

THERMAL ENERGY STORAGE:

MGTES, A KEY ENABLER FOR THE FULL
TRANSITION TO RENEWABLES

PON UB Forum IT – "Supporting the Green Transition"

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www.magaldigreenenergy.com

Magaldi is worldwide leader material handling technologies in high temperature production cycles

Magaldi Group

Incorporated in **1929**, Magaldi is a leader in customized solutions to convey materials at very high temperatures and in severe process conditions, guaranteeing the **highest dependability** and **environmental protection**.

The Company has been able to secure more than **55 patents** for proprietary technologies (of which **12 patents** on **Renewables** technology).

Magaldi in 2021 has established **Magaldi Green Energy** to bring to the market the best **Thermal Energy Storage** solution

Corporate video

<https://www.youtube.com/watch?v=NeGcs-f5kS8>

Source: Magaldi Green Energy Business Plan 22-30

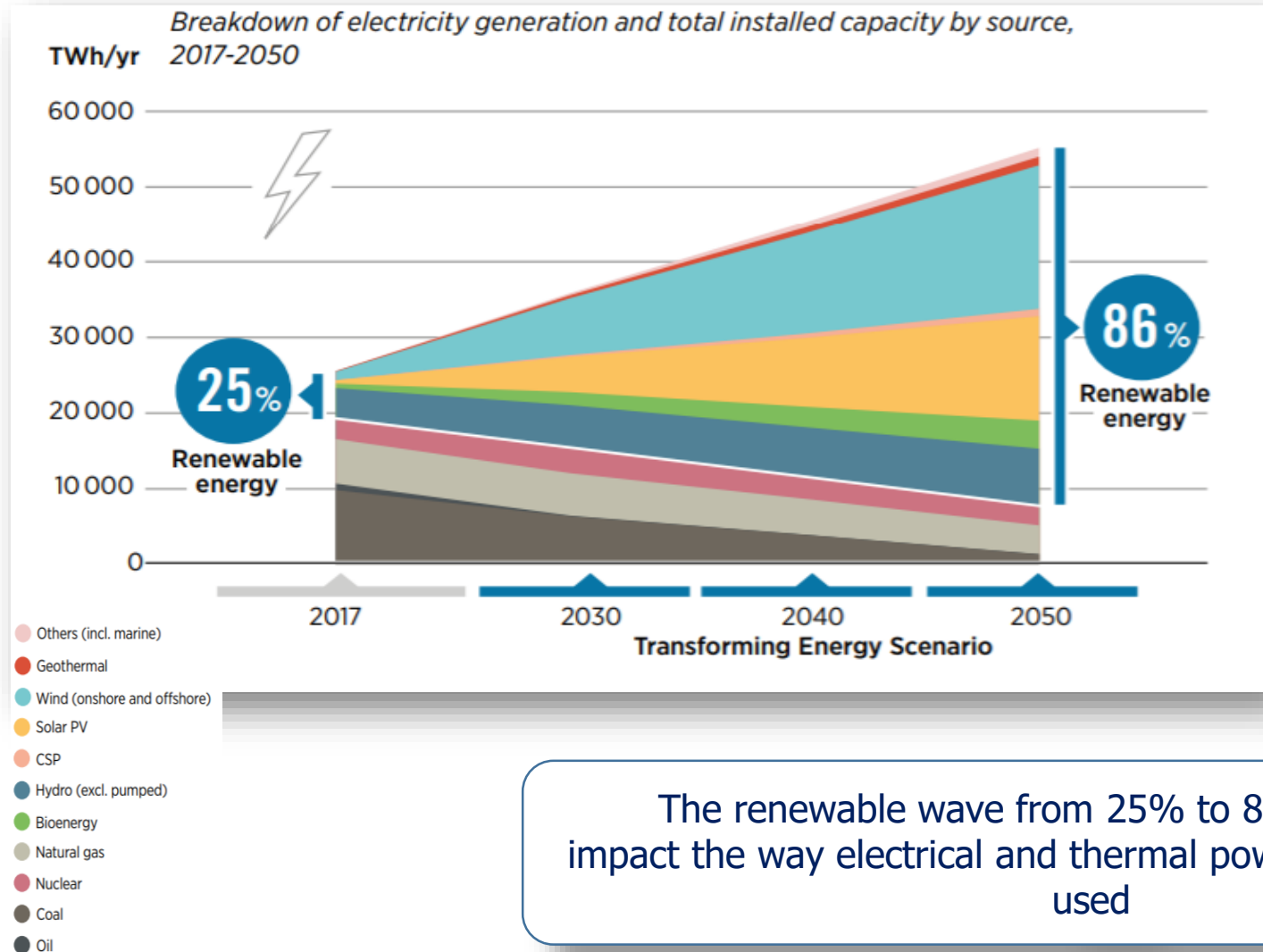


Our Clients and Partners



Energy Megatrends:

change in energy installed capacity mix will generate major industrial challenges

