrogels based on casein can improve soil aeration and drainage, increasing its productivity. They optimise fertiliser release, reducing pollution: they are effective in removing pollutants and organic compounds. They can be used for water treatment. They can act as water reserves and be added to the soil to increase its water retention capacity, reducing the need for irrigation. Furthermore, they transform potential waste into a high value-added resource, acting as a controlled release system for nutrients. This technology enables cultivation in conditions of extreme water scarcity, minimising the chemical footprint and regenerating the fertility of marginal soils.
Possible applications
Gels offer a sustainable approach to environmental problems. Casein-based gels transform dairy waste into a smart matrix for agriculture 4.0, overcoming the limitations of polymer systems that are polluting and less sustainable. They are efficient and environmentally friendly, acting as a biodegradable water lung. They reduce the chemical footprint and remediate soils from heavy metals and plastics.
Main advantages
• Ecological sustainability. • Controlled release of useful substances. • Release and absorption of water. • Removal of pollutants. • Low cost. • Industrial scalability. • Recycling of waste from other industries.

Technology Readiness Level	**Industrial Property**
TRL 4	-

NUC202505 – RAPERIN - Detector for ionising radiation and particles based on inorganic perovskites

Description of the technology
The innovation consists in the development of a solid-state detector based on inorganic perovskites (CsPbBr3, CsPbCl3). Compared to traditional semiconductors (CZT, silicon), these advanced materials offer superior stopping power and signal detection efficiency in more compact, lightweight and economical devices. Perovskite growth techniques guarantee high performance at low production costs. Thanks to its thermal stability and resistance to ionising radiation, perovskite does not require cooling, simplifying the detector and reducing energy consumption even in hostile environments. The aim is to bring the technology from the laboratory to a simulated operating environment (e.g. testing with real sources in radiological emergency scenarios).
Possible applications
The device allows real-time monitoring of ionising radiation and particles, ideal for environmental campaigns and nuclear safety. In scenarios of accidental contamination or radiological emergencies, it guarantees rapid response times. It is an innovative solution for inspections by international organisations (IAEA), enhancing the effectiveness of surveillance and radiation protection standards.
Main advantages
• Operability at room temperature. • Resistance to radiation. • Low cost and ease of crystal growth compared to traditional semiconductors. • More compact and lightweight devices. • Excellent transport properties, essential for electrical signals. • Industrial scalability. • Integration of the active medium into the device structure. • Flexibility of detectors.

Technology Readiness Level	**Industrial Property**
TRL 4	-

NUC202506 – SPRING - Perovskite scintillators for imaging ionising radiation

Description of the technology
New generation perovskite-based detectors and scintillators. Thanks to their chemical, physical and optical properties, these materials offer high light output, fast response times and good resistance to ionising radiation. These characteristics exceed the limits of traditional organic or inorganic technologies in medical diagnostics and plasma diagnostics in nuclear fusion experiments. The optimisation of the chemical composition, new synthesis methods, the size of the active material, such as nanocrystals and quantum dots, and their integration into amorphous and crystalline matrices will improve the stability, performance and final geometry of the system, offering innovative solutions with high potential.
Possible applications
Scintillators, radiation protection diagnostics, medical diagnostics and imaging, nuclear fusion plasma diagnostics, ionising radiation detectors, composite materials for photonic and optoelectronic applications, nanomaterials, light-emitting materials.
Main advantages
• Faster scintillation response. • Greater luminous efficiency through the use of specific chemical formulations. • Low cost. • Elimination of toxic and carcinogenic materials such as Cd. • High resistance to radiation. • Variable light emission depending on the chemical composition used. • Versatility in the geometry of the final composite.

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

NUC202507 – GRAFEMI - Graphene-based protective coatings for protection against electromagnetic interference (EMI shielding)

Description of the technology
Graphene-based polymer composite coatings designed to achieve high EMI shielding through combined absorption and controlled reflection mechanisms. Compared to existing EMI shielding coatings and technologies, the proposed technology allows application using common techniques (e.g. roller application) on any type of substrate. Furthermore, the coatings are designed to withstand vacuum, UV radiation, extreme thermal cycles and reduced degassing, maintaining electrical and mechanical stability, allowing for use in space applications.
Possible applications
Graphene-based composite coatings can be applied to architectural surfaces, mobile device casings and aerospace components to mitigate electromagnetic interference and protect sensitive electronic systems in terrestrial and space environments. The proposed technology is based on literature findings and research activities on conductive graphene composites, EMI functional coatings and advanced materials for aerospace, supported by electromagnetic modelling and accelerated ageing studies.
Main advantages
• High shielding/density ratio. • Lightweight and compatible with different surfaces. • Reduced thickness compared to metal shielding. • Application on substrates with user-friendly techniques.

Technology Readiness Level	**Industrial Property**
TRL 3	-

NUC202508 – WISE-Joint - Weigh-In-motion Sensing Expansion Joint

Description of the technology
Bridges and viaducts are exposed to excessive stress caused by the illegal transit of overloaded commercial vehicles. This necessitates more frequent routine maintenance, or rather, bringing forward extraordinary maintenance. To date, this phenomenon has been combated through patrols and the enforcement of static weighing of suspect vehicles, or through the costly installation of dynamic weighing portals (measurement of the weight of the vehicle in transit). The proposed technology gives expansion joints (indispensable in viaducts and common in bridges) the function of dynamic weighing. Virtually all types of joints have a mechanical design based on cantilever or supported beams. Both designs are suitable for the application of the proposed technology with low additional production costs and no additional installation costs. By equipping the classic expansion joint with the dynamic weighing function, the infrastructure is provided with an intrinsic capacity for permanent control of fraudulent overloaded transit.
Possible applications
The applications concern the commercial road transport sector. The main application concerns structural protection and the planning of maintenance activities for bridges and viaducts. Further applications concern pricing and, in general, differentiated regulation of commercial vehicle transit, including in the management of intermodal transfers.
Main advantages
• Function deliberately conferred, as an additional function, on an industrial product that is mandatory for another function. • Cost-effectiveness; existing dedicated products; require ad hoc procurement and installation. • Novelty in performing multiple functions; potential patentability. • Industrial product innovation. • Possibility of use in any context as an alternative to existing products.

Technology Readiness Level	**Industrial Property**
TRL 5	-

NUC202509 – RADLIF - Lithium fluoride-based optical ionising radiation detectors for applications in dosimetry, radiotherapy, radiobiology and cosmic radiation

Description of the technology
Crystal-based detectors, pressed powder tablets and thin films of lithium fluoride (LiF) that allow images of ionising radiation beams to be obtained and the absorbed dose after irradiation to be calculated by reading the visible photoluminescence signal emitted by the defects created in the LiF by the radiation, which can be acquired with a spectrometer or a conventional fluorescence microscope. The detectors also allow high spatial resolution images to be obtained of the tracks left by the passage of individual particles. The LiF films are grown on different substrates (glass, silicon, aluminium, flexible plastic substrates) with geometry and dimensions that can be adapted as required.
Possible applications
Detection of ionising radiation (X-rays, gamma rays, protons, electrons, neutrons, ions) for biomedical applications (radiotherapy and radiobiology), in materials science, energy, photonics and aerospace (space weather monitoring). High spatial, energy and dosimetric resolution characterisation of the aforementioned ionising radiation beams.
Main advantages
• Linear response of the photoluminescence signal as a function of dose up to 100 kGy and dynamic range of 114 dB (19 bits). • Reusable after annealing and does not require chemical development for photoluminescence reading. • Photoluminescence stable over time, independent of dose rate. • High spatial resolution (< 250 nm), wide field of view (> 1 cm^2) and equivalence to human tissue.

Technology Readiness Level	**Industrial Property**
TRL 4	-

NUC202510 – SOAP - Advanced optical sensors based on biocompatible quantum dots and smart polymers

Description of the technology
Optical sensors that combine photoluminescent nanoparticles, based on silicon, carbon or zinc, with smart polymers for applications in advanced diagnostics, environmental monitoring and security. The selected nanoparticles, produced by laser pyrolysis, are an optimal alternative to toxic quantum dots, and their functionalisation with smart polymers, capable of responding to changes in temperature, pH, ionic strength or the presence of chemical and biological agents, represents a winning strategy for the development of biocompatible, accurate, selective and user-friendly sensors. The proposed system is versatile, modular and can be integrated into photonic devices, allowing the creation of miniaturised sensors that are easily industrialised.
Possible applications
The optical sensors offered are used in the biomedical, industrial, security, environmental monitoring and artistic material degradation sectors, even in the most common applications, such as determining pH, the concentration of organic and inorganic analytes in the air and water, and the presence of metabolites and organic molecules in human and animal fluids and tissues.
Main advantages
• Biocompatibility and low or zero toxicity of the final device and its components. • Miniaturisation and ease of use. • Versatility and applicability in heterogeneous environments and contexts. • Tunability in wavelength or intensity of light emitted in response to external stimuli. • High control of the optical and morphological properties of individual components and sensor performance.

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

NUC202511 – LOCATE - LED Optics for Crime Analysis and Trace Evidence

Description of the technology
The LOCATE system allows the detection of forensic traces (fibres, fingerprints, body fluids) using high-resolution images (100 µm at 7 m) of an area of interest placed under high-power LED lighting and coloured absorption filters, exploiting the absorption/diffusion or fluorescence of the target. The system is designed to operate autonomously on an altazimuth mount between 3 and 10 m via remote control, allowing the operator to scan a selected area of interest directly via a graphical interface. By redesigning the light source and parallax correction mechanics, it can be easily miniaturised, so that it can be carried by hand or positioned on a UAV or UGV.
Possible applications
Forensic applications: • Blood detection • Fingerprint detection • Biological fluid detection • Textile fibre detection • Gunshot residue detection Application in environmental monitoring: • Presence of oils and pollutants in water. Application in cultural heritage: • Identification of alterations in works of art.
Main advantages
• Remote operation: no contamination of the crime scene, compatible with UAV/UGV. • Automated scanning of an area of interest between 3 and 10 m. • Technological solutions that allow use even in outdoor scenarios, eliminating environmental noise. • Eye-safe: based on incoherent radiation. • Modular system adaptable to the technical requirements of the desired targets (distance, vector).

