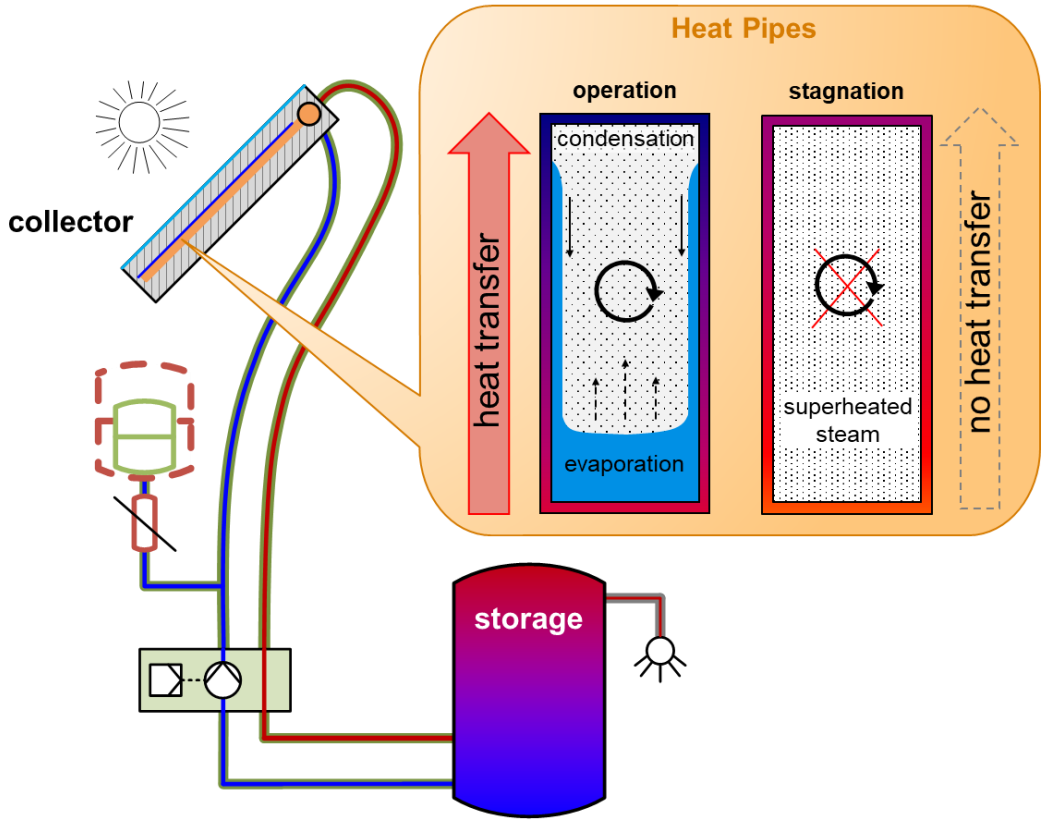