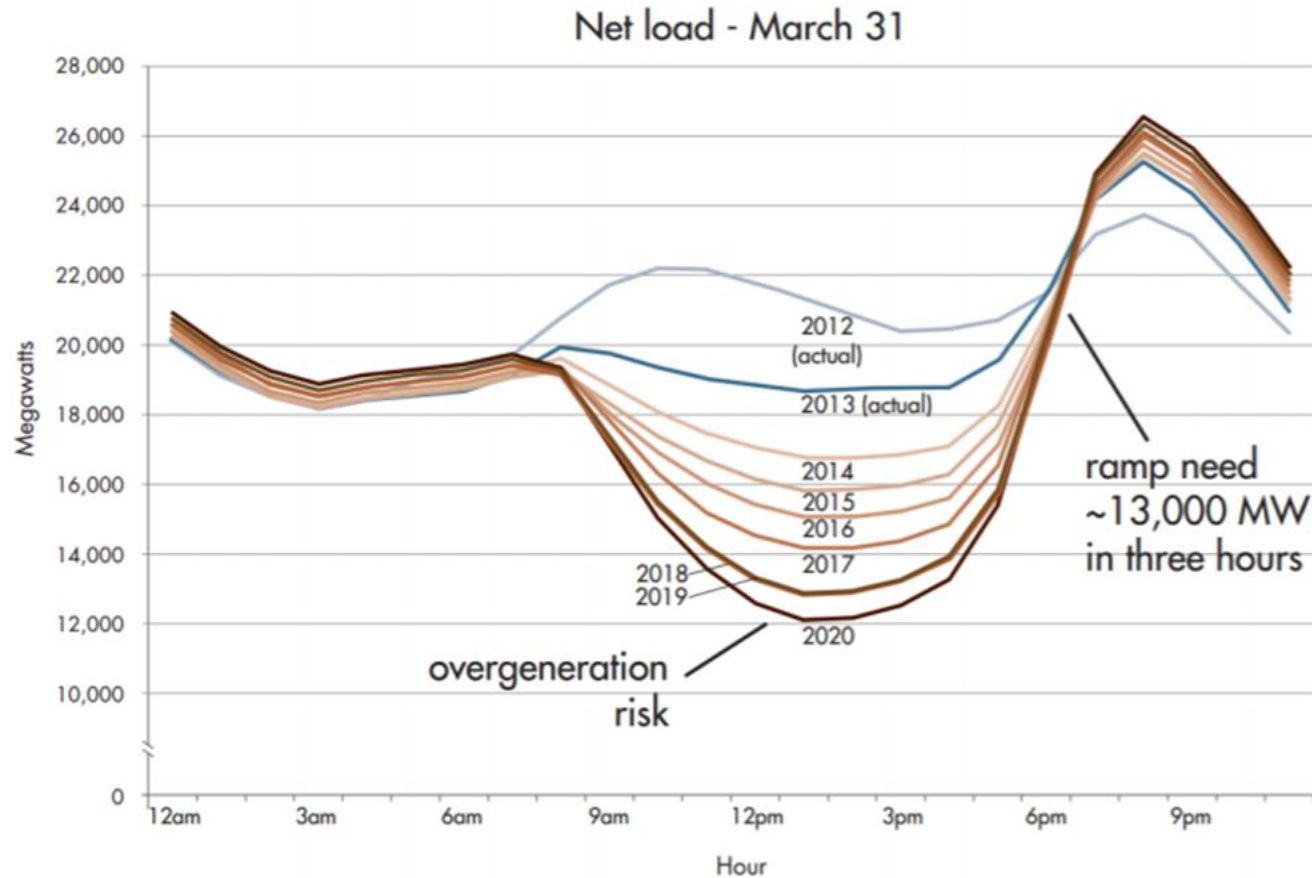


MAJOR INDUSTRIAL CHALLENGES:

1. **Integration of highly variable renewables** to meet demand reliably
2. **Industrial** sectors use “fossil” power to produce **heat**, renewables without storage might impact heat availability dramatically

The renewable wave from 25% to 86% in 2050 will impact the way electrical and thermal power is distributed and used

Challenge 1: **Integration** of highly variable renewables to meet **demand** reliably



Grid: High intermittency, specialized services needed to stabilize transmission quality and reliability when moving from 3 pm to 9 pm

The more solar production the higher will be the gap between electricity demand (stable) and supply (increasing) in sunny hours, at sunset and during night hours. The 24/7 renewable integration is a big challenge.

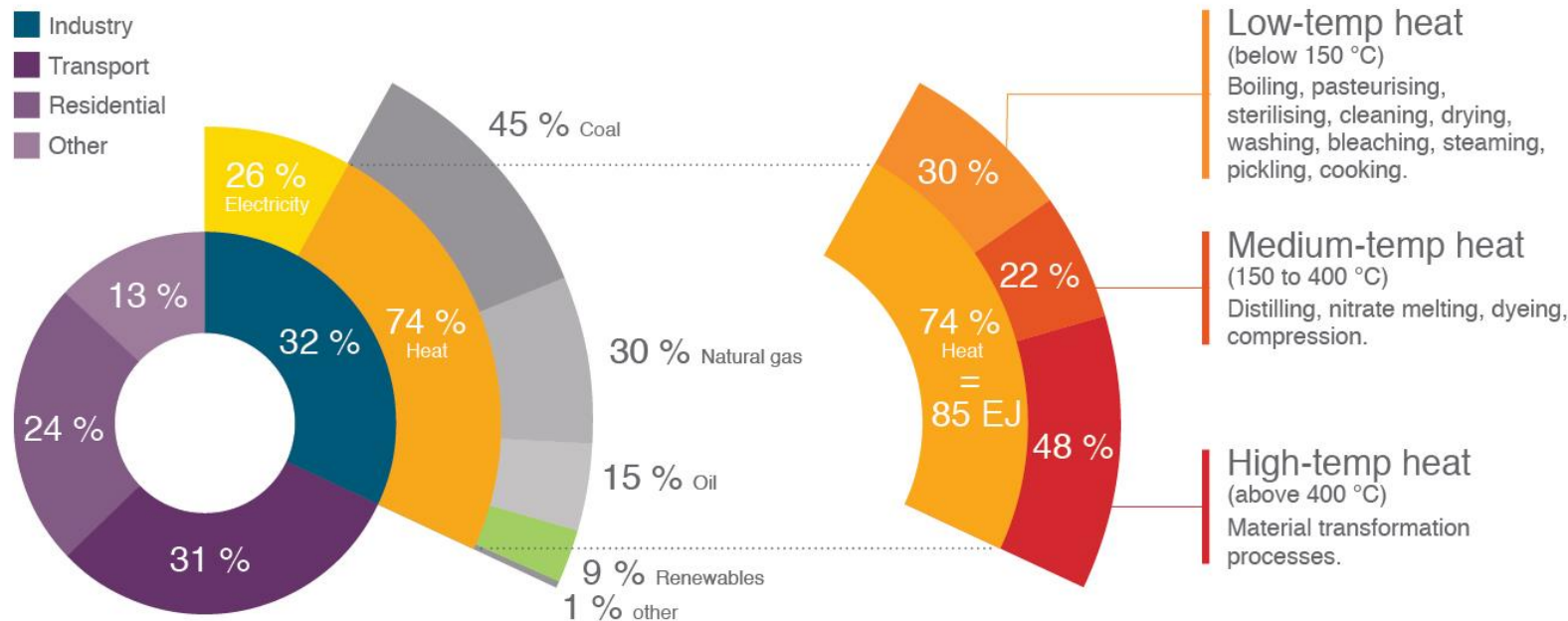
Source: California CAISO case up to 2020

The duck curve—named after its resemblance to a duck—shows the difference in electricity demand and the amount of available solar energy throughout the day. When the sun is shining, solar floods the market and then drops off as electricity demand peaks in the evening. The Duck Curve illustrates an important aspect of the challenges that renewable energy such as solar poses to utility managers, and how these have evolved over a much shorter time period: the greater input of solar energy during these bright hours significantly lowers demand on the electrical grid. The duck curve represents a transition point for solar energy: high solar adoption creates a challenge for utilities to balance supply and demand on the grid 24/7.