Technology Readiness Level	**Industrial Property**
TRL 5-6	-

NUC202512 – IRIS - Integrated time-Resolved Imaging Spectroscopy

Description of the technology
Innovative scanning laser system based on laser-induced fluorescence (LIF), a spectroscopic technique that provides information on the surface chemical composition of samples by analysing the fluorescence emitted following the interaction of the laser beam with the surface. The system is portable, compact, non-invasive, capable of operating remotely and providing real-time responses. Its innovative feature lies in its ability to integrate multispectral fluorescence maps and hyperspectral point measurements, thanks to the optical collection system designed for rapid configuration changes. The detection of time-resolved signals, through the optimisation of electronics and hardware, constitutes a further technological advance.
Possible applications
The system is designed for the chemical-physical characterisation and rapid mapping of surface materials. Possible applications are mainly, but not exclusively, in cultural heritage, for diagnostic analysis, recognition of constituent materials, monitoring of degradation, detection of restoration work, and optimisation of conservation and restoration actions.
Main advantages
• Faster measurement with real-time responses, high spatial resolution and wide field of view. • Greater selectivity and sensitivity in detecting fluorescence signals, thanks to the time-resolved component, with better discrimination of overlapping spectral contributions and reduction of false positives. • Combined multi/hyperspectral analysis: rapid surface mapping and detailed analysis of critical areas, enabling comprehensive diagnostics 'from screening to detail' with a single instrument. • Non-invasive and remote inspection, suitable for delicate or inaccessible surfaces, minimising the risk of sample alteration and increasing operational safety. • Greater application robustness in real-world contexts, without the need for sample preparation and improved measurement repeatability.

Technology Readiness Level	**Industrial Property**
TRL 6-7	-

NUC202513 – SLAM – Portable LIBS instrument for elemental analysis of solid materials and trace samples

Description of the technology
The instrument directly measures the elemental composition within the laser spot and the evaporated layer in real time. The instrument is portable (handheld) or static, highly sensitive, with an integrated camera for sample viewing and WiFi connectivity. The static structure includes X-Y-Z micrometric slides for precise positioning and surface scanning; in handheld mode, a system ensures optimal alignment. The results are displayed quickly and saved automatically with sample photos, timestamps and associated metadata. Managed via laptop, it is designed for control on an LCD mounted on the sensor head. The integrated acoustic detection option provides additional data on the material, including the degree of detonation/combustion of detected traces.
Possible applications
• Rapid analysis of the elemental composition of solid or liquid samples, including light elements; analysis of traces on surfaces. • Mapping of the surface and stratigraphic distribution of elements on a solid sample. • In combination with acoustic measurements - information on the hardness/quality of the material, or recognition of explosive/combustible material in traces.
Main advantages
• Direct, rapid and sensitive measurements of even light elements in macroscopic or trace samples. • Surface scanning and high-resolution stratigraphy. • Compact and portable instrument, easy to use. • Material recognition can be implemented. • Data is automatically saved and sent to the API. • Laser-induced acoustic waves generate additional information about the sample.

Technology Readiness Level	**Industrial Property**
TRL 5-6	-

NUC202514 – HARPD (Hazelnut Reflectometric Pathogen Detection) - Detection of pathogens in hazelnuts using reflectometry techniques

Description of the technology
By analysing alternatives to fluorescence spectroscopy measures on this type of pathogen, it was found that reflectometry measures can be used to detect the difference between leaves attacked by the fungus and healthy leaves. This feature allows healthy leaves to be quickly and easily distinguished from diseased ones. Possible upgrades to the system include the ability to detect other types of pathogens and the feasibility of applying lidar techniques.
Possible applications
The proposed system can detect attacks by Erysiphe corylacearum, a fungal pathogen native to East Asia that has recently severely affected hazelnut crops in Italy. The system is simple and allows for user-friendly and rapid detection, without sampling or sample preparation, using a reflectometric imaging system to detect infected leaves in a crop, enabling early and targeted intervention.
Main advantages
• Compared to techniques that use fluorescence spectroscopy, the system provides a simpler response that requires less processing. • The system can operate like a standard camera. • The system can be mounted on drones to map entire plantations. • In principle, the system can use lidar techniques for remote measurements from a great distance.

Technology Readiness Level	**Industrial Property**
TRL 3	-

NUC202515 – AGROLIBS - Detection of heavy metals and/or pesticides in food matrices using laser-induced breakdown spectroscopy (LIBS)

Description of the technology
Laser-induced breakdown spectroscopy (LIBS) is a rapid chemical analysis method that uses a short laser pulse focused on the sample to create a small plasma composed of atoms and ions of the chemical species present in the sample itself. It is possible to obtain information on the chemical composition of the sample and thus search for contamination from heavy metals, pesticides and, potentially, any hazardous compounds of interest. The data is obtained in a matter of seconds. LIBS therefore provides an almost instantaneous chemical characterisation of the sample. Depending on the chemical element and the matrix to be examined, the technique can have a sensitivity of up to parts per million.
Possible applications
The search for traces of heavy metals or pesticides in the agri-food sector is of great interest, posing risks to public health and environmental contamination. The LIBS technique is proposed for quality control and real-time detection of these contaminants in foods such as cereals, meat or vegetables directly in the field or at production sites.
Main advantages
• Real-time data acquisition: measurement takes just a few seconds. • The technique requires little or no sample preparation. • In-situ sample testing with portable systems. • All chemical elements are detectable. • Potentially automatable -> online monitoring during the production process. • Able to measure samples at depths of up to tenths of a millimetre.

Technology Readiness Level	**Industrial Property**
TRL 7-8	-

NUC202516 – SPAZIO-MIRA - Early Monitoring of Musculoskeletal Alterations in Orbit Based on MIRcroRNA and AI

Description of the technology
The proposed technology integrates bioinformatics, artificial intelligence and advanced biosensors to develop a rapid, non-invasive diagnostic system for early and continuous monitoring of musculoskeletal health. Specific microRNAs are identified as molecular biomarkers of bone and muscle loss induced by microgravity and cosmic radiation in long-duration space missions. The biomarkers are detected in easily accessible biological fluids using nanostructured biochips and highly sensitive miniaturised sensors. The data is analysed by AI algorithms that extract diagnostic signatures and generate personalised profiles, supporting autonomous decisions in isolated environments. The solution is transferable to terrestrial medicine for the prevention of osteoporosis and muscle atrophy related to ageing, menopause and prolonged bed rest.
Possible applications
The technology enables the development of non-invasive diagnostic tools for early monitoring of musculoskeletal health during long-duration space missions, improving the safety of astronauts exposed to microgravity and cosmic radiation. Based on miRNA biomarkers and AI, it supports rapid screening and autonomous diagnostics in isolated environments, with important implications for terrestrial medicine in the prevention and control of osteosarcopenia, osteoporosis and muscle atrophy related to ageing, menopause and prolonged bed rest.
Main advantages
• Non-invasive, rapid point-of-care diagnostics that can be used directly on board without external medical support. • Early and continuous monitoring of musculoskeletal health, reducing clinical risks and irreversible damage. • Improved psychological well-being of astronauts thanks to autonomous health monitoring and reduced stress and uncertainty. • Predictive and personalised capabilities thanks to artificial intelligence. • Use of easily accessible fluids (saliva, urine, serum) • Easy transferability to the terrestrial clinical context

Technology Readiness Level	**Industrial Property**
TRL 4	-

NUC202517 – FLACS - Laser photoacoustics for security checks

Description of the technology
The proposed solution, developed at ENEA and based on laser photoacoustic spectroscopy, meets the need for rapid, reliable and non-destructive analysis for security and safety checks. The technique can identify and distinguish substances based on their spectral fingerprint, without altering the sample. Integration with multivariate analysis methods increases accuracy and discrimination capability. The system developed and optimised at ENEA is available in two versions: - laboratory prototype on a mobile platform (30x60x80 cm; 30 kg) - portable prototype for in situ analysis (42x27x15 cm; 6 kg) Versatility can be expanded by inserting different types of lasers, depending on the application required by the sector's needs.
Possible applications
The proposed technology meets security control requirements by preventing and detecting intentional and/or accidental threats that cause contamination in a wide range of scenarios, including the environment and agri-food. Possible areas of application: • Monitoring of hazardous substances in solid and liquid foods • Contamination of soil and agricultural products
Main advantages
• Non-destructive analysis, without chemical reagents and without complex sample preparation • Rapid screening (5 to 10 minutes) • Suitable for automation and remote management • Can be used in situ • Easy to use • More compact and portable than FT-IR, GC-MS, HPLC • Versatility and adaptability to different samples and scenarios, including environmental ones

Technology Readiness Level	**Industrial Property**
TRL 4-5	-

NUC202518 – MICONDEXRIC - Microwaves for material recycling - Creation of a microwave prototype for rapid analysis of materials for separation and recycling

Description of the technology
Micondexric is a system that uses microwave radiation between 60 and 110 GHz, low power (a few hundred milliwatts) and a geometry that simultaneously measures the reflected and transmitted power. The system consists of a microwave source, with its emission horn, which produces a beam with a transverse dimension of approximately 2 cm, and two detectors with their respective antennas. Both the source and the two detectors are located at a maximum distance of approximately 10 cm from the sample of material flowing through. It is fast (the measurement takes ten milliseconds) and compact. It is therefore suitable for the rapid separation of mixed materials (metals, wood, glass, plastic, etc.) or for verifying the purity of a separation that has already taken place (for example, in the separation and recycling of wood).
Possible applications
• Rapid separation of various materials (metals, glass, wood, plastic, bricks, etc.) on a conveyor belt • Final check after separation to avoid errors or foreign materials • Separation of wood from other impure materials
Main advantages
• The advantage of this system is that it is very compact, approximately a 20 cm cube. • The microwave power is very low and contained within the device, therefore posing no safety issues. • It is very fast (the measurement can take about ten milliseconds). • It is therefore suitable for the rapid separation of mixed materials, or for verifying the purity of a separation that has already taken place.

