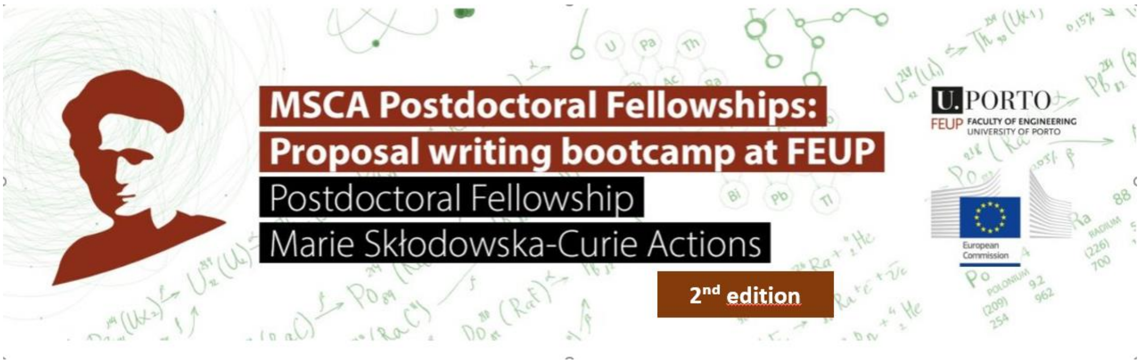

SUPERVISOR INFORMATION	
First and Last name	Luísa Andrade
URL of supervisor webpage	https://sigarra.up.pt/feup/pt/func_geral.formview?p_codigo=487476
Department	Department of Chemical and Biological Engineering
Field(s) of research	Perovskite Solar Cells; module prototyping; electrochemical characterization
PROJECT PROPOSAL	
Title (optional)	Optimizing Perovskite Solar Cells for Sustainable and Scalable IoT Integration
Brief project description	

Perovskite solar cells (PSCs) have proven to be a groundbreaking advance in photovoltaic technology, achieving an efficiency of 26.7 % in just a decade, rivaling the 26.8 % efficiency of mature silicon technology. This remarkable performance can be attributed to their unique optoelectronic properties, such as bandgap tunability, long carrier lifetime, high mobility, excellent light absorption, and ease of fabrication. Furthermore, PSCs are lightweight, cost-effective and flexible, owing to solution-based manufacturing processes, making them particularly suitable for Internet of Things (IoT) applications, where light weight, flexibility and cost efficiency are essential. The potential for high-throughput roll-to-roll manufacturing makes PSCs ideal candidates for large-scale production.

This project aims to optimize PSCs for integration into IoT systems by addressing critical challenges such as stability, scalability and lead toxicity. An important focus will be the development of lead-free perovskite materials for efficient indoor light harvesting. Key objectives include fine-tuning the bandgap of perovskite absorbers to enhance performance under indoor lighting conditions and developing charge transport materials and passivation layers to minimize recombination losses. Priority will be given to eco-friendly materials, avoiding hazardous substances and critical raw materials. Two different types of lead-free perovskite materials will be investigated: organic-inorganic hybrid perovskite and chalcogenide perovskite thin films. Tin-based perovskites are particularly promising due to their tunable bands and high carrier mobility, leading to significant advances in efficiency. To further improve these materials, 2D-3D heterostructures will be developed to improve passivation and stability. Chalcogenide perovskites, known for their stability, non-toxicity and abundance, will be explored as a viable alternative to lead-based perovskites. Machine learning and data mining techniques will be used to predict the optoelectronic properties, stability and synthesizability of these materials to guide experimental work. In addition to the optimization of perovskite materials, scalable deposition techniques will be explored to enable the production of large-area devices. The long-term stability of the fabricated lead-free PSC devices will be evaluated under different environmental and mechanical stress factors. By overcoming these challenges, this project will position PSCs as a competitive alternative to existing IoT energy technologies. The development of self-powered IoT solutions will reduce reliance on conventional batteries and promote the sustainability of IoT networks. In addition, this work will contribute to the green and digital transformation of European industry by revolutionizing production and monitoring strategic value chains.