Expression of Interest (EoI)

MSCA Postdoctoral Fellowships 2026

Host Institution: University of L'Aquila, Italy — Department of Engineering, Computer Science and Mathematics, Software Engineering Group, FrAmeLab laboratory

Project

`GreenTestAI: Energy-Aware Autonomous Testing for AI-Intensive Software Systems`

Hosting Information: University of L'Aquila (UnivAQ), Italy

Offer Deadline: July 01st, 2026
EU Research Framework: Horizon Europe - MSCA Postdoctoral Fellowships 2026
Country: Italy
City: L'Aquila

Organisation/Institute

Organisation: Software Engineering Research Group, University of L'Aquila, Italy
Department: DISIM - Department of Engineering, Computer Science, and Mathematics. Secondment: Åbo Akademi University, Finland.

Contact Information

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Secondment/Collaboration Opportunity

Up to eight months: Software Testing Laboratory, Mälardalen University, Sweden (Prof. Daniel Sundmark)

Description

Project Title: GreenTestAI: Energy-Aware Autonomous Testing for AI-Intensive Software Systems

Research Context & Motivation

Artificial Intelligence (AI) systems are increasingly integrated into modern software-intensive systems, including Large Language Model (LLM) applications, agentic systems, AI copilots, autonomous decision-support systems, and intelligent software engineering tools. Recent advances in AI have significantly improved automation, productivity, and decision-making capabilities across multiple domains [7, 3].

At the same time, the computational demands of AI systems continue to grow. Recent studies have shown that large-scale AI models can incur substantial energy consumption, carbon

emissions, and operational costs during both training and inference [6, 5, 4]. While Green AI research has largely focused on optimizing model development and deployment, comparatively little attention has been devoted to the sustainability implications of software testing activities for AI systems.

Testing AI-intensive systems introduces additional computational burdens through regression testing, prompt evaluation, hallucination testing, safety validation, robustness assessment, and continuous monitoring. Existing testing frameworks primarily optimize traditional quality objectives such as coverage, reliability, and defect detection while largely overlooking sustainability concerns. Consequently, organizations often execute large volumes of computationally expensive tests without understanding their associated energy and environmental costs.

From a software engineering perspective, sustainability is increasingly recognized as a first-class quality concern that should influence architectural decisions, development processes, and operational practices [1, 2]. However, no systematic framework currently exists for measuring, optimizing, and autonomously managing the energy and carbon costs of software testing activities in AI-intensive systems.

This project addresses this challenge by introducing GreenTestAI, a novel research paradigm for Energy-Aware Autonomous Testing that jointly optimizes software quality, energy consumption, carbon footprint, execution time, and operational cost throughout the testing lifecycle.

Goal & Objectives

To establish the scientific and engineering foundations of energy-aware autonomous testing for AI-intensive software systems, enabling sustainable quality assurance while minimizing environmental and computational costs.

1. **Architectural Objective** Define reference architectures, design principles, and architectural tactics for integrating energy-awareness into testing infrastructures. The resulting framework will support sustainability-driven quality assurance throughout the software lifecycle and establish the foundations of Green Testing Engineering.

2. **Optimization Objective** Develop AI-driven optimization techniques capable of selecting, prioritizing, and executing the minimum set of testing activities required to achieve target quality levels. The objective investigates the trade-offs between testing effectiveness, energy consumption, execution time, and operational cost.

3. **Measurement Objective** Establish novel metrics, analytical models, and benchmarking methodologies for quantifying the energy consumption, carbon footprint, and sustainability impact of software testing activities. The objective aims to make testing sustainability measurable, comparable, and reproducible across different environments.

4. **Autonomous Objective** Develop intelligent testing agents capable of continuously reasoning about quality, risk, energy, and sustainability objectives to autonomously adapt testing strategies during execution. The objective seeks to enable self-optimizing testing ecosystems that balance software assurance needs with environmental constraints.

Research Method

The project will follow an experimental software engineering methodology combining Green Software Engineering, AI testing, software architecture, and autonomous systems research.

First, a systematic investigation of sustainability challenges in AI testing will be conducted to identify current limitations, energy hotspots, and opportunities for optimization across modern testing workflows. This phase will establish the conceptual foundations of Green Testing Engineering.

Second, the project will design a reference architecture for energy-aware testing infrastructures and define architectural tactics, sustainability-aware workflows, and optimization strategies that explicitly integrate energy, carbon, quality, and cost considerations into testing decision-making.

Third, a prototype platform based on autonomous testing agents will be developed. The platform will incorporate energy profiling, carbon estimation, adaptive test selection, test prioritization, and runtime optimization mechanisms to continuously balance testing effectiveness with sustainability objectives.

Fourth, extensive empirical evaluations will be conducted using representative AI-intensive systems, including LLM-based applications, agentic systems, software engineering copilots, and AI-assisted development tools. The proposed approach will be compared against traditional testing strategies using metrics related to quality assurance, energy consumption, carbon emissions, execution time, and operational cost.