Technology Readiness Level	**Industrial Property**
TRL 5	-

NUC202519 – THZMAT Terahertz for materials research - Development of a prototype broadband THz-TDS spectrometer for measurements on materials and biological samples

Description of the technology	
The frequency range 100 GHz - 7 THz covers relevant phenomena relating to the composition/structure of materials, through characteristic resonances and rotational-vibrational cut-offs, uniquely defining specific constituent elements of materials. I propose the creation of a physical 2D scanning system and a Gaussian optics system that optimise focusing and scanning capabilities in relation to the different morphology of the samples. The device will be based on the completely optical beating of a laser beam, producing an extremely precise spectrum representative of the material's spectroscopic lines, seeking to maximise temporal resolution. Objectives: material characterisation and identification of any contaminants.	
Possible applications	
• Non-destructive measurement of the opto-mechanical properties and composition of materials • Non-destructive measurement of the condition of biological samples • Detection of specific components and compounds	
Main advantages	
• Non-destructive testing • Use of harmless radiation in the far infrared and submillimetre region • Well-developed and reliable technology for individual components • Complete 'photograph' of the properties of interest with a single instrument	
Technology Readiness Level	**Industrial Property**
TRL 4	-

NUC202520 – ALAST - Highly efficient laminate architecture for tritium production in hybrid systems - Proof of concept of high-efficiency multilayer blanket for tritium production in hybrid fusion-fission reactors

Description of the technology
Blanket structure designed for hybrid fusion-fission reactors for tritium production. The demonstrator uses an external neutron source (E=14 MeV) to irradiate a multilayer system composed of multiplying materials (lead) and moderators (polyethylene) using special Timepix detectors with lithium fluoride deposition (which simulates the lithium-producing material). The configuration is designed to slow down the neutrons and maximise the cross-section for tritium production in lithium. The experiment will validate neutron models and numerical simulations by measuring tritium production under conditions representative of future hybrid systems.
Possible applications
The technology is mainly applicable to the production of tritium to support the start-up and operation of future fusion reactors in an innovative way, to the development of hybrid fusion-fission systems, but also to the production of medical radioisotopes and the transmutation of nuclear waste, contributing to energy security and the sustainability of the fuel cycle.
Main advantages
• Optimisation of tritium production through neutron multiplication • Early experimental validation of innovative blanket concepts • Flexibility of application in hybrid fusion-fission systems • Support for fuel production for future fusion plants • Use for other purposes (production of medical and industrial radioisotopes and nuclear transmutation)

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

NUC202521 – SCHERM-GA - Screens optimised with Genetic Algorithms – Experimental Validation of Multilayer Screens Optimised with Genetic Algorithms for Protection against Ionising Radiation

Description of the technology	
Innovative multilayer screens for ionising radiation, designed using an architecture based on genetic algorithms (GA). The GA methodology automatically optimises the sequence of materials to minimise the total ionising dose on sensitive electronics and people.	
Possible applications	
• Protection of sensitive electronics in nuclear facilities (fusion and fission) • Shielding of satellites and space probes from cosmic rays. • Protection of medical devices in radiotherapy • Safety of electronic systems in environments with industrial and medical radioactive sources (radiation protection for diagnostics and therapy)	
Main advantages	
• Automatic optimisation vs. traditional empirical design • Significant reduction in TID compared to conventional solutions • Reusable database for future simulations	
Technology Readiness Level	**Industrial Property**
TRL 3-4	-

NUC202522– ILLUMINA - Innovative Led Lamp for Ultraviolet Material Irradiation and Next-generation Applications

Description of the technology
The proposed innovation is an LED lamp with near ultraviolet (NUV) emission (with wavelengths between 250 nm and 400 nm), which reproduces, in that spectral range, solar radiation in space outside the Earth's atmosphere. The LEDs, selected for wavelength, light output and number, are arranged in an optimised configuration on a printed circuit board and suitably cooled. The lamp can be used to test the resistance of materials of interest for space applications to the ultraviolet radiation emitted by the Sun outside the Earth's atmosphere. By acting on the spectrum emitted by the lamp, it is possible to switch the various wavelengths on/off, for experiments on plant organisms and for sanitising surfaces.
Possible applications
Main application: ultraviolet radiation exposure of materials of interest for space applications, both inorganic and organic, for resistance testing. Other possible applications: • UV irradiation of plants/fruit to stimulate the production of substances that increase resistance to pathogen attacks (pre- and post-harvest) • Sanitisation of surfaces from viruses, bacteria and fungi
Main advantages
Compared to existing sources (mercury or xenon discharge lamps), this ultraviolet LED lamp: • reproduces the ultraviolet spectrum of the sun outside the Earth's atmosphere with excellent approximation. • is powered by low voltage. • has very fast start-up times. • is modular. • does not emit in the visible and infrared ranges. • has adjustable spectral emission. • has a longer average life.

Technology Readiness Level	**Industrial Property**
TRL 4-5	-

NUC202523 – IMDT Improved Data Transmission sub-GHz - Innovative prototype for the detection and transmission of environmental and biometric data using the LoRa protocol

Description of the technology
Long-distance communication of environmental sensor data and biometrics using the LoRa protocol (bidirectional sub-GHz channel) has rapidly gained market share in recent years. This proposal draws on the knowledge of millimetre waves and near-optical waves accumulated by our laboratories over years of research into plasma diagnostics. The aim is to integrate existing technologies with specific modulation and radio transmission units to fill the current gaps, starting from a simulated environment to develop a laboratory demonstrator capable of improving the performance of existing technologies. This is achieved by using wider frequency bands and innovative carrier generation systems based on spark gap emitters and other quasi-optical devices, as well as synchronous modulation.
Possible applications
• Monitoring and transmission of environmental and technical parameters • Remote detection and transmission of spatial configurations and dimensions • Detection and transmission of leaks and faults • Telemetry of unmanned devices for civil use
Main advantages
• Improved connection stability and increased bandwidth • Ability to easily vary the bands used to exclude interference • Increased transmission speed through the parallel use of complementary frequency bands

Technology Readiness Level	**Industrial Property**
TRL 4	-

NUC202524 – Q-NUT MM (Quality of NUTs via Millimetric wave Methods) - Millimetre wave device for determining the quality of dried fruit

Description of the technology
The technology developed uses non-ionising radiation with high penetration capacity, capable of passing through any shells and detecting the amount of water contained in the sample, which is an indicator of the sample's quality. Multiple applications can be envisaged in the nut supply chain, as well as in the qualitative assessment of seeds or other samples.
Possible applications
• Determination of nut quality without the need for shelling • Determination of the amount of water inside seeds or dried fruit • Determination of the amount of water in generic samples, with applications also in the field of cultural heritage and industry • Determination of subsurface defects or inhomogeneities in non-conductive samples, with applications in industry and cultural heritage
Main advantages
• Non-invasive, non-destructive analysis (non-ionising radiation). • Subsurface analysis, not available with other technologies. • Avoids having to open the sample for testing. • Potentially applicable to total production, not just samples (fast technique). • Synergistic use of physical data and neural networks.

Technology Readiness Level	**Industrial Property**
TRL 4	-

NUC202525 – Digital BPM - Development of digital Beam Position Monitor (BPM)

Description of the technology
Conventional BPMs determine the position of the beam by detecting a pair of voltages or currents whose values are a continuous function of position. This detection must be extremely accurate and is carried out using expensive analogue electronics. A different configuration of the sensitive electrodes, combined with a detection algorithm that operates natively in digital mode, reduces the complexity of the control electronics, delegating many functions to the (less expensive) software instead of the traditional (more expensive) analogue hardware. Furthermore, as the system is modular, it allows the level of precision required to be increased as needed, depending on the application.
Possible applications
All applications in which a particle beam must be collimated: nuclear diagnostics, nuclear medicine, sputtering/ion deposition in (micro/nano) manufacturing processes, selective irradiation.
Main advantages
• reduction in production costs • increased reliability • increased configurability and flexibility of use • increased immunity to interference

Technology Readiness Level	**Industrial Property**
TRL 3	Patent n. IT102018000003379

SSPT202501 – MATISSE - Smart Asian Tiger Mosquito Sexing

Description of the technology
The Wolbachia bacterium induces natural sterility that can be exploited to produce male mosquitoes capable of sterilising wild females. ENEA has developed and already tested this technology on tiger mosquitoes, reaching TRL7 (https://pubmed.ncbi.nlm.nih.gov/37022600/). A crucial issue for large-scale application is the efficient separation of the sexes. The innovation is based on the use of RNA interference as a molecular approach to automatically separate males and females, significantly improving on current mechanical methods, which are inefficient, or those based on artificial intelligence and expensive, bulky machinery. The existence of similar technology developed in a similar species demonstrates the robustness and feasibility of the approach within the anticipated timeframe.
Possible applications
The idea aims at the commercial development of a strategy to control diseases transmitted by the tiger mosquito, based on exploiting the biological properties of a bacterium hosted by many insects and completely harmless to humans: Wolbachia (https://www.mdpi.com/2076-0817/14/3/285). Implementing this idea would significantly reduce operating costs and decisively increase the sustainability of control.
Main advantages
• Significant reduction in the production costs of tiger mosquito sterilising males • Significant increase in the efficiency of the logistics chain for the distribution of sterilised males throughout the territory • Increased efficiency of current tiger mosquito sexing systems • Facilitation of the elevation of the TRL of the tiger mosquito control technology developed by ENEA • Development of a technology that can also be adapted to other similar contexts

Technology Readiness Level	**Industrial Property**
TRL 5	-

SSPT202502 – PROCHIT-CRAB - Integrated Process for Extracting Chitin from Blue Crab Shells

Description of the technology
Modular process for extracting chitin from blue crab shells, based on chemical, biological and enzymatic approaches with low environmental impact, which can be integrated with physical technologies in order to improve yield and efficiency. Among the activities to be developed: the structural, morphological and thermal characterisation of the chitin obtained in order to verify its purity and stability; the feasibility of recovering secondary materials, such as mineral fractions ($CaCO_3$) and pigments (astaxanthin); preliminary assessments of the biological functionality of chitin, as a priming agent and/or phytoprotective agent, to explore its potential application in agronomy.
Possible applications
Development of a sustainable and modular process to obtain high-quality chitin for applications in agriculture, as a priming agent or plant protection product, and in agro-industrial supply chains, as a raw material for bio-based products (chitosan and derivatives). The residual biomass from the process (mineral fractions and pigments) can be used in the food, cosmetics and industrial sectors.
Main advantages
• Valorisation of an invasive species into an economic resource for food, agronomic and industrial uses • Development of a sustainable process with low environmental impact • Modular process integrated with innovative approaches (green solvents, enzymes, ultrasound) • Increased extraction yield and product quality • Valorisation of secondary process flows • Process scalability

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

SSPT202503 – Carliros-Whey - Bioprocesses for the production of carotenoids from red yeasts using dairy waste

Description of the technology
Innovative process for the production of carotenoids from red yeasts, including torularodine, using by-products from the dairy industry. The technology aims to optimise the production and extraction process in order to launch the product on the market and meet the growing demand for high added-value compounds based on new biomolecules for nutraceutical, pharmaceutical and cosmetic applications. At the same time, the technology aims to contribute to the sustainable management of dairy waste in a circular economy perspective, transforming an environmental problem into an economic resource.
Possible applications
Potential applications of the technology include the development and formulation of new complementary feeds (the market for carotenoids for animal feed is estimated to reach $3.41 billion by 2026), food additives, supplements, novel foods, nutraceuticals and pharmaceuticals based on red yeasts or their extracts.
Main advantages
• Contributes to increasing and improving the production of natural carotenoids. • Enables the creation of products based on new carotenoids such as torularodine, which are not yet available on the market. • The carotenoid extraction method is green and avoids toxic solvent residues in the product. • Transforms waste into high added-value products.

