Cold Battery Storage

August 2021

Company Profile

- SAB Engineers GmbH was founded in 2018 as part of the SAMI Holding of Saudi Arabia
- The company is located in Germany close to the City of Bingen at River Rhine
- SAB Engineers developed a **Cold Battery Storage** in close cooperation with the Institute for Energy Systems of the Technical University of Darmstadt

TECHNISCHE UNIVERSITÄT DARMSTADT

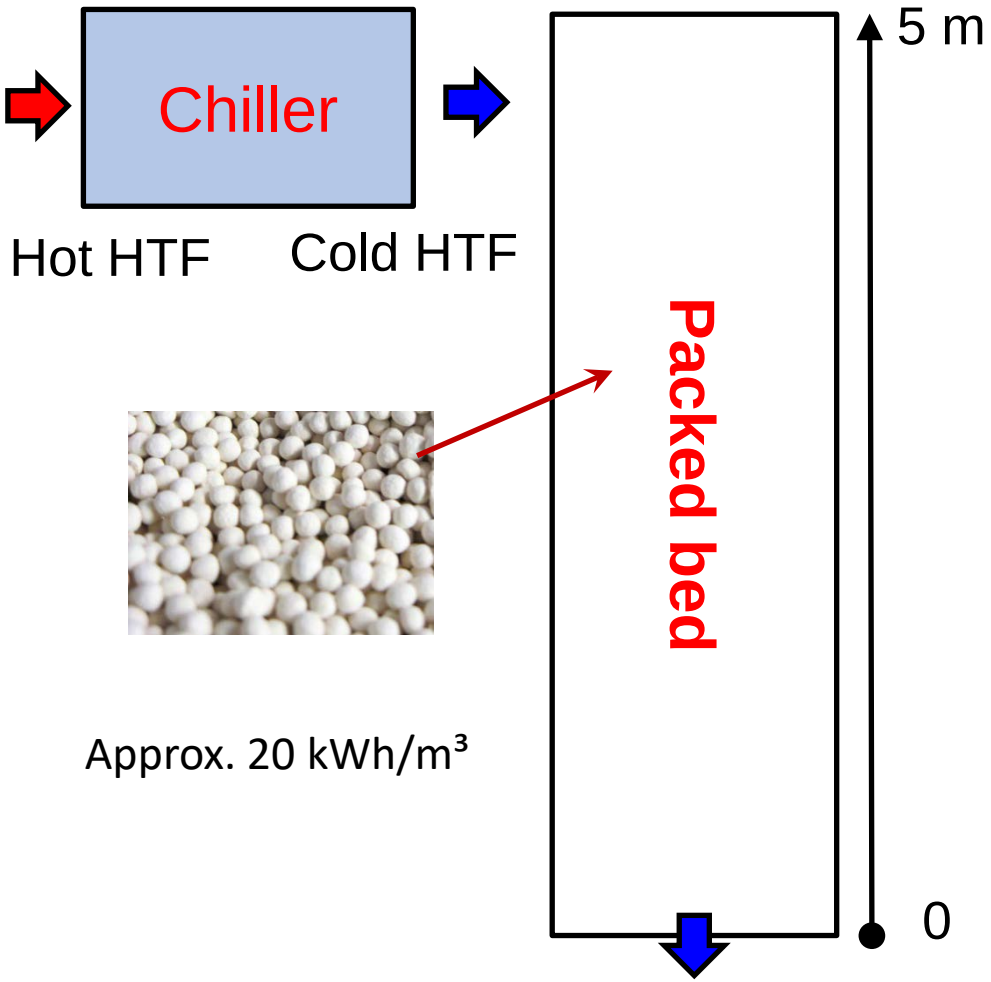
- Study with global player for cold systems showed technical and economical feasibility of the system.

