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MILP ALGORITHM FOR OUTLET TEMPERATURE OPTIMIZATION OF A HYBRID CONCENTRATED SOLAR SYSTEM FOR SHIP CONSIDERING A 1D SOLAR FIELD AND A DUAL PHASE THERMOCLINE STORAGE

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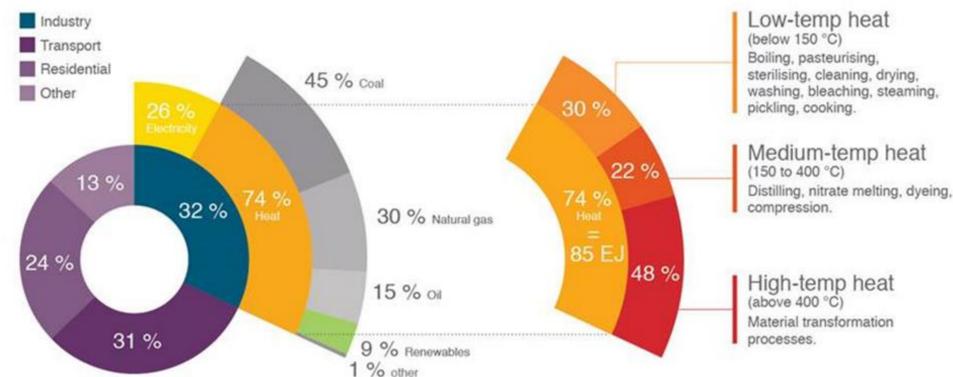
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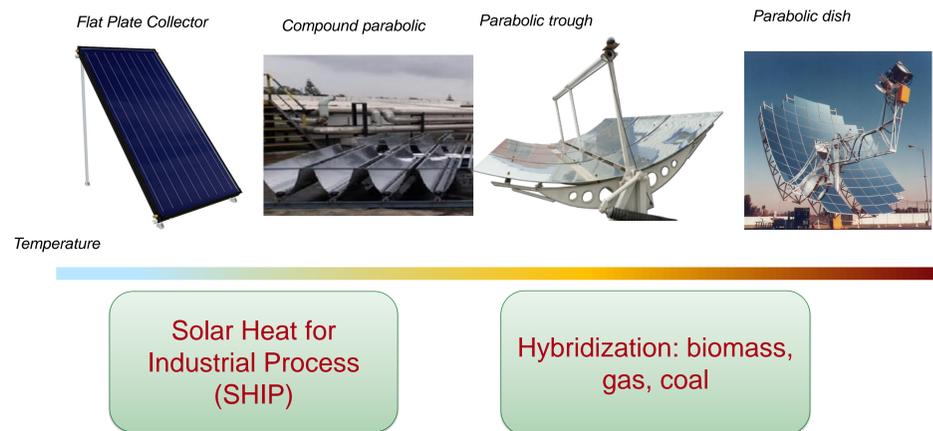
CONTEXT

Heat for industry represent 25% of total final energy need; while electricity represent 20%: renewable solar heat is a promising option for process heat



SolarPayback (2017) Solar-Heat-for-Industry-Solar-Payback

TECHNOLOGIES



PROBLEMATIC

How to optimize a solar system hybridized for SHIP?

Efficiency of solar field increases with decreasing outlet temperature : Flexible Heat Integration

