



INFERNO

Opinion Article

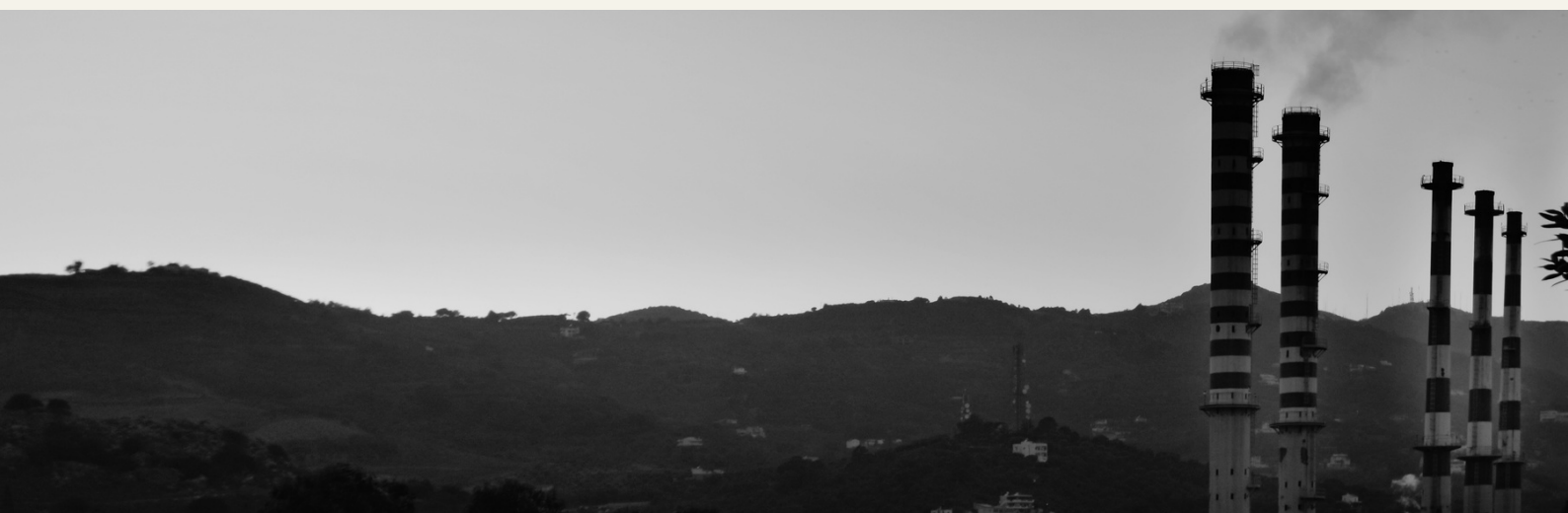
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A Journey from PhD Research to INFERNO's Clean Energy Vision

As I am close to finishing my PhD at Tyndall National Institute, I am delighted to be part of the INFERNO Project as a Research Assistant. Under the supervision of Dr. Kafil M. Razeed, my PhD work focused on developing efficient thermoelectric materials and micro-thermoelectric cooler devices; an experience that will be valuable in contributing to INFERNO's ambitious goals in industrial waste heat recovery.

INFERNO is a European Union-funded project focused on improving the energy efficiency and sustainability of energy-intensive industries. By developing a hybrid energy-harvesting system integrating thermophotovoltaic (TPV) cells, metasurface collectors, and thermoelectric generators (TEGs), the project aims to convert waste heat from high-temperature industrial processes into clean electricity. This innovative approach offers a scalable solution for sectors such as glass, steel, and cement production, which are responsible for significant energy usage, losses, and carbon emissions.



During my PhD, I worked on enhancing the thermoelectric efficiency of thin-film materials grown by the electrodeposition method and on the design and fabrication of micro-thermoelectric coolers for the thermal management of photonic integrated circuits. As the outcome of this work, I have published two first-author journal papers [1 and 2], one conference paper [3], and several co-authored journal papers. I have also received the BOC Gases Postgraduate Bursary 2025 for outstanding research, which is a prestigious annual award at Tyndall National Institute (<https://lnkd.in/ewhSPEJ6>).

The thermoelectric cooler devices operate on the Peltier effect, a thermoelectric phenomenon that allows cooling or heating when an electric current passes through the device. Interestingly, the same devices can also generate electricity when exposed to a temperature difference via the Seebeck effect, another key thermoelectric phenomenon; such devices are called thermoelectric generators (TEGs). The skills and experience I have gained here are directly transferable to my new role, where I am now working on developing thermoelectric materials and multilayer interfaces between thermoelectric legs and metal interconnects to enhance energy conversion efficiency. My familiarity with thermoelectric device design allows me to approach INFERNO's hybrid TPV-TEG concept with a strong understanding of both the materials and device integration challenges.

[1] <https://doi.org/10.1016/j.applthermaleng.2025.128468>

[2] <https://doi.org/10.1016/j.jallcom.2024.177313>

[3] <https://doi.org/10.1109/THERMINIC57263.2022.9950684>



I am particularly excited about the project's interdisciplinary nature, bringing together expertise across from Europe to create a high-impact, sustainable energy harvesting technology. Joining INFERNO also represents a significant step in my career journey, from academic research to applied innovation with real industrial impact. Working in a collaborative European project allows me to expand my technical expertise, enhance my communication skills across disciplines, and engage with partners at the forefront of energy technology.

As the project progresses, I look forward to contributing to the development and validation of robust, efficient thermoelectric components for hybrid systems that can make a measurable difference in reducing energy waste.



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Rajvinder Kaur is an experienced researcher in the field of thermoelectric thin-film materials and devices using electrodeposition and microfabrication techniques. She is nearing completion of her PhD on micro-thermoelectric devices for active thermal management of photonic integrated circuits at Tyndall National Institute, University College Cork. Rajvinder holds an MSc degree in Physics (Nano Science & Technology) from Punjabi University, Patiala, India. She is currently associated with the INFERNO Project as a Research Assistant, focusing on developing advanced thermoelectric materials and, specifically, interfaces for the device integration for waste heat recovery.