A sign of present times and technology is miniaturization. An example is electronics - devices are designed for large scale of integration and performance and are required to be primarily small in size. For example, over the time of the last 25 years, the clock frequency of microprocessors have increased from several MHz to several GHz along with increasing of the density of elements placed in practically unchanged (or even reduced) space. At the same time, significant changes have occurred in heating engineering and broadly understood energy sector. In the near future, the wide dissemination of ORC cogeneration and solar installations is expected. This means that many times higher heat fluxes have to be removed from the similar surfaces. Also the heat exchangers must be highly compacted and highly efficient. Traditional techniques based on convective single-phase heat exchange reached its limits. Consequently, the transition to high efficiency heat transfer mechanisms associated with phase transitions (boiling, condensation) was made. Due to the need to costs reduction, reliability improvement, noise reduction and simplification of the structure, another trend occurs now - the renaissance of the solutions using natural circulation (thermosyphons, heat pipes). The expected further increase of the requirements for efficient cooling and heat exchange demands the consideration of the further increasing the efficiency of heat transfer during phase transitions.

For many years now, the author of the proposed project is engaged in a program of experimental investigations of heat transfer during the phase transitions carried out at the Chair of Energy and Industrial Apparatus of Mechanical Engineering Faculty of Technical University of Gdansk. He participated in the study of heat transfer during the flow boiling in minichannels, then he developed the research towards intensification of heat exchange within the framework of his doctoral thesis. Further studies included the research issues on critical heat flux and flow condensation. Currently, the author intends to expand the area of interest on the minigaps. Minigap, apart from mini channel is the main geometry for heat transfer in micro heat exchangers and in all kinds of energetic microsystems.

As follows from the literature review, the minigap geometry is more favorable than minichannel in many aspects. It's also a model which gives potentially greater research capabilities, including two-dimensional analysis and visualization of temperature distribution as well as visualization of boiling structures. The works cited in the project description indicate the existence of the possibilities of further heat transfer intensification. The aim of the proposed project is to identify the opportunities to intensify the heat exchange in minigap evaporator of the thermosyphon circuit and an analysis of the impact of the intensification on the work and efficiency of the circuit. The proposed intensification methods are: modification of the minigap wall microstructure, use an inserts introducing surges of the flow. The intention is to continue and to develop the research programme on heat transfer intensification in minichannels started by the author within the framework of his PhD. It is planned to seek the correlation allowing to determine the optimal level of intensification.

Within the project framework, the author is going to carry out a comprehensive experimental and theoretical studies. The experimental part of the work will concern the heat transfer intensification during the flow boiling through the minigap (100 mm width, thickness from 0.5 to 3mm) in combination with study on thermosyphon loop, providing the natural circulation of refrigerant. Above-mentioned minigap will serve as evaporator in this loop. The heat will be supplied to the minigap by thermal radiation. It will provide a model system that can be reaped for many applications in the future. Theoretical part of the work will be dedicated to verification and, possibly, the modification of the correlation for boiling and condensation in the flow, which is developed by the research team for many years now. Within the framework of theoretical research, it's planned to formulate a new equation describing heat transfer during the development of the flow boiling through the minigap. Creation of accurate computational models will facilitate the effective design of the future systems. All these activities will be combined with the exact visualization, designed to recognize the flow structures, mechanisms underlying the work of the circuit and potential accompanying phenomena. As the author in the overall of his work is interested in visualization techniques, he plans an extensive use of these techniques in this project. This will consist, among others, on the recording of continuous wall temperature distribution and flow structures in minigap, simultaneous with the acquisition of data with the use of “traditional” sensors. It is a comprehensive and innovative approach which may result in an accurate and thorough description of the phenomena. The identification of properties of new working fluids will facilitate their subsequent selection for specific applications. It is an urgent need due to the decommissioning of the "classic" working liquids of a well-established properties. In these respects, the applicant hopes to contribute to the development of science.