

# EnergyNest: the Thermal Battery Company

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ATA Insights Webinar: *What comes after molten salt?*

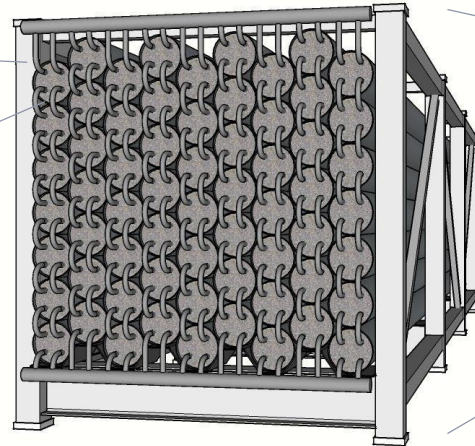
June 27, 2018

# The Thermal Battery: uniquely simple and robust

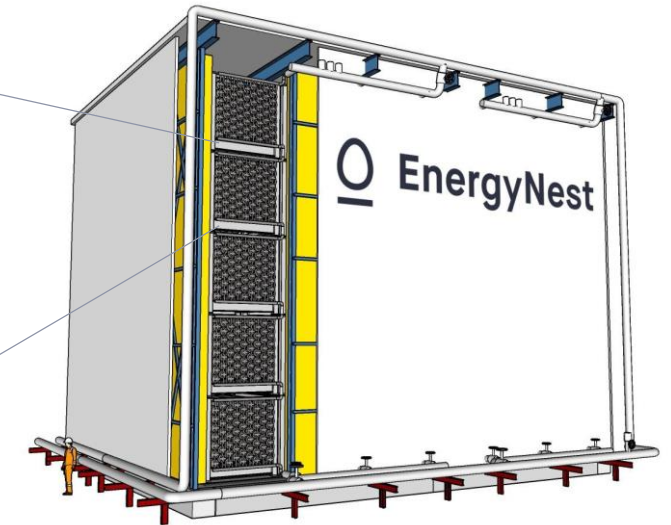
Thermal Battery element



Thermal Battery module



Thermal Battery system



- Proprietary technology & design, customized according to client needs
- Modular & fully scalable – from Megawatt to Gigawatt hours
- Compatible with most heat transfer fluids incl. thermal oil & water/steam
- Thermal efficiency of up to 99 %
- Lifetime > 50 years
- No risk of HTF freezing
- Simple, non-disruptive installation and operation

Module	Dimensions (LxWxH) [m]	Weight [tons]	Capacity [MWh <sub>th</sub> ]
40"	12 x 2.4 x 2.4	93	1.9 - 2.3
20"	6 x 2.4 x 2.4	45	0.8 - 1.2

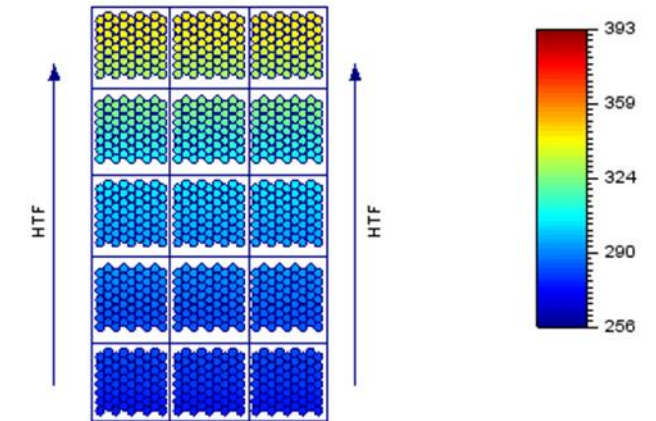
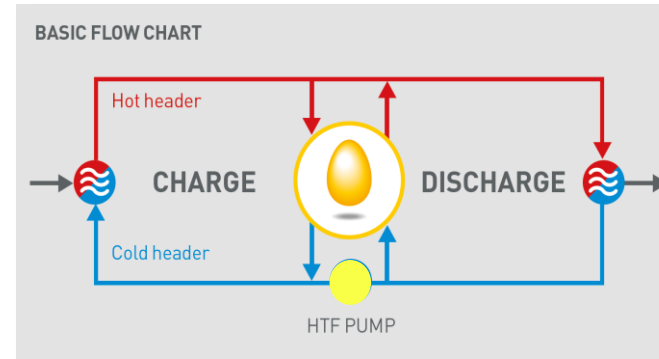


Received  
Seal of  
Excellence  
from EU  
Horizon2020  
SME

# How charging and discharging works

## 01 Charge

When charging the thermal battery system, hot HTF flows through the steel pipes from the top to bottom, transferring its thermal energy to the storage material.



