Aligned with the EU's energy transition framework, DETECTIVE (Development of a novEl Tube-bundlE-CaviTy lInear receiVEr) endeavors to evaluate and propose an innovative solution to improve the efficiency of linear absorbers utilized in concentrated solar power (CSP) plants across Europe. These plants play a crucial role in supplying renewable electricity to EU nations. The project aims to concentrate on linear cavity concepts, applying them to conventional CSP systems, and reaching the most optimal design based on economic viability for widespread industry adoption.

To realize this objective, DETECTIVE will draw upon accumulated experience and knowledge via a methodical development pathway. This will encompass modeling, analysis of experimental studies, and economic evaluations to facilitate market dissemination. A range of designs will be explored utilizing numerical tools to create a prototype on a commercial scale. Subsequently, experimental testing and performance evaluations will be conducted within established frameworks to assess the absorber's effectiveness in enhancing the efficiency of solar systems in the relative environment. In the last phase, a cost model will be formulated to provide comprehensive insights into the new solar systems' benefits for power and process heat production. This analysis will encompass financial considerations at the installation, operational, and maintenance stages. Furthermore, the project will evaluate its environmental impact using life cycle assessment models, integrating these findings with sustainable development goals to align with the energy transition format. Finally, through collaboration with industrial partners and other stakeholders, DETECTIVE will implement a series of go-to-market strategies to facilitate technology dissemination and commercialization processes, ensuring its integration into the mainstream energy sector.

One key strategy proposed by DETECTIVE to expand the European CSP market involves extending the geographic reach of regions endowed with sufficient Direct Normal Irradiance (DNI). This is achieved by demonstrating that the new PTC design compensates for lower DNI levels by enhancing optical efficiency through the linear cavity concept. Such an approach holds particular appeal for countries outside the traditional Sun Belt, notably those in central Europe experiencing lower DNI levels compared to southern nations. Another pivotal incentive promoted by DETECTIVE to drive greater adoption of CSP technology is the heightened sustainability offered by PTC power plants through integration with thermal storage facilities. The enhanced PTC design allows for greater heat gain, resulting in expanded thermal storage capacity. Consequently, this mitigates the impact of intermittent solar radiation on power generation output, making CSP technologies more reliable in regions with unpredictable weather conditions. This, in turn, broadens the market for CSP technology across diverse geographical areas.

It is expected that the developed receiver will emerge as a viable alternative to the current evacuated receiver units used in parabolic trough collectors, offering full competitiveness in terms of efficiency, performance, and cost-effectiveness. With respect to design parameters, and drawing on previous research in the literature, it is believed that the linear cavity solar absorption results in higher efficiency. In more details, multiple reflections occurring inside the cavity enhance optical performance and solar flux distribution within the receiver, leading to smaller temperature gradients and thermal stresses. As the design originated from cylindrical geometry, the thermal losses of the cavity, which is a function of HTF temperature, wind velocity, mass flow rate and surface emissivity are much reduced compared to the rest of linear cavity designs. Furthermore, the capability to establish a vacuum inside the cavity annulus is more convenient than alternative models proposed in the literature. It is also anticipated that this configuration surpasses the temperature limits of heat transfer fluid compared to existing alternatives, consequently enhancing the overall efficiency of the system. Ultimately, DETECTIVE has the potential to shift the energy niche market towards CSP systems, driving increased investments in parabolic trough collector power plants by lowering the Levelized Cost of Energy.