Forthcoming Research and Industry for
European and National Development of SHIP

FRIENDSHIP

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What is FRIENDSHIP?

FRIENDSHIP is a Horizon 2020 project.

Topic LC-SC3-RES-7-2019 - Solar Energy in Industrial Processes

It aims to demonstrate that solar heat can be a reliable, user-friendly, high quality and cost-effective resource to meet the heat requirements for industrial sectors as Textile, Plastics, Wood, Metal and Chemistry.

Project Information

FRIENDSHIP
Grant agreement ID: 884213

Start date	**End date**
1 May 2020	30 April 2024

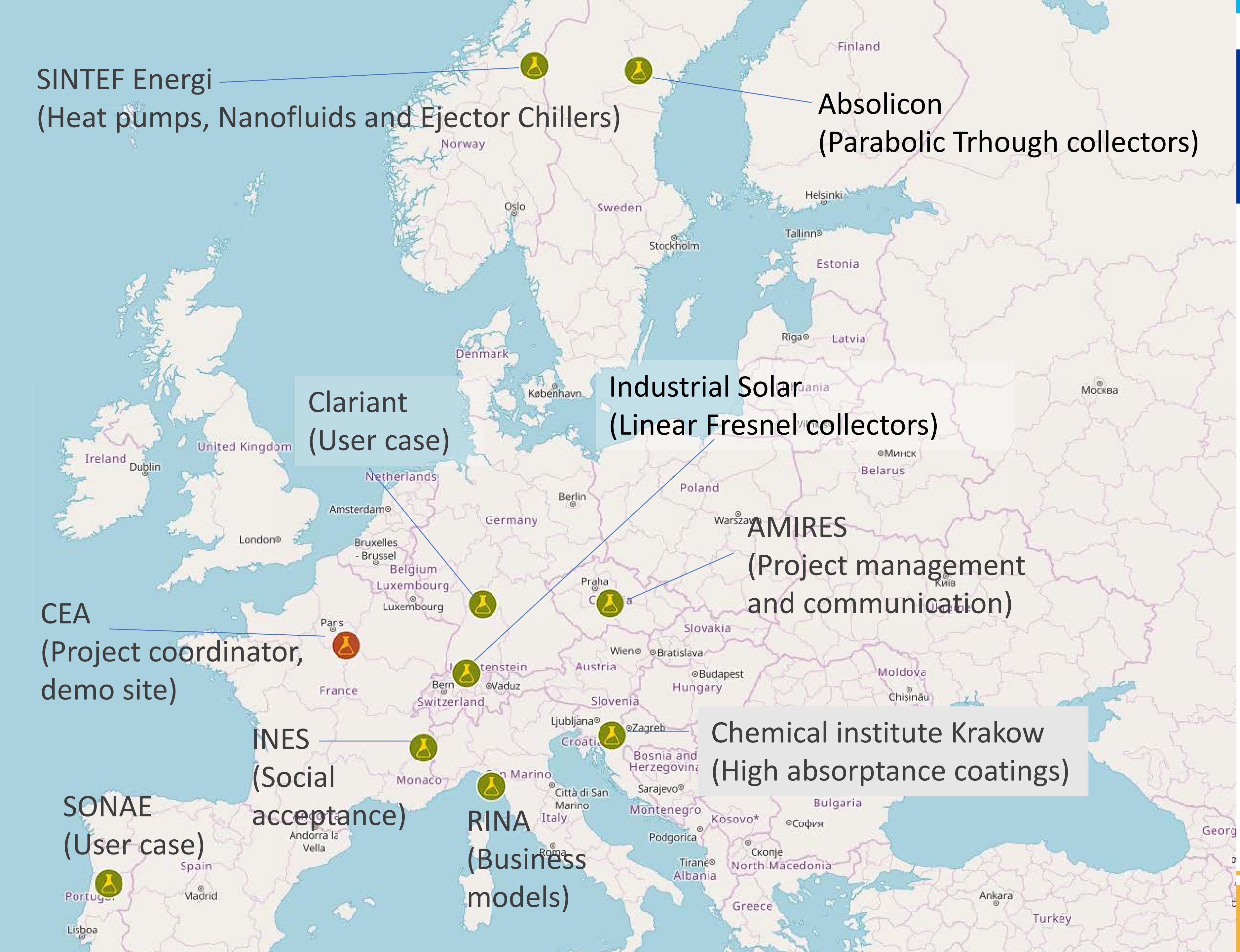
Funded under
H2020-EU.3.3.2.
H2020-EU.3.3.1.2.

