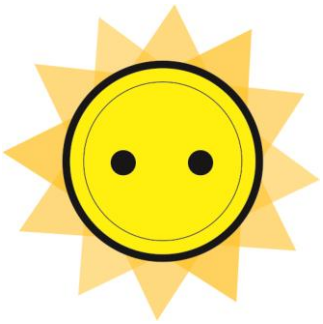

Thermophotonic energy conversion for efficient heating and cooling in buildings (TPXENERGY)

Consortium:
Department of Micro and Nanosciences, Aalto University
Prof. Harri Lipsanen
Dr. Sami Suihkonen
Mr. Lauri Riuttanen
Engineered Nanosystems Group, School of Science, Aalto University
Prof. Jukka Tulkki
Dr. Jani Oksanen
Mr. Anders Olsson
Mr. Mikko Partanen
Optoelectronics research centre, Tampere University of Technology
Prof. Mircea Guina
Dr. Teemu Hakkarainen
Dr. Antti Tukiainen
Mr. Arto Aho

Theoretical studies and recent experimental breakthroughs in solid state laser cooling and small bias electroluminescent (EL) cooling have shown that optical technologies may provide a high performance alternative for the prevailing heat pumps. In long term optical technologies can even replace the conventional heat pumps by devices operating at up to 60-80% of the Carnot limit without harmful refrigerants. This would be a substantial improvement over the TE devices and small compressor based heat pumps typically operating at 10-20 % (TE) and 40-60 % (MC) of the Carnot limit and result in a substantial decrease in energy consumption of heating and cooling, responsible for nearly 20 % of the global energy consumption.

The goal of the TPXENERGY project is the very first demonstration of EL cooling and thermophotonic (TPX) heat transfer in simplified thermophotonic heat pump (THP) structures consisting of light emitting diodes (LEDs) and photovoltaic cells. In contrast to previous attempts to demonstrate large bias EL cooling, we fully exploit the benefits of enclosing the LEDs in a semiconductor cavity. This eliminates the conventional light extraction challenges and dramatically enhances the optical interaction strengths and emission efficiency.

Altogether, the TPXENERGY project makes a pioneering contribution to a field that may have a major impact on the future directions of energy conversion research and potential to start the long anticipated revolution in the solid state heating and cooling technologies. The research also involves extensive doctoral education supporting the future needs of the Finnish optoelectronics and semiconductor industry.