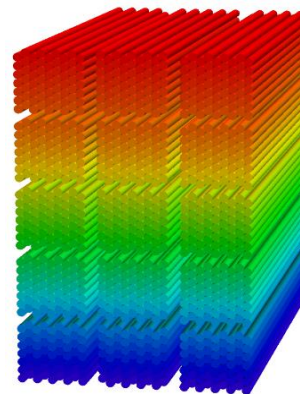
## 02 Store

Energy is stored with minimal heat loss until it is needed.

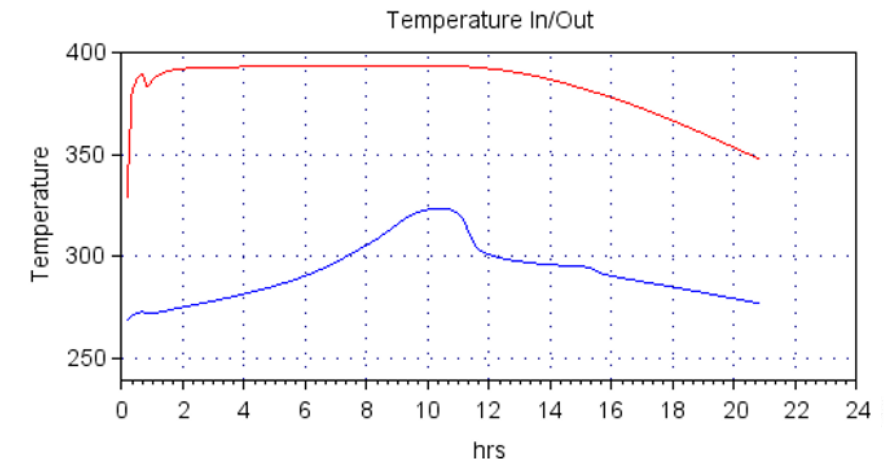
## 03 Discharge

During discharge the flow is reversed; and cold HTF flows in at the bottom and exits hot from the top of the thermal battery.

Hot side



Cold side



The Thermal Battery can also provide constant temperature and pressure HTF during the whole discharge