Overall budget
€ 4 999 423,74

EU contribution
€ 4 999 423,74

Coordinated by
COMMISSARIAT A L ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES
France

European Commission | HORIZON 2020



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SINTEF ENERGI AS
Norway

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Germany

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Slovenia

RINA CONSULTING SPA
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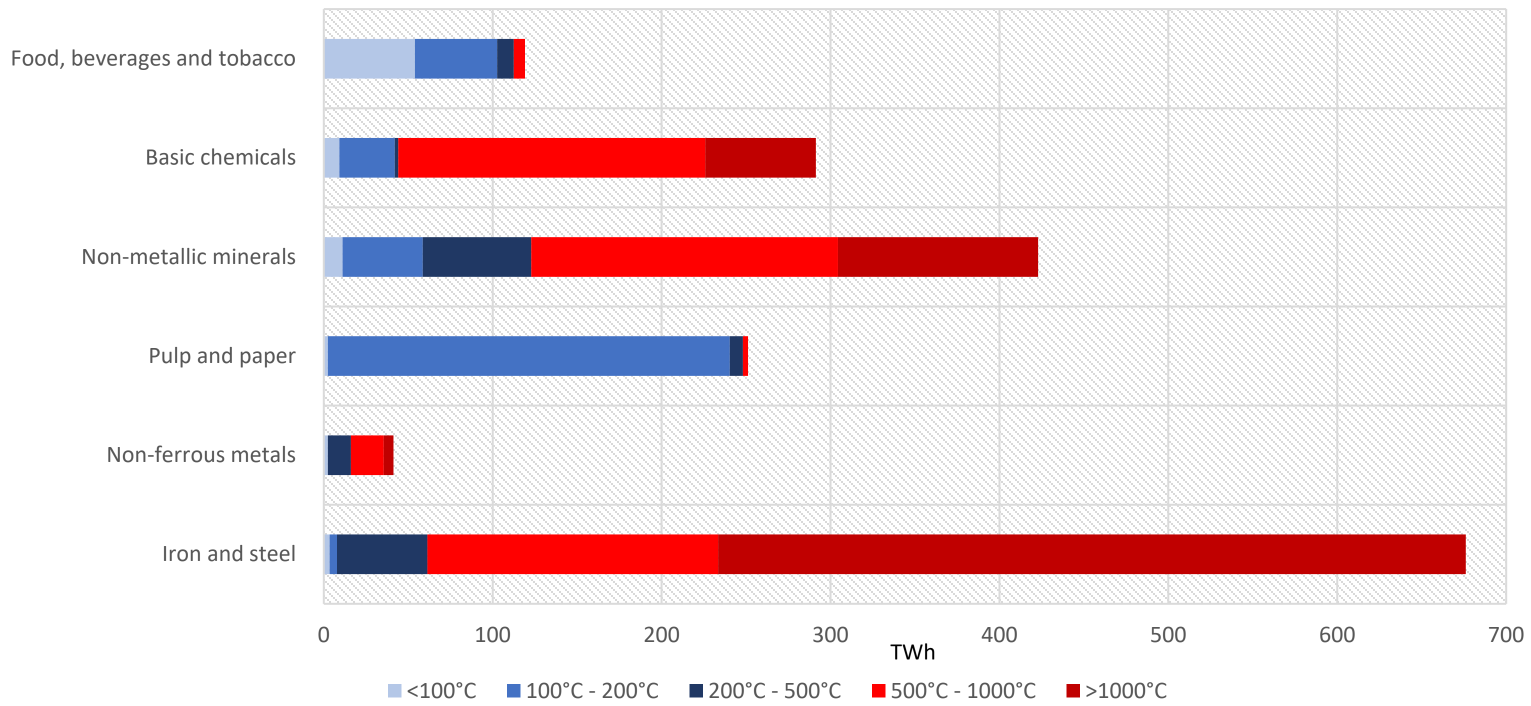
SONAE MC - SERVICOS PARTILHADOS, SA
Portugal