Challenge 2: **Industrial** sectors use “fossil” power to produce **heat, renewables** without storage might impact heat availability dramatically

Global heat demand for industry:



74% of energy demand for industry is used for process heat and steam

90% of that is generated by burning coal, oil and gas

50% of applications are below 400 C Degrees and 50% above

Energy mix transformation will impact heat availability, requiring a strong integration of clean power sources with Thermal Storage solutions to secure heat supply

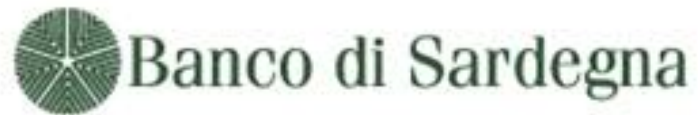


Magaldi STEM CSP/CST

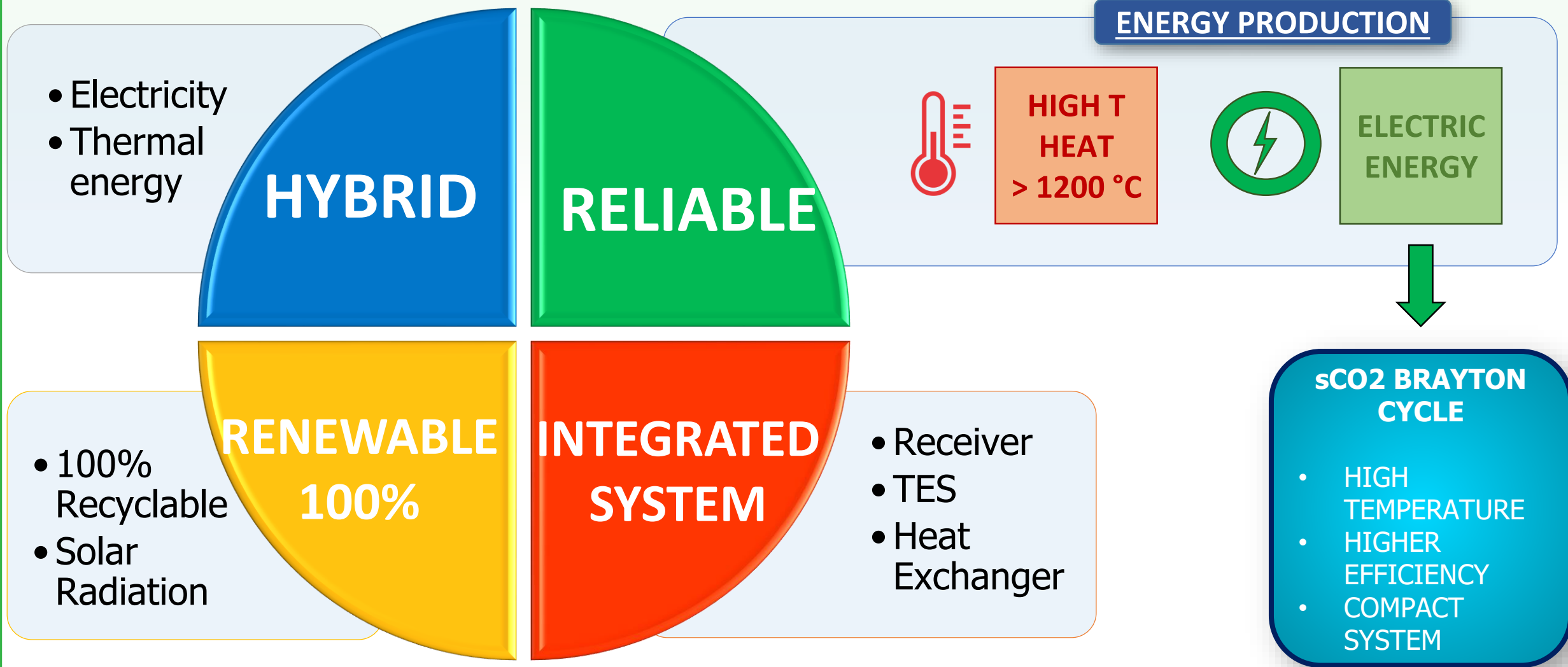
FoakSTEM project funded by NOP 2014/2020