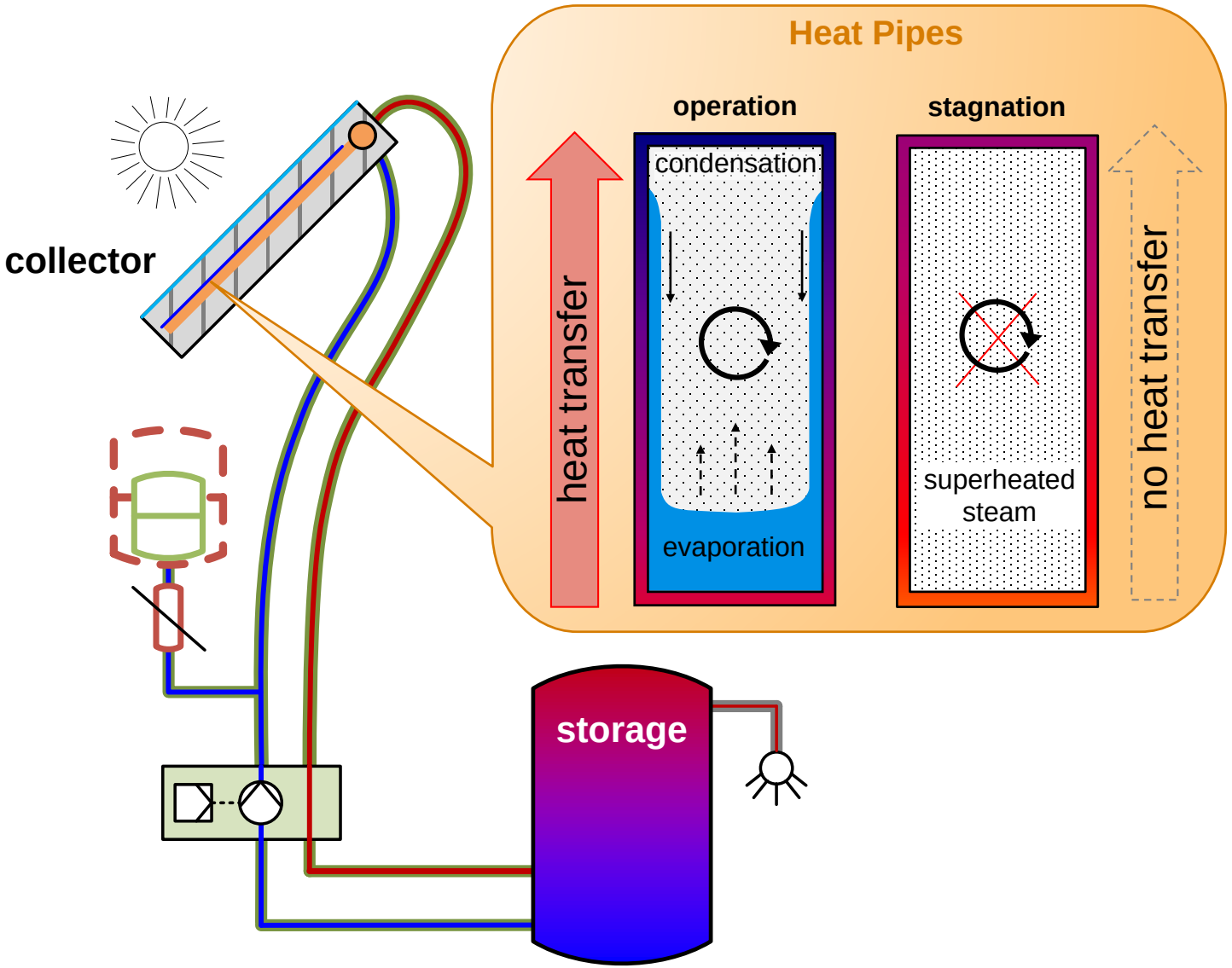