AMIRES SRO
Czechia

Thermal energy demand in the EU

Thermal energy demand in Europe per temperature range, TWh

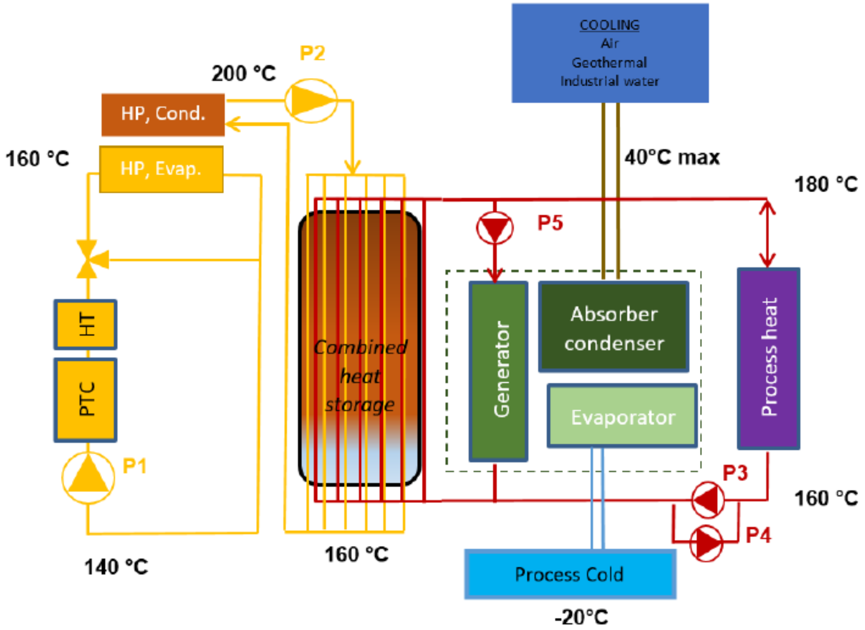


Final energy demand by subsector and temperature level EU28 + Norway, Iceland and Switzerland, 2012.
Author elaboration on data from Rehfeldt, M., Fleiter, T. & Toro, F. A bottom-up estimation of the heating and cooling demand in European industry. *Energy Efficiency* **11,** 1057–1082 (2018). https://doi.org/10.1007/s12053-017-9571-y

SHIP 200 and SHIP 300

FRIENDSHIP will develop two systems, able to supply heat at temperatures up to 300°C and cold at temperatures down to -40°C.

It will also provide integration considerations on two partner cases, Clariant (Chemicals) and SONAE (Wood).