SYSTEM

METHOD

MAIN HYPOTHESIS = SOLAR FLUX KNOWN

RESULTS

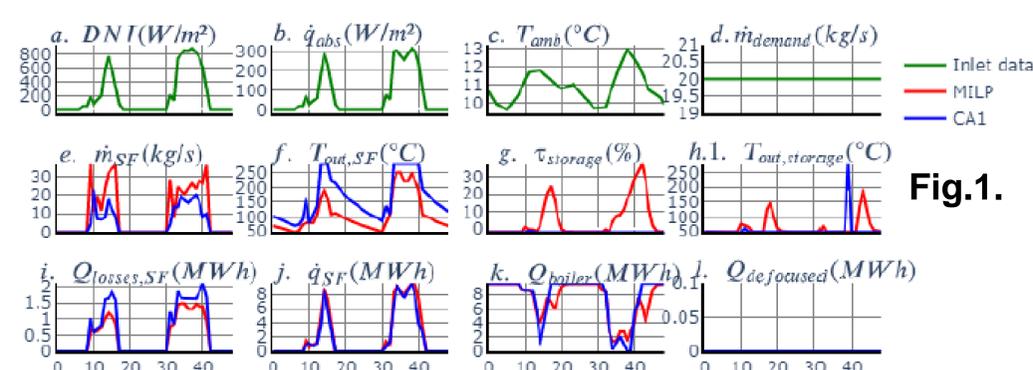
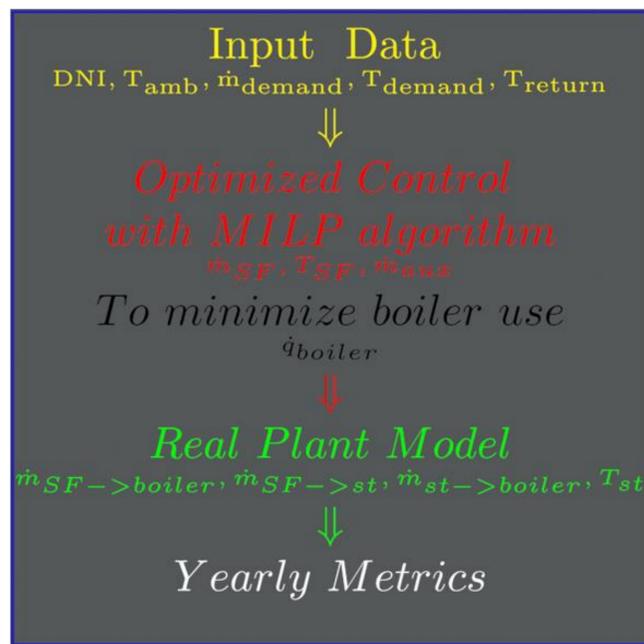
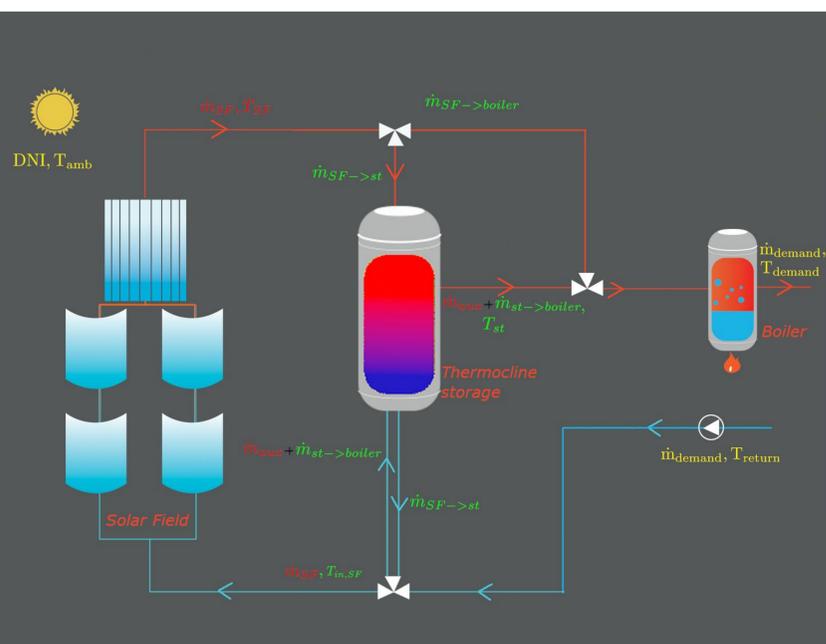
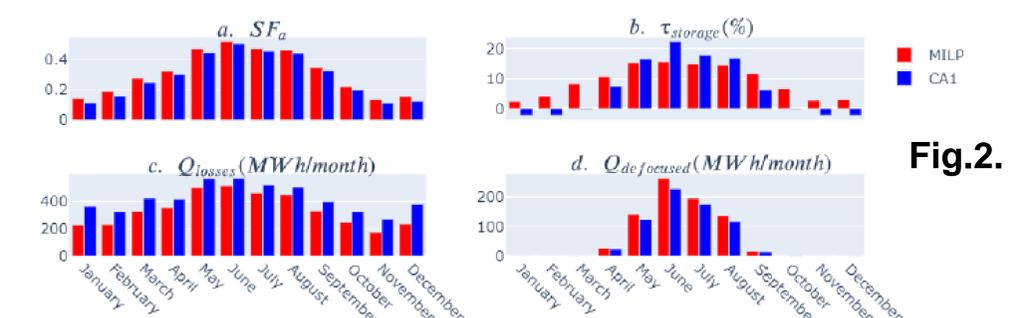


Fig.1. February 25th at Tarragona.
Fig.2. Yearly results.



Optimization of SF's outlet temperature (Fig.1.f.) with the MILP algorithm, which in winter lowers heat losses (Fig.1.i. and 2.c) and maximizes storage use (Fig.1.g. and 2.b), as compared with Control Approach 1 (CA1) which always tries to work at process temperature. In summer, heat losses of the storage are minimized through defocalization in the morning and storing only in the afternoon.

Solar fraction (Fig.2.a.): part of the energy supplied to the process from the sun, improved from **28.5%** (CA1) to **30.9%** thanks to the MILP algorithm.

REFERENCE:
Kamerling, S., Vuillerme, V., Rodat, S., 2021. Solar Field Output Temperature Optimization Using a MILP Algorithm and a 0D Model in the Case of a Hybrid Concentrated Solar Thermal Power Plant for SHIP Applications. Energies 14, 3731. <https://doi.org/10.3390/en14133731>