August 2021

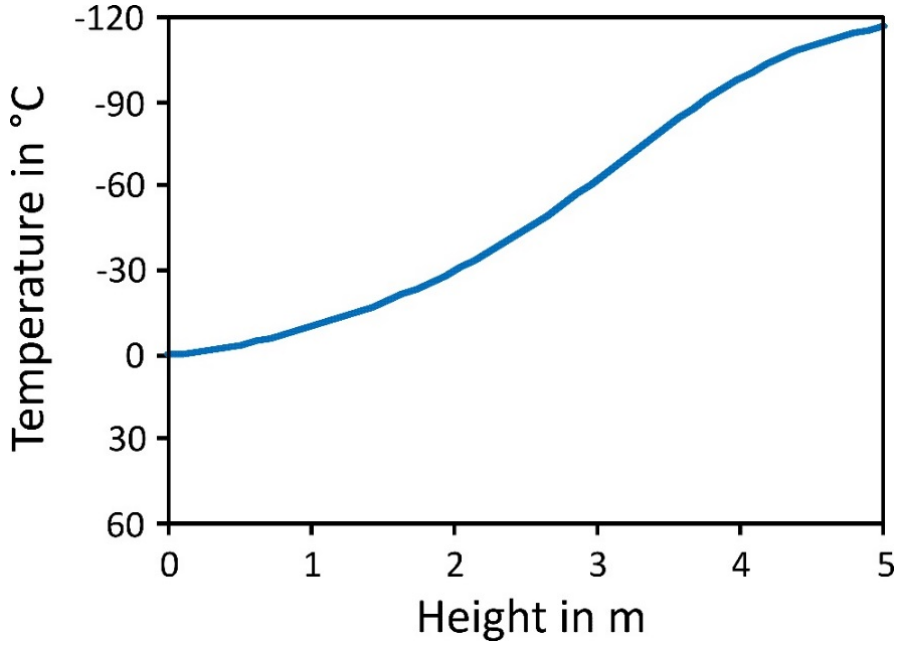
What is a Cold Battery Storage

- A sensible thermal energy storage system is used to store the coldness
- The Cold Battery Storage (CBS) can be a Plug-In assembly for existing systems
- The process consists of a chiller, packed bed system, a compressor and a heat exchanger coil
- The chiller provides a low temperature of about -50 °C or lower
- The bed system consists of single packed bed or more, randomly filled with monodisperse or polydisperse solid particles
- The compressor enables the circulation of the heat transfer fluid (HTF) (e.g. carbon dioxide) in the circuit
- The heat exchanger coil delivers cooling to the end users

Cold Battery Storage Process (I)



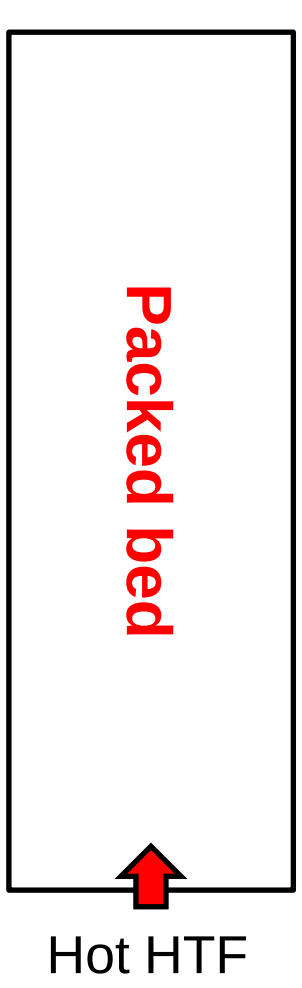
Approx. 20 kWh/m³



Charging

The HTF inflow cools down the packed bed material up to the specified temperature level.

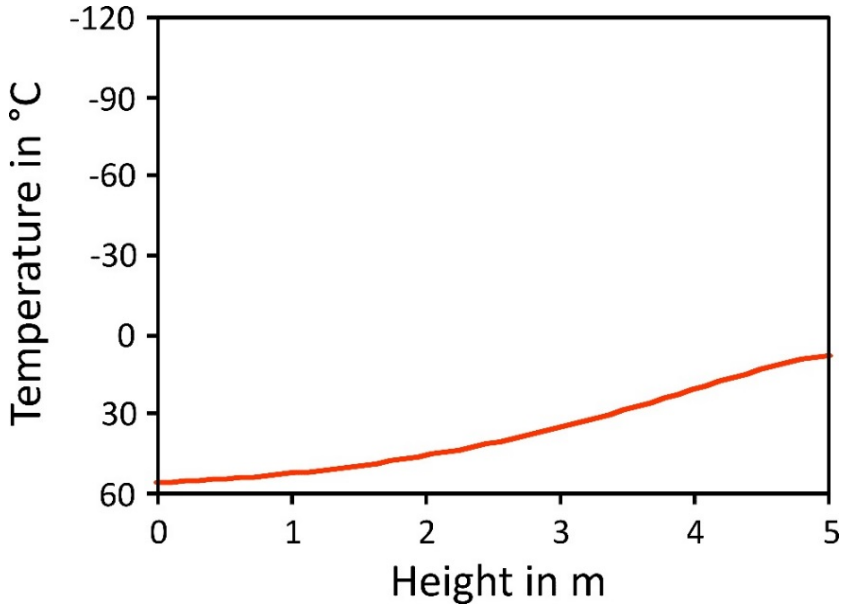
Cold Battery Storage Process (II)