TRNSYS type for the simulation of temperature limiting heat pipe collectors

J. Jensen, B. Schiebler, F. Giovannetti

Goals in HP-SYS:



- Solar thermal system concept without stagnation loads
- Monitoring of real systems
- Simulation of the systems
- Testing & verification of expected cost benefits

➢ **Poster M09: Heat pipe collectors with overheating prevention in a cost-optimized system concept**

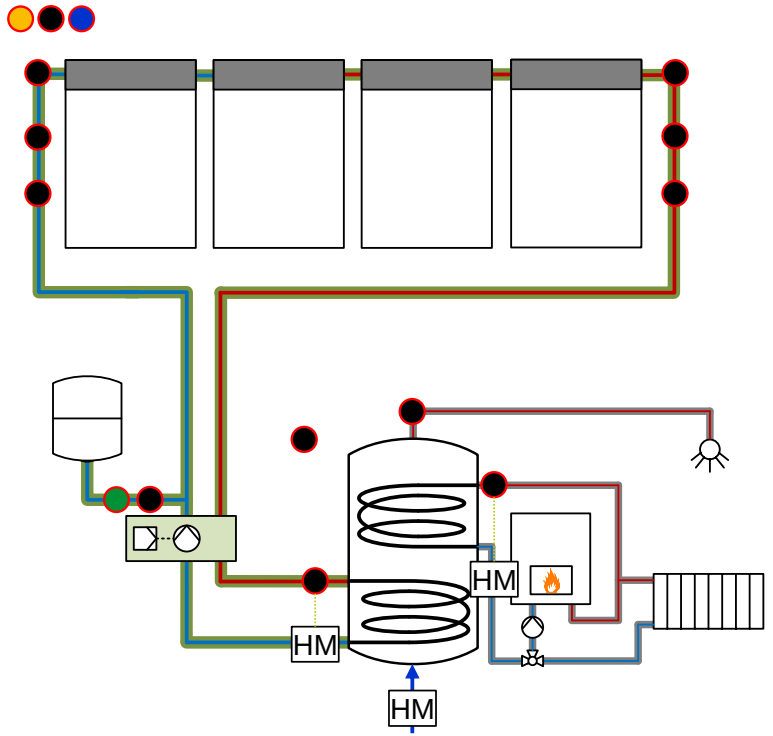
Overview of the demonstration systems

FPC 2

ETC 2

ETC 3

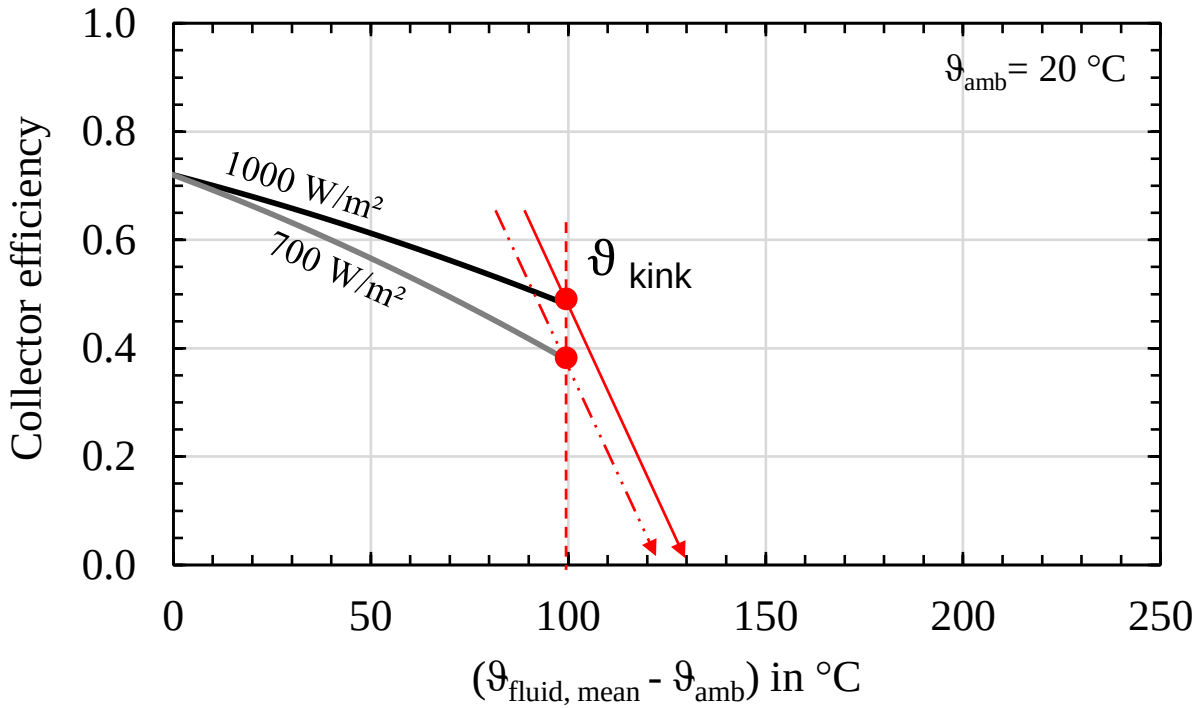
ETC 1



- temperature
- humidity
- pressure
- irradiation
- HM heat meter

➢ **Modelling of the demonstration systems in TRNSYS!**

Mapping of the heat pipe limitation?



Collector efficiency curve

$$\eta_{coll} = \eta_0 - a_1 \cdot \frac{\bar{\vartheta}_{fluid} - \vartheta_{amb}}{G} - a_2 \cdot \frac{(\bar{\vartheta}_{fluid} - \vartheta_{amb})^2}{G}$$