Fondo Ricerca e Innovazione

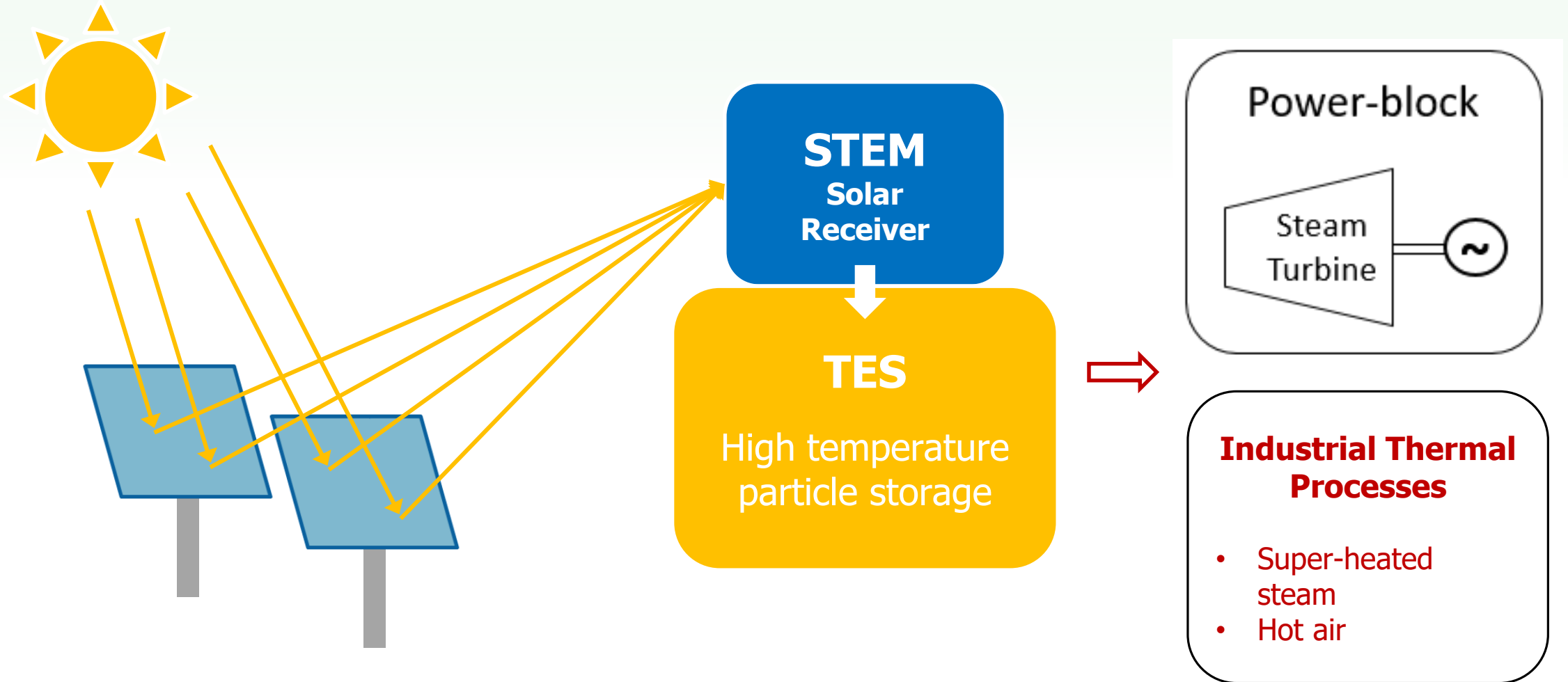
Managed by Banco di Sardegna and Sinloc



STEM: Solar Thermo-electric Magaldi



STEM-CSP and CST: Concentrated Solar Power / Thermal



Principle of Magaldi technology

Bed of fluidizable solid particles

MODE ON

The system is ready to exchange energy

**Fluidized
Sand Bed**

**Not
fluidized
Sand Bed**

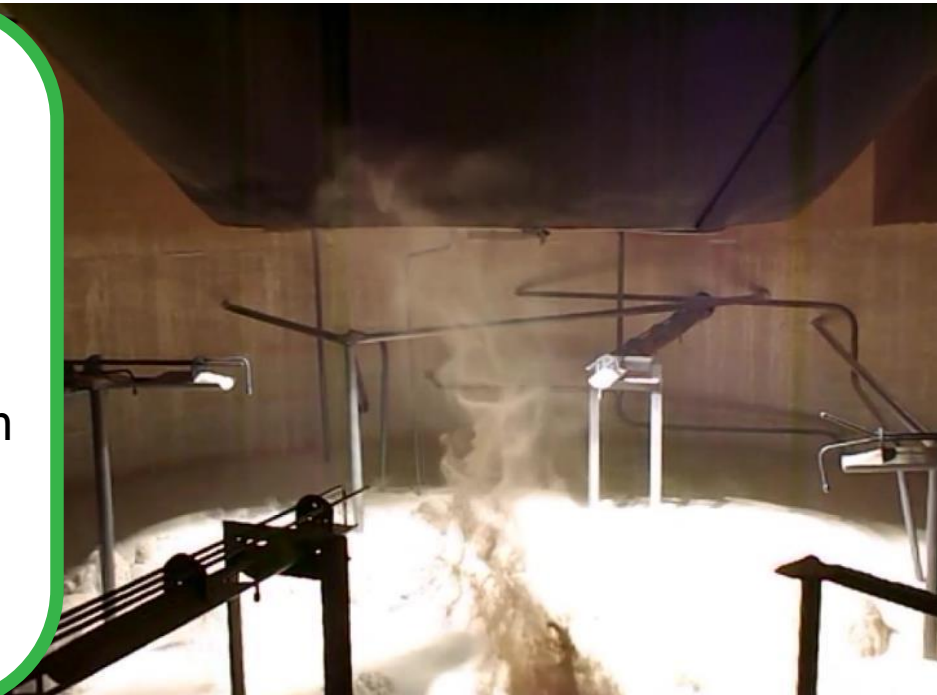
MODE OFF

Thermal insulation at maximum temperature

High Thermal
Diffusivity

$\sim 1 \times 10^{-3} [\text{m}^2/\text{s}]$
i.e. ~ 1000 times higher than
concrete, rocks, gravel etc.

