

▶ **THERMAL SYSTEMS**
2023





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(Simon)

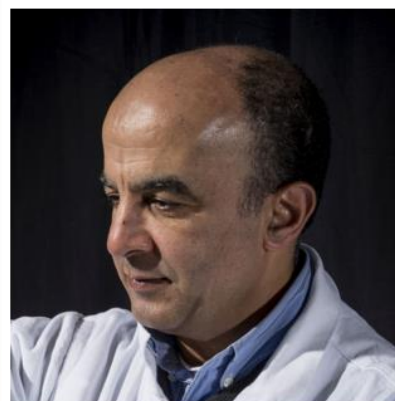
Who we are



Smidt, R.P.
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Tijani, M.E.H
(Hassan)



Vries, W.
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Wemmers, A.K.
(Anton)



Zondag, H.A.
(Herbert)

› WHAT WE DO

- › Contribute to
 - › About 40 projects
 - › 5 investment projects (Carnot, Faraday, Energy Storage, Mollier, FLIE)
 - › 6 roadmaps (Industry, Fuels & Feedstock, Embedding & Integration, Wind, Solar, Buildings & Infrastructure)
- › Studies, modelling, experiments on thermal materials, components, systems and processes
- › Main focus is on development of industrial heat pumps, drying processes and heat storage technology
- › Activities recent years:
 - › Experimental
 - › Modelling
 - › Studies

