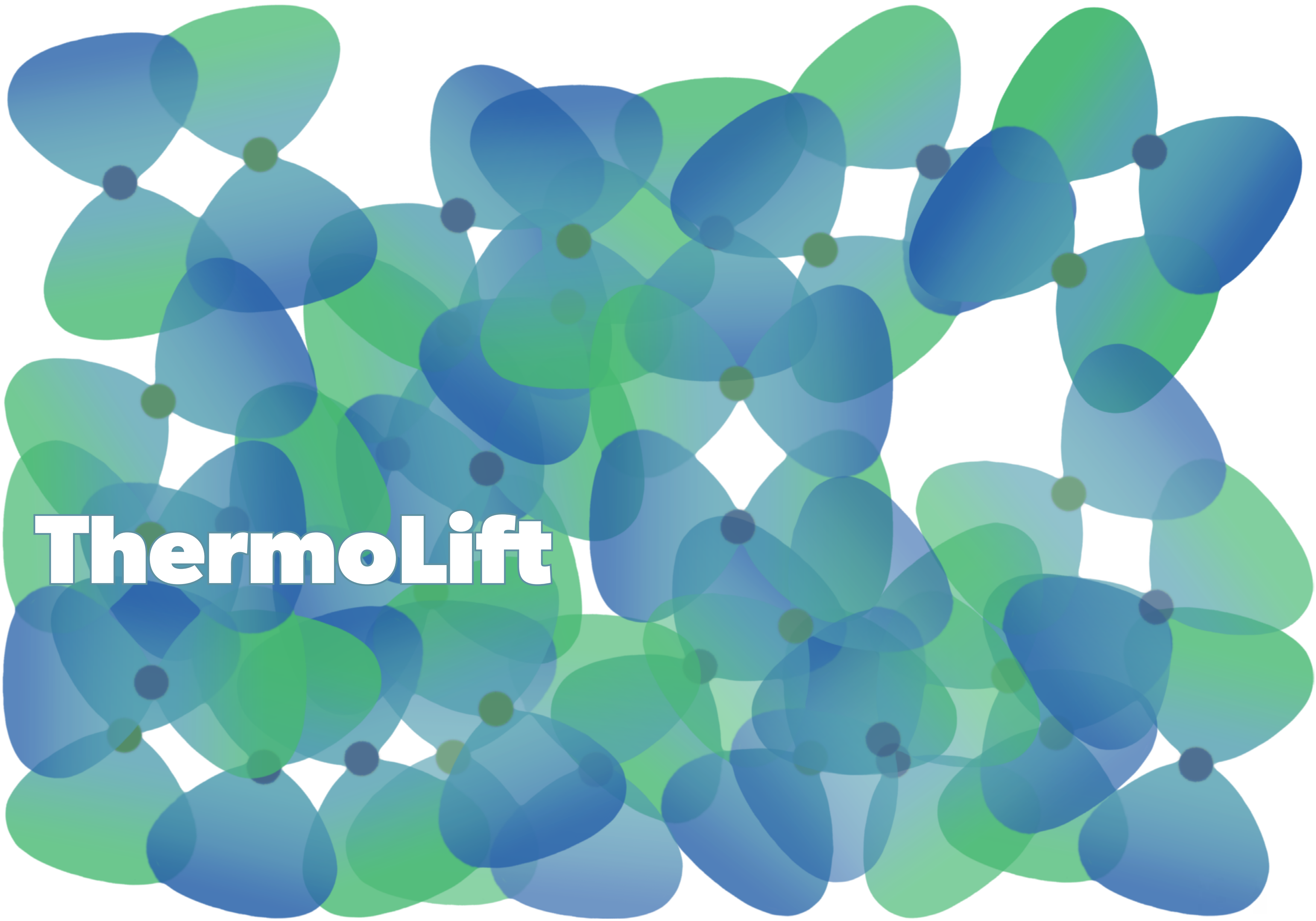
ThermoLift



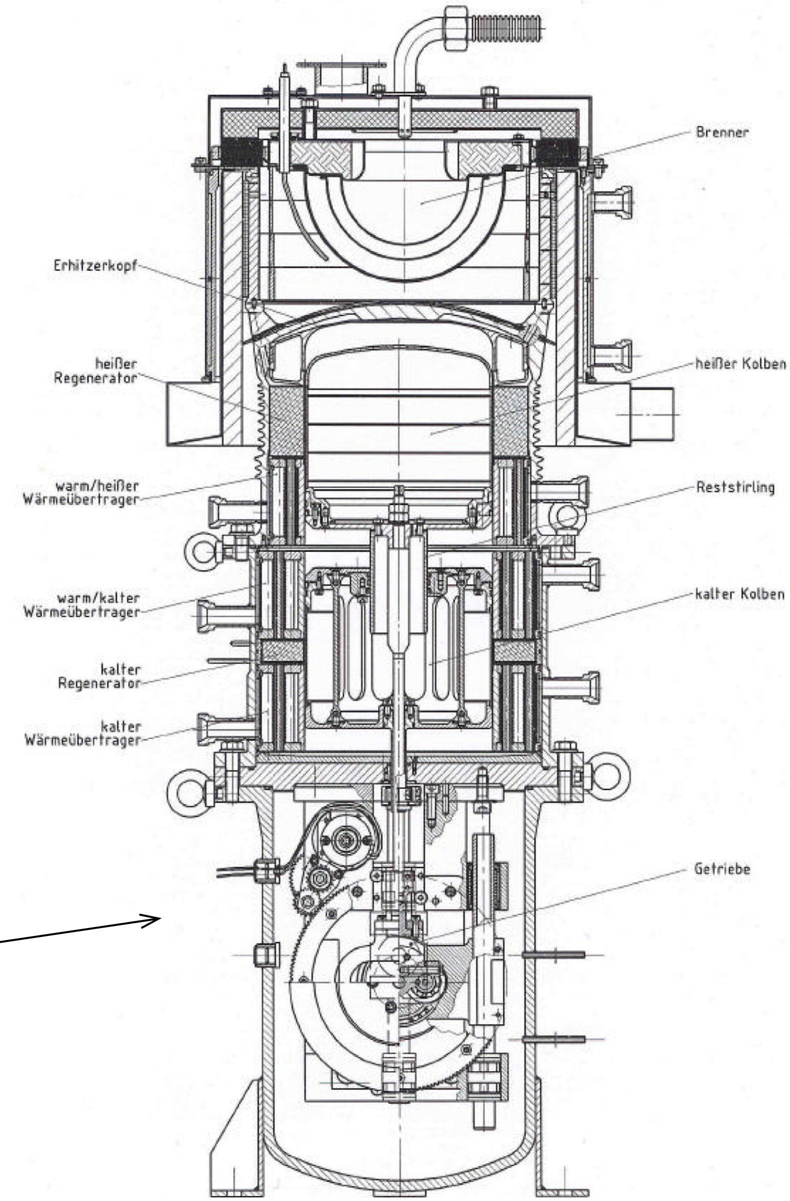
Cooling and Heating Buildings wth Hydrogen

Heating and cooling buildings and heating water account for about 28% of total energy consumption in Austria. Providing heating and cooling via electricity (generated in power plants) is a detour in our opinion, because a lot of valuable energy is wasted in low-temperature electrical generation.

The fundamentally better solution is the combustion of hydrogen in heat-driven thermodynamic machines, such as the ThermoLift, in which heat is extracted from the environment. The mode of operation is similar to Stirling engines and Vuilleumier heat pumps but differs in important respects.

The ThermoLift's thermal-regenerative gas cycle requires a heat source of 500° to 1000° Celsius, which can be generated by flameless, NOx-free hydrogen combustion: no CO_2, no pollutants, and no electricity consumption.

However, a parabolic mirror could also serve as a solar heating head, a hydrogen-fueled burner - or a hybrid.



Sectional drawing of the 20 kW Vuilleumier heat pump from the BVE project (Germany, 1999) with mechanical synchronization.

