CSP ERA-NET has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 838311

CSP
CONCENTRATED SOLAR POWER

InnoSolPower

INNOvative SOLar micro-TES with high-POWER density

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"Exchange od Experiences" Webinar – 28 September 2023

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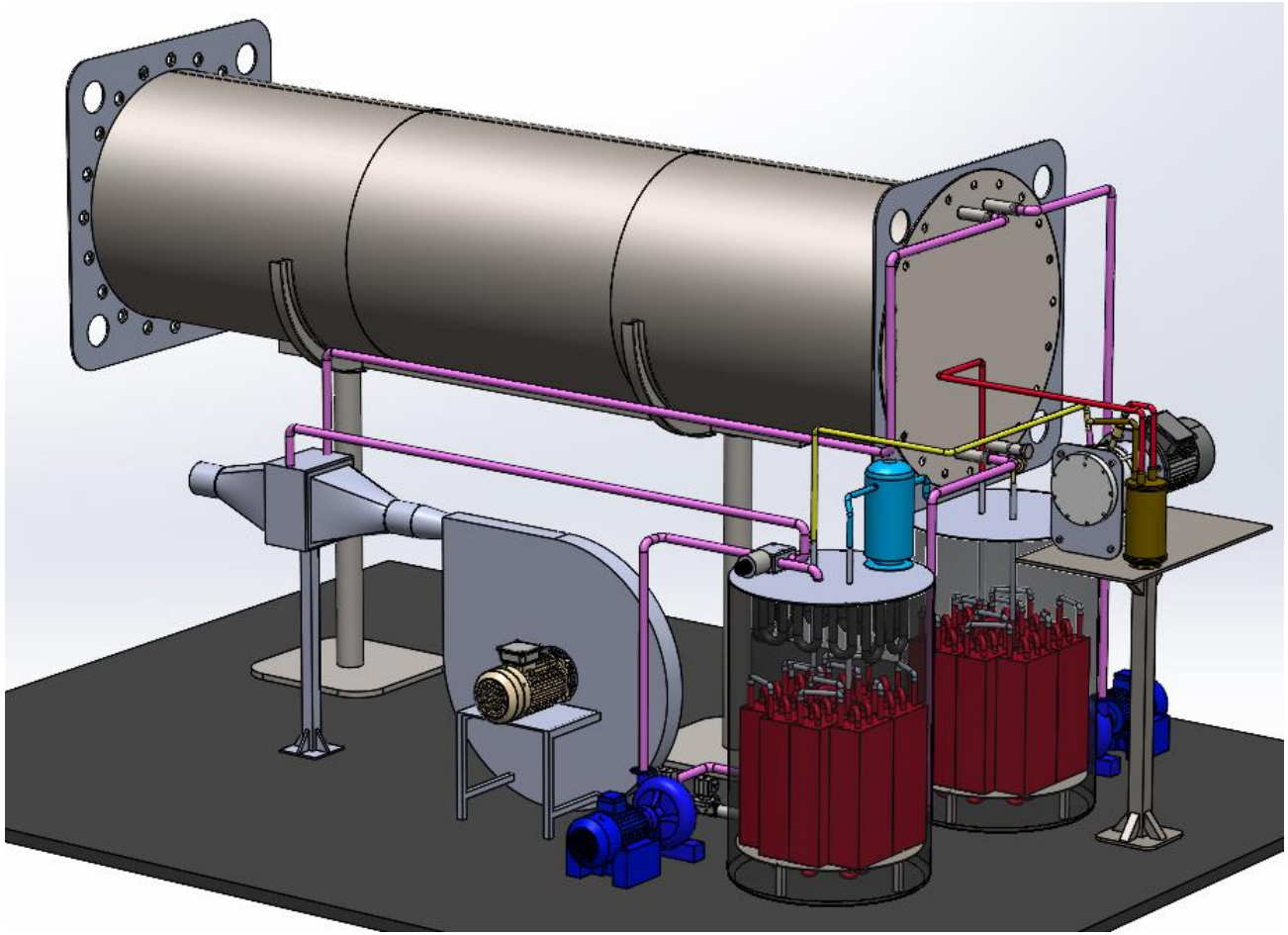
InnoSolPower is novel

