

# ISEC

2<sup>nd</sup> INTERNATIONAL  
SUSTAINABLE ENERGY  
CONFERENCE 2022

05 – 07 April 2022  
Congress Graz  
Austria

## Multi-Purpose Pit Thermal Energy Storage In Combination With Heat Pumps



**Morten Vang Bobach – MSc Mechanical Engineering**

*Product Manager*

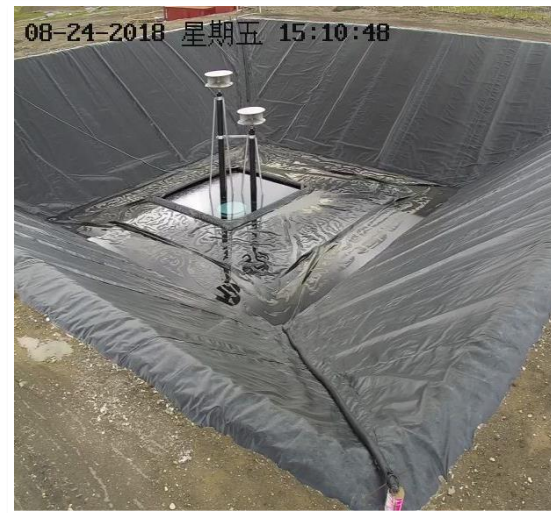
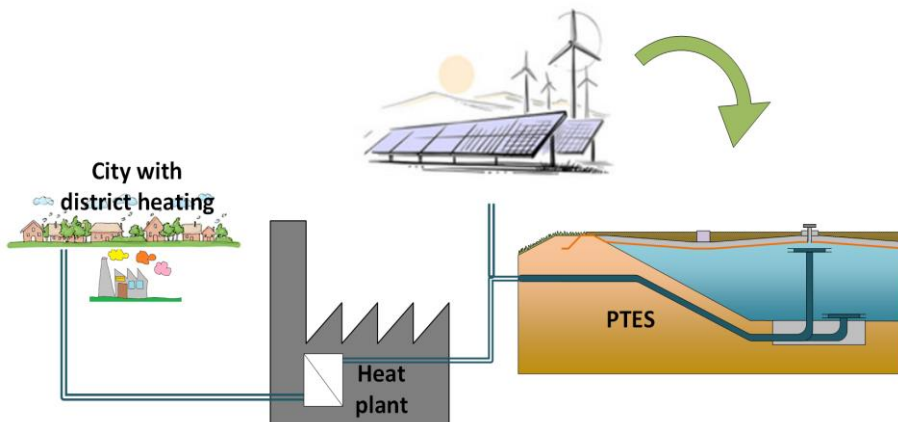
[mvb@aalborgcsp.com](mailto:mvb@aalborgcsp.com)