Technology Readiness Level	**Industrial Property**
TRL 4	Patent n. IT102023000018729 dated 25/09/2025

SSPT202504 – SPHINGOCOSO - SPHINGObacterium for the biological management of soil contaminants

Description of the technology
The proposed technology uses a naturally occurring microorganism, already proven (ENEA studies) to be capable of degrading polypropylene, integrated into a scalable process for producing biomass. This is then used to functionalise biochar for agricultural use, combining the benefits of soil conditioner with a biological function that acts against plastics, improving soil health and reducing the accumulation of microplastics. Innovation responds to the need for sustainable and scalable solutions to tackle plastic pollution in agri-environmental systems, with benefits for the environment and health, contributing to pollution reduction, improving ecosystem quality and transforming an environmental problem into a functional resource for agriculture.
Possible applications
The technology is applicable to the pilot and industrial-scale production of microbial biomass capable of degrading polypropylene. The biomass is integrated into functionalised biochar to be used as an agricultural soil improver with a dual function: improving soil health and reducing microplastics, while maintaining the standard agronomic benefits of biochar.
Main advantages
• Natural and sustainable biodegradation • Reduction of pollution and recalcitrant plastic waste • Integration into circular economy processes • Ecological restoration of plastic-contaminated ecosystems • Scalability of the technology • Viable large-scale solution

Technology Readiness Level	**Industrial Property**
TRL 4	-

SSPT202505 – S.O.LI.D - Optimised Freeze-Drying Systems for Ready-Made Sauces Dry

Description of the technology
The technology enhances production residues and surplus sauces and creams by transforming them, through freeze-drying, into ready-made "dry" sauces. The aim is to obtain foods that are stable at room temperature with a shelf life of more than 12 months, ensuring chemical stability, microbiological safety and sensory quality. The process reduces waste, recovers resources, optimises energy consumption and uses sustainable packaging methods. The result is a safe, high-quality food product that is easy to transport and store, promoting a circular and sustainable model and serving as an example of technological innovation applied to the circular economy.
Possible applications
Ready-made "dry" sauces, obtained from the processing of surplus and residues from the production of sauces and creams according to a circular approach, can be easily rehydrated for domestic or industrial use. They can be used as ingredients in recipes, snacks or ready meals, facilitating transport, storage and distribution, reducing waste and promoting sustainable practices in catering and the food supply chain.
Main advantages
• reduces food waste by making use of surplus produce • guarantees long shelf life (>12 months) at room temperature • maintains high quality, safety and sensory characteristics • facilitates transport and storage thanks to the 'dry' product • promotes sustainable packaging and circularity

Technology Readiness Level	**Industrial Property**
TRL 3	-

SSPT202506 – ECO-FUN - Eco-sustainable Agri-food Technologies for the Development of the Italian Mushroom Industry

Description of the technology
The main problem with seed oil production plants is the correct management of residual plant biomass, which can amount to several hundred tonnes per year. Preliminary studies conducted in IFAL laboratories have shown that this material, which is still rich in organic substances, can be used in mushroom cultivation. Mushrooms are able to assimilate it, using it as nourishment and thus producing a denser and more compact mycelium than conventional growth substrates. The use of these waste products in the mushroom production chain not only maximises circularity in an ecologically sustainable way, but also adds economic value, giving a significant boost to the production of foods with high nutritional value.
Possible applications
Production of edible mushrooms, such as oyster mushrooms (Pleurotus ostreatus), king oyster mushrooms (Pleurotus eryngii) or cornucopia mushrooms (Pleurotus conucopiae), adding certain vegetable by-products (SOV) from the processing of seed oils (sunflower, corn, grape seed) to the classic cultivation substrates. (sunflower, corn, grape seed).
Main advantages
• Increased mushroom production yields • Reduced mushroom production costs • Commercial exploitation of currently unused waste (grape seed meal) • Commercial exploitation of low-value waste (maize and sunflower waste) • Increased competitiveness of the mushroom farms involved compared to their foreign competitors

Technology Readiness Level	**Industrial Property**
TRL 5	-

SSPT202507 – k-BREAD - Biotechnological evolution of Koji from fermented bran for the development of innovative and functional baked goods

Description of the technology
K-BREAD innovates bran upcycling by combining biotechnology and digitalisation through solid-state fermentation (SSF) with Aspergillus oryzae, managed by an IoT system: sensors and machine learning algorithms monitor the bioreactor in real time to ensure standardisation and scalability. Processing increases bioactive compounds and palatability while reducing anti-nutritional compounds. In vivo tests on human cells will be carried out to confirm physiological benefits and bioavailability. Final validation takes place in the METROFOOD-IT Kitchen Lab, where the by-product is transformed into healthy ingredients ready for the market, ensuring that nutritional value translates into real health benefits.
Possible applications
K-BREAD enables the industrial upcycling of bran into functional ingredients for the bakery sector, improving digestibility and sensory profile (umami). Applications include the development of healthy baked goods (clean label), the valorisation of cereal waste in a circular economy perspective, and the optimisation of digital bioreactors through AI.
Main advantages
• smart-ingredient: Transforms bran into a bioactive ingredient rich in umami • up-cycling: Optimises cereal waste with a view to the circular economy • adaptive AI control: Machine learning guarantees standardisation and maximum bioavailability of nutrients • validated efficacy: Exceeds the limits of common methods thanks to in vivo tests that confirm physiological benefits

Technology Readiness Level	**Industrial Property**
TRL 4	-

SSPT202508 – BAMP - Bio-Active Material for Packaging

Description of the technology
To address the need to reduce food waste, increase the shelf life of fresh products and simplify the end of life of packaging, B.A.M.P. has been developed, an innovative bio-film based on ENEA (SSPT-AGROS-IFAL) know-how. The material has a bacteriostatic function, protects food and prolongs its freshness, while maintaining a natural transparency that enhances the product at the point of sale. Made from biodegradable matrices extracted from agri-food waste and a blend of natural polymers with antimicrobial properties, B.A.M.P. functions like plastic but exceeds its limitations: separated from paper, it can be disposed of as organic waste, reducing its environmental impact and the risk of microplastics.
Possible applications
B.A.M.P. is a transparent film made from biodegradable biomaterial that extends shelf life and reduces food waste. Unlike PE-PVC films used in packaging, B.A.M.P.'s revolutionary single-material design eliminates the problem of disassembly thanks to its ease of disposal. It improves food preservation and protects the environment.
Main advantages
• Functional performance: integrates protection and bacteriostatic activity, extending shelf life compared to passive plastic films. • Circular origin: uses biodegradable matrices from agri-food waste, unlike conventional bioplastics • Easy end-of-life: separable from paper and disposable in organic waste, outperforming multilayer films • Lower environmental impact: does not generate microplastics, a critical limitation of existing technologies

Technology Readiness Level	**Industrial Property**
TRL 4	-

SSPT202509 – Be-Yeast-PRO - BEer by-product YEAST-derived PROtein (food & nutra) - High-Pro functional ingredients from spent brewery yeast

Description of the technology
The solution recycles spent brewer's yeast, a production waste product, transforming it into a high-protein powder (CNF). After a washing phase aimed at removing bitter compounds, the biomass undergoes controlled autolysis (50 °C) to promote the release of proteins, peptides and amino acids. The liquid obtained is then fractionated by tangential filtration, combining microfiltration and diafiltration, followed by nanofiltration (MWCO 800 Da) to concentrate the low molecular weight fractions. The concentrate (CNF) is then stabilised by spray drying (yield ~70%), obtaining a stable and homogeneous powder. The final product has a protein content of approximately 70% on a dry basis and exhibits interesting functional properties in vitro, including antioxidant activity (DPPH/ABTS), inhibition of α-amylase and α-glucosidase, and prebiotic activity.
Possible applications
High-protein functional ingredient from spent brewer's yeast (~70% dry matter protein), in powder form and easy to measure out. Applications: protein enrichment and flavour enhancement in bread/pizza, snacks, baked goods and prepared foods; supplements/nutraceuticals; ingredient for 'clean label' drinks and foods with prebiotic activity and potential support for glycaemic control.
Main advantages
• Upcycling of an abundant by-product: reduces waste and disposal costs • High protein concentration (~70% dry matter) and presence of essential peptides/amino acids: "high protein" ingredient • Multifunctional ingredient: antioxidant, antimicrobial, prebiotic activity and potential anti-glycaemic effect (in vitro tests) • Potential opportunity to exploit all by-products of the powder production process • Scalable and green process (membranes + spray drying), without organic solvents

Technology Readiness Level	**Industrial Property**
TRL 5	-

SSPT202510 – PlantAb - Peroxidase labeled antibodies and biomolecules

Description of the technology
Biomolecules are fundamental reagents in diagnostics in any sector (medical, veterinary, agri-food) and are often functionalised to enable their detection. In enzyme-linked immunosorbent assays (ELISA), antibodies are associated with the peroxidase enzyme which, through a colorimetric reaction, allows the quantification of target molecules. The patented technology replaces chemical conjugation, allowing complete antibodies (IgG) or other biomolecules to be conjugated with peroxidase using biotechnology. These molecules produced through plant farming can be used in any immunoenzymatic assay and replace existing diagnostic reagents, contributing to cost-effectiveness and sustainable production (company) and ensuring application advantages (users).
Possible applications
Development of innovative reagents and diagnostic tests based on recombinant biomolecules produced biotechnologically in plants. The reagents obtained in this way can replace traditional reagents in any diagnostic sector (biomedical, veterinary and agri-food) and be used in diagnostic systems such as: ELISA, Biosensors, Lateral Flow.
Main advantages
• Reduced production and purification costs for diagnostic reagents • Standardisation and analytical reproducibility • Reduced analysis times • Cost-effectiveness and sustainability of the plant production process • Applicable to existing diagnostic systems

Technology Readiness Level	**Industrial Property**
TRL 4	Patent n. IT102023000016701

SSPT202511 – GREEN-PULSE - Targeted cancer therapy using electroporation of a plant-derived immunoconjugate

Description of the technology
The treatment of solid tumours is complicated by the low penetration of chemotherapy drugs. The proposed technology is based on the use of a new molecule, scFvH10-GrB (immunoconjugate), produced in plants at low cost and composed of the H10 antibody (owned by ENEA), which recognises a receptor present on solid tumours, fused to a cytotoxic molecule, Granzyme B, capable of inducing cell death. The innovation lies in combining the use of the scFvH10-GrB molecule with electroporation to increase drug penetration in solid tumours. Initial proof of concept of the molecule's cytotoxic efficacy and increased antibody penetration mediated by EP was obtained on glioblastoma spheroids (brain tumour) spheroids.
Possible applications
Possible applications include: • Targeted cancer therapy for solid tumours mediated by electroporation • Development of new non-invasive treatments for solid tumours with low permeability
Main advantages
• The immunoconjugate (antibody-drug conjugate-ADC) is produced in plants at very low manufacturing costs • The integration of electroporation and ADC molecules is an innovative strategy for improving the therapeutic delivery of biopharmaceuticals in low-permeability solid tumours • This approach could pave the way for the development of new non-invasive cancer treatments