➢ **Lower irradiation → steeper curve**

$\Delta\vartheta_{max\ (1000\ W)} \approx 235$ °C

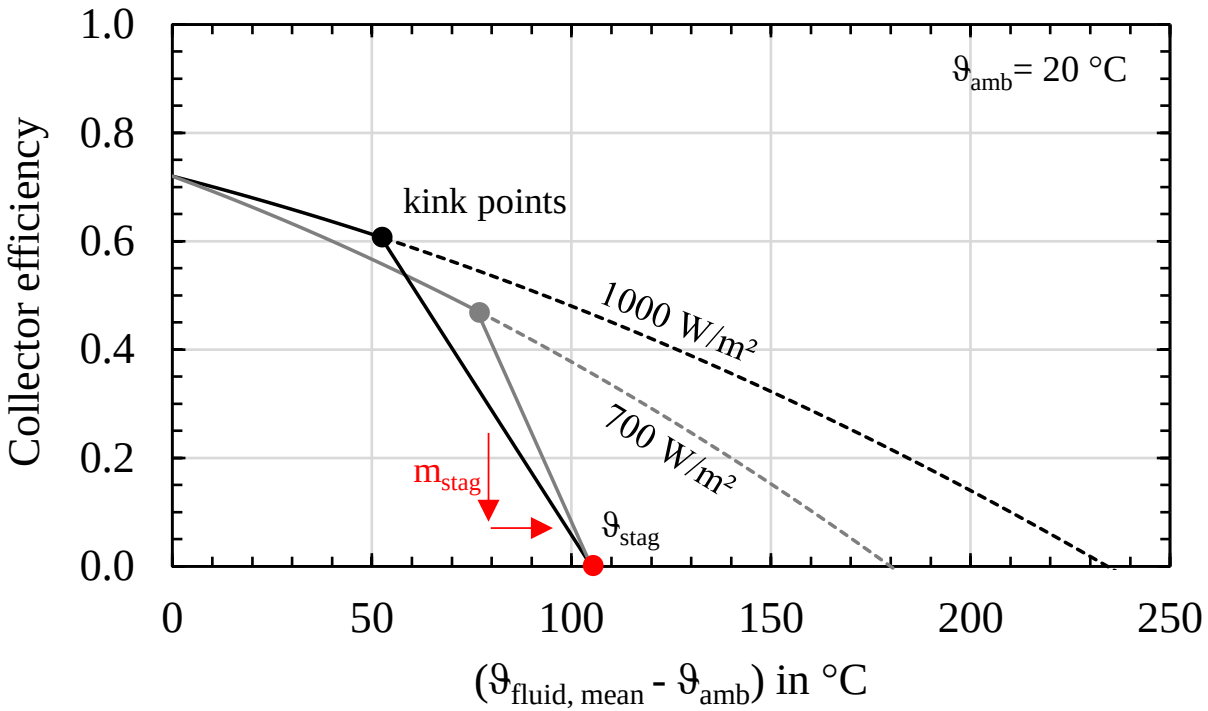
$\Delta\vartheta_{max\ (700\ W)} \approx 180$ °C

Solar Keymark temperature limitation

- 2-part efficiency curve
- Differing parameter values starting at ϑ_{kink}
- Mismatched for lower irradiances

➢ **„2-part curve“ approach leads to deviations in the simulation!**

Modelling of the heat pipe limitation?



Collector efficiency curve

$$\eta_{Koll} = \eta_0 - a_1 \cdot \frac{\bar{\vartheta}_{Fluid} - \vartheta_{Umg.}}{G} - a_2 \cdot \frac{(\bar{\vartheta}_{Fluid} - \vartheta_{Umg.})^2}{G}$$

Heat pipe limitation

$$\eta_{Koll} = \boldsymbol{m_{stag}} \cdot \frac{\vartheta_{Fluid} - \vartheta_{\boldsymbol{stag}}}{G}$$