**AALBORG CSP**  
- Changing Energy

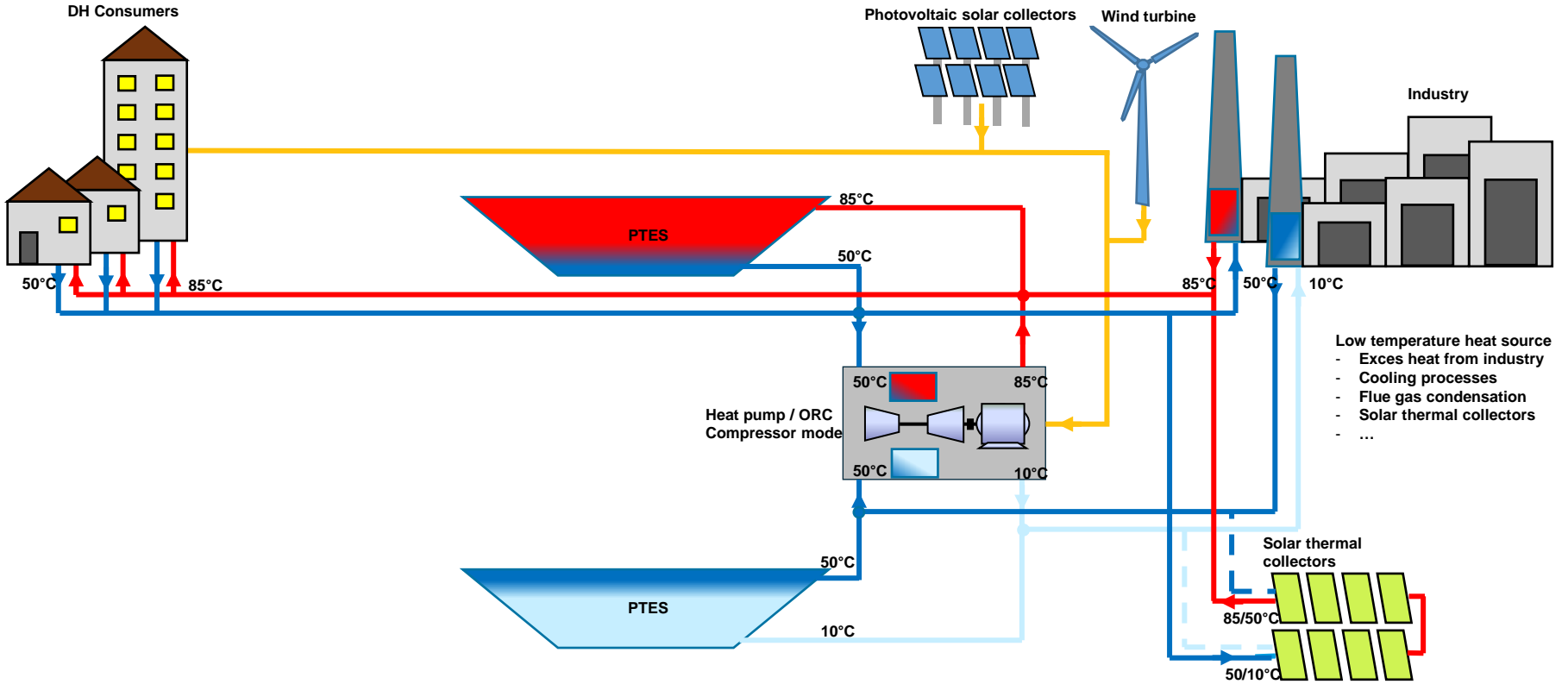
# PTES, Pit Thermal Energy Storage

## Low cost storing energy in a green future

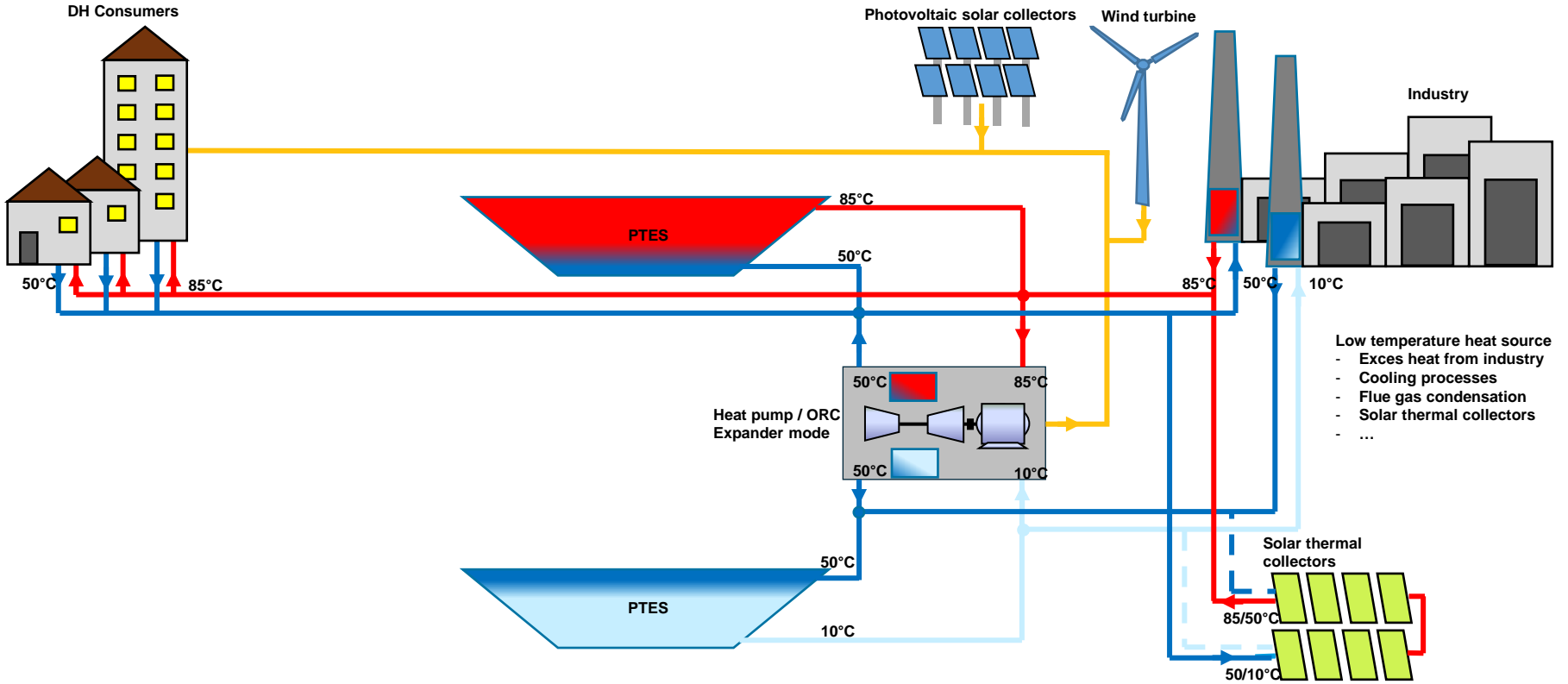
- A flexible energy system that will enable the conversion from conventional fossil fuel energy to fluctuating renewable energy sources requires large scale energy storage.
- The PTES technology is a low-cost energy storage for thermal energy up 90°C. Energy is simply stored in pure water.
- PTES enables storing of excess energy for later use in district heating networks resulting in increased flexibility and efficiency of the heat production. This includes:
  - excess heat from solar heating plants, power plants or industrial processes
  - excess electricity produced by wind or PV stored as heat
- Collecting waste heat/power and using it for district heating later helps lower energy loss and reduces our carbon footprint.