Technology Readiness Level	**Industrial Property**
TRL 4	-

SSPT202512 – FAST-BREED - High-efficiency speed breeding platform for horticultural species

Description of the technology
The technology consists of a speed breeding method for tomatoes based on the identification of specific conditions of photoperiod, light intensity and light spectrum. The process, tested on three cultivars, two determinate and one indeterminate, accelerates the tomato growth cycle by increasing the number of annual generations from 3 to 5, obtaining seeds with a germination rate of over 90%. The results obtained show that the response is genotype-dependent, making the method extendable to other tomato cultivars or other horticultural species to evaluate and optimise their response. The solution reduces the time and cost of genetic improvement, responding to the need to accelerate varietal innovation in the agricultural sector.
Possible applications
Speed breeding technology makes it possible to significantly accelerate genetic improvement programs in tomatoes and other horticultural species, increasing the number of annual generations. It is applicable in public and private breeding and represents a key tool to reduce varietal development times and increase the competitiveness of the seed sector.
Main advantages
• Reduction of genetic selection times • Demonstrated increase in annual generation cycles • Protocol experimentally validated and expandable on a large scale in tomato (Solanum lycopersicum) • Applicability to other species of horticultural interest

Technology Readiness Level	**Industrial Property**
TRL 5	-

SSPT202513 – BIOGLUSAFE-3 - Integrated BIOtechnological approach for the development of flours with high technological properties with celiac disease-SAFE -3 GLUTINE proteins

Description of the technology
As part of the BIOGLUSAFE research activity, a α"detoxified" -gliadin and HMW-glutenin have been designed, produced, tested and patented, made safer for celiac patients by preserving the technological properties so that if added to naturally gluten-free flours they allow the creation of doughs and products comparable in organoleptic terms to those obtained with gluten-containing flours. The assays carried out so far indicate that these proteins do indeed have reduced immune-stimulating properties. BIOGLUSAFE-3 aims to: i) deepen the characterization of immunotoxicity on cell lines/organoids and biopsies; ii) to verify the characteristics of doughs obtained with gluten-free flours to which -αgliadin and HMW-glutenin are added.
Possible applications
Celiac disease is an autoimmune disease characterized by the establishment of a state of chronic inflammation of the small intestine triggered, in genetically predisposed individuals, by the ingestion of gluten proteins (gliadins and glutenins) present in the grains (seeds) of some cereals (wheat, spelt and similar species such as barley). In celiac or gluten intolerant subjects, the only treatment available today is to completely and permanently eliminate gluten from the diet. The social costs of celiac disease are very high and are reduced only when the patient learns through a specialist diagnosis that he or she is suffering from the disease and adopts the appropriate diet. To promote adherence to the diet in many countries, including Italy, health systems offer partial reimbursement of the expenses incurred by patients for the purchase of food. Although considerable progress has been made to improve the palatability of gluten-free foods, industrial products available on the market are often high in calories and have a lower nutritional value. The project, through an integrated biotechnological approach, is aimed at creating a new category of foods for gluten-intolerant or celiac individuals, no longer gluten-free but gluten-safe, with organoleptic (consistency) and nutritional (no additives) properties superior to the products currently on the market.
Main advantages
Preparation of foods for celiac subjects that are safe but healthier than those currently on the market (because they are free of additives) and more similar in organoleptic properties to those obtained with flours containing gluten.

Technology Readiness Level	**Industrial Property**
TRL 4	Patent No. WO 2023/012561, Priority No. IT102021000021194 Patent No. 102025000022489

SSPT202514 – BOB-TMS - Characterization and Calibration of Flat and Angled BOBine TMS

Description of the technology
Integrated methodology for the characterization, calibration and advanced modelling of TMS coils, including those with angled geometries and non-standard configurations, which introduce complexities that cannot be managed with the simplified models currently in use. The solution combines high-precision experimental measurements and dedicated numerical modeling to obtain validated, parameterizable and shape-independent coil models. The integration of current TMS tools into neuronavigation systems and computational codes allows to faithfully represent the real geometry of the coil, improving positioning, reproducibility and estimation of the induced electric field, and overcoming the limits of generic approaches available today.
Possible applications
The methodology supports the integration of any TMS coil into neuronavigation systems and simulation codes, improving positioning accuracy and electric field calculation. It is applicable to neuroscience research, development of new coils, and optimization of clinical protocols.
Main advantages
• Possibility of using neuronavigation systems and standard induced electric field calculation on coils of different geometries, both planar and angled. • Increased versatility and accuracy of TMS stimulation. • Precise and targeted positioning of angled coils for deep treatments.

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

SSPT202515 – NasusDS - Device for the assessment of personal exposure to air pollutants

Description of the technology
The NasusDS device leverages the advantages of low-cost miniature electrochemical gas sensors with the benefits of smartphone technology. It allows the measurement of personal exposure to air pollution because it has a high degree of portability being its size comparable to that of a smartphone. In addition, it can create home monitoring networks as it connects via Bluetooth with a smartphone device. It has very low electricity consumption, allowing a good autonomy in terms of batteries. It also allows the use of a wide range of sensors characterized by different technologies and the combination of these characteristics allows the creation of air quality maps.
Possible applications
The technology makes it possible to measure the concentrations of the main air pollutants in every environment frequented by an individual: building interiors, vehicle interiors and urban environments. Its ability to connect via Bluetooth with any smartphone allows you to create small home networks, if, for example, you have the possibility of housing a sample for each room.
Main advantages
• Measuring personal exposure to different types of air pollutants • Allows the use of different types of sensors, devices and technologies • Ability to create air quality monitoring networks in a few simple steps • Measurements of air pollutants on the move

Technology Readiness Level	**Industrial Property**
TRL 7-8	-

SSPT202516 – SentinAir - Air Quality Monitoring Platform

Description of the technology
The technology makes it possible to have an instrument similar to a "Swiss army knife" capable of using sensors and devices based on different types of technologies and with different electronic interfaces. Similar solutions on the market use only one type of technology or sensor, and generally, force the use of the device only in certain areas: either indoors, or outdoors. The proposed platform, thanks to its particular software structure and its hardware capable of interfacing via any electronic interface to sensors or devices, solves this problem.
Possible applications
The SentinAir platform is a versatile, low-cost tool for real-time air quality control and monitoring where the installation of chemical analyzers cannot be carried out for logistical, economic, or environmental comfort reasons. It is used in apartments, hospitals, public offices, or in monitoring networks for outdoor environments such as urban areas.
Main advantages
• Can be used in all environments (indoor, outdoor, or in the laboratory) • Allows the use of different types of sensors, devices and technologies • Enables the creation of sensor networks without the aid of third-party cloud services • Allows a high degree of customization

Technology Readiness Level	**Industrial Property**
TRL 7-8	-

SSPT202517 – RE-SiBAT - Silicon Recovery for Batteries

Description of the technology
The installed photovoltaic capacity in the world is growing strongly and, considering a useful life of photovoltaic (PV) panels of 25–30 years, by 2050 it is estimated that 60–78 million tons of PV will be disposed of. End-of-life PVs are a resource of valuable materials, including silicon, which is classified by the EU as a strategic material. It is therefore essential to recover silicon from PVs at the end of their life in order to be able to re-introduce it into high value-added supply chains, such as lithium-ion batteries. To this end, ENEA has patented a purely mechanical purification process, with low environmental impact, useful for making the recovered silicon suitable for use as an anode material (TRL 4). RE-SiBAT aims to increase the TRL of this process, solving some critical issues.
Possible applications
The activity embraces both the recycling sector of discarded photovoltaic panels and the sector of lithium-ion batteries for portable electronics and electric mobility. The silicon recovered from decommissioned or defective modules is reused for the production of anodes with high specific capacity for lithium-ion batteries with better performance than commercial ones.
Main advantages
• Lithium-ion batteries with higher energy density than commercial batteries • Reducing the use of graphite (natural graphite is a strategic material for the EU) • Reuse of silicon from PV panels without chemical purification • Use of CMC instead of PVDF as a polymer binder in the silicon-based anode with advantages related to cost, environmental impact and sustainability

Technology Readiness Level	**Industrial Property**
TRL 4	Patent n. IT102023000018996

SSPT202518 – DEGREE-PV – GREEn Delamination for the efficient recycling of end-of-life photovoltaic panels

Description of the technology
The recycling of PV panels at the end of their life is essential for the sustainable management of resources and the circular economy. DEGREE-PV tackles the delamination of the panel by chemical-physical means with green solvents to be used as an alternative or in support of the technologies currently in use: chemical, thermal and mechanical (shredding) characterized by the use of unsustainable solvents, high energy expenditure, dangerous gaseous emissions and contamination of the collected fractions. DEGREE-PV promotes the delamination of the panel layers also using physical processes, such as microwave and/or ultrasonic treatments and/or heating at low temperatures. The effectiveness of the method will be tested by the chemical-physical characterization of the recovered components.
Possible applications
DEGREE-PV concerns the recycling of PV panels through chemical delamination applicable to existing treatment plants. The process makes it possible to recover recyclable plastic fractions, isolate and properly dispose of fluorinated plastics, avoid mutual contamination of glass, silicon, silver and copper, ensuring greater purity of the individual components.
Main advantages
• Use of chemical solvents with low environmental impact • Reduced contamination of all collected fractions • Increased value of recovered secondary materials • BS (backsheet) recycling possible if indicated in the Digital Product Passport • Absence of hazardous gaseous emissions for thermal systems if BS fluorinated • Less energy-intensive and more effective process than thermal and mechanical

Technology Readiness Level	**Industrial Property**
TRL 3	-

SSPT202519 – GUSCI - Shells for Structural, Circular and Innovative Uses

Description of the technology
The proposed technology provides a sustainable solution for the disposal/reuse of shellfish shells at sea: experimental modules will be created using mixtures, consisting of cements and/or mortars combined with shredded shells, optimized to promote marine colonization, in particular of the flat oyster (*Ostrea edulis*, filter feeder, which traps CO2 and forms submerged structures that promote biodiversity and regenerate marine environments). The goal is threefold: to reuse the waste of local mussel farming in the Gulf of La Spezia with a view to circular economy, to combat climate change by creating practical solutions to promote biodiversity and contain coastal erosion in an area with high biodiversity and vulnerable to climate change.
Possible applications
The sustainable reuse of waste shells produced by shellfish farming is limited (to date in the poultry food industry and in agriculture) and with sustainability issues. The project aims to reuse the biomaterial of the shells in the marine environment, creating structures with a view to the circular economy to encourage the establishment of useful organisms.
Main advantages
• Valorisation of shells, processing waste from shellfish farming • reuse of shells locally, with benefits for the marine environment • use of sustainable structures, which can facilitate the colonization of organisms naturally present in the Gulf, providing ecosystem services • CO2 sequestration by facilities (as a climate change mitigation action)

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

SSPT202520 – FaciLE - Facilitate local Land incorporation in Environmental applications

Description of the technology
Development of algorithms and software for mapping soil characteristics from satellite data and inventories available for environmental applications with surface details in terms of buildings, infrastructures, land morphology and plant species. The prototype will transform data from sources (local, national, European) into usable data from environmental models at local scale. The data collected will be subjected to trust procedures, integrated in space and time to make them consistent, and then made available to stakeholders for applications. The first version will be for atmospheric models (meteorological, chemical transport, climate) applied to cities or urban areas for an integrated management of surface and activity changes.
Possible applications
Monitoring of changes in the territory and their impacts on the environment, in support of territorial prevention and planning policies for the adaptation and mitigation of climate change, pollution reduction and biodiversity conservation. Support for the protection of outdoor cultural heritage and the management of smart cities (energy and mobility).
Main advantages
• FaciLE will provide a tool and finished products to map land cover at the local scale through integrated processing of data from various sources at various scales with a high level of 3D detail, currently not available. • The approach, partially developed in the Life VEG-GAP, will be operationalized for urban planning applications and air quality and climate plans.