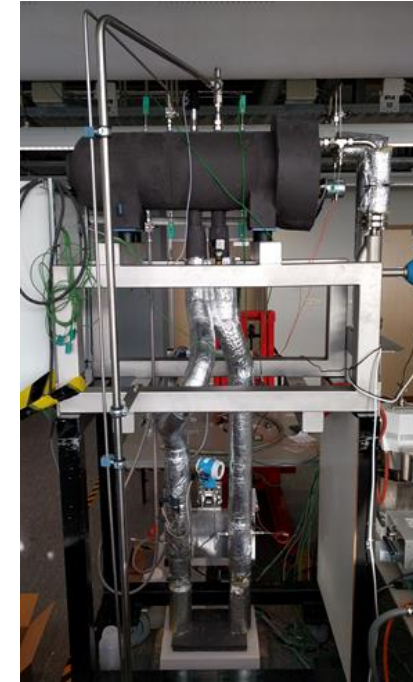
EXPERIMENTAL WORK



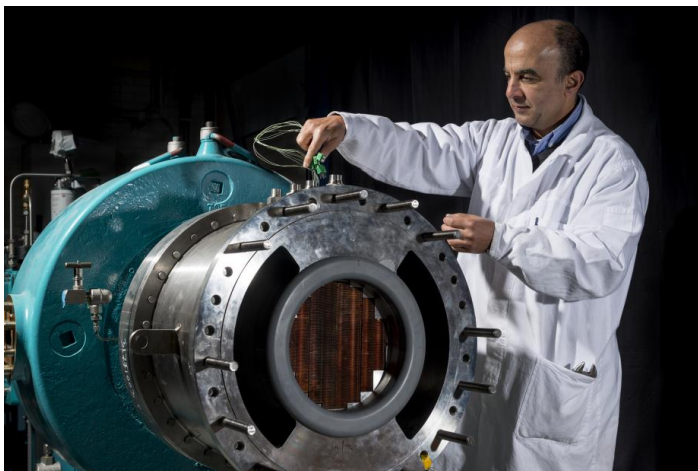
Freeze concentration installation



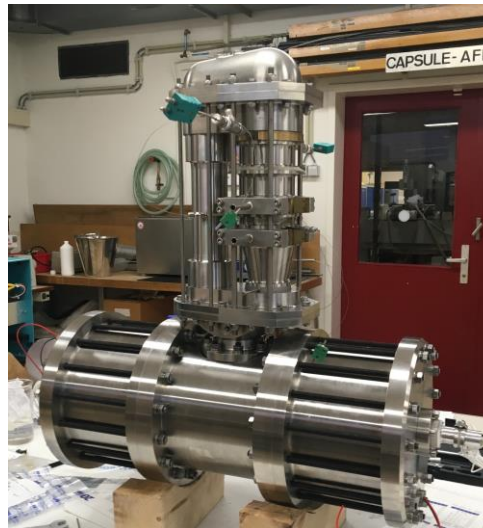
Low Capex heat pump



TE conversion



TA setup with piston compressor



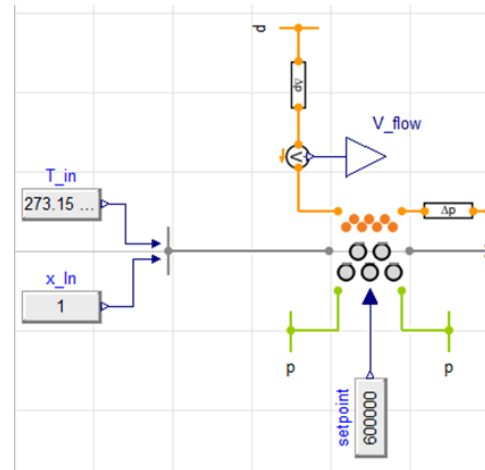
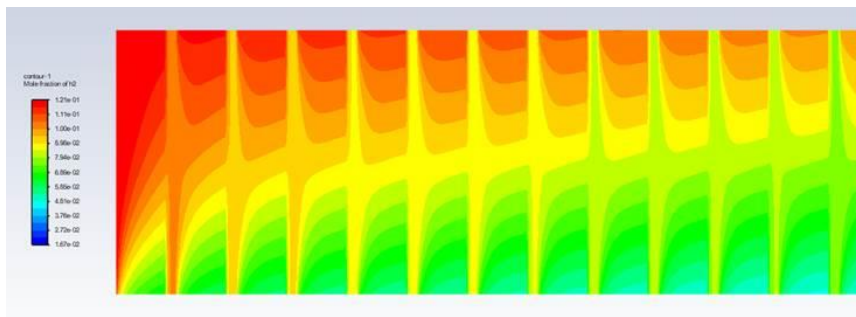
1 kW TA



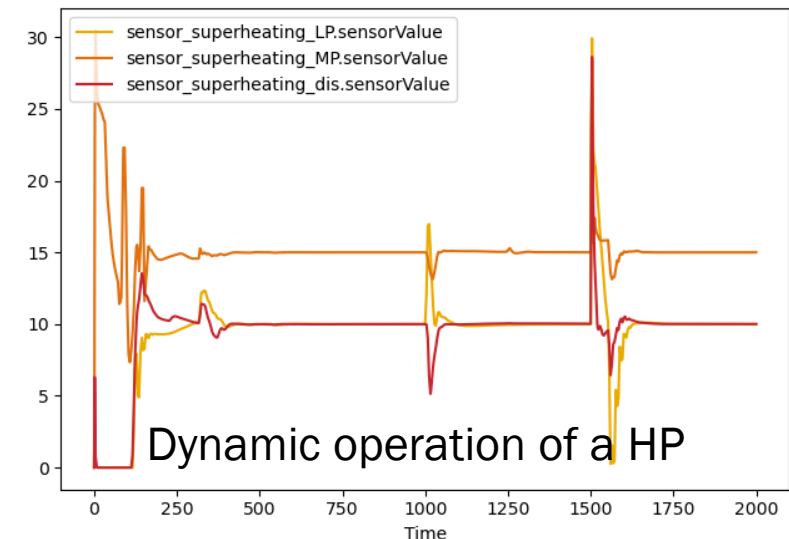
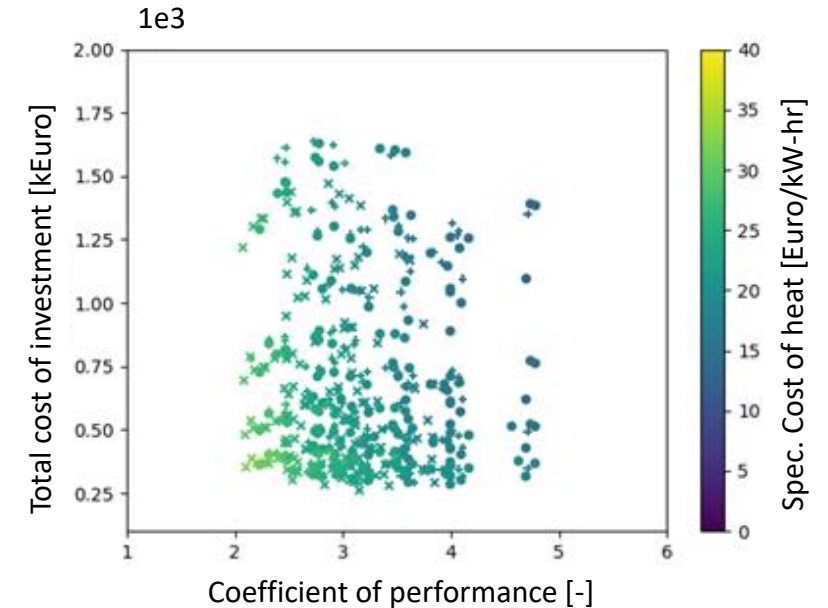
Molten Salt setup