# Combining PTES and heat pump

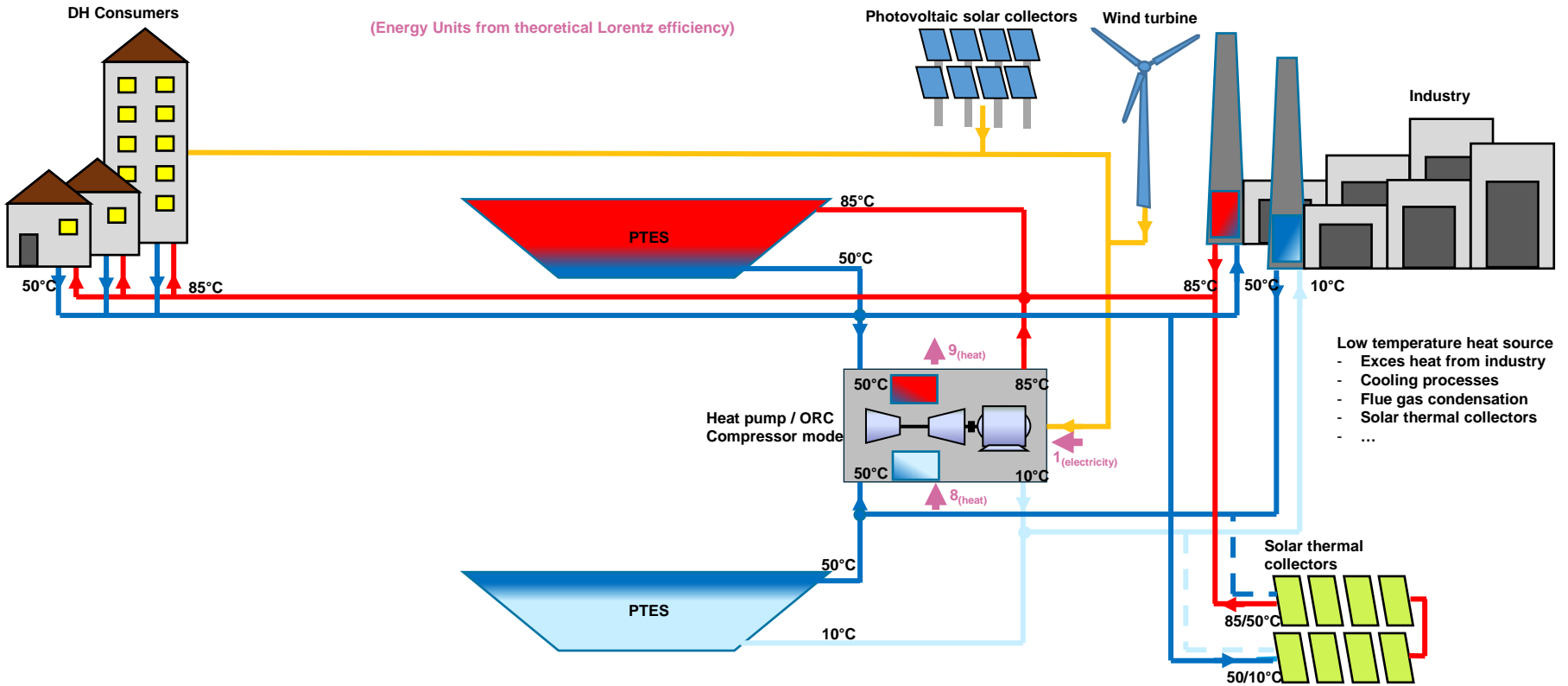


# Reverse the proces – PTES as electricity storage



# Efficiency - Charging

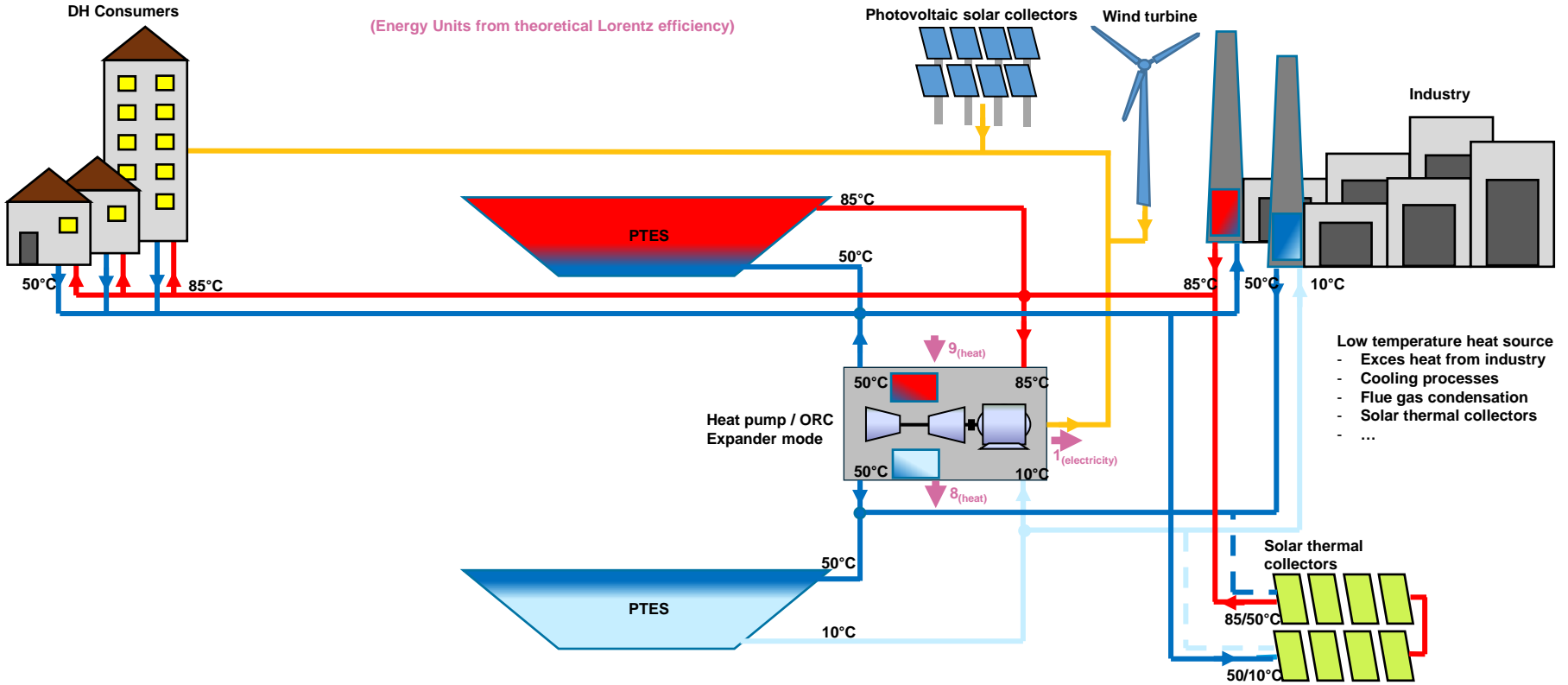
