

Thermal modelling of the dish/Stirling system

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Since July 2004, a 10-kWe Dish/Stirling unit is in operation at the PROMES Laboratory in Odeillo. This system is one of the several Country Reference Units of the Envirodish project. It is a Eurodish system developed by DLR and SBP for solar electricity generation using a Stirling engine externally heated by concentrated solar radiation.

The work presented here is focused on a global thermal model of the energy conversion of 10 kW_{el} Eurodish Dish/Stirling system.

Using solar flux maps close to the cavity aperture calculated by the ray-tracing code SOLTRACE, the optical losses of the concentrator can be determined (reflectivity, spillage). Then, a nodal method is used to calculate the heat losses in the cavity by conduction, convection, reflection and IR emission. A thermodynamic analysis of a SOLO V-160 Stirling engine is performed. The Stirling engine is divided in 32 control-volumes and equations of ideal gas, mass and energy conservation are written for each control-volumes with some assumptions. The differential equation system is resolved by an iterative method developed in Matlab. Temperature, mass, density of working gas, heat transfers and the mechanical power are calculated for one Stirling engine cycle of 40 ms and for a constant Direct Normal Insolation. The model gives consistent results correctly fitting with experimental measurements.