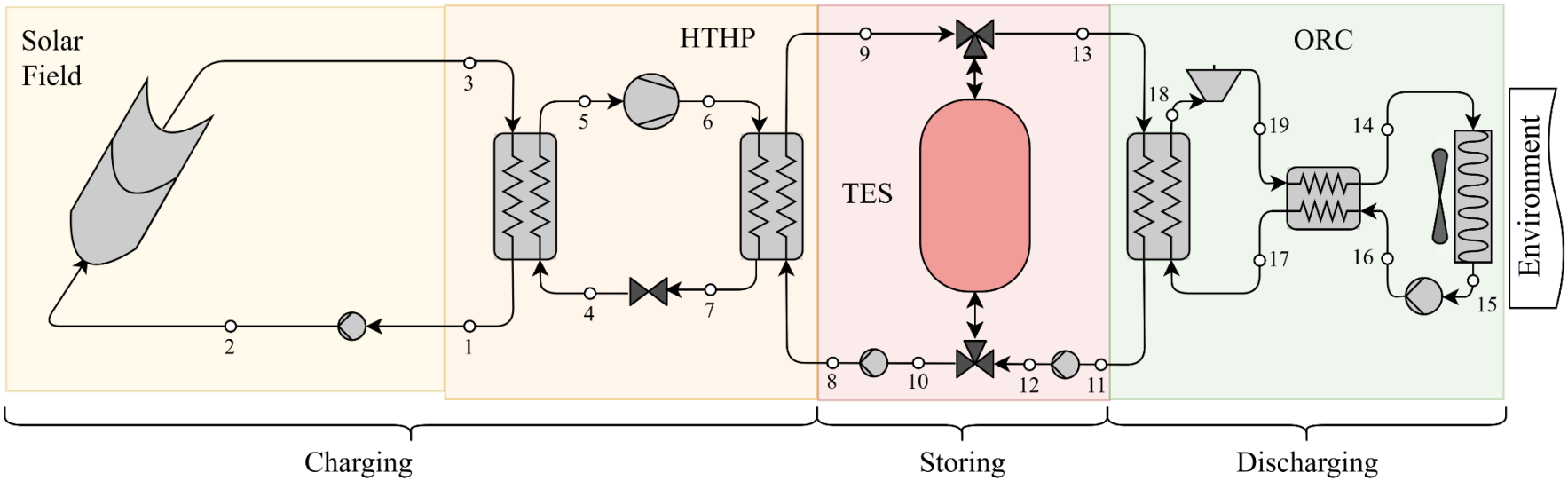
- Safe and environmentally friendly phase change material (PCM salt) **homes, schools and small enterprises**,
- **TES is not pressurized**, PCM salt fully static and encapsulated
- High temperature (>130°C) TES (100°C from local µCSP tracker),
- Novel HTHP with a **high coefficient of performance (COP>10)**
- Plug and run system (manufactured in factory, minimal installation cost),
- **Solar heat is locally produced, stored and consumed**
- 20 year trouble-free operation (minimal maintenance cost)



System model

Parameter	Value
mdot [kg/s]	0.14
p_{in} [bar]	12.40
p_{out} [bar]	19.55
pressure ratio [-]	1.58
T_{in} [°C]	110.00
T_{out} [°C]*	132.50
$W_{el,in}$ [kW]*,**	1.73

- Steady state modelling
- Final layout
  - Components in series
  - Micro-TES connected with intermediated oil loops