(Energy Units from theoretical Lorentz efficiency)



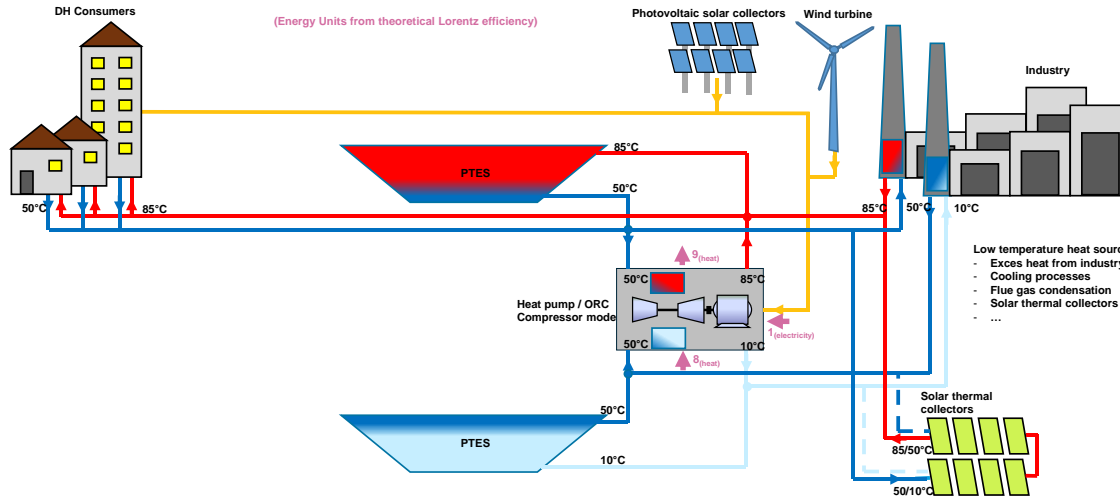
- Low temperature heat source
- Exces heat from industry
  - Cooling processes
  - Flue gas condensation
  - Solar thermal collectors
  - ...

