POWERDRIVER aims to develop an innovative environmentally friendly thermo-electric power generation system for automotive and marine applications, that is powered by exhaust waste thermal energy to reduce fuel consumption, emissions and costs.

Thermo-electric (TE) materials offer the opportunity to generate electricity from waste heat. However, due to the temperature dependence of the Figure of Merit (ZT), the average efficiency of TE materials is relatively low and varies across the operating temperature range (100-500 degrees C). Whilst current TE generators (TEGs) are able to achieve high efficiencies within a relatively small temperature range, their efficiency is still too low for practical, commercial applications and their TE properties can rapidly degrade due to elevated temperatures, under thermal cycling, and as the result of the differential thermal expansion effects of different TE materials that make-up these devices.

Highly efficient nano-structured TEGs and functionally graded segmented TEGs based on just one TE material type where the doping level (and the peak ZT temperature) vary through the TE materials thickness, are both novel, cost effective technologies that allows us to achieve a consistently high ZT value across the entire operating temperature range. By nano engineering and careful doping of these materials, the PowerDriver project will create two specific highly innovative, efficient TE technologies:

1. Nano-structured TEG

- High peak ZT (>1.6): The use of nano-structured materials will enable us to achieve a high ZT and thus a high efficiency (~11%) in an appropriate temperature range.
- Thermal stability: In the temperature range of 330-850 Degrees C and that can be thermally cycled over working temperature range without loss of structure or properties.
- Cost Competitiveness: The nano-structured materials should enable us to achieve an inexpensive and recyclable solution.
- Environmentally benign: The nano-structured materials are non-toxic and are allowable under the RoHS directive.

2. Functionally graded segmented TEG, enabling:

- High ZT (>1.0) across the entire operating temperature range: Doping of the TE materials with different doping levels allows the ZT peak temperature to be varied so that a functionally graded TEG can be created so that each layer is maintained at its optimal temperature across the thermal gradient, allowing a consistent and high ZT value to be achieved across the operating temperature range.
- Cost Competitiveness: Optimal electrical output across the entire operating temperature range will allow us to achieve a cost of €0.5/W of electricity produced, in comparison to >€1/W for existing segmented TEG technologies.
- Superior electrical and mechanical properties: The materials will differ only with respect to the degree of doping (up to ~0.1%) which will allow a segmented TEG with very similar structure throughout its thickness to be achieved which will

therefore allow us to achieve reduced contact resistance and greatly reduced differential thermal expansion/contraction significantly improving the electrical and mechanical properties.

The Power Drive project will further advance TE chemistry and structural understanding by creating a highly innovative nano-structured, functionally graded and multi-layer TEG structure compounds, targeting commercial competitiveness in waste heat energy recovery applications. The Power Driver TEG solutions will be demonstrated for a high profile case study application: The use of waste heat from automotive and marine for production of electrical output to power on-board applications. Such applications have not been achieved commercially due to materials limitations in terms of output per € and long-term thermal stability.

The POWERDRIVER project meets the core requirements of the R4SME programme, by:

- Generating new knowledge, materials, processes and products targeting improved competitiveness for an SME core group who are each under threat within their respective industry sectors;
- Aiding pan-European mobilisation of an SME supply chain partnership, who each encompass unique technology, know-how and services essential for the realisation of the POWER DRIVER objectives;
- Requiring the outsourcing of high risk R&D to a pan-European consortium of research centres who encompass specialist facilities & know-how essential for undertaking the required R&D;
- Resulting in an innovative cost effective based functionally graded thermo-electric technology for automotive, marine and other applications, advancing the state-of-the-art and enabling knowledge based added value material & product applications;
- Generating science and technology that will impact positively on the environment, improve European citizen safety and securing quality of life, and improve the commercial competitiveness of end-user and supply chain SME companies across numerous market sectors

Team

The POWER DRIVER consortium includes 11 partners from 6 different European regions. RTD participants have been selected due to their specific expertise, resources and proven track record within the S&T requirements of the project. Collectively they constitute the critical mass of resources and know-how (working with the SMEs) to deliver the planned research programme. The SME participants represent a distinct and complementary supply chain for the POWER DRIVER nano-powders, consolidated materials and integrated thermo-electric generator systems and are primary beneficiaries of the project results.

The SMEs are established in their respective fields and have the know-how to ensure commercial success. Each SME will individually take a leading role in coordination and monitoring of specific areas of the work programme for which they are the primary beneficiary and have agreed to ensure the appropriate level of resources and expertise are dedicated to such activities. The SMEs have committed resources for take-up and validation of the project results, for exploitation not only within the primary marine market, but also wider exploitation to new market sectors such as automotive and industrial waste heat energy recovery.