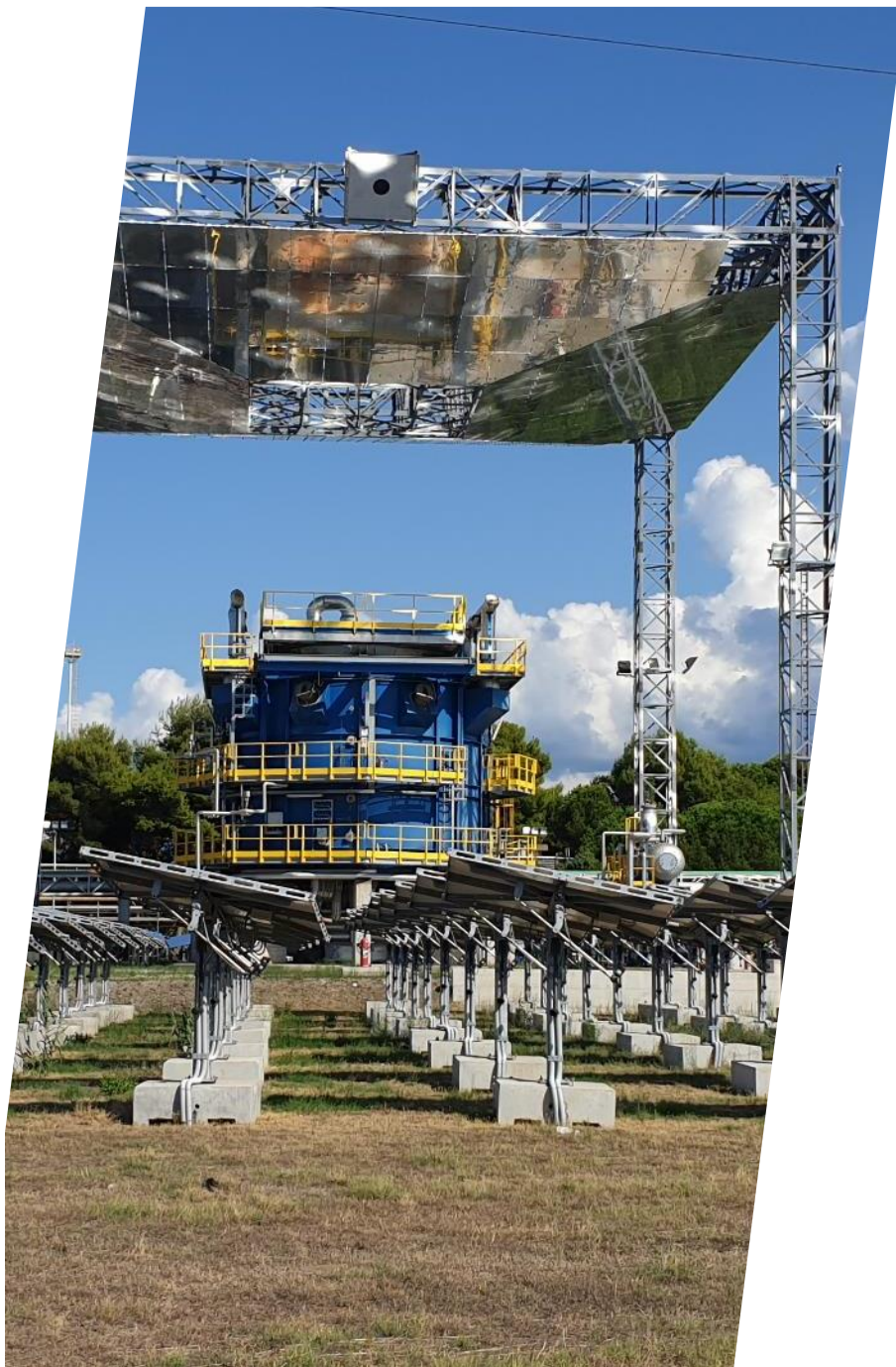
Fast Response Time



Long term
storage

$< 1 \%$ per day

Negligible
losses



Magaldi STEM-CSP

STEM-CSP (Solar Thermo-Electric Magaldi) is a patented **CSP** (Concentrated Solar Power) **technology with TES** (Thermal Energy Storage), which collects and converts **solar energy** into thermal energy to be used immediately or stored and **dispatched on-demand**.

The key element is a **fluidized sand bed** which allows to reach high temperatures with consequent high capacity in thermal energy storage.

STEM-CSP is suitable for **distributed energy production** in geographical areas featuring high solar irradiation (**DNI**).

STEM-CSP Video

<https://www.youtube.com/watch?v=92-rmLgCgHU>



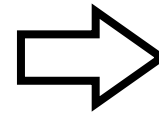
STEM-CST: Main objectives



**Decarbonization of
industrial processes**



**Renewable thermal
energy production**



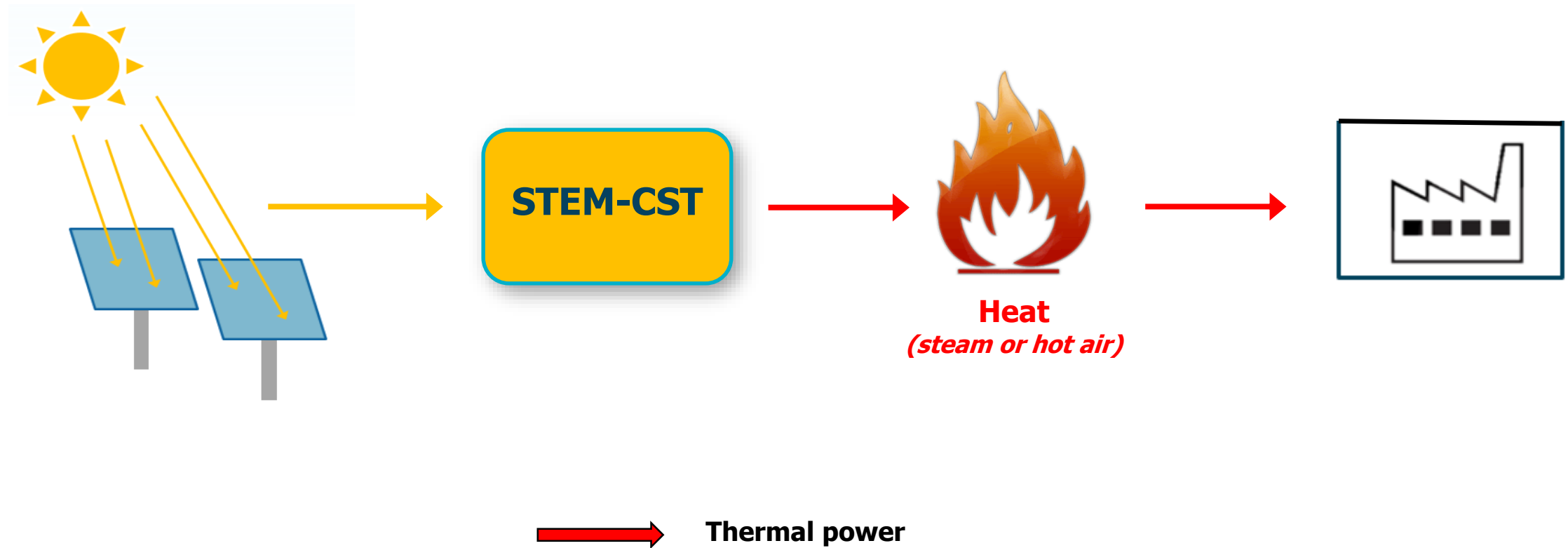
This technology is able to offer a **stable production of thermal energy** starting from non-programmable renewable sources.

Fully compatible with the energy transition and **necessary to achieve the decarbonization** goal of the industrial sector.

The generation of heat from fossil fuels will be replaced by **low-cost heat generation** technologies.