Finally, Open Science practices will be adopted by releasing datasets, benchmarks, experimental protocols, source code, and evaluation results, ensuring reproducibility and facilitating industrial adoption of sustainable testing practices.

Technology & Infrastructure

The fellow will have full access to:

- The FrAmeLab and UnivAq equipment (workstations, Caliban High-Performance Computing Cluster)
- ACM/IEEE library archives
- Office space within the Information Engineering, Computer Science, and Mathematics Department (DISM).

The project will leverage:

- Large Language Models
- Small Language Models
- Multi-Agent Frameworks
- Energy Monitoring Tools
- Carbon Estimation Frameworks
- Software Testing Platforms

Expected Output

As per our team policy, we will work together to publish on top journals (such as IEEE TSE, ACM TOSEM, JSS, IST) and in top conferences (such as ICSE, ICSA, ECSA, FSE, ASE, MODELS). The MSCA fellow will work in collaboration with the FrAmeLab team members. He/She will be mentioned as the first author in all those publications he/she will lead.

- **Contribution 1:** First reference architecture for Energy-Aware Autonomous Testing of AI-intensive systems.
- **Contribution 2:** Novel metrics and analytical models for quantifying testing-related energy consumption, carbon emissions, and sustainability performance.
- **Contribution 3:** AI-driven optimization techniques for sustainable test selection, prioritization, and execution.

- **Contribution 4:** Autonomous testing agents capable of balancing software quality objectives and sustainability constraints.
- **Contribution 5:** A benchmark suite and reproducible evaluation framework for Green Testing Engineering research.

Proposing Research Group

The Software Engineering Research Group (SWEN) is recognized as one of the worldwide leaders in software engineering. Its members have been organizing and co-leading international conferences such as ICSA, ASE, ICPE, MODELS, and being active members of the organizing committee of conferences such as ICSE, ASE, FSE, MODELS, ICSA, ECSA, and others.

We ensure a supportive environment for career development.

- **Global Network:** Active participation in over ten Horizon Europe projects.
- **Infrastructure:** State-of-the-art facilities located in L'Aquila.
- **Mentorship:** Our supervisors have supervised tens of Ph.D. students and PostDocs, most of them holding a professorship or a practitioner position worldwide.

Our Support for Your Proposal

We don't just host you; we help you win. Candidates selected for this topic will receive:

- **MSCA Master Class:** A 1-day intensive workshop (July 2026) on proposal writing.
- **Expert Review:** One-to-one feedback from our scientists.

Candidate Requirements

- **Degree:** PhD in Computer Science, Software Engineering, or related disciplines. It must be obtained by Sept 9, 2026, and not earlier than Sept. 2018.
- **Publications:** A strong publication track record (e.g., high-impact journals and conferences)
- **Prior Knowledge:** Research focus on (Software Engineering or Software Architecture) and (Software Testing) and (LLM or GenAI or LLM Agents).
- **Language Proficiency:** Excellent command of spoken and written English, strong interpersonal skills, and the ability to work both independently and in a team.
- **Mobility Rule:** Compliance with the MSCA mobility rule. Among them, candidates must not have resided in Italy for more than 12 months in the 3 years before the deadline.

Interested?

Interested candidates should send the following to `henry.muccini@univaq.it` by **July 10th, 2026** with subject "MSCA Postdoctoral Fellowships 2026":

1. A brief CV (max 2 pages).
2. A motivation letter (1 page) outlining research alignment.
3. A 1-page summary of your proposed research idea.

We look forward to building a winning proposal with you!

References

[1] Becker, C., Chitchyan, R., et al.: Sustainability design and software: The karlskrona manifesto. ICSE Companion (2015). https://doi.org/10.1109/ICSE.2015.179

[2] Calero, C., Moraga, M.Á., Bertoa, M.F., Duboc, L.: Green software and software quality. In: Green in Software Engineering, pp. 231–260. Springer (2015)

[3] Liu, J., Wang, K., Chen, Y., et al.: Large language model-based agents for software engineering: A survey. ACM Transactions on Software Engineering and Methodology (2026). https://doi.org/10.1145/3796507

[4] Luccioni, A.S., et al.: Power hungry processing: Watts driving the cost of ai deployment? Proceedings of the AAAI Conference on Artificial Intelligence (2024)

[5] Schwartz, R., Dodge, J., Smith, N.A., Etzioni, O.: Green ai. Communications of the ACM **63**(12), 54–63 (2020). https://doi.org/10.1145/3381831

[6] Strubell, E., Ganesh, A., McCallum, A.: Energy and policy considerations for deep learning in nlp. In: Proceedings of the 57th Annual Meeting of the Association for Computational Linguistics. pp. 3645–3650 (2019). https://doi.org/10.18653/v1/P19-1355

[7] Wang, L., Ma, C., Feng, X., et al.: A survey on large language model based autonomous agents. Frontiers of Computer Science **18**(6), 186345 (2024). https://doi.org/10.1007/s11704-024-40231-1