The BVE ThermoLift project was a collaboration between the companies Bosch and Viessmann, as well as the Chair of Thermodynamics at the University of Dortmund. The aim of the project was the development of a gas-driven Vuilleumier heat pump for heating and domestic hot water production in buildings. Professor Dr.-Ing. Peter Hofbauer was already significantly involved in this development.

Modern approaches to this technology **focus on the use of hydrogen** and have substantially advanced and redesigned the Vuilleumier cycle. The exceptional cooling capacity of the ThermoLift system—both for buildings and technical processes—is a particular focus in current development. Synchronization of pressure and temperature cycles is no longer controlled solely mechanical; modern electronic control enables more efficient utilization of secondary ambient heat and cooling sources.

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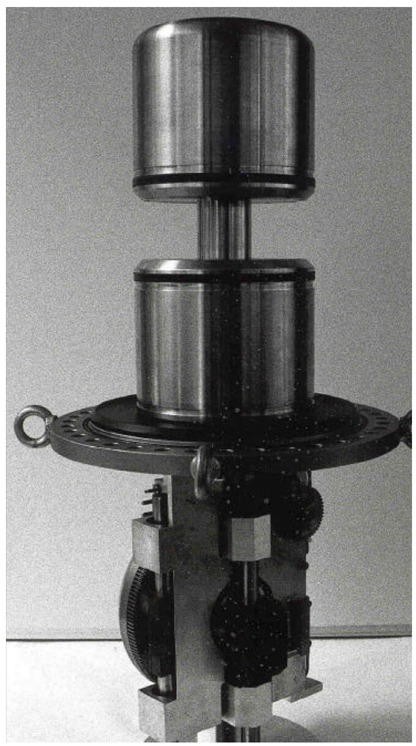
Hydrogen combustion, a parabolic mirror used as a solar heater head, or a hybrid, can be used as a **heat source that initiates the thermodynamic cycle**, in which a working gas is first moved from a hot chamber into two warm chambers, and then, out of phase, further into a cold chamber. Heat energy is extracted from the working gas, and stored in regenerators. Depending on the design of the thermodynamic process, temperatures close to absolute zero (-273.15° Celsius) can even be achieved in the cold chamber.

Heat for heating is (partly) extracted from the environment (for example the outside air) - and for cooling from the rooms in the building to be air-conditioned. **This means that cooling and heating can be provided simultaneously, highly efficiently and with zero emissions.** This is practical in households and a particularly great advantage for commercial and industrial processes. For example, the sales area of a supermarket can be heated in this way - and the refrigerated display cases cooled at the same time without any further energy consumption



The drive mechanism of the first 20 kW Vuilleumier heat pump built in the BVE project 1999.

Drive of the ThermoLift with Hydrogen Reaction in the Tubular Reactor

The oxidation of hydrogen must proceed safely and robustly. The transfer of energy from the hydrogen reaction with oxygen takes place in the ThermoLift with the novel Tubular Reactor. The heat of reaction is transferred directly to the tubes of the reactor. The colder working gas of the ThermoLift flows through these specially arranged tubes in an oscillating manner. This extracts heat from the reaction zone and prevents the formation of nitrogen oxide. The exhaust gas from the hydrogen-powered Tubular Reactor is absolutely free of harmful gases and CO2

Solar-Hydrogen Hybrid (SolarLift)

The generation of drive heat can be supplemented with solar energy. The required temperatures of 500° to 1000° Celsius can be provided by a Solar Concentrator (parabolic mirror as solar heater head), which is connected to the ThermoLift. Heat transport can be provided by hot air as long as the temperature does not exceed 1300° Celsius to safely prevent nitrogen oxides. Thus, on sunny, hot days, cooling of buildings is possible using only solar energy. If not enough solar energy is available, the hydrogen reaction can be switched on. The fan of the ThermoLift supplies either the hydrogen-air mixture or solar-heated air to the reaction zone.

Decarbonization of Natural Gas in the Building (Mini Decarbonizer)

The existing natural gas network could be retained and supplemented if a small decarbonizer in the building were economically feasible. The hydrogen would be separated from the carbon powder on site and available for heating and cooling

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