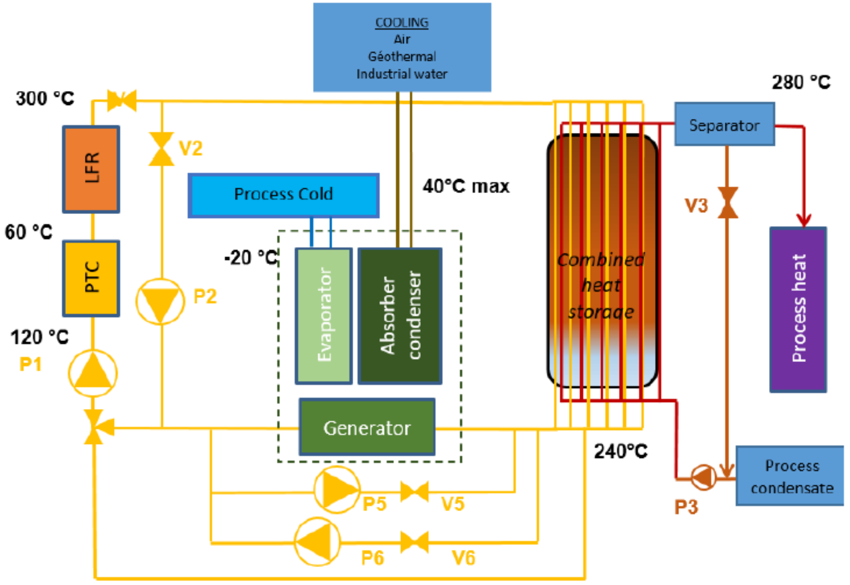


Figure 29: **SHIP300** Conceptual design for an indirect steam generation system in case the return temperature is about 120 C.

Validation