# Efficiency - Discharging

(Energy Units from theoretical Lorentz efficiency)

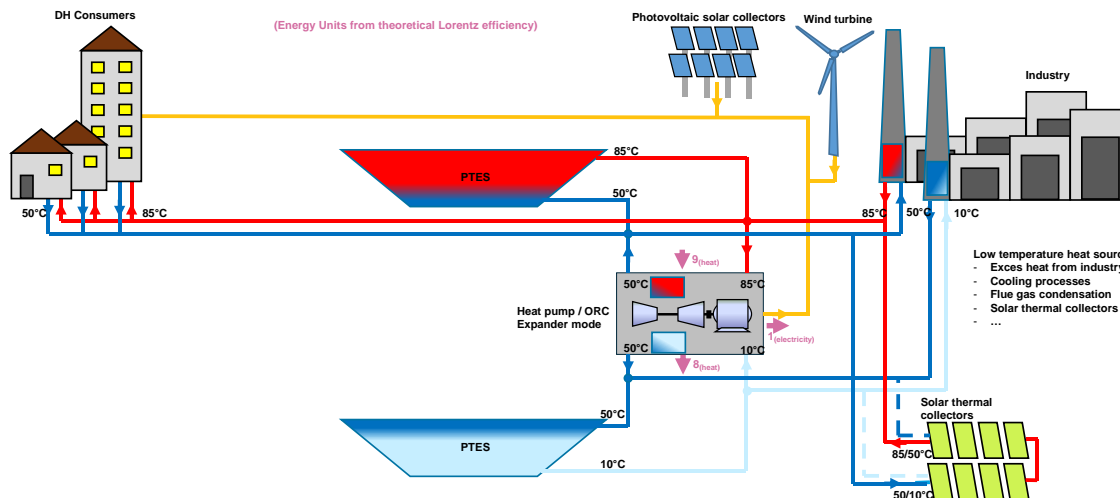


# Round trip efficiency – power to power



<b>Charging</b>	
<b>Ideal:</b>	<b>Realistic?:</b>
$\eta = 9/1 = 9$	$\eta = 9 \cdot 0.7 = 6.3$

<b>Discharging</b>	
<b>Ideal:</b>	<b>Realistic?:</b>
$\eta = 1/9 = 0.11$	$\eta = 0.11 \cdot 0.7 = 0.08$



<b>Round trip power to power</b>	
<b>Ideal:</b>	<b>Realistic?:</b>
$\eta = 9 \cdot 1/9 = 1$	$\eta = 6.3 \cdot 0.08 = 0.50$

## New cover installation in Marstal



10,000 m<sup>2</sup> customized lid solution for Pit Thermal Energy Storage in Marstal, Denmark

[\(4\) 10,000 m<sup>2</sup> customized lid solution for Pit Thermal Energy Storage in Marstal, Denmark - YouTube](#)

## Two main problems has been identified at existing PTES installations R&D project started 2017. Resulting in new lid design

### Danish PTES installations

DTU:	500 m3	1983
Ottrupgaard	1.500 m3 / 43,5 MWh	1995
Marstal Sunstore 2	10.000 m3 / 638 MWh	2003
Marstal Sunstore 4	75.000 m3 / 6.960 MWh	2012
Dronninglund	60.000 m3 / 5.570 MWh	2013
Gram:	122.000 m3 / 11.300 MWh	2015
Vojens:	203.000 m3 / 18.800 MWh	2015
Toftlund:	70.000 m3 / 6.500 MWh	2017
(Langkazi, Tibet)	15.000 m3 / 1.000 MWh	2018
Høje Tåstrup	70.000 m3 / 3.300 MWh	2022

### A- Water accumulation in insulation

Water diffusing through the floating liner accumulate inside the insulation.

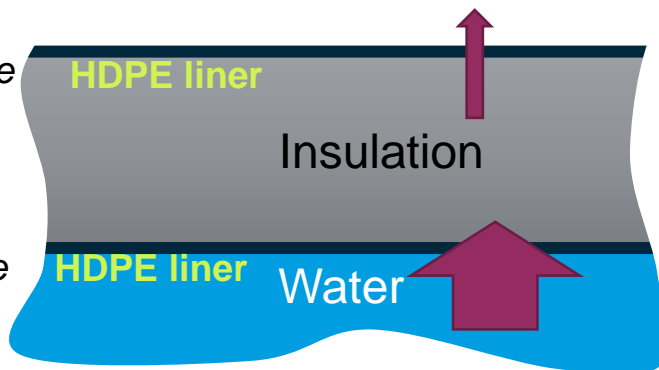
Water accumulation reduce efficiency of the insulation.