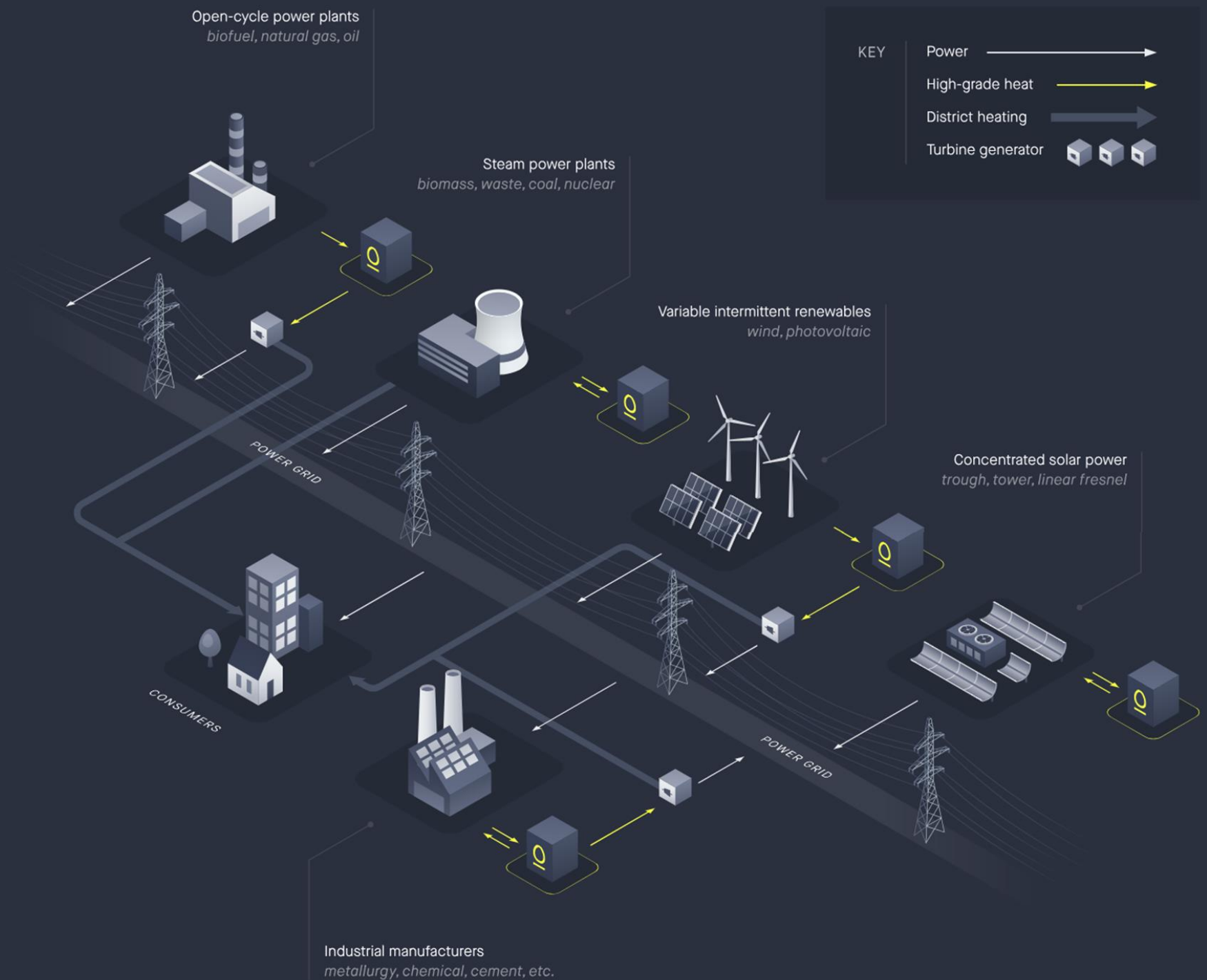
# HEATCRETE® – our superior storage medium

- **HEATCRETE® is a high-performance concrete**, made from abundant geomaterials
- HEATCRETE® has **superior thermo-mechanical properties\***
- HEATCRETE® is chemically stable to **withstand thermal cycling at high temperatures**
- HEATCRETE® is co-developed with, and **manufactured by, HeidelbergCement**
- EnergyNest has secured **global exclusivity** for use in commercial energy storage applications

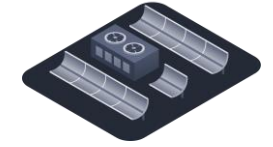
*\* Hoivik et al., “Demonstration of EnergyNest thermal energy storage (TES) technology”, SolarPACES 2016, AIP Conference Proceedings 1850, (2017)*