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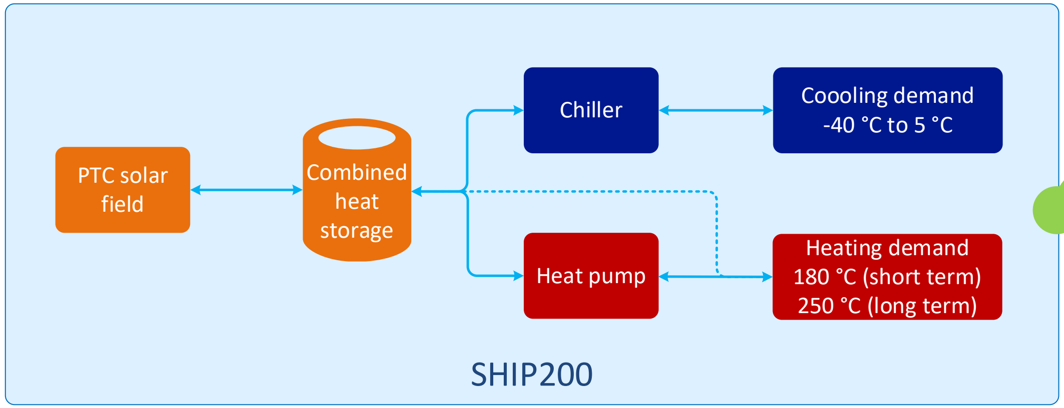
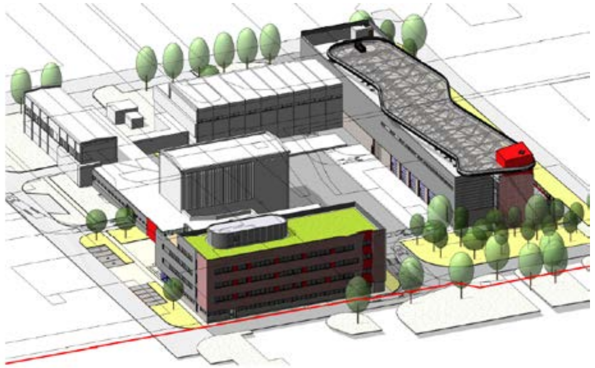
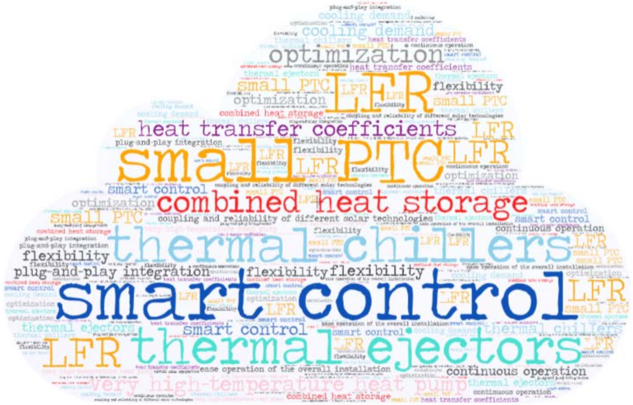
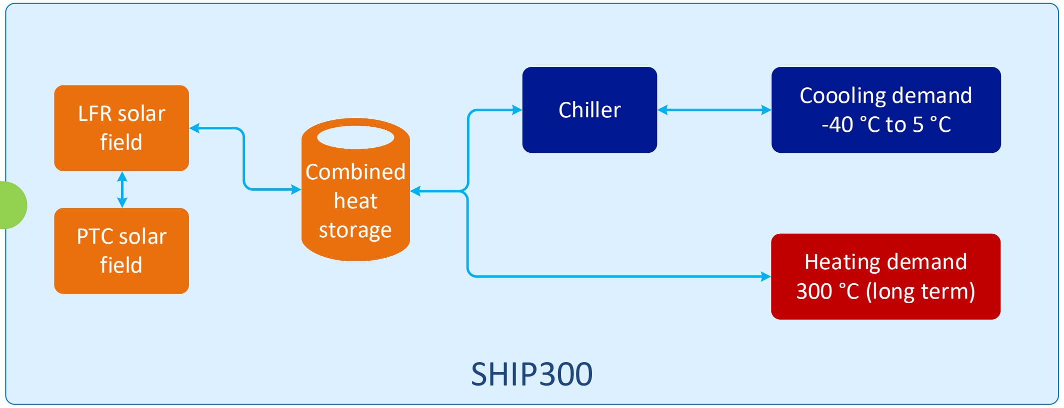