### B - Rainwater ponding on top

Because of the flexible nature of the floating lid, rainwater will form ponds at the lowest points. Ponds increase in size over time. The load from water ponds can damage the insulation.

Low temp: 10°C

Low diffusion rate



High temp: 90°C

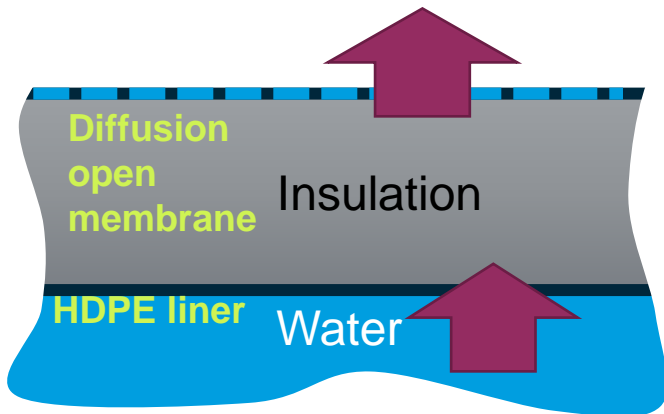
High diffusion rate

# Water accumulation inside insulation cause increased heat loss Diffusion open top membrane to avoid water accumulation

**Patented**

## A- Water accumulation inside insulation

The top liner of the lid is replaced by a diffusion open membrane. This type of membrane is known from roof design in buildings and allow water to diffuse out of the insulation. Membrane prevents water accumulation.



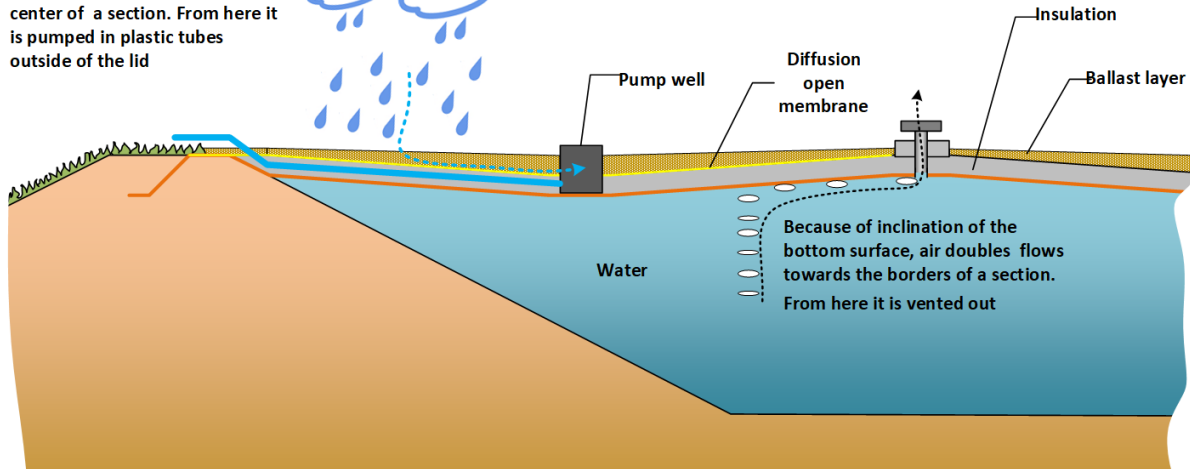
# Water ponding on top of lid, cause local load/damage of insulation Sectionized lid design with built in drain system for rainwater

**Patented**

**B- Rainwater ponding on top**  
The top cover is divided into sections, each with own drain system. On top of each section a ballast layer forms a slope shape of the surface allowing water to be pumped away from the surface



Because of inclination of the top surface, rainwater flows towards the pump well in the center of a section. From here it is pumped in plastic tubes outside of the lid



# New lid design with improved efficiency, lifetime and serviceability

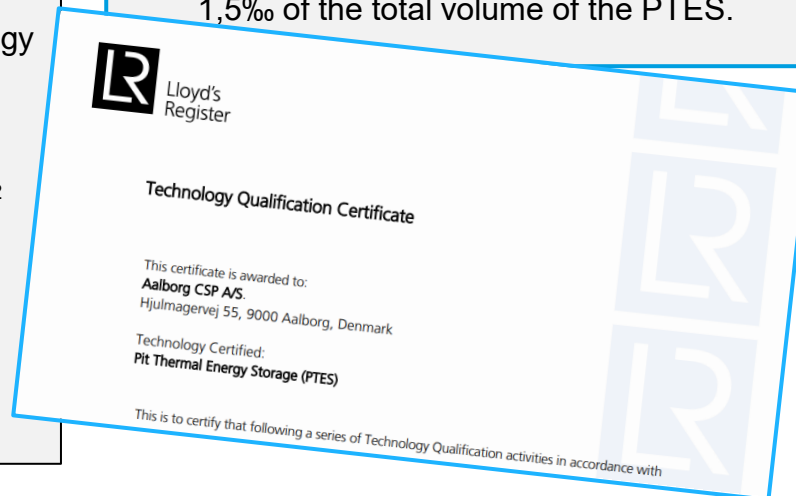
## Energy storing technology ready for implementation in large scale

