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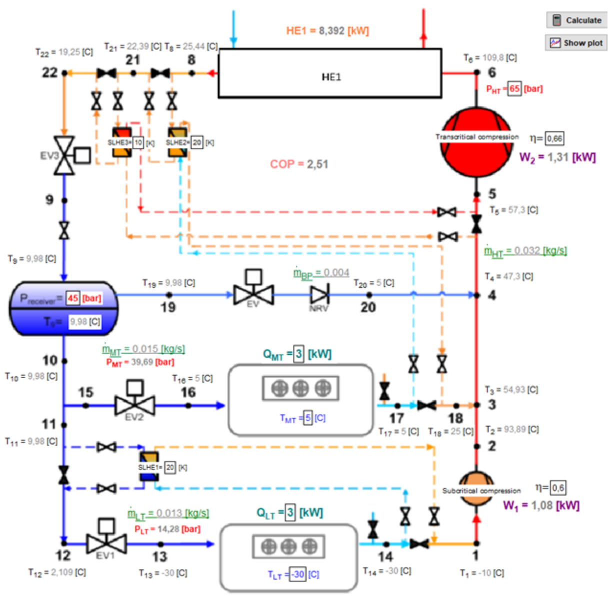
Sustainable Off-grid solutions for Pharmacies and Hospitals In Africa

Modelling and simulation of heat sink cascade CO_2 systems in low-income countries with high ambient temperature

Authors: Ina COLOMBO, Kokouvi Edem N'TSOUKPOE, Michael KAUFFELD, Oliver Schmid, Yosr ALLOUCHE, Nicholas KIGGUNDU, Alex PAURINE, Graeme MAIDMENT

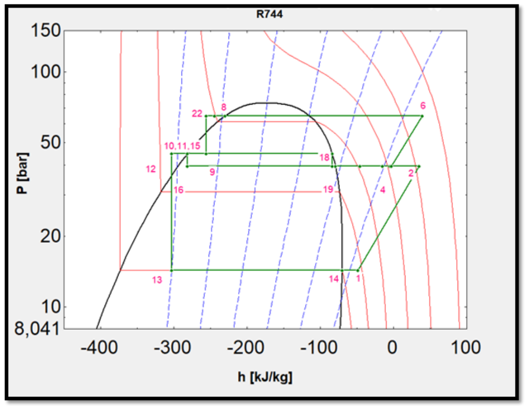
SOFACT N°3

Cascade subcritical systems are the most adapted and practical CO_2 applications for high ambient temperature climate conditions in low-income countries. This paper describes the theoretical performance of a typical CO_2 low temperature (LT) and medium temperature (MT) booster system using low temperature heat sinks of potential ground sources from different African locations and climate conditions.



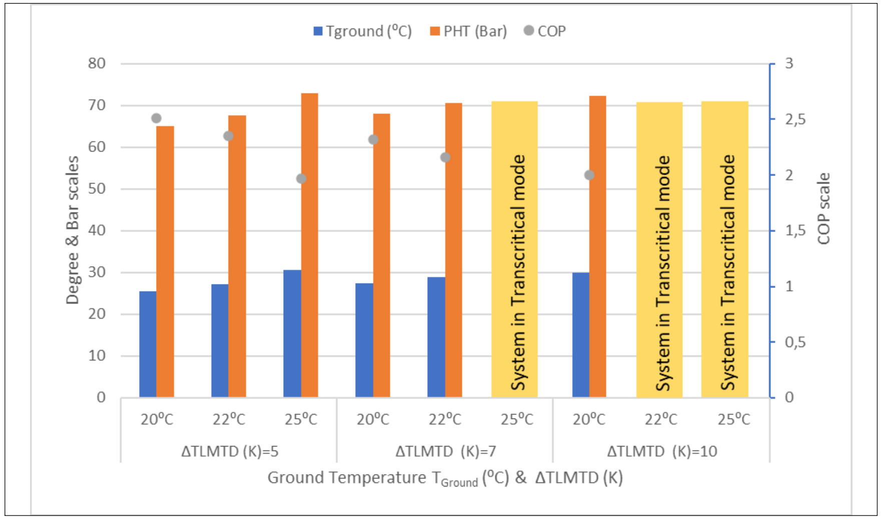
EES modelling of the CO_2 cascade LT and MT booster system using low temperature heat sinks

EES modelling is used to analyse the performance of this CO_2 system with different logarithmic mean temperature difference.



System P-h diagram

The MT /LT subcritical CO_2 booster refrigeration system modelled in this paper has been in fact built and installed at the LSBU facilities which was funded by the UK EPSRC.



COPs with different condensing vs ground temperatures

The ground/water temperatures of the SophiA pilot countries have been investigated for the purpose of this model.

Ground temperatures in Malawi and Uganda

Malawi: average temperature of 26-27°C, at a depth of 40-50 cm.
Uganda: monthly measures in the forest between 20°C and 22°C.

System performance

The higher the ground temperature, the lower the COP. The lowest system COP (2) was achieved for the highest ground temperature of 25°C. The highest COP (2.7) was achieved for the lowest ground temperature of 20°C with a ΔTLMTD of 5K.

Ground temperatures in Uganda and Malawi are appropriate to maintain the system in a subcritical steady state. Model achieved subcritical conditions during most of the year with ground temperatures below 22° with COPs varying from 2 to 2.7 depending on the ΔTLMTD of the heat exchanger. Expensive borehole solution and the difficulty to maintain the subcritical mode make the implementation of such CO_2 energy efficiency solution fairly feasible in low-income countries.

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Corresponding author: i.colombo@iifiir.org.
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