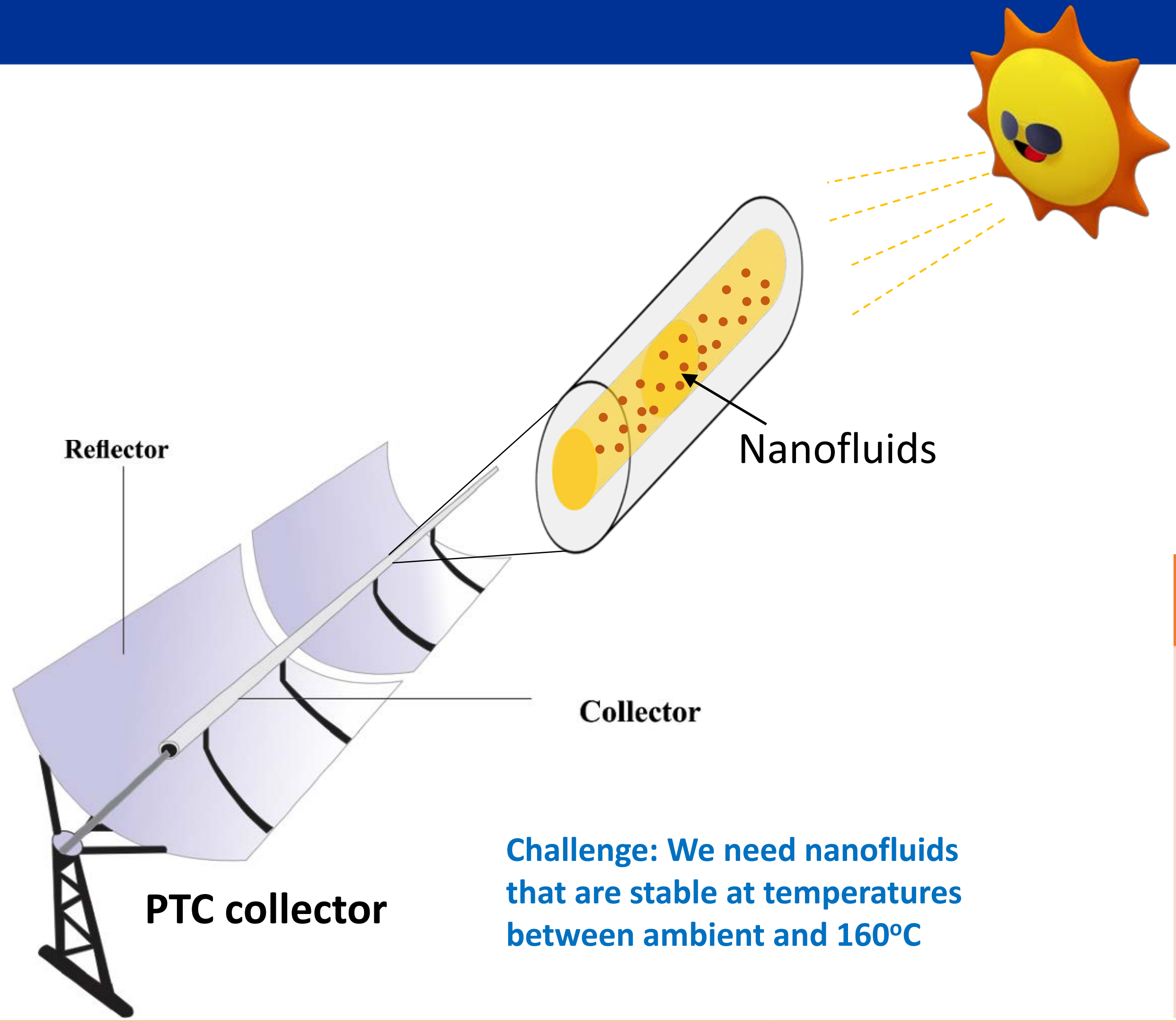
Validation of SHIP200 in relevant conditions
Demo site Grenoble (FR), Annual DNI 1,400 kWh/m²