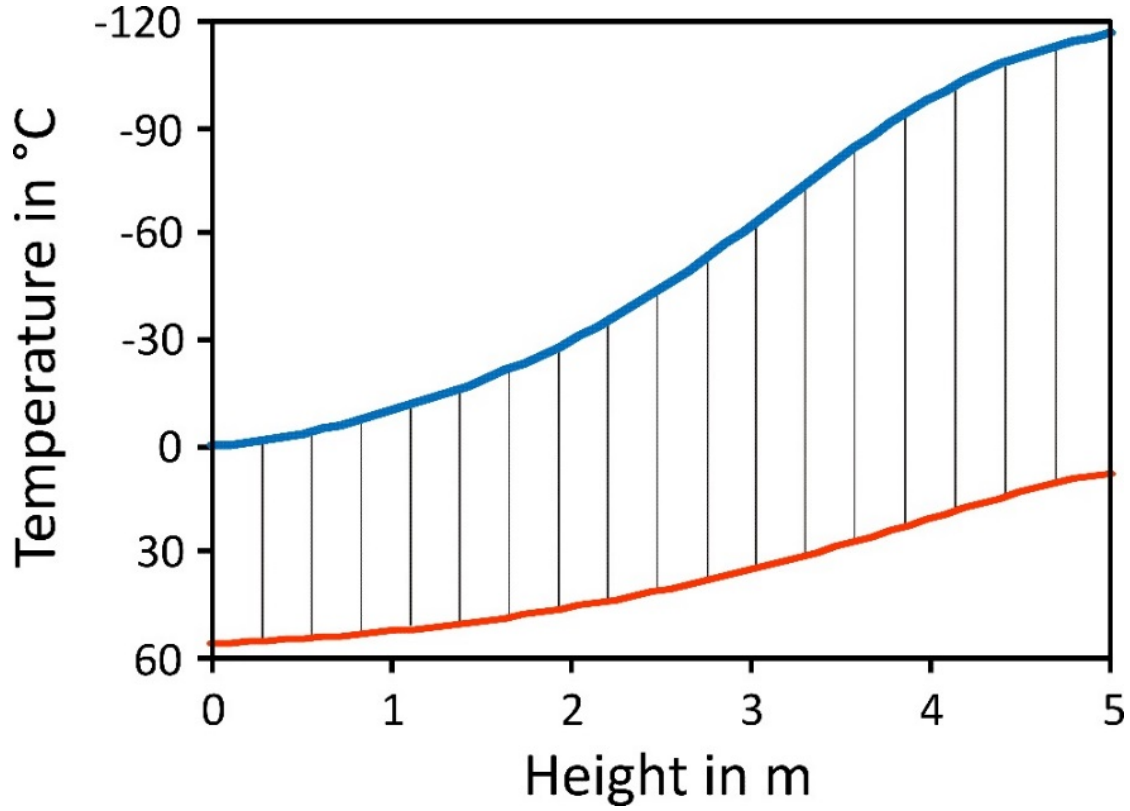


Cold HTF

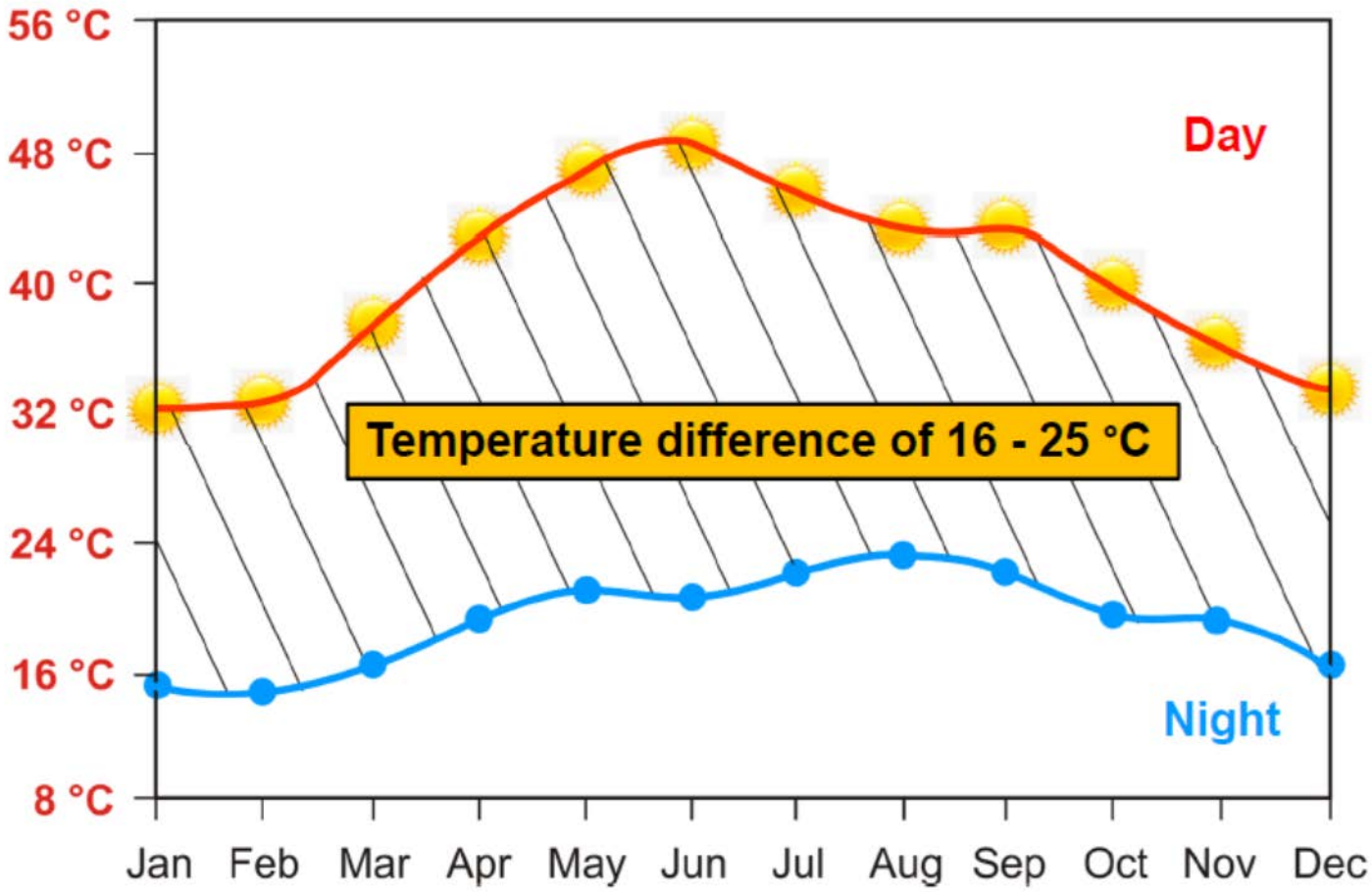
Discharging

HTF inflow absorbs the temperature of the packed bed material





Cold Battery Storage