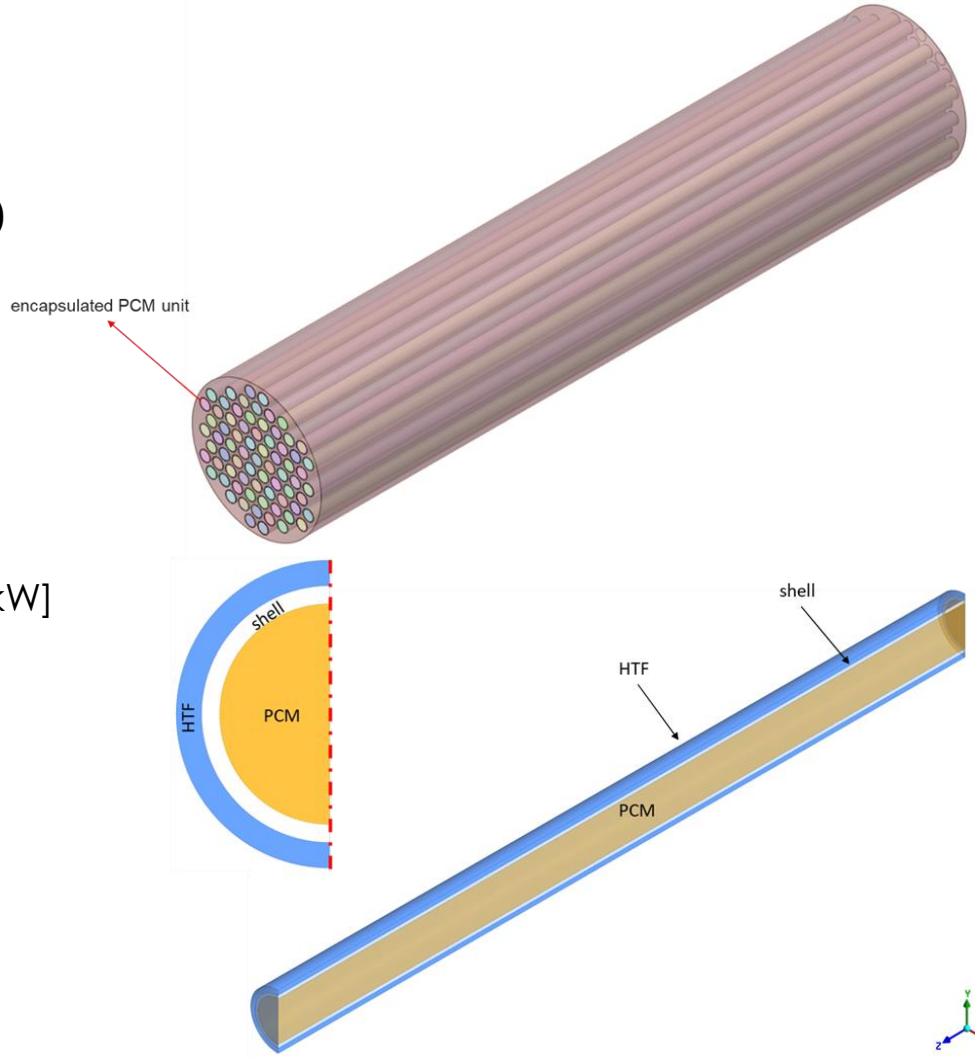
PCM materials & performance

Selected Materials

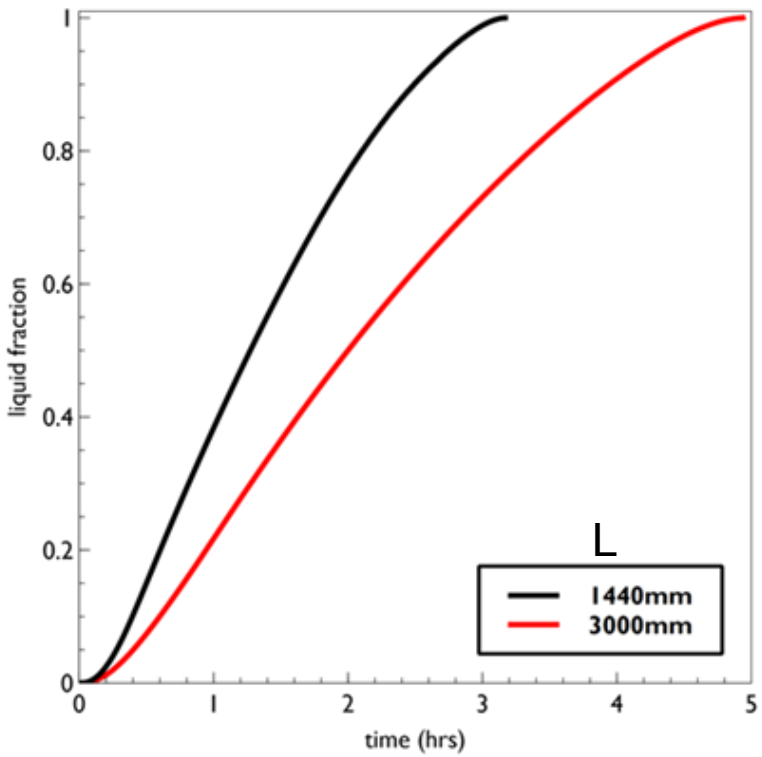
- Heat storage material: S117 **($MgCl_2 \cdot 6H_2O$)**
- Tank: Steel 306 (Prototype SS304)
- Insulation: Rockwool 70mm
- Heat transfer fluid: Renotherm 320