Numerical validation of SHIP300 in relevant conditions
End-users sites (DE, PT, SP)



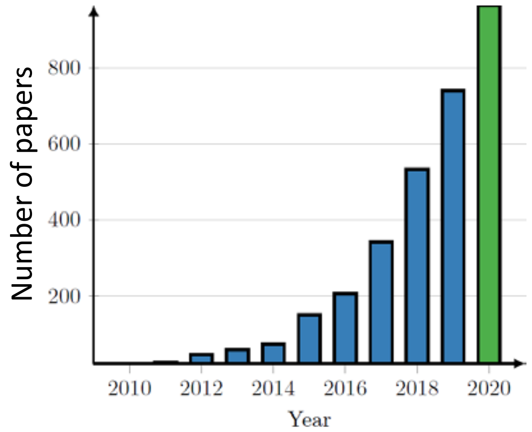
Nanofluids



Challenge: We need nanofluids that are stable at temperatures between ambient and 160°C

Nanofluids for PTCs have become a popular research topic during the last decade.

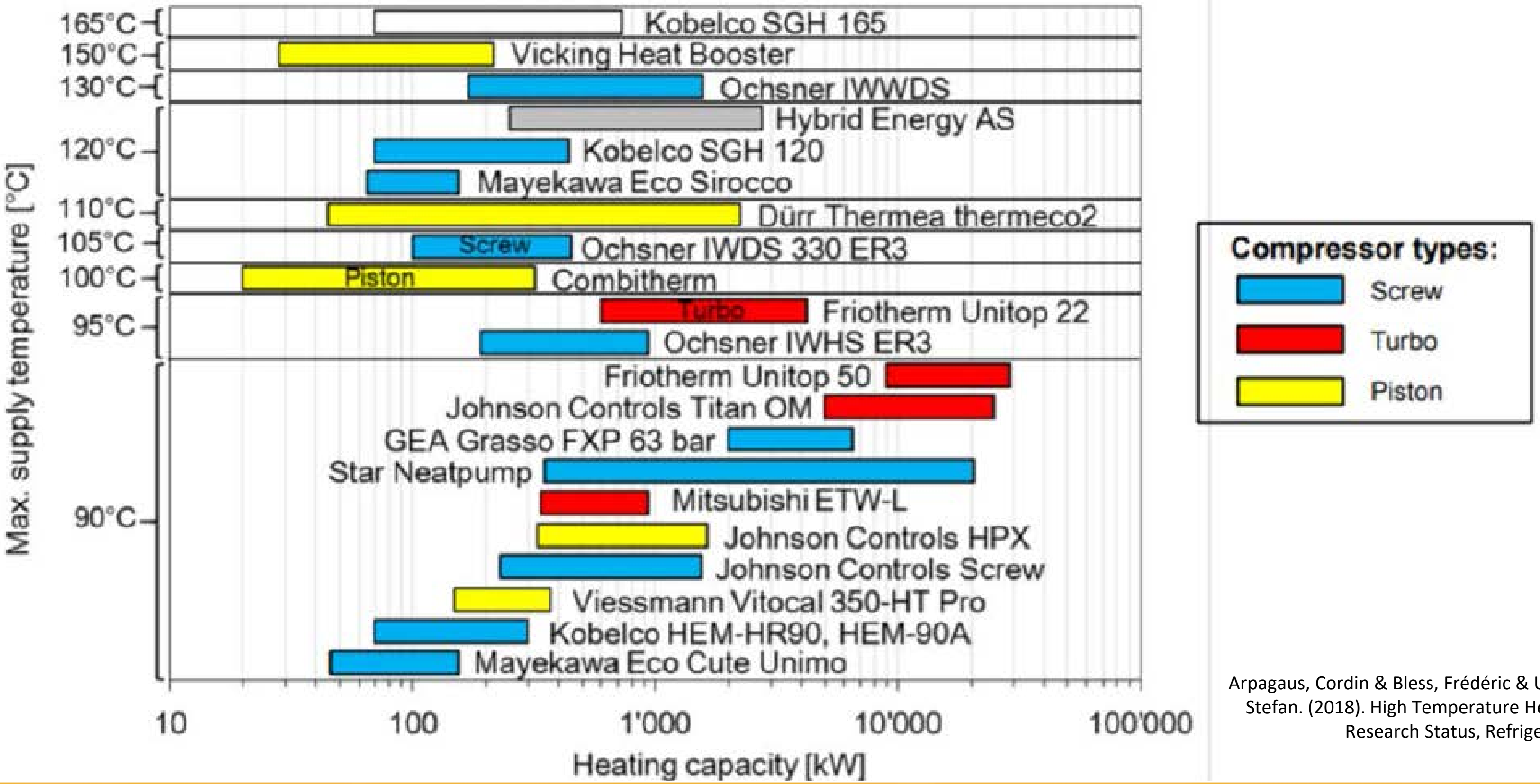
Nanofluids for PTC



Advantages	Drawbacks
• Good thermal properties • Inherently stable compared to e.g. microfluids (Brownian motions overcome gravitational settling)	• High cost of production • Stability can be broken by agglomeration – stabilization mechanisms are challenging at high temperatures • May lead to increased corrosion and erosion