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

SSPT202521 – ELPIS - Electrochemical Learning sensor for PFAS Intelligent Surveillance

Description of the technology
Low-cost sensor for PFAS based on molecular fingerprint polymers (MIPs). Since PFAS are chemically stable and non-electroactive, MIP cavities allow selective analyte recognition and indirect signal transduction by electrochemical techniques, without direct reactions. The solution is compatible with real aqueous matrices. The use of chemometric analysis according to a Quality by Design approach will allow to optimize the performance of the device, which will be applicable in the environmental, industrial and energy sectors. Alternative low-cost sensory solutions will also be evaluated in a comparative way.
Possible applications
Continuous monitoring of PFAS in surface, groundwater, drinking water and wastewater, even in remote or hard-to-access sites. Control of contaminated areas, industrial plants and energy infrastructures (including hydrogen/fuel cell supply chain), to support environmental protection, public health and regulatory compliance.
Main advantages
• In-situ and real-time monitoring, without sample transport • High selectivity towards target PFAS • Reduced time, cost and logistics compared to laboratory methods • Sensor compatible with remote monitoring systems • Quality by Design approach for robustness, repeatability and scalability • Chemometric analysis for multifactorial calibration

Technology Readiness Level	**Industrial Property**
TRL 3	-

SSPT202522 – RFB - Functional Coatings for Bioplastics

Description of the technology
Development of coatings (inorganic, organic or hybrid) using physical, chemical or combined techniques, to be applied especially on bioplastics/biopolymers that are biodegradable or compostable at the end of their life, with a view to sustainability and eco-design. The purpose of these functional coatings will be to modulate the properties of bioplastics in terms of antimicrobiality, gas or vapor barrier, wettability, optical/aesthetic characteristics, to improve or expand their uses in the food, biomedical, transport, aerospace, textile, etc. sectors.
Possible applications
Coating of bioplastics for high-barrier packaging, antimicrobial biomedical devices, technical textiles, filters. Agri-food: food/beverage packaging Biomedical: tools, devices, implants, prostheses Components in means of transport and public/private environments -Textiles: garments, fabrics Aerospace: components for spacecraft, suits Air/water filtration: masks, filters.
Main advantages
• Efficiency: Improved performance • Durability: extending the life of products • Versatility: various modular functional properties, treatment possibilities of various types of bioplastics/biopolymers • Scalability: adaptability to production processes • Reduced environmental impact: biodegradable/compostable bioplastics, low carbon footprint materials and coating processes

Technology Readiness Level	**Industrial Property**
TRL 4-5	-

SSPT202523– DECAMERON - DErived CArbon MatERials Realized for Optical Nanodevices

Description of the technology	
Sustainable synthesis methodology to produce carbon-based photoluminescent and/or electroluminescent nanostructures, alternatives to the rare earth-based phosphors currently used. The aim is for an industrially scalable process, and with tunable photoemission by adjusting the synthesis parameters. It is also intended to experiment with vegetable carbon sources, to reduce the use of fossil fuels and give further added value to the process. White light-emitting diodes (wLEDs) are critical for next-generation lighting technologies. However, given that they use various critical raw materials (CRMs), such as rare earths, they are a concern in terms of sustainability and security of supply.	
Possible applications	
Advanced photo- and/or electro-luminescent carbon-based nanomaterials; light sources for optics and optoelectronics, for lighting, displays, integrated optics, sensors; Possible applications in medical diagnostics as biomarkers.	
Main advantages	
• Materials derived from chemical synthesis, free of components that come from mining • Modulation of light emission starting from a single material and changing only the synthesis parameters • Materials of carbonaceous origin, so it is easy to reuse or dispose of the exhausted active material, so the technology has a low environmental impact	
Technology Readiness Level	**Industrial Property**
TRL 3-4	-

SSPT202524 – OPTIMA-3D - Optical ProtoType for Imaging, Measurements & Analysis – 3D

Description of the technology
Instrument that allows to carry out an analysis of the scattered light from a sample, in order to obtain, through the acquisition and processing of a single image, the angular distribution of the scattered light, and therefore the information of roughness, the state of a surface, or the size and refractive index of particles. The light scattered by a sample is engraved on a fluorescent diffuser. The image that is formed on this screen is acquired and processed, being able to obtain the angular data of the scattered light from the sample. A key and innovative element of the set-up is the fluorescent screen, which transmits light in all directions, regardless of the energy and direction of the incident beam.
Possible applications
Determine the roughness and finish of surfaces, or the size and refractive index of particles, by means of optical characterization, with installations that allow the evaluation of any discrepancies and/or mechanical stress of materials even on production lines. The technique is proposed to replace the Angular Resolved Scattering and Dynamic Light Scattering techniques.
Main advantages
• Elimination of repeated angular measurements to obtain the entire three-dimensional mapping of the diffuse beam • Simplification of the optical set-up (elimination of mirrors, integrating spheres, lenses, etc.) • Reduction of measurement times • Possibility of repeated measurements over time of the sample under examination: instantaneous information of roughness, alignment, crosslinking, n and k indices, etc.

Technology Readiness Level	**Industrial Property**
TRL 4	Patent n. IT102016000091073

SSPT202525 – EtiMoBenD - Smart Labels for Perishable Goods Tracking

Description of the technology
The proposed technology concerns an RFID-type electronic label, designed to transmit sensory data related to the storage conditions of the product to which it is applied, and optionally a unique identifier. The label is applied to primary or secondary packaging and communicates wirelessly with a dedicated reader, optimized to detect information in the vicinity of the label itself. The transmission uses only the variation of the electromagnetic spectrum of the RFID channel. Labels can be produced on a large scale and at low cost using printing and/or converting techniques. The reader is compact and can be integrated into mobile devices, reducing costs and space. The technology is fully compatible with existing RFID systems.
Possible applications
Monitoring of perishable goods, if exposed to temperatures or other unsuitable environmental parameters, for agri-food, pharmaceutical, logistics, medical, and when it is necessary to detect the exceeding of thresholds or doses of exposure. Applications can include food and beverages (wines, oils, dairy products, etc.), pharmaceuticals, cosmetics, electronics, chemicals, or biologics.
Main advantages
• No batteries or other power systems on the label • No RFID chip required • Lower costs than commercial tags • Possibility of introducing sensors on the labels • Production possibilities using printing and/or converting technologies

Technology Readiness Level	**Industrial Property**
TRL 4-5	Patents n. IT102016000079657 and n. IT102020000001084

SSPT202526 – ECOWELD - Enhanced Compatibility of Optimized WELDing for Dissimilar

Description of the technology
Electron beam welding of dissimilar materials involves integrating welding for both wire repair and additive manufacturing (AM) inserts. The electron beam allows the heat input to be precisely adapted to the different properties of the materials, stabilizing the weld pool, reducing defects and residual stresses. The use of specially designed filler wires and AM inserts allows for a controlled transition between materials, improving chemical and mechanical compatibility. The complete high-speed control of the energy input allows the simultaneous execution of welding, heat treatment and control with the correction of porosity and cracks, promoting zero-defect manufacturing, increasing the sustainability of welding processes, reliability and service life of components.
Possible applications
Dissimilar joints advanced lightweight aerostructures (e.g. Ti/Al/steels); manufacture of cryogenic engines (Ni, Ti superalloys, steels, CuCrZr); localized repairs with additive manufacturing inserts; multi-material pressurized components in the aerospace/energy sector; Direct Energy Deposition with filler wire to control the interface, reduce brittle phases and increase reliability.
Main advantages
• Enabling for dissimilar welds in aerospace, energy and batteries, thanks to the high modularity of the energy density associated with specific joint chemistry formulations • Optimized energy-to-matter transfer regardless of the material being processed • The vacuum process guarantees the possibility of treating all materials including reagents

Technology Readiness Level	**Industrial Property**
TRL 5-6	-

SSPT202527 – DO. SI. - Safe dosimetry

Description of the technology	
The proposed solution is based on the different use of sensors already in use at hospitals that carry out radiotherapy. In particular, an innovative electronic circuit has been developed that can drive the MOSFETs of which the sensors are composed in different ways. In addition, a Synthetic Intelligence section has been added that can quickly read the absorbed dose value.	
Possible applications	
The proposed solution aims to create an innovative product in the field of safety and precision of cancer treatment through radiotherapy.	
Main advantages	
• Real-time dose reading • Accuracy of the dose taken • Safer radiation oncology	
Technology Readiness Level	**Industrial Property**
TRL 7	-

SSPT202528 – MACETE – Materials with high Electrical and Thermal Conductivity

Description of the technology
A concrete need in aerospace is for lighter, more reliable and easily cooled electronic and antenna components. Today, standard metals or polymers with limited thermo-electric performance are often used, with increased weight and costs. Our solution develops advanced engineering plastics that, thanks to two-dimensional materials (such as graphene and boron nitride), combine lightness with high heat dissipation and, when necessary, electrical conduction or shielding. Everything will be made with industrially ready processes: injection molding or filament 3D printing, reducing adoption times and costs. The expected benefits include electronics and systems, such as antennas, that are lighter and have "tailor-made" thermal and electrical properties.
Possible applications
Materials for electronic components and antennas in the aerospace field based on engineering plastics (such as PEI/PEEK/PAEK) reinforced with 2D nano-crystals (h-BN, graphene), obtaining adjustable thermo-electric properties, lightness and low release (outgassing). The same functionality can be achieved with 2D filled glues or coatings.
Main advantages
• High thermal and electrical conductivity with low percentage by weight of 2D fillers: weight and cost reduction • Industrial processes: advanced materials for injection molding and 3D printing • Functional selectivity: h-BN increase in thermal conductivity; graphene increase in both thermal and electrical conductivity • Engineering plastics (PEI/PAEK/PEEK): low outgassing, thermal stability