# All our applications

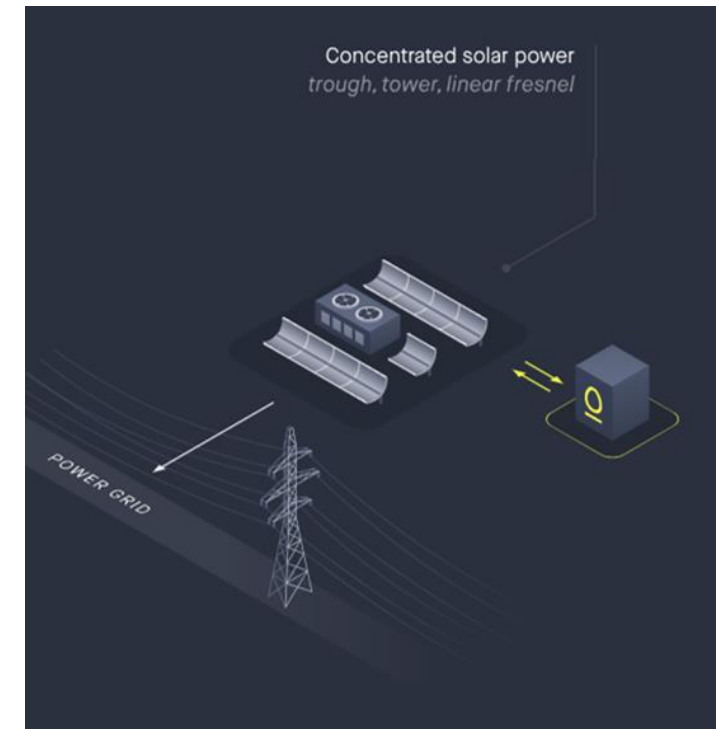


# CSP: an alternative to molten salts

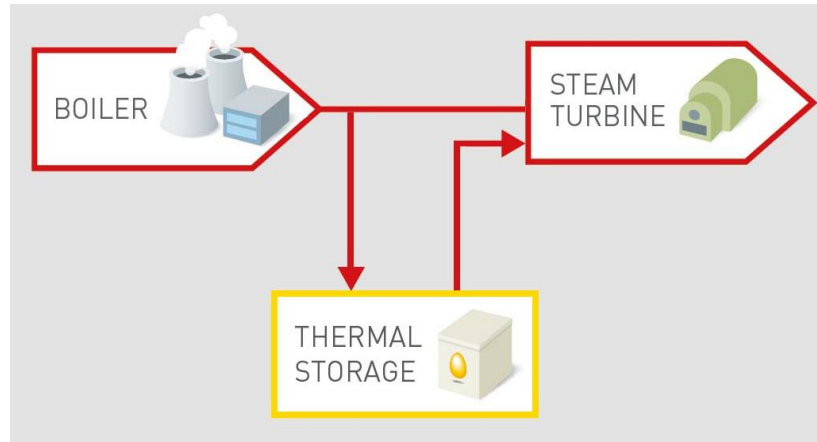


- Reduced CAPEX:
  - Less and simpler equipment
- Reduced OPEX:
  - Simpler technology, simpler O&M, cheaper spare parts
- Reduced parasitic consumption:
  - No salt pumps & no electric tracing
- Higher electricity production\*
- Ability to deep discharge beyond designed capacity before days with high DNI
- However, high barriers to enter into CSP TES market

\* Hoivik et al., "Demonstration of EnergyNest thermal energy storage (TES) technology", SolarPACES 2016, AIP Conference Proceedings 1850, (2017)