Contrast to solar Keymark

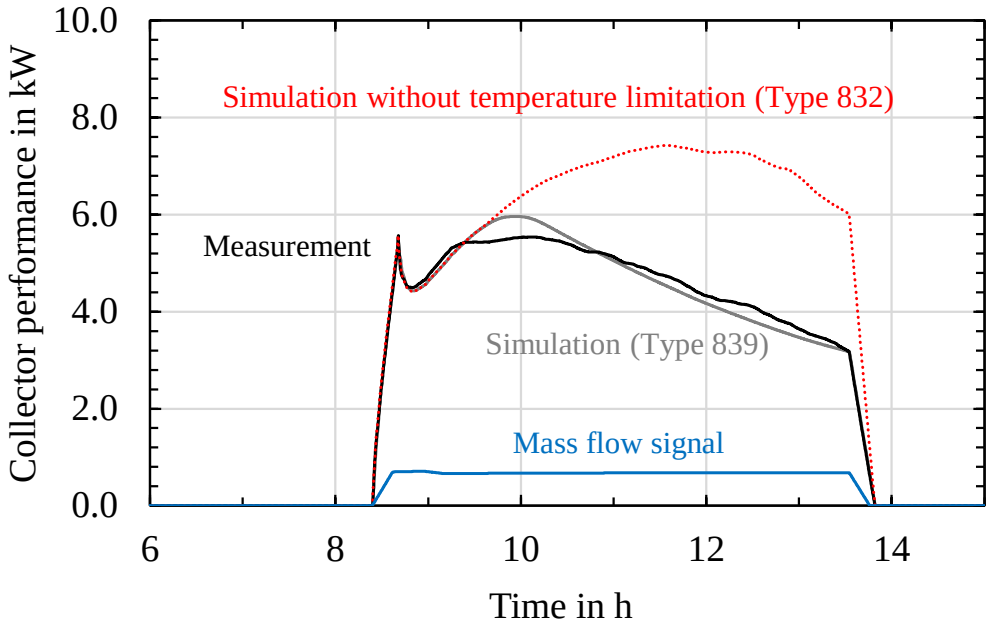
- Slope of shut-off curve varies with irradiation
- Constant ϑ_{stag}

➢ **Real shut-off behavior of heat pipes can be simulated in TRNSYS Type 839 based on TRNSYS Type 832!**

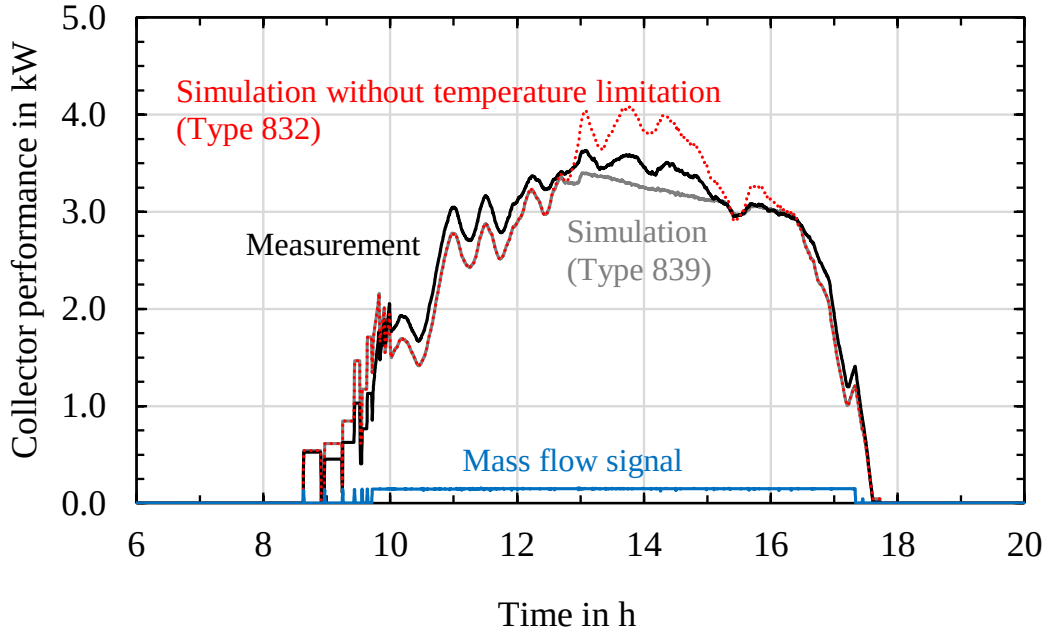
Source: Haller, M.; TRNSYS Type 832 v5.10 „Dynamic Collector Model by Bengt Perers“ Updated Input-Output Reference; SPF Institute for Solar Technology 2014