Application Area



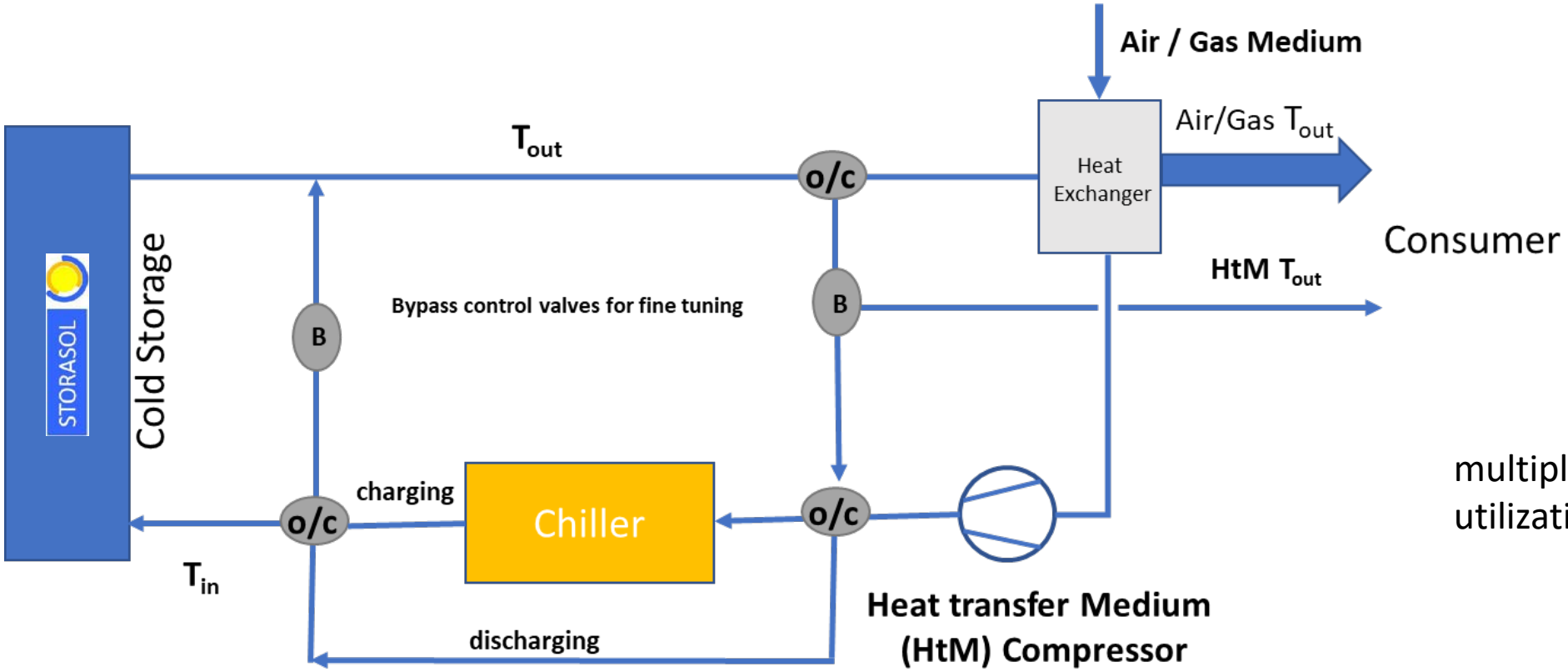
The CoP of a Chiller system depends strongly on the ambient temperature, thus higher electrical power consumption at higher ambient temperatures