# Steam power plants: STEAM-TES for new flexibility



Direct integrated into steam-water cycle

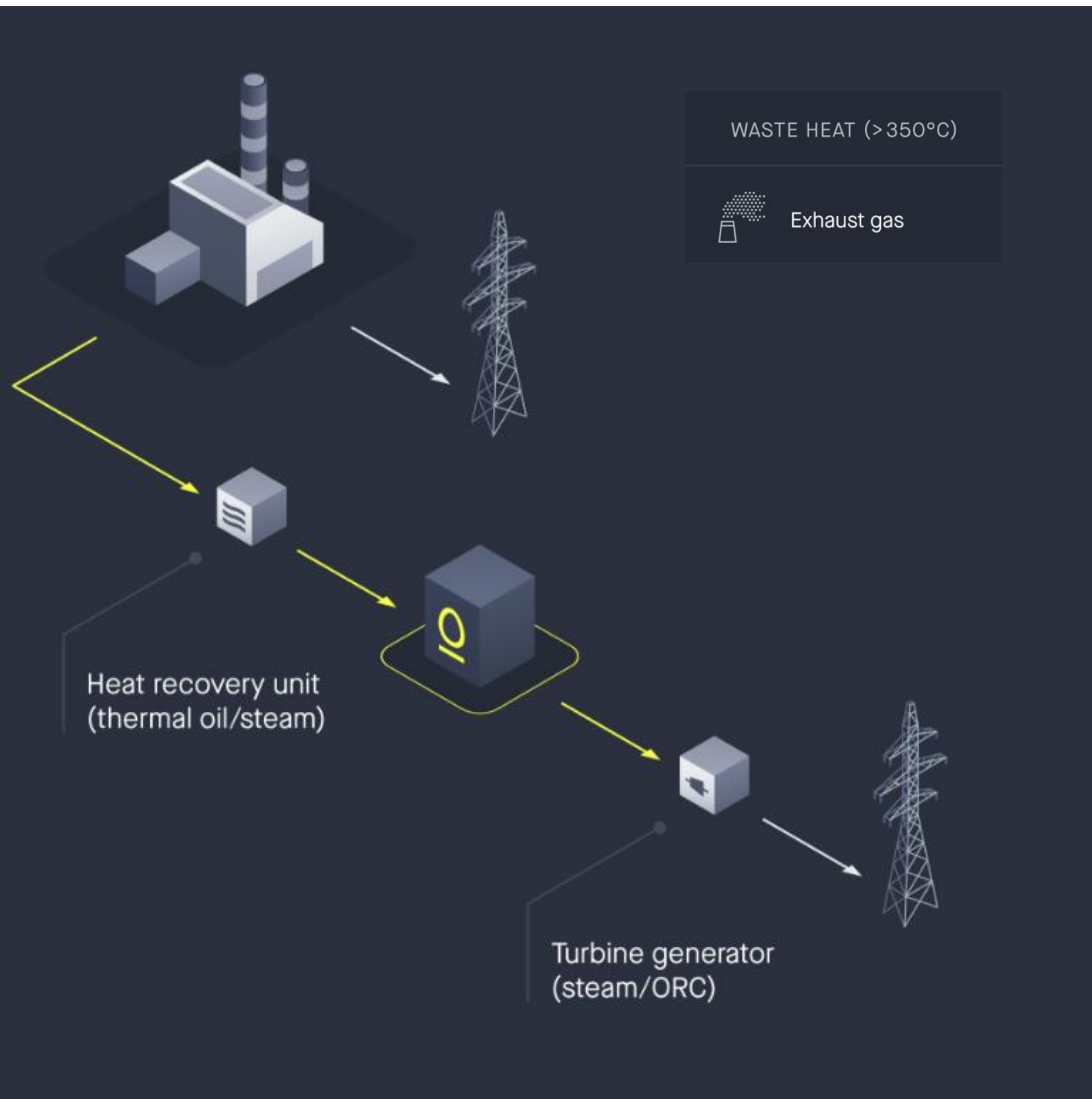
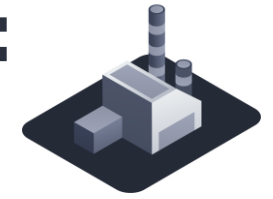
Maintain boiler load while reducing or boosting the turbine output for increased flexibility

## Main value proposition

- The Thermal Battery generates superheated or saturated steam within seconds
- Ancillary services (primary, secondary, tertiary)
- Electricity price arbitrage
- Increased peak load & reduced minimum load
- Fast shutdown / start-up with low energy loss