Validation

FPC2-system

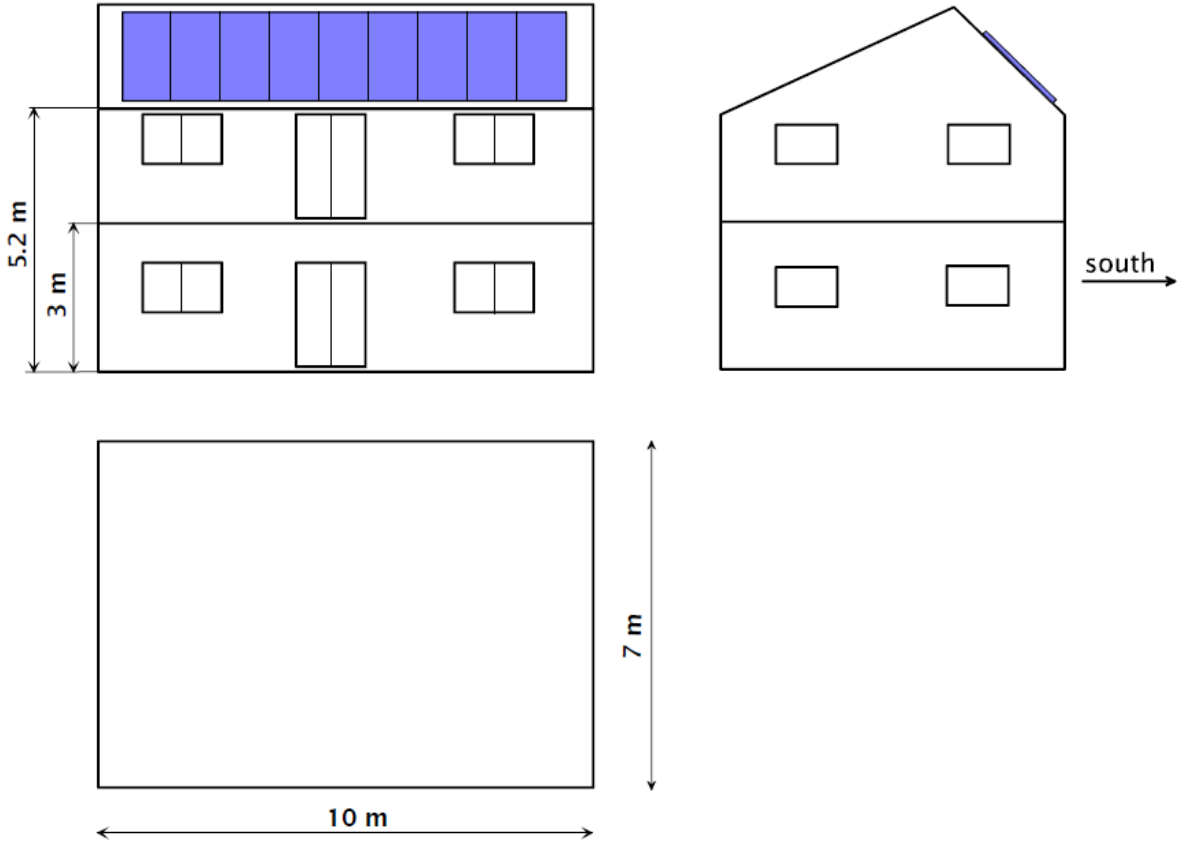


ETC2-system



➢ **Type 839 fits measurement data well!**

System simulations



Source: Heimrath, R.; Haller, M.; The Reference Heating System, the Template Solar System of Task 32; IWT TU Graz 2007