MODELLING

- › Energy use calculations for Radial Multi-zone Drying (vortex chamber)
- › Thermo-economic modelling for industrial heat pumps (cycle layout, working media, components)
- › Modelling of convective and contact dryers
- › Dynamic modelling and control strategies for industrial heat pumps
- › Design of a hot air - molten salt heat exchanger
- › Electro-chemical and thermal modelling of PEMWE stacks
- › CFD modelling membrane reformer for H₂ production



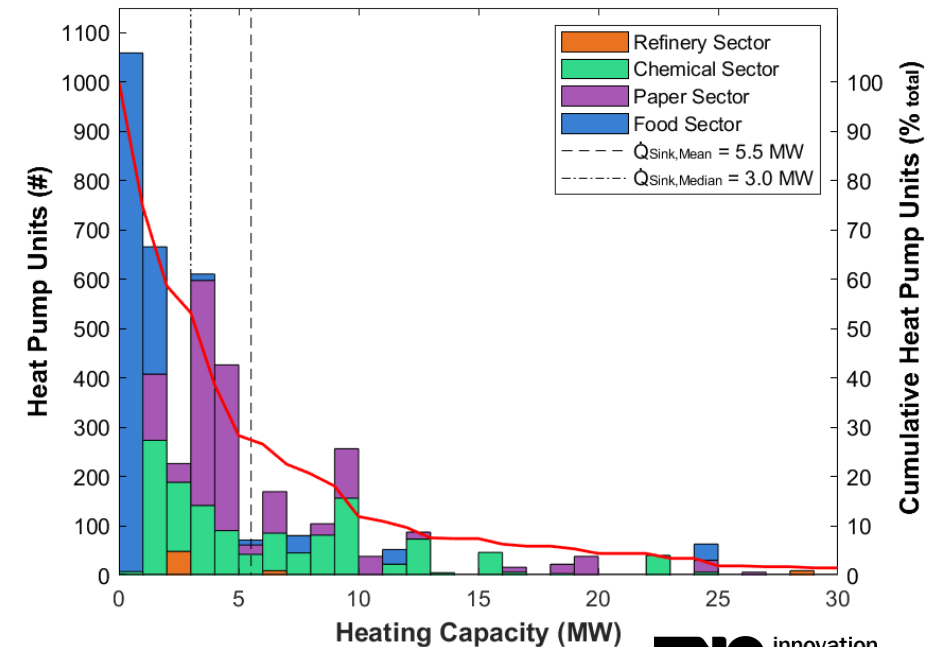
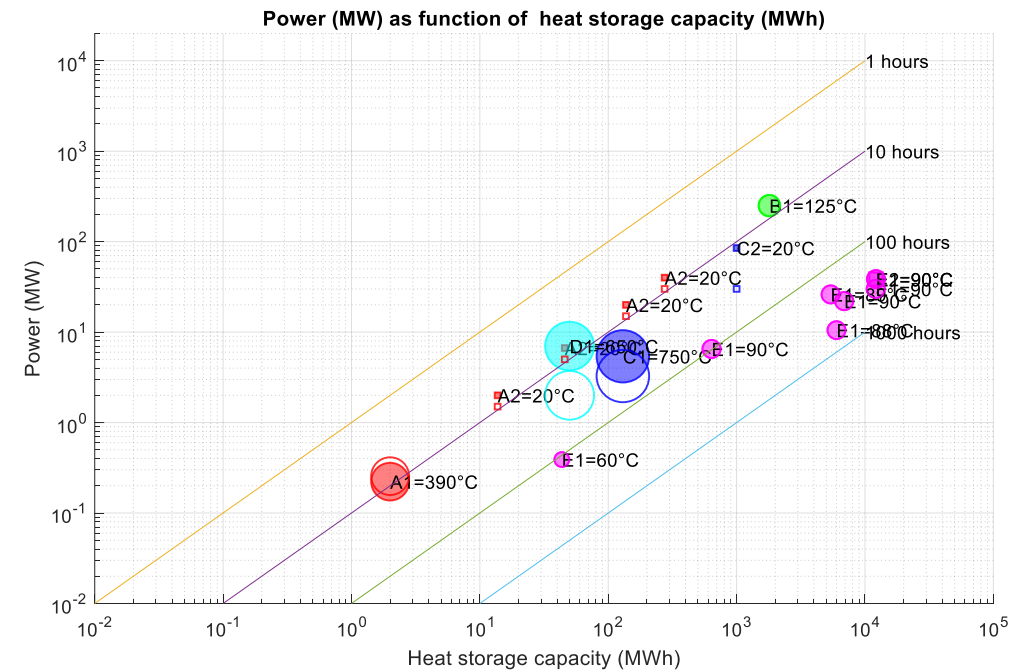
Paper dryer model



