

# GRAPHERGIA

Innovative pilot lines for sustainable graphene-based flexible and structural energy harvesting and storage devices



We expect that GRAPHERGIA's dual focus on represents a paradigm shift in the graphene industry, promising scalable and sustainable advancements that will shape the future of energy storage and smart textiles."

**Spyros Yannopoulos**  
Project Coordinator

**T**HE GRAPHERGIA project seeks to transform energy solutions with sustainable, efficient power technologies. It focuses on developing eco-friendly dry electrode fabrication for energy storage devices, leveraging the potential of lasers in graphene synthesis. The project's ambition is two-fold: it will create self-charging e-textiles for biomechanical energy harvesting, making the charge-as-you-go lifestyle a reality for everyone. In parallel, it aims to develop cost-effective lithium-ion batteries (LIBs) for space applications, marking a significant step towards a more sustainable energy future.

## MEETING NEW CHALLENGES

GRAPHERGIA will establish scalable, eco-friendly pilot-scale methods for crucial real-world applications. It focuses on breakthrough developments in materials, processes, and integration, aiming to provide sustainable, long-term solutions in the rapidly advancing fields of energy harvesting and storage, meeting the growing market demands for cutting-edge energy applications.

**Smart e-textiles:** Envision clothing that not only connects you wirelessly to the IoT but also powers itself. GRAPHERGIA will develop multifunctional, self-charging smart textiles that integrate advanced wearable electronic systems seamlessly into fabrics. It will revolutionise the fabrication of graphene-based triboelectric nanogenerator (TENG) electrodes on textiles and develop a ground-breaking power management system, designed to significantly enhance the efficiency of TENG output.

**Li-ion batteries:** GRAPHERGIA will redefine LIB technology with advanced graphene-based electrodes, employing a novel "dry-electrode" fabrication approach integrating 2D materials and process-oriented methodologies, utilising cost-effective raw materials and scalable fabrication techniques to ensure economically viable and environmentally sustainable solutions. It will create highly efficient graphene-based electrodes for LIBs using scalable, green, laser-assisted processes.

## SUSTAINABLE SOLUTIONS

GRAPHERGIA embodies a commitment to pioneering advancements in graphene technology, underscored by several fundamental principles:

**Eco-friendly manufacturing:** Our process is waste-free and excludes the use of hazardous substances, aligning with environmental protection goals.

**Cost-effective production:** We implement a single-step method at room temperature, eliminating the need for specialised equipment or further treatment of graphene.

**Scalable technology:** The process is designed for rapid, large-scale production, leveraging industrial-type laser technology for immediate graphene synthesis and integration.

**High-quality standards:** Our method produces graphene quality in harmony with the "Good Practice Guides" and ISO graphene standards.

**Adaptability:** Direct graphene growth on various substrates negates the need for transfer processes.

**Integrated modularity:** The ambient condition synthesis facilitates an integrated system with real-time quality monitoring capabilities.

**Versatile precursor usage:** Capable of converting a range of precursors, including polymers, biomass, and carbides, into premium graphene and graphene-nanohybrids through tailored laser treatment.

**Resourcefulness:** Reducing dependence on traditional wet-chemistry methods, thereby streamlining production processes, and enhancing efficiency.

**Promoting material independence:** By reducing reliance on imported Critical Raw Materials (CRMs), it enhances the EU's energy autonomy while simultaneously strengthening environmental sustainability and conserving resources.

## NEW HORIZONS

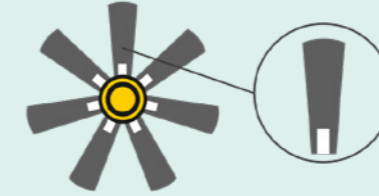
During 3.5 years, GRAPHERGIA is dedicated to enhancing the scalable, economic and environmentally friendly production of graphene-based materials, targeting high-impact products in the energy sector for significant societal, economic and environmental benefits. Our three demo cases include:

**Self-charging textile development:** Manufacturing an all-in-one textile capable of energy harvesting and storage. It will integrate single electrode TENGs into, e.g., T-shirts and belts for energy storage and gait monitoring, and embedding these technologies into upholstery fabrics for transport interiors to boost comfort and safety.

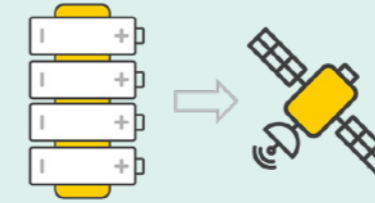
Self-charging textile development.



Self-powered structurally integrated sensors for aerospace structures.



Advanced graphene-based LIB module for space applications.



**Self-powered structurally integrated sensors for aerospace structures:** Demonstrating a miniaturised TENG-based sensor in a scaled aerospace composite structure. This demo case aims to integrate a self-powered wireless temperature/strain sensor into a composite fan blade, enhancing data accuracy for better and quicker design decisions in aerospace.

**Advanced graphene-based LIB module for space applications:** Designing, manufacturing and testing a graphene-based LIB module prototype for space applications. This demo will validate the efficacy of our laser-assisted fabrication technology at TRL 5, focusing on optimal laser-scribed graphene electrodes and LIB cells.

Challenges in these areas will be addressed through rigorous research and development, leveraging our beneficiaries' expertise in graphene technology and our commitment to innovative solutions.

## COLLABORATIONS

By joining the Graphene Flagship community, GRAPHERGIA stands to gain substantial benefits. Participation in this dynamic network offers unparalleled opportunities for collaboration, knowledge sharing, and visibility. Our project will gain access to cutting-edge research, key stakeholders, and potential partners across Europe. This involvement will not only accelerate our own graphene innovations but also help in disseminating our breakthroughs to both the scientific community and the public at large, enhancing our project's impact and recognition.

In parallel, our project will bring fresh perspectives, innovative approaches to graphene-related material development, and a commitment to advancing the collective goals of the community. Through active participation and sharing of our research advancements, GRAPHERGIA aims to be a key contributor to the continuation of the GFI's mission, fostering advancements in graphene technology and applications.



The GRAPHERGIA team.  
Credit: GRAPHERGIA



## PROJECT COORDINATOR

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