Technology Readiness Level	**Industrial Property**
TRL 4-5	-

SSPT202529 – DE-MOF - MOF-based desiccant device for the sustainability of dehumidification processes

Description of the technology
Desiccant device based on the advanced polymer/MOF COMPOSITE (PVDF-HFP/Al-fumarate), developed in ENEA through an original process with sustainable solvents, is proposed. The composite exhibits a vapor adsorption curve that allows the effective drying of the air with which it is put in contact and to be subsequently regenerated even at low temperatures, lower than those of traditional materials. Previous activity has already shown in the laboratory an ideal behavior of the material for industrial dehumidification processes, with high efficiency and low environmental impact. The desiccant device will allow to demonstrate the application effectiveness of the composite in the real operating conditions of industrial processes.
Possible applications
The primary application is dehumidification processes (food industry, pharmaceuticals). The advantage extends to HVAC systems, enthalpy recuperators and thermal storage. Other applications: intelligent packaging for asset protection, portable dehumidifiers and low-impact drying cells for the agro-industry.
Main advantages
• Sustainability of processes: low regeneration temperature (also through thermal waste) compared to traditional materials; Reduction of the environmental impact of industrial dehumidification • High performance: high water vapor adsorption capacity • Operational efficiency: Superior performance effectiveness with fewer resources deployed

Technology Readiness Level	**Industrial Property**
TRL 3-4	-

SSPT202530 – GLAM WIND - Green and Low environmental impact design solutions by Additive Manufacturing for mini WIND turbines

Description of the technology
Innovative method of production of the wind rotor of small turbines, based on additive manufacturing (AM). AM will be used for: • production of innovative moulds and tools in reinforced technopolymer, with particularly complex shapes optimised for wind power and for the specific installation site, intended for the lamination of blade shells in lightweight and recyclable fibre-reinforced composite • on-demand production of non-structural components, functional to the integration of the rotor and the reduction of the visual impact of the system. The aim is therefore to achieve a more sustainable approach to production, using technological solutions based on AM and eco-design, and at the same time improve the landscape integration of small-scale wind turbines.
Possible applications
Innovative production of wind turbines, through molds produced for 3D printing polymer composites for the production of components. Use of similar moulds in related production sectors, such as aeronautics/nautical. Use of small-scale wind turbines in areas with strong landscape constraints, thanks to the reduction of their visual impact obtained with new materials and production processes.
Main advantages
• Reduce mold production costs and time by using AM and polymer composites instead of metals • To create recyclable moulds with complex geometries, exploiting the potential of Design for AM • Reduce the visual impact of small wind turbines, increasing environmental sustainability and the use of strategic raw materials • Implement industrial co-development for future wind farm configurations

Technology Readiness Level	**Industrial Property**
TRL 3	-

SSPT202531 – UV-ORBITSIM - Device and method for the simulation of ultraviolet radiation in Earth orbit

Description of the technology	
UV simulator for space environment based on multi-channel LED matrix (≈270/308/340/380/400 nm) integrated with UV→UV fluorescent converter deposited on reflective internal surfaces (e.g. annular reflector) to obtain an almost continuous and moldable UV spectrum as much as possible in compliance with ASTM E-490 standards (std). A closed-loop control reads irradiance/spectrum at the sample floor (UV sensors and spectrometer) in real time and regulates the currents of the LED channels by compensating for thermal drift and aging, with thermal management (liquid-cooled plates) and vacuum chamber operation.	
Possible applications	
Accelerated vacuum qualification of materials, coatings, adhesives, optics and components intended for missions in Earth orbit, with UV irradiation with adjustable spectrum (265–405 nm) and measurement at the sample plane; support for test campaigns for satellite integrators, test centers and R&D laboratories.	
Main advantages	
• Higher UV spectral fidelity than Hg/Xe lamps far removed from ASTM E-490 or LED arrays alone • Feedback on the spectrum to the sample plane (includes re-emission of the UV→UV converter) • Improved uniformity and repeatability in vacuum, with automatic drift compensation • Scalable modular architecture (power, sample distance, spectral profile)	
Technology Readiness Level	**Industrial Property**
TRL 4	-

SSPT202532 – MaCPro-SiSiC - CVI-Assisted Method for the Production of 3D Composites in SiSiC

Description of the technology
Process involving the integration of 3D printing with the CVI (Chemical Vapour Infiltration) process to obtain SiSiC composites, as an alternative to the conventional process (Liquid Silicon Infiltration). SiSiC preforms, after printing, will be infiltrated with carbon by CVI: the CVI process takes place in the gas phase, thus allowing the infiltration of C even in the smallest porosities. This C will then be available to Si in the subsequent reaction bonding/sintering phase, for the production of densified SiSiC composites with low residual porosity. The use of 3D printing allows the efficient use of resources, the reduction of processing waste and the production of components with complex geometry, which cannot be obtained with conventional forming methods.
Possible applications
The applications of SiSiC 3D composites obtained with the proposed methodology differ according to the final ratio between SiC (high specific stiffness) and Si (electrical conductivity), making them suitable for the production of e.g. electric heaters or high-efficiency heat exchangers for different application areas and with a view to sustainability.
Main advantages
• Lower residual porosity due to the infiltration of C in the gas phase • Improved handling resistance after printing due to consolidation with C • Production of components even with complex geometry • Reduced final mechanical machining • Reduction of processing waste • Greater uniformity of Si distribution • Possibility of using both SiC and Si recycled powders

Technology Readiness Level	**Industrial Property**
TRL 3	-

TERIN202501 – OLI.D.IN. - Use of by-products from fermentation processes for the production of fuel oils for green diesel by means of an insect biofactory

Description of the technology
The innovative technology consists of process innovation aimed at the recovery of exhausted yeasts and their enhancement into nutritional additives in insect biofactories for the production of oil for energy purposes. The innovation is focused on oil yeasts (*Lipomyces*) residual from the fermentation process and extraction of the fat component, which can be used together with insect oil for the production of HVO biodiesel. The proposed solution would contribute to the competitiveness of the bioenergy supply chain through the valorisation of microbial waste and would provide a new nutritional supplement to the insect farming sector, in line with the principles of the *Green Economy*. The discarded biomass will be tested in substrates for the insects *Tenebrio molitor* and *Hermetia illucens*.
Possible applications
Final products (nutritional additives and insect oils for energy purposes) could be applied in line with the *Green Economy* to: • feed/substrates for insect breeding; • "starter" feed for Hermetia illucens *larvae-inoculum* intended for the bioconversion chain, waste for the production of products for green chemistry and biorefinery; • Insect oils for "green" diesel.
Main advantages
• Economic enhancement of by-products of the production process based on oil yeasts, generating value from waste, greater competitiveness and sustainability of the HVO biodiesel supply chain. • Recovery for energy purposes of oils from insects bred on fermentation by-products; • New nutritional additive for animal feed, obtained from by-product according to the principles of the *Green Economy*.

Technology Readiness Level	**Industrial Property**
TRL 3	-

TERIN202502 – AGRO HI-GREEN - Valorization of agri-food waste and biochar by Hermetia illucens for the production of high value-added lipids useful in Green-Chemistry and a soil conditioner for carbon storage

Description of the technology
Use of the biological driver *Hermetia illucens* for the bioconversion of agri-food waste, with the primary objective of optimizing the yield and quality of the larval lipid profile for applications in green chemistry, through the integration of biochar in the growth substrate; another aim will be to obtain a soil conditioner with greater agronomic value. The innovation involves the study of new biomass formulations to be converted, enriched with different concentrations of biochar, in order to improve the physicochemical characteristics of the substrate, to stabilize the intestinal microbiota of the larvae and potentially influence the accumulation of fatty acids, to facilitate the process of larval separation from the residue (frass) and to obtain a soil conditioner enriched in N and C.
Possible applications
Biochar in the bioconversion process of agri-food waste through *Hermetia illucens*, can affect the composition of fatty acids accumulated in the larvae, making the oil extracted from *H.i.* a sustainable alternative to high-oleic sunflower oil for the production of biofuels, biolubricants, surfactants and bio-based compounds. In addition, biochar allows the storage of CO2 in the soil.
Main advantages
• Valorisation of agri-food waste and biochar • diversification of reuse, creation of new market outlets in the field of Green chemistry and greater profit • low environmental impact of the technology: rearing of larvae on agri-food waste and low energy input (T 27°C, dark) • Stimulus for territorial development of industrial symbiosis

Technology Readiness Level	**Industrial Property**
TRL 4-5	-

TERIN202503 – SSTOBIOMETHANE - Production of biomethane from sewage sludge and organic wastewater

Description of the technology
Sewage sludge from civil and industrial wastewater contains organic and inorganic substances of interest. Recent regulations have redefined its agricultural use. In Italy, in 2022, of the 3.5 million tons produced, only 43.4% is sent for recovery, while the rest is destined for disposal. Anaerobic digestion also produces by-products such as digestate, which can be used as a soil conditioner or to obtain biomethane. The proposed technology recovers secondary currents, reducing environmental impact and increasing biomethane yield thanks to sorbents in the reaction bed that capture CO2. The resulting syngas has high methane content and H2/CO ratio favorable to methanation. The results show final streams with over 96% methane, suitable for injection into the grid.
Possible applications
The proposed technology is used in energy recovery applications of organic matrices that are difficult to treat with other plant solutions. Potential uses include: • Production of biomethane from organic waste • Energy recovery from organic matrices and/or waste in general • Heat treatment and energy conversion of sewage sludge • Heat treatment and energy conversion of digestate
Main advantages
• Flexibility of use with different solid matrices with high moisture and ash content • Plant modularity • Scalability • Possible use of in-bed sorbents for direct CO2 capture • Simple construction of the reactor and small dimensions • Portability

Technology Readiness Level	**Industrial Property**
TRL 6	

TERIN202504 – RODIM - Robot for Mechanized Deweeding

Description of the technology	
Wheeled or tracked robot capable of moving autonomously in horticultural crops by simultaneously exploiting a GPS-RTK receiver, an inertial sensor, cameras and LASER range-finders for its localization, navigation and mapping of the field. The same robot, using AI image analysis techniques, will be able to distinguish weeds from cultivated plants, uprooting the former through the mechanical operation of special tools (hooks, brushes, etc.). Also with AI techniques, the growth of the cultivated products can be monitored, in order to promote precision agriculture.	
Possible applications	
Mechanical weeding of cultivated fields and regular monitoring of the growth of horticultural crops. The device could be purchased by consortia or cooperatives to give it for use by members, or by companies that intend to offer the service to third parties.	
Main advantages	
• Reduction of phytosanitary treatments for greater sustainability of horticultural crops • Reduction of water waste • Improved production efficiency • Better soil management • Overcoming labor shortages	
Technology Readiness Level	***Industrial Property***
TRL 3	-