Heat Pumps for Solar Thermal Boost

200 °C FRIENDSHIP

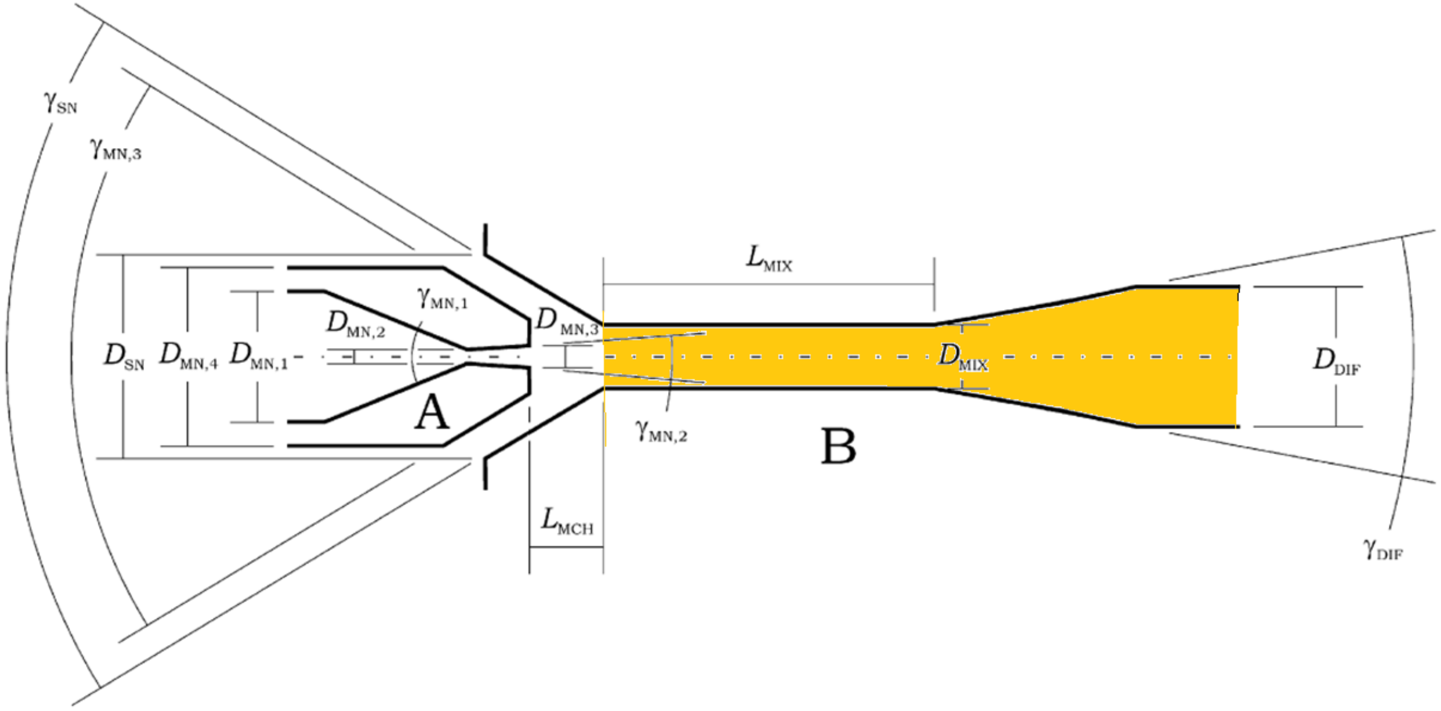


Arpagaus, Cordin & Bless, Frédéric & Uhlmann, Michael & Schiffmann, Jürg & Bertsch, Stefan. (2018). High Temperature Heat Pumps: Market Overview, State of the Art, Research Status, Refrigerants, and Application Potentials.

Innovative cooling technologies

Accounting for the nucleation limit is key for accurate prediction of critical mass flow rates through constrained geometries

Øivind Wilhelmsen[a,b], Ailo Aasen[a]



Innovations

- High temperature heat pumps
- Integration of heat pump with solar parks
- Ejector and absorption chiller modelling
- Heat storage technologies (PCM)
- Smart control system to ensure consistent heat flow to the process

Results – so far

HIGH-LEVEL COMPONENT SPECIFICATION FOR EACH COMPONENT OF THE SHIP SYSTEMS,

DEFINED SHIP SYSTEMS OPERATION MODES WITH DECISION TREE TO SWITCH BETWEEN THESE MODES AND A PRELIMINARY COST ESTIMATE AND FUNCTIONAL ANALYSIS

PROPOSED TWO GENERAL SYSTEM DESIGNS, ONE FOR A SHIP 200 AND ONE FOR A SHIP 300 SYSTEMS.

PROVIDED INTEGRATION CONSIDERATIONS IN TWO DIFFERENT ENERGY-INTENSIVE INDUSTRIES, AND DESIGNED AN INTEGRATION QUESTIONNAIRE

PRESENTED COST ESTIMATES OF MAIN EQUIPMENT, DISCUSSED COST CONSIDERATIONS AND LEVELIZED COSTS OF HEAT OF VARIOUS CONFIGURATIONS

PROVIDED CRITICAL KPIS FOR THE SYSTEMS TO APPEAL TO THE PROCESS INDUSTRY HAVE BEEN OUTLINED.

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Thank you for your attention !

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