### New lid design for Pit Thermal Energy Storage

- Solving problems from previous projects.
- Lid design protected by two patents
  - Diffusion open top cover construction to avoid water accumulation inside insulation material
  - Top cover surface is built in sections, each with own drain system for surface water. Each section is centered around a pumping well with an inward fall towards it allowing water to be led away from the surface and insulation layer easily.
- Improving lifetime and reliability.
- Reduced service costs.
- During the entire design phase, the technology has been reviewed by Lloyd's Register, resulting in a Technology Qualification Certificate.
- Large scale installation in Marsal (10.000 m<sup>2</sup> surface area) . Running since April 2020.
- Easy scalable due to sectionized design
- Technology ready for installation 😊

### Claims listed in Technology Qualification from Lloyd's Reg.

1. The lifetime of the PTES is at least 25 years.
2. The efficiency of the PTES is at least 90%
3. The PTES is capable of storing heat up to maximum 90°C
4. Reliability: Service and maintenance can be carried out without interfering with normal operation. This gives an availability factor of 100%
5. Charging and discharging power is minimum 90MW
6. Once installed and operating the PTES requires a minimum of operational resources
7. At least 90 % of the components of the PTES are recyclable.
8. The maximum yearly required amount of make-up water is 1,5‰ of the total volume of the PTES.

