Aim of the project: In recent decades, rapid societal and technological development increased energy demand and substantially depleted fossil fuel reserves, caused pollution and overall disruption of the global climate. To prevent depreciation of living standards, it is time to focus on safe, efficient and inexpensive renewable energy solutions. In modern societies, almost half of energy is used for cooling (especially for thermal comfort, production, distribution, and storage of food and medications) and the demand will certainly increase. Therefore, to reduce energy consumption it is very important to switch from electric to thermally driven refrigeration equipment. Moreover, equipment that relies on environment friendly refrigerants (especially water). Unfortunately, it appears that the performance of thermal equipment using common heat transfer fluids has reached its operational limit. Now it is more important than ever to turn the gaze from applied sciences (i.e., development of a new kind of heat exchangers and systems) back to the basic research including phase transitions (i.e., boiling) and thermal performance of natural working fluids.

This proposal focuses a little studied aspect of pool boiling phenomena of water - **heat transfer during formation and departure of bubbles from a bundle of tubes at thermodynamic conditions near the triple point**. In bundled configurations, bubbles growing and detaching from the lower tubes are expected to slide along the surface of the upper tubes, promoting both the activation of additional cavities and the evaporation of a superheated thin film captured at the bubbles' base. On the other hand, large bubbles typical for low pressures may prohibit subcooled liquid from reaching the surface of neighbouring tubes and decrease heat transfer. **Which effect dominates at low-pressure and why? These are the interesting scientific questions that we intend to answer in this project.** Our experimental studies will fill the knowledge gap in low-pressure boiling on tubes, allow to determine boiling regimes for different working conditions, and provide new data to form valid heat transfer coefficient (HTC) correlations.

Research carried out in the project: We intend to unveil how the geometry of the bundle influences the low-pressure boiling of water using thermal analysis and visual observation of **the bubble dynamics on a single tube and on standard bundle configurations**. The study of bundle geometry will reveal **the influence of tube patterns and spacing** on the boiling heat transfer characteristics in restricted spaces between tubes. Significant part of our investigation will be focused on **the influence of hydrostatic pressure** and showing the differences between low-pressure boiling on a tube bundle in a partially and fully flooded evaporator. Most importantly, amassed experimental data will be used to **develop heat transfer correlation(s)** optimised for tube bundles and sub-atmospheric conditions.

Reasons for choosing the research topic: Existing heat transfer technologies are so advanced that any further improvement could only be fuelled by basic research. Scientists understand the general principles of boiling phenomena and were able to derive useful empirical correlations. Still, the process appears to be fully understood at atmospheric pressure but needs further research in near vacuum. We have highlighted some of the interesting questions in previous paragraphs, and this proposal aims to close some of the gaps in the knowledge.

Our project will deliver data necessary for thermodynamic optimisation, reduction of size and heat flux density limits of low-pressure thermal systems using natural working fluids. The new heat transfer correlation(s) would be of importance not only for heat transfer researchers but also for engineers that design, build and optimise heat exchangers for sub-atmospheric applications. The outcomes may contribute to the development of thermal systems used in energy production, thermal comfort management, refrigeration, air-conditioning, food preservation, medicine storage and distribution, and many more. The expected future benefits range from simple reduction of investment and operating costs, all the way to new innovative applications, improved storage and transport capabilities, reduced dependency on non-renewable energy sources, decreased carbon emissions, and consequently slowed changes of climate and energy crisis.