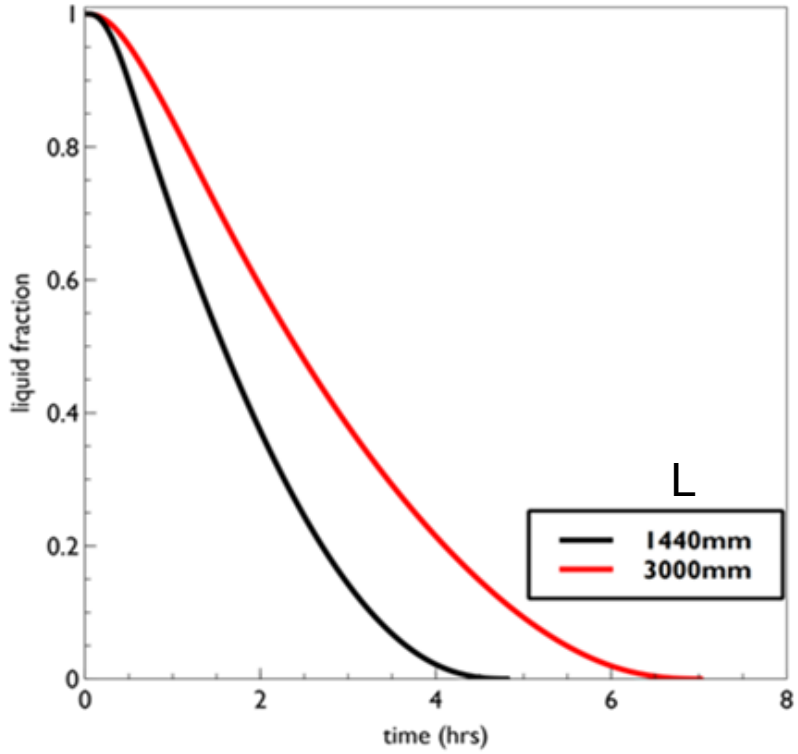
Energy & Power Calculations

- Charging power 27 kW [prototype: 6 kW]
- Discharging power 48 kW [prototype: 10 kW]
- Total heat strorage capacity 159.8 kWh [prototype: 25 kWh]



Initial TES Design

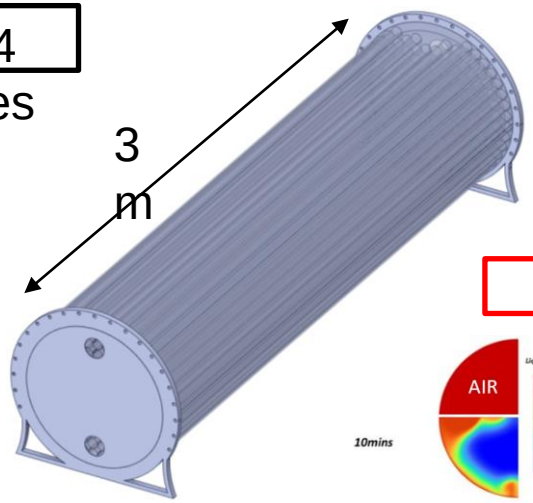




- Stored energy per tube of ***3m*** length: **0.3 kWh**
- Number of tubes: **73** [prototype: 164 tubes]
- **In reality, half of the tubes were filled with PCM**