STEM-CST: Typical application case

Stand alone CST configuration



STEM Technologies

Key Points

Fluidized bed of solid particles:

When fluidized, a bed of solid particles will behave as a fluid

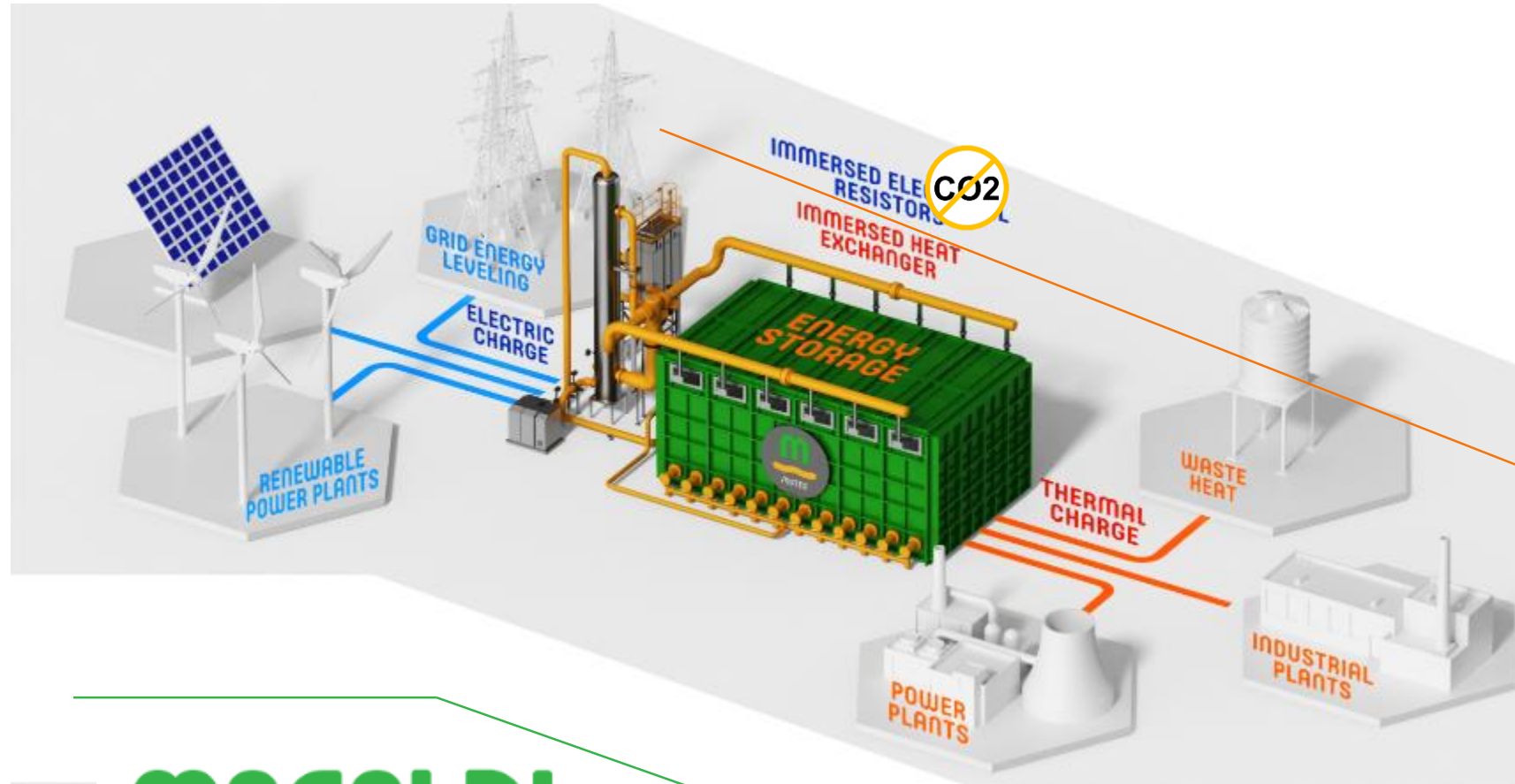
- Fluid bed solid particles with operating temperature up to 1000°C
- Elements immersed in fluidized bed (e.g. heat exchangers) can freely expand at high T, keeping contact with storage media for reliable heat exchange.
- Significant heat capacity keeping a homogeneous temperature field.

Thermal diffusivity

- Fast response time in heat charge and discharge.
- Efficient heat transfer to the HTF (250 W/m²K).
- Negligible losses: heat can be stored for days or weeks.
- Heat transfer fluid (steam, air, CO₂ etc).



MGTES – Magaldi Green Thermal Energy Storage



MAGALDI
dependable energy storage



The scope for MGTES

Renewables will increasingly generate clean power, however the more intermittent energy the higher the risk of energy curtailments & network reliability issues

Situation

Climate change is a global challenge that must be addressed pragmatically.

We are on the cusp of a renewable revolution that requires additional technologies to secure the efficient flow of energy from power generators to final users.

Problem

Energy from renewable sources is available intermittently, therefore electricity grid operations need to apply curtailments when there is an oversupply from solar or wind sources.

The skyrocketing renewable capacity will imply more curtailments and consequently more clean energy waste.

Solution

This sustainable energy growth paradox can be solved by storing the increasing renewable electricity surplus in form of heat and developing industry specific applications.

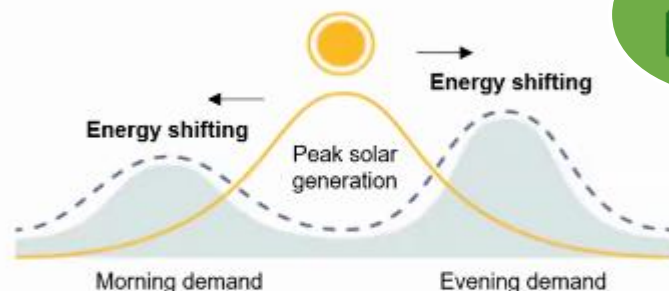
Our Thermal Energy Storage (MGTES) provides long duration applicability for virtually any industrial sector



Long Duration Energy Storage (LDES):

The technology that will enable energy to power our grids and accelerate power neutrality. It enables surplus energy to be stored from wind, solar to be enabled when needed in an affordable, reliable and sustainable way for days and weeks.