TERIN202505 – WILD-SAFE - Intelligent multi-sensor acoustic network for early detection of forest fires and safety in natural areas

Description of the technology
The technology is based on a network of multi-sensor devices with very low energy consumption installed on trees. Each module integrates omnidirectional microphone, environmental sensors and SubGHz communication, with local processing via neural networks (edge AI). The key innovation is the analysis of the acoustic spectrum as the primary trigger to detect fires in the early stages — long before thermal signals — and to recognize events such as gunshots, chainsaws, cries, voices or animal species. The network is fully remotely reconfigurable (FOTA) and only transmits targeted alarms, drastically reducing energy requirements. The data flows into terrestrial or satellite gateways for continuous monitoring even in disconnected areas.
Possible applications
Distributed system for early detection of forest fires, forest protection, safety of people in remote areas, prevention of timber theft, ecosystem monitoring and search for missing persons. Support to Civil Protection, Carabinieri Forestali, park managers and forestry companies.
Main advantages
• Early fire detection thanks to acoustic analysis (wood crackling) • Works 24/7 without depending on satellites or optical visibility • AI edge architecture: low power consumption, minimum data transmission • Remotely reconfigurable modules for multiple missions (fire, security, animal species) • Coverage even in areas without a cellular network via satellite IoT

Technology Readiness Level	**Industrial Property**
TRL 6-7	-

TERIN202506 – CEM0+ - CEMENT AT KM 0 +

Description of the technology
Cement is a material that combines safety and durability with a high impact on the environment (4%÷7% of global CO_2, with a highly energy-intensive manufacturing process and the need to have a large amount of raw materials. With past design activities, a highly innovative cement was created, compared to the production phase, in which part of the traditional components were replicated with 0 km materials, chemically similar to traditional ones, coming from the surroundings of the cement plant (in particular mussel shells suitably treated). The results achieved are excellent, in terms of mechanical and functional performance, and allow us to continue experimenting towards an industrializable mix design with a higher level of TRL.
Possible applications
The innovative CEM0 is part of the classification of cements produced and available on the market: it is used in the construction sector for the construction of durable and highly safe works. CEM0 can be used as a support and coating mortar, for structural applications in new works or renovation of the building heritage or cultural heritage.
Main advantages
• Increased energy efficiency • Global CO2 reduction • Reduction of environmental impact and circularity of solutions • Sustainable use of natural resources • Valorisation of waste products • Improved mechanical performance • Durability of the final product • Improved machinability

Technology Readiness Level	**Industrial Property**
TRL 5	-

TERIN202507 – GECOPLUS - Advanced Green Ecolight Cement mOrtar

Description of the technology
The proposed mortar is the result of the optimization of a previous lightened mix, with the aim of further reducing density and environmental impact and increasing energy performance. The introduction of recycled cellular glass, in combination with polymeric waste, thanks to its highly porous structure, makes it possible to obtain a material with high insulating power and a significant contribution to the reduction of heat loss. The use of binders with a lower carbon footprint completes a solution that complies with the principles of circular economy and European directives on sustainable resource management. The product is designed to create light, high-performance and easily applicable substrates, improving the overall energy efficiency of the building.
Possible applications
Low-density cementitious mortar for energy-efficient substrates and/or screeds, ideal for redevelopment and new constructions. Based on an innovative mix that combines selected construction and demolition waste and recycled aggregates, it improves thermal and acoustic insulation and guarantees lightness, durability and ease of installation, without compromising mechanical performance.
Main advantages
• Increased energy efficiency • Global CO_2 reduction • Reduction of environmental impact and circularity of solutions • Sustainable use of natural resources • Valorisation of waste products • Material lightening • Improvement of mechanical and thermal/acoustic performance • Greater resistance to capillary rising water • Durability of the final product

Technology Readiness Level	**Industrial Property**
TRL 4	-

TERIN202508 – MAT-ENE - Development of monitoring techniques on advanced materials for energy applications

Description of the technology
The technology concerns an integrated, non-invasive monitoring system on advanced materials for the energy sector: from electricity generation (wind) to storage, to transport (battery containers, storage). The system is based on the integration of thermography and smart metal alloy (NITINOL) wires, characterized by shape memory and superelasticity, inserted into the matrix of a composite. The wires, as a result of mechanical stress, deform, return to their initial state at the end of the stresses. By heating them (e.g. with the passage of current) it is possible to highlight any structural damage and/or internal defects of the material through thermographic measurements in situ and/or in operating conditions (e.g. wind turbines), optimizing the timing of intervention.
Possible applications
The components of the proposed monitoring system - Nickel Titanium metal alloy wires, with a high strength/weight ratio and shape memory capacity, and thermography - allow its application in various sectors, when it is necessary to define, in real time, the consequences of mechanical and/or thermal stresses on the behavior of materials: aerospace, automotive, energy.
Main advantages
• Non-destructive monitoring in situ and in real time. • Reduction of complex and invasive controls. • Introduction of an innovative, replicable and scalable monitoring protocol at an industrial level. • Reduced maintenance operating costs. • Extend the service life of structures and components. • Early defect detection for predictive component maintenance.

Technology Readiness Level	**Industrial Property**
TRL 4	-

TERIN202509 – OPTIM-H_2 - OPTical sensing for Intelligent Monitoring of H_2 storage

Description of the technology
FBG sensors adapted to hydrogen tanks for stationary and mobility applications, i.e. in ATEX contexts with high safety and reliability requirements. The absence of power supply at the measuring point eliminates the risk of ignition in the event of hydrogen leaks. In addition, FBG sensors can operate in a multisensory configuration, for distributed monitoring on large plants, providing noise-free signals, facilitating integration into hybrid systems or hydrogen vehicles. Finally, FBG sensors have the advantage of being able to be incorporated into polymer composite materials, facilitating their integration into the tank for built-in and non-invasive diagnostics.
Possible applications
Continuous real-time structural monitoring of H2 tanks with fiber optic sensors (FBG), for the measurement of deformations and temperature at a large number of points. The solution allows the structural integrity of the tanks to be checked even in operating conditions following loading-unloading cycles, detecting cracks or degradation, preventing failures, increasing operational safety.
Main advantages
• Continuous, real-time monitoring • Early detection of cracks and degradation • Temperature and strain measurement in multi-sensory chains • Superior reliability and accuracy compared to conventional sensors • No maintenance and periodic calibration • No power supply at the measuring point and reduced risk of fire due to leaks of H2 or other flammable material

Technology Readiness Level	**Industrial Property**
TRL 3	-

TERIN202510 – BIOFIDS 2.0 - Photobioreactor for BIOlogical Desulfurization of biogas

Description of the technology
The BIOFIDS system has the potential to be used in biogas clean-up processes necessary for upgrading to biomethane with numerous advantages over current chemical-physical methods. It includes a biogas inlet section containing H_2S, a transparent LED-illuminated photobioreactor, a crop recirculation circuit and a settling section. The obligate anaerobic strain Chlorobium limicola oxidizes H_2S, producing elemental sulfur that precipitates and is recovered, while the culture recirculates in the reactor. The absence of O_2 and the high solubility of H_2S make the treated biogas suitable for upgrading to biomethane. The system, with low energy consumption and self-sustaining, allows the recovery of bio-sulfur of commercial interest.
Possible applications
The BIOFIDS system sustainably replaces chemical-physical desulphurization modules in anaerobic digestion plants for the production of biogas and biomethane, improving the quality of energy carriers, reducing waste and chemical consumption. The bio-sulphur produced can be exploited in agriculture, promoting a circular economy and less use of synthetic soil improvers and phytosanitary products.
Main advantages
• Sustainable and competitive technology compared to conventional systems • Total H_2S removal in a single stage • No chemical reagents and low energy consumption • Anaerobic process, suitable for upgrading to biomethane • Bio-sulfur recoverable and exploitable in agriculture with soil conditioner and phytosanitary properties

Technology Readiness Level	**Industrial Property**
TRL 5-6	Patent n. IT0001428761

TERIN202511 – BIOINK - Sustainable conductive water-based inks from biomass biochar for energy, sensor and flexible electronics applications

Description of the technology
The proposed technology develops sustainable conductive inks by replacing critical and polluting materials that are widely used today. In BIO-INK, fossil-based carbon black and graphite, a critical raw material, are replaced by biochar obtained from renewable biomass, while fluorinated binders such as PVDF (polyvinylidene fluoride) and toxic solvents such as NMP (1-methyl-2-pyrrolidone) are replaced by cellulosic polymers and water-based formulations**.** This approach reduces environmental impact, health risks, and process costs while maintaining high electrical performance and facilitating industrial adoption. The solution enables printable electrodes for energy storage, sensing platforms and flexible electronics, promoting scalability and circular economy.
Possible applications
BIO-INK involves the development of conductive water-based, sustainable inks derived from biomass biochar, as a green alternative to graphite and carbonaceous nanomaterials. Applications in advanced electrochemical devices for energy storage (anodes for LIB and NIB) and in high-performance, scalable sensing platforms through printing technologies and industrial processes.
Main advantages
• Sustainability: Replacing carbon black, graphite, PVDF and NMP with biochar, cellulosic polymers and water, reducing environmental impact and emissions • Safety and costs: elimination of toxic solvents and energy-intensive processes, with benefits for industrial health and competitiveness • Scalability: Printable inks compatible with existing processes for energy, sensing and flexible electronics

Technology Readiness Level	**Industrial Property**
TRL 4	-

TERIN202512 – NAVE - Anti-Counterfeiting and Efficient Verification Nanostructures

Description of the technology
Invisible markers created on the basis of the nanostructured polymers and designed in a scientifically sophisticated way, once incorporated into products, can only be detected with specific reading technologies, making unauthorized copying or reproduction extremely difficult. Thanks to their customizable structure, nanostructured polymers can be designed to contain unique information about a product, such as identification codes or production dates. This allows precise traceability throughout the distribution chain, facilitating the authentication of original products. The production costs of such markers can be adjusted to the value of the object to be protected, while reading technologies are fully accessible.
Possible applications
Counterfeiting is a global problem that affects many sectors, particularly the energy sector. It creates a serious threat not only to companies but also to public safety and the environment. Using counterfeit equipment such as switches, cables, solar and wind components poses risks of catastrophic failures, fires, electrocutions and power supply disruptions.
Main advantages
These markers: • offer a higher and/or additional level of security than traditional protection methods => *Increased security* • can be designed to fit the specific needs of a product or industry => *Customization and versatility* • their inherent strength makes them suitable for a wide range of industrial and cultural applications => *Durability*

Technology Readiness Level	**Industrial Property**
TRL 4-5	-