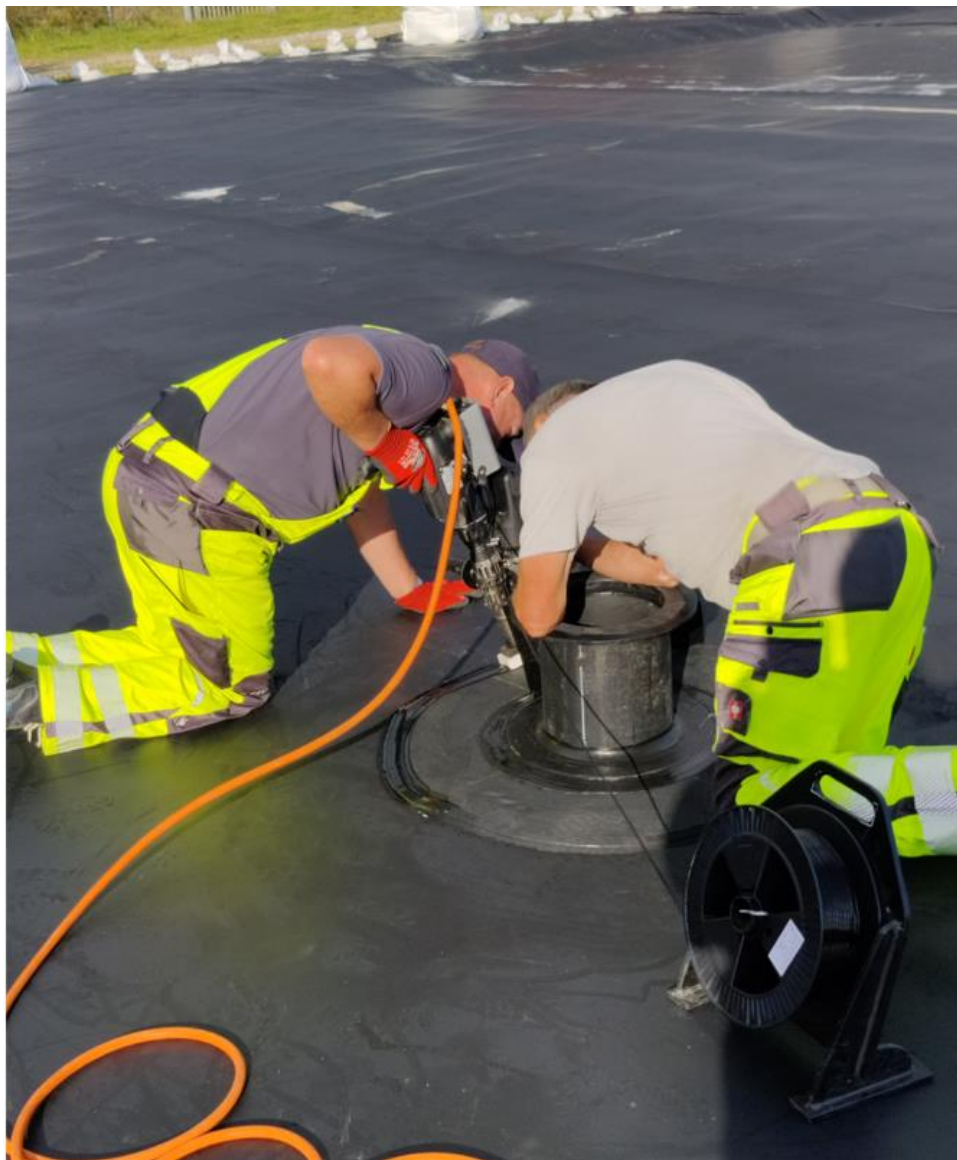


## Most recent project – Dronninglund - new PTES cover in operation from March 21<sup>st</sup> 2022











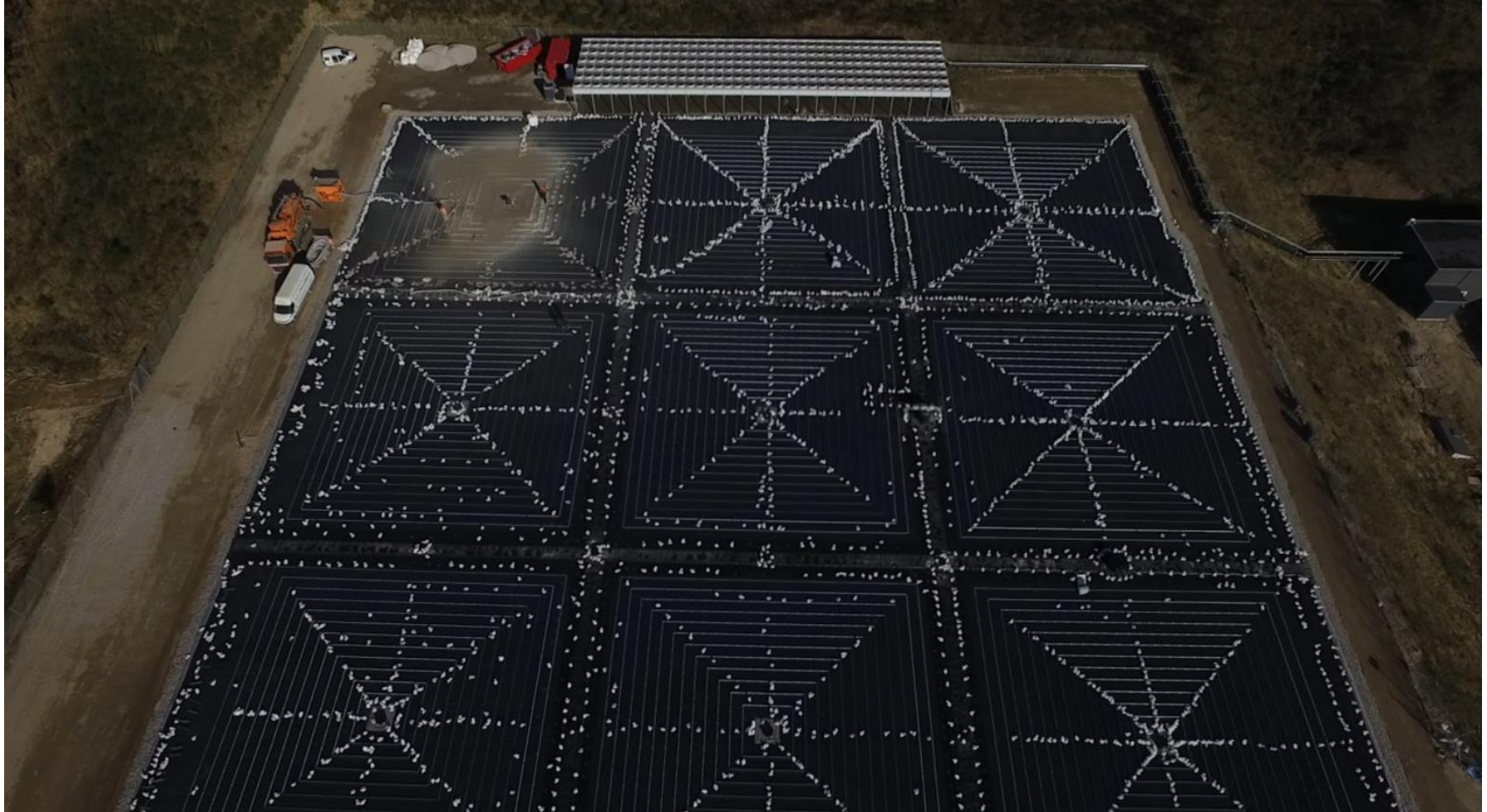


2021/11/04















*THANK YOU FOR YOUR ATTENTION*

## **Multi-purpose Pit Thermal Energy Storage in Combination with Heat Pumps**

**Morten Vang Bobach – MSc Mechanical Engineering**

*Product Manager*

[mvb@aalborgcsp.com](mailto:mvb@aalborgcsp.com)