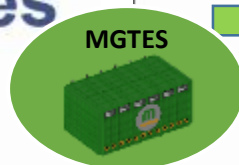
LDES unlock many different use cases



Energy shifting



Grid services



Many technological approaches tackle the same fundamental need

Thermal

Store energy thermally to release electricity and heat (e.g. Stirling engines, molten salt)



Mechanical

Store gravitational potential or kinetic energy (e.g., PSH, gravity based, CAES, LAES, Liquid CO₂)



Electrochemical

Batteries of different chemistries that store electrical potential energy (e.g., air-metal, flow batteries)



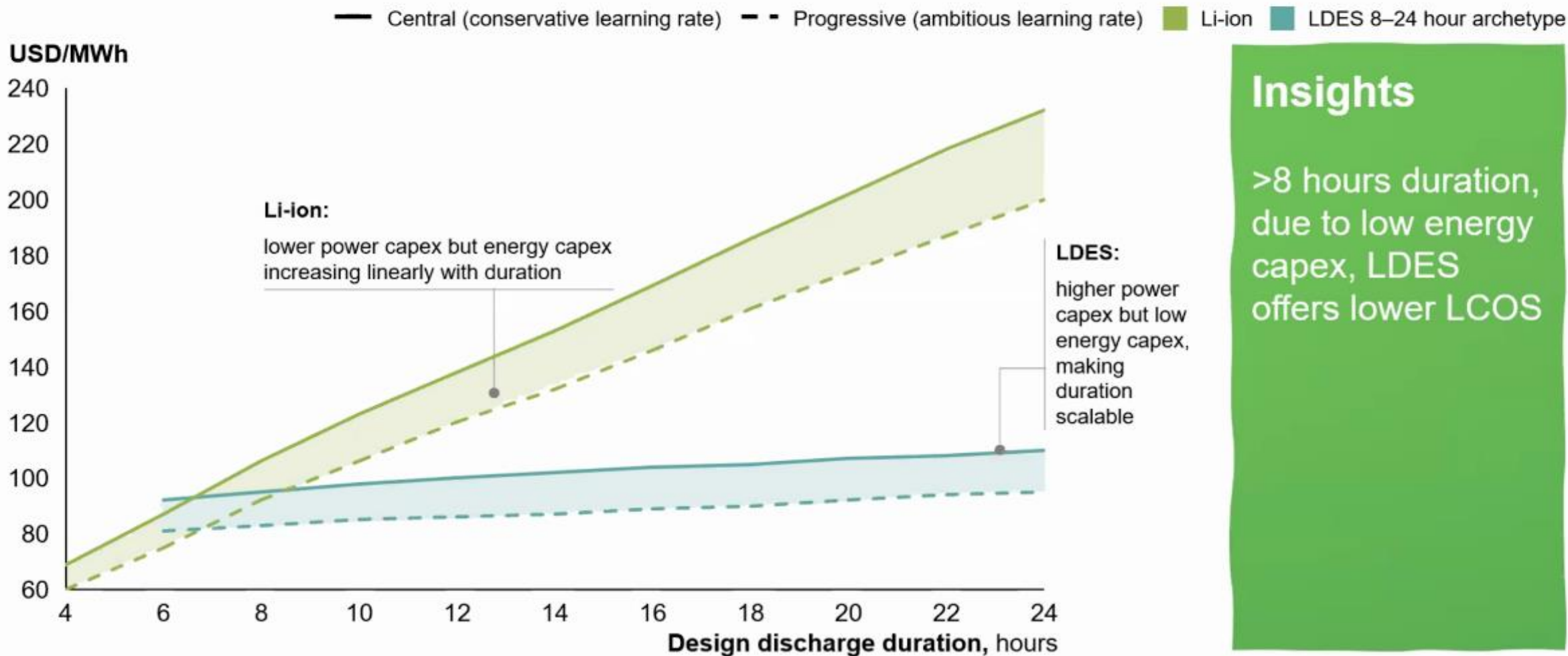
Chemical

Store energy in chemical bonds (e.g., H₂, power to gas to power)



LDES likely cost-competitive for durations >6-8 hours

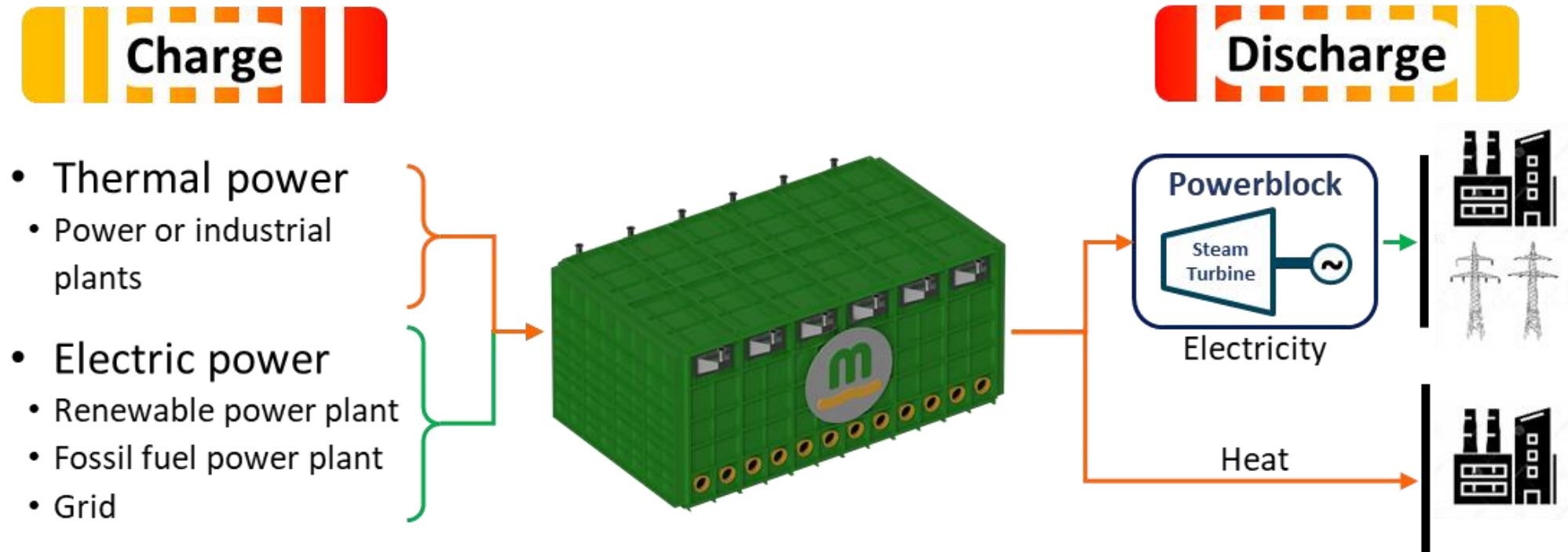
2030 energy storage LCOS competitiveness by duration for selected technologies (USD/MWh)