# Open cycle gas turbines & recip. engines: Increased output at zero CO<sub>2</sub> footprint

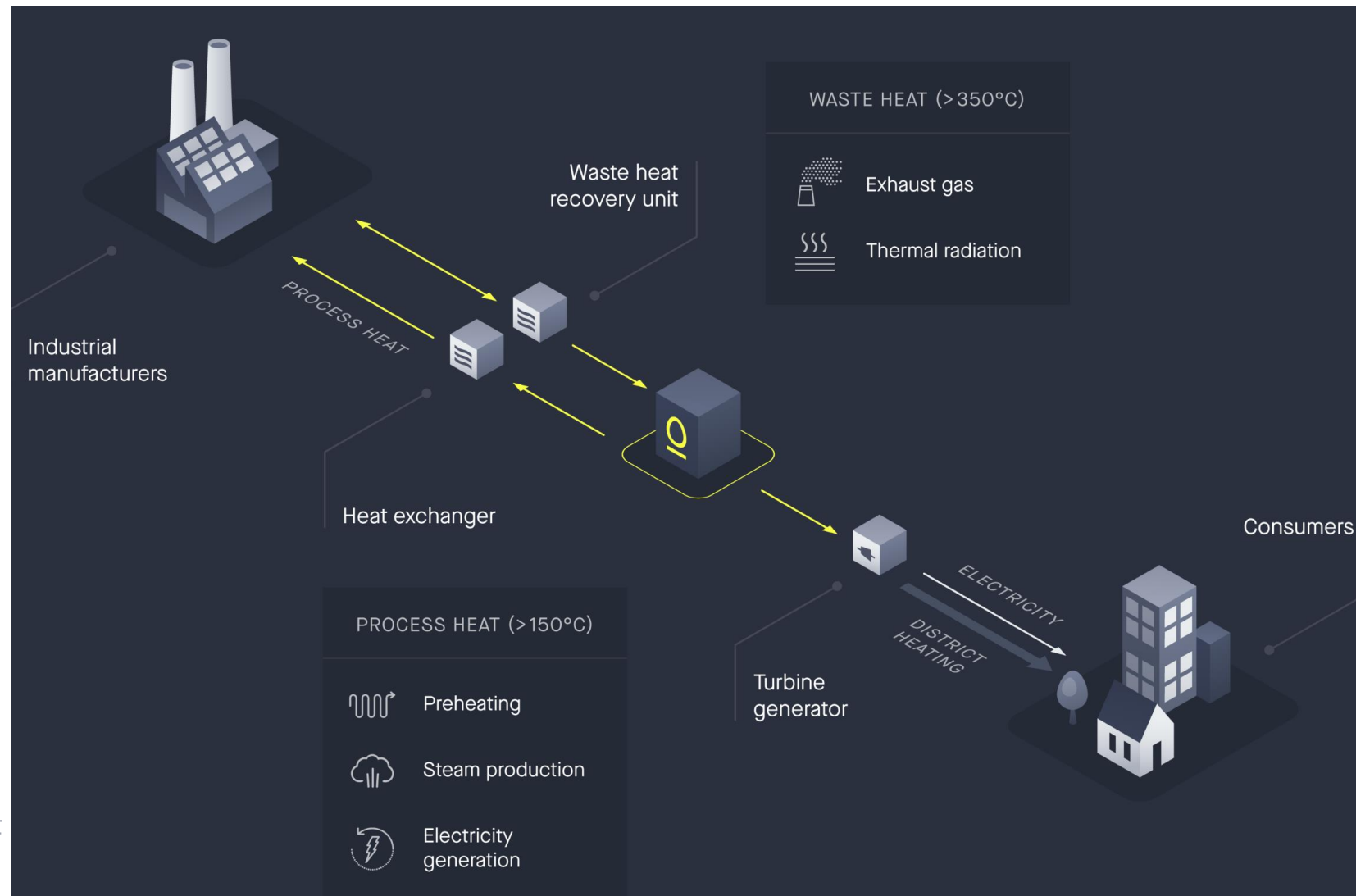


## Main value proposition

- Increased electricity output by up to 30-45 %
- Avoided additional CO<sub>2</sub> emissions
- Ancillary services (secondary, tertiary)
- Electricity price arbitrage
- Increased peak load