Storing coldness through the night when CoP is high and electrical power consumption is low (Chiller on)

Utilizing coldness during the day when CoP is low and electrical power consumption is high (Chiller off)

saves significant electrical power consumption for the production of coldness

Cold Battery Storage
Plug-In application with Bypass



multiple outlet temperature utilization possible

Cold Battery Storage
Internal System application

The Cold Battery Storage can be applied as condensate cooler in modern transcritical cooling systems or in liquid systems as Sole Cooler.

For such applications are individual engineering solutions required.

Cold Battery Storage
Demo Unit Assembly

Demo Unit with a capacity of 15 kWh utilizing sensible heat of ceramic pellets

Cold Battery Storage
Commercial Unit

Battery Storage
Example for Economical Set-Up

Cold Battery Storage

Economical Benchmark — South East Europe

Capacity (kWh)	600

el. tariff night €ct/kWh	4

el.tariff day €ct/kWh	11

CoP for direct evaporating system with CO2

Period Mai - Sept.

Temp. Night °C 12 — Temp. Day °C 27

Savings with battery			Modul charging at night			Discharging at day		
days per period	el. kWh per period	Cost € per period	CoP	el. cons. kWh	el. cost €	CoP	el. cons. kWh	el. cost €
153	21.336	5.178	2,27	264,3	10,6	1,49	403,8	44,4

Period Oct. - April

Temp. Night °C 2 — Temp. Day °C 11

Savings with battery			Modul charging at night			Discharging at day		
days per period	el. kWh per period	Cost € per period	CoP	el. cons. kWh	el. cost €	CoP	el. cons. kWh	el. cost €
207	6.407	3.364	3,27	183,5	7,3	2,80	214,4	23,6

Total savings per Year	kWh	Euro
	27.743	8.541

- Assumptions made for:
  a. el. tarrif
  b. average temperatures
  c. operating periods
- Final figures to be verified for individual applications

Cold Battery Storage
Evaluation Data

In order to evaluate the application for a cold battery storage we need the following data:

- process flow sheet of the installation
- Required cooling capacity (Qc in kWh) and associated electrical power consumption (Qel. in kWh) at defined ambient temperature → thus defining the CoP figure

Example →

Hour		Outside temp.			Q0 total	Pel MT	COP MT
			[°C]		[kW]	[kW]	[-]
0	01.01.2021	00:00:00	4,43		77,4	24,3	3,18
1	01.01.2021	01:00:00	4,24		77,4	24,1	3,21
2	01.01.2021	02:00:00	4,06		77,4	23,8	3,25
3	01.01.2021	03:00:00	3,99		77,4	23,8	3,26
4	01.01.2021	04:00:00	3,92		77,4	23,7	3,26
5	01.01.2021	05:00:00	3,88		77,4	23,7	3,26
6	01.01.2021	06:00:00	3,85		77,4	23,7	3,26

- Electrical tariff (ct/kWh) for day and night
- Average ambient temperature for day and night for monthly periods for a full calendar year

Thank you for your attention