Insights

>8 hours duration,
due to low energy
capex, LDES
offers lower LCOS

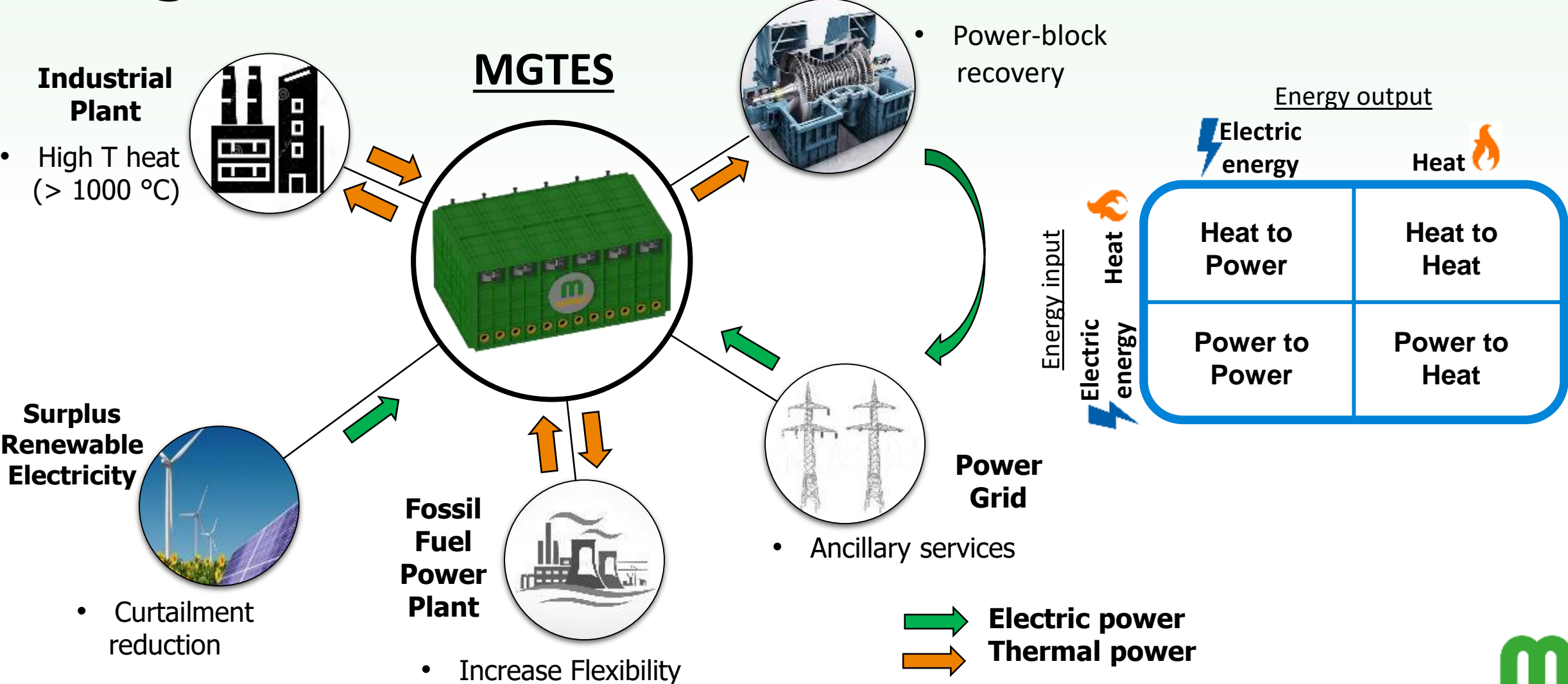
MGTES technology (Magaldi Thermal Energy Storage) is a fluid bed (sand) thermal storage capable of absorbing both heat and electricity at the input.



The charge / discharge of MGTES technology is focused on thermal storage by means of fluidized sand particles that allow to reach high temperatures with high diffusivity and reduced thermal losses.

MGTES: Applications/Integrations

Conversion of Fossil Fuel Power Plants into Thermal Energy Storage Clusters



There are 5 reasons why Magaldi Green Thermal Energy Storage (MGTES) will be a relevant solution to support a reliable renewables massive penetration into the energy mix

- 1 Magaldi is worldwide leader material handling technologies in high temperature production cycles (power plants, waste to energy, other industrial plants)
- 2 MGTES is a 100% ESG compliant thermal storage solutions with a number of advantages compared to alternative TES technologies (i.e. Molten Salts)
- 3 MGTES is a thermal storage solution which connects power and heat input/outputs, in a virtually unlimited number of applications (long discharge duration)
- 4 MGTES has a high Technology Readiness Level (TRL). We tested MGTES for 10.000+ hours and we are at the second advanced prototype fully running
- 5 Magaldi is offering MGTES First Of A Kinds in the Middle East, Europe, US and Australia for P2P and P2H applications



Closing remarks:

Magaldi technologies show a number of unique features and advantages for Thermal Energy Storage solutions. Let's make the green revolution together!

Energy Mix Integrability

Optimal usage of different energy sources both from renewable and fossil fuel plants, electricity and thermal, high integrability

Modularity

The system fits for a large range of TES capacity, power output and temperature ranges, both in power and industrial sector

Competitiveness

Long life infrastructure offering low LCOS with minimal OpEx and high potential for successful applications in any sector and region

Dedicated R&D

MGTES technology represents a reliable system presently supported by 10+ patents, with a dedicated R&D Team

Green/ESG

High end-of-life residual value: all components are made of completely reusable and not hazardous materials.

Made in Magaldi

Magaldi is a world leader Italian company for high temperature bulk