Dynamic operation of a HP

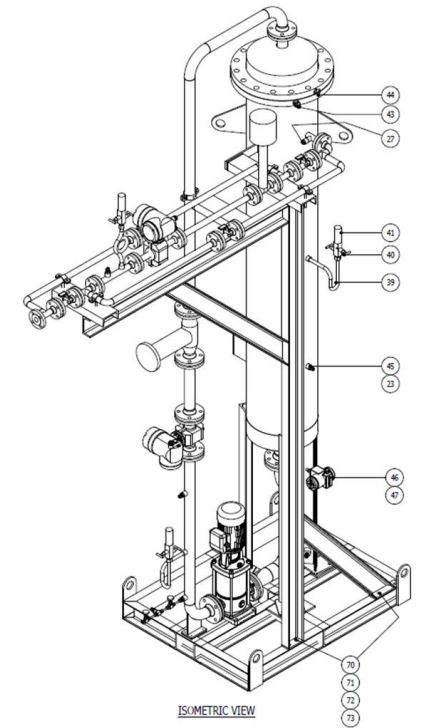
STUDIES

- › Carnot batteries
- › Database on heat storage technologies
- › White paper prepared on industrial heat pumps in cooperation with fellow EU institutes
- › Electric cracking – review paper prepared
- › Market study industrial heat pumps
- › Industrial heat demand and renewable electricity supply scenarios in 2050
- › Assessment of fuel cell cogeneration (power, steam) technology
- › Future heating technologies



› OTHER (UPCOMING) ACTIVITIES

- › Mayakawa (2 MW heat pump) commissioning & experiments
- › Sorption drying experiments
- › Experiments on dynamic behaviour 2 MW heat pump
- › Performance measurement PCM heat storage system
- › Commissioning & experiments high-temperature (180°C) heat pump skid
- › Working media for high-temperature (180°C) heat pumps tested
- › Assessment of future technology chains for production of industrial heat from renewable electricity
- › Steam compression heat pump infrastructure commissioned and DBS technology tested
- › Fuel cell cogeneration technology acquired, commissioned, experiments
- › Experiments with molten salt heat storage technology
- › TA heat pump steam production tests
- › Mollier and FLIE lab in operation
- › On-site experiments on drying of molded fiber under controlled conditions
- › Feasibility study sorption in ammonia synthesis and cracking processes in industry





› **THANK YOU FOR
YOUR TIME**

TNO innovation
for life