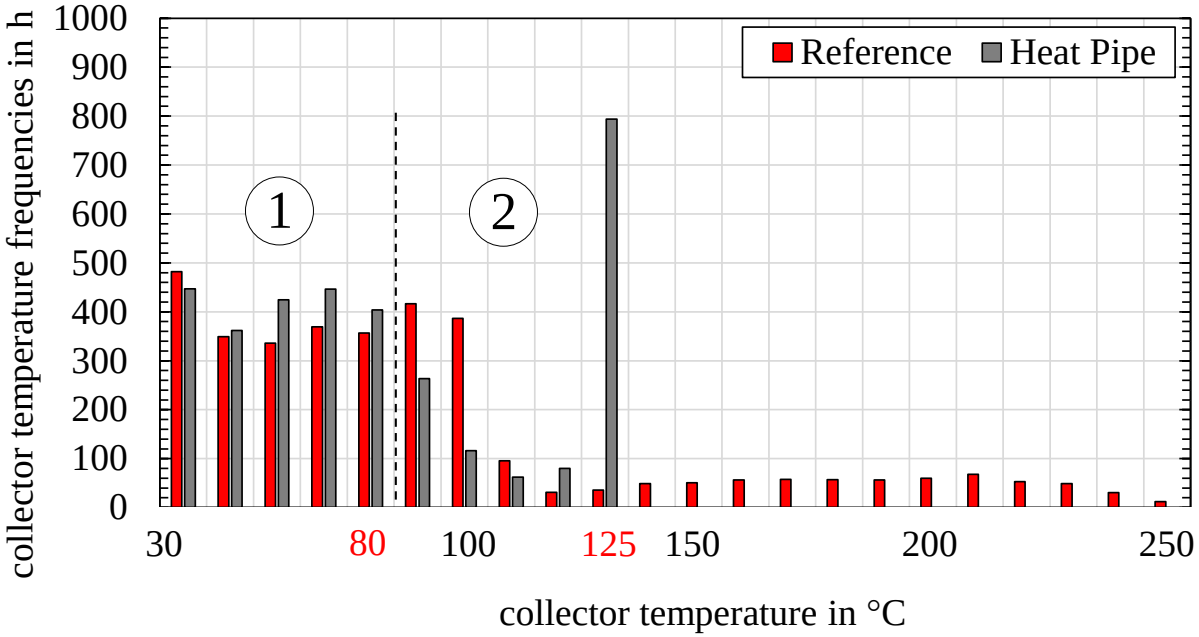
- Demonstration systems
- IEA SHC Task 32 reference building

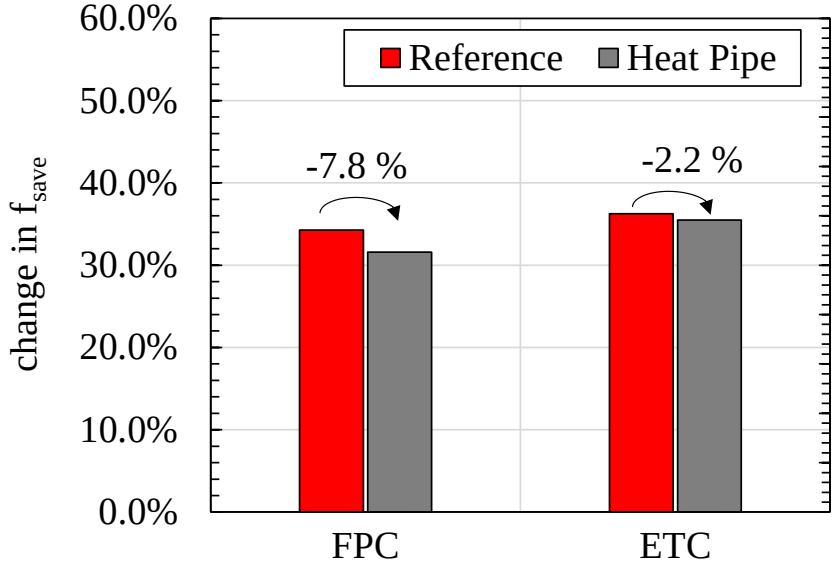
➢ **Task 32 building gives a better comparision regarding system behavior**

Boundary Conditions

- Collector gross area: 20 m²
- Storage volume: 900 l
- Energy demand: 45 kWh m^{-2} a^{-1} ,100 kWh m^{-2} a^{-1}

Reference building SFH45, Würzburg site





f_{save} : saved fossil auxiliary energy through the use of a solar thermal system

① unaffected operation

② heat pipe limitation

➢ **Difference in f_{save} is mainly caused by the difference in the collector aperture area (FPC)!**

Conclusion

- Implementation of a realistic shut-off function in TRNSYS
- Demonstration systems could be simulated with satisfactory deviations
- Comparison of direct flow reference collector and heat pipe collector

  ➢ **Heat pipe collector: Only low reduction of yield in the systems investigated!**

  ➢ **Outlook: Use of the TRNSYS-type in large-scale solar thermal systems**

Questions?

Thank you for your attention!

Institute for Solar Energy Research

Julian Jensen

Workgroup Thermal Collectors

Department Solar Systems

05151 / 999-521

jensen@isfh.de

Supported by:

Federal Ministry for Economic Affairs and Climate Action

on the basis of a decision by the German Bundestag

Niedersachsen

AKOTEC SOLARTHERMIE

KBB SOLAR COLLECTORS