# Energy intensive industries: Turning waste heat into valuable energy

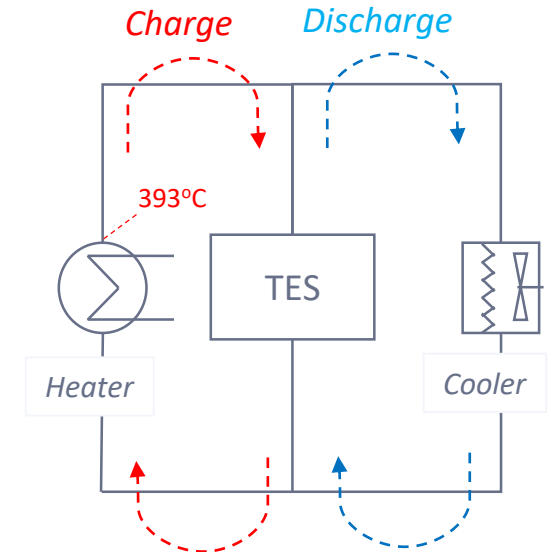


# Pilot Test facility at Masdar Institute Solar Platform

Heater & Cooler

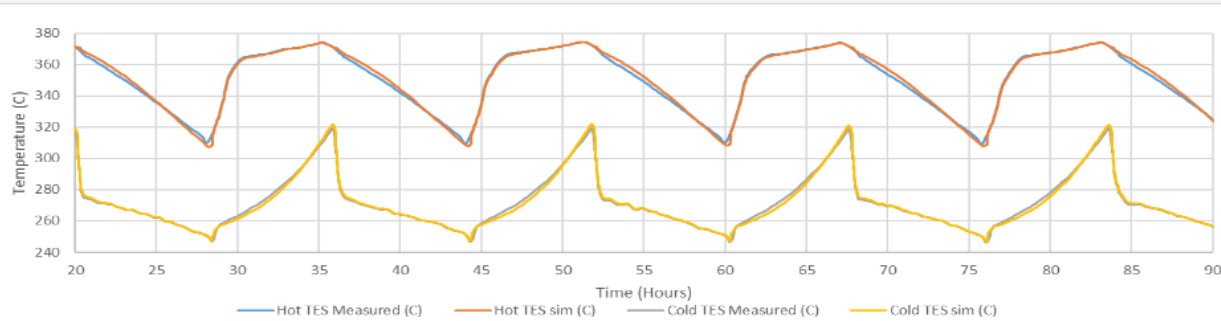


TES Pilot System



- Dowtherm-A HTF heated by electrical heater (100 kWth) emulating solar conditions, max. temp 393°C
- Cooler emulating HTF return temperatures from a steam generator or heat sink
- Thermal storage capacity: 4 modules x 250 kWhth
- 280 charge-discharge cycles completed over 6000 operation hours

# No performance or material degradation after ~6000 hrs of operation



Element from "hot-side" of TES –  
operation temp: 310-380 °C



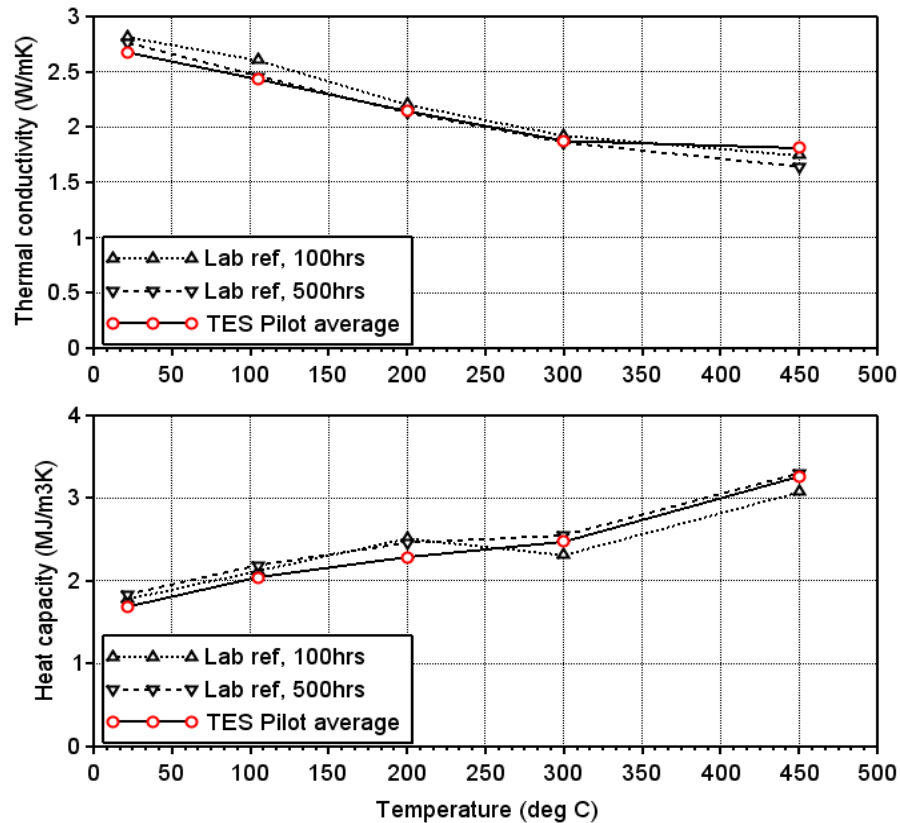
Element from "middle" of TES –  
operation temp: 260-360 °C



Element from "cold-side" of TES  
– operation temp: 240-320 °C

- Repeatable performance, exceeding the designed capacity – 3<sup>rd</sup> party validated
- Performance validated through numerical simulations
- TES partially decommissioned
- Close inspection shows no cracks or separation between steel tubes and storage material

# Verified long-term thermal and mechanical properties



- Thermal properties of HEATCRETE® documented by external testing of both lab samples and core samples from TES pilot
- Long-term thermal properties remain constant
- Thermal cycling has not impacted the material integrity





Contact us

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