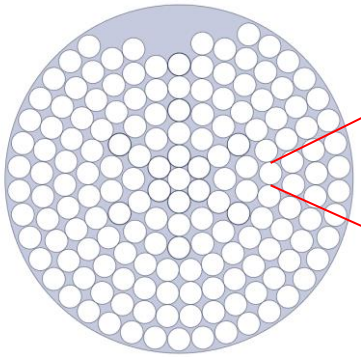
Final TES Design

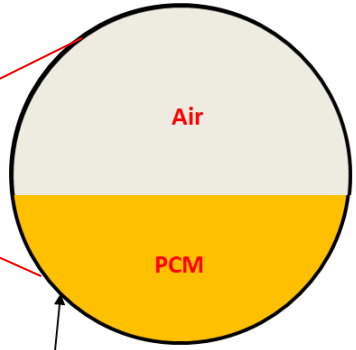
164 tubes



3 m

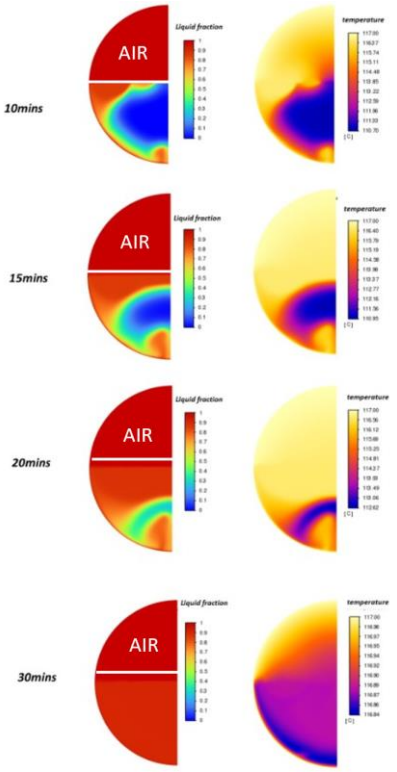
0.78 m





Constant temperature

Melting

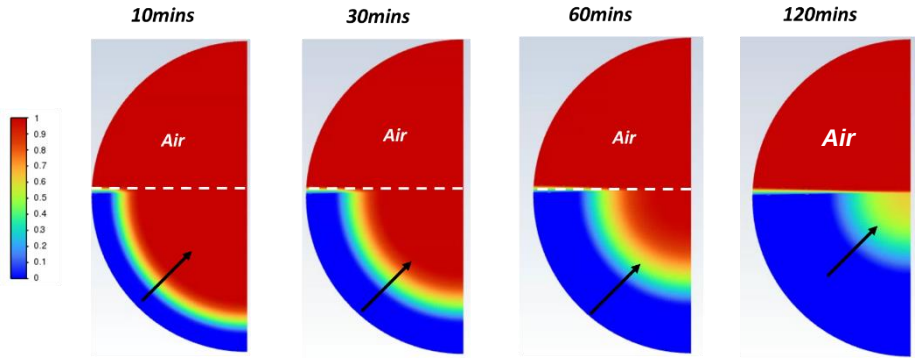


CFD modeling

Enthalpy porosity method

+ volume of fluid

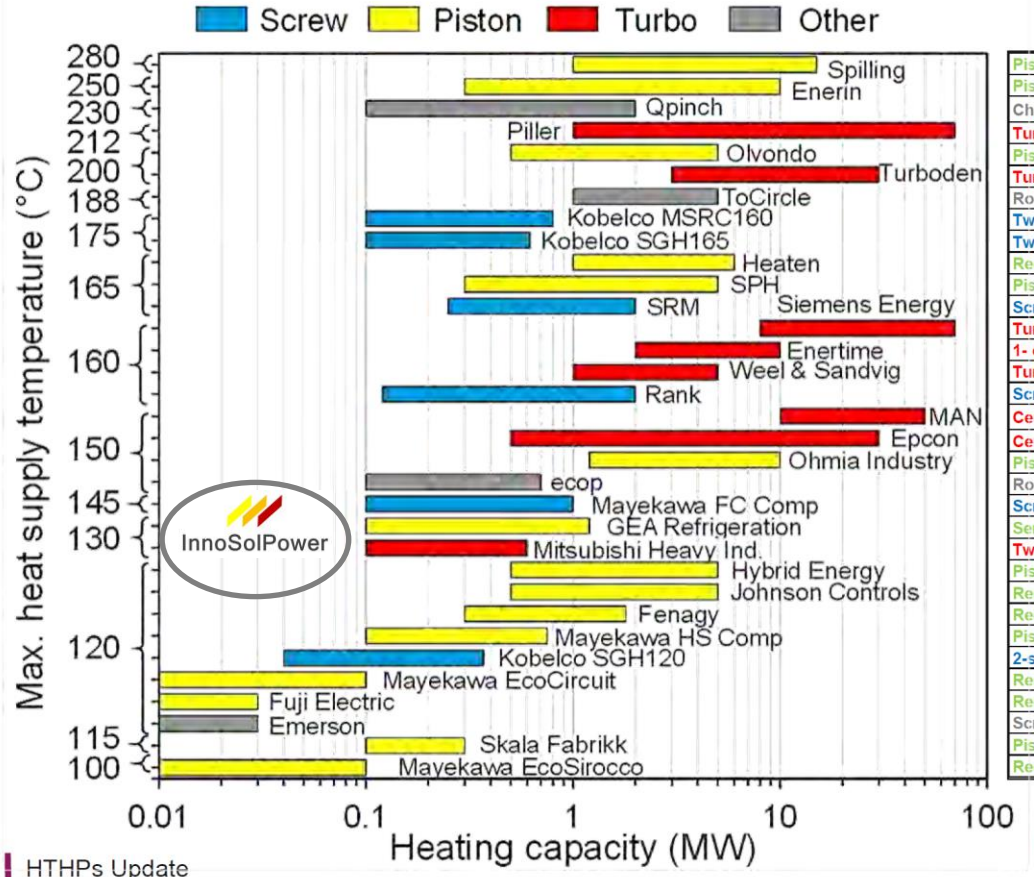
Solidification



HTHP market today

New Developments and Products for Supply Temperatures above 100 °C

Max. supply temperature vs. heating capacity of various HTHPs



Piston (MVR)	R718 (water)
Piston	R704 (helium)
Chemical heat transformer	R718, H_3PO_4 and derivatives
Turbo (MVR)	R718
Piston (double acting)	R704
Turbo	Application specific
Rotary vane	R717 (ammonia), R718
Twin -screw (MVR)	R718
Twin-screw (MVR)	R245fa/R134a (mixture), R718
Reciprocating, custom design	HFOs (hydrofluorolefins)
Piston	HFOs (hydrofluorolefins)
Screw (MVR)	R718
Turbo (geared or single-shaft)	R1233zd(E), R1234ze(E)
1- or 2-stage centrifugal	R1336mzz(Z), R1224yd(Z), R1233zd(E)
Turbo (MVR)	R718
Screw	R245fa, R1336mzz(Z), R1233zd(E)
Centrifugal turbo with expander	R744 (CO_2)
Centrifugal fan / Blower	R718
Piston, Centrifugal fan (MVR)	R717, R718
Rotational heat pump	ecop fluid 1 (He, Kr, Ar)
Screw	R601 (n-pentane)
Semi-hermetic piston	R744
Two-stage centrifugal	R134a
Piston/screw	R717/R718 mixture
Reciprocating	R717, R600 (n-butane) (cascade)
Reciprocating	R744
Piston	R600 (n-butane)
2-stage twin-screw	R245fa
Reciprocating	R1234ze(Z)
Reciprocating	R245fa
Scroll and EVI scroll	R245fa, R410a, R718
Piston (semihermetic)	R290 (propane), R600 (cascade)
Reciprocating	R744 (CO2)

Based on data from IEA HPT Annex 58
https://heatpumpingtechnologies.org/annex58/task1

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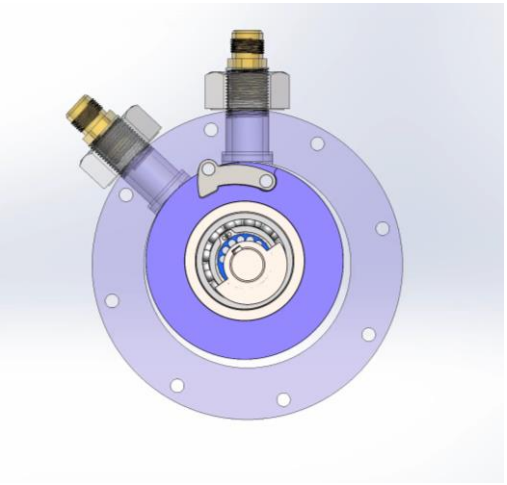
OST

Reference: High-Temperature Heat Pumps for Industrial Applications –New Developments and Products for Supply Temperatures above 100 °C, Webinar: 2023 High-TemperatureHeat Pumps Update, 22 February2023, Institute forEnergy Systems IES, Dr. Cordin Arpagaus



Thank you!!

Presented by Sinan Akmandor, Dr. (Pars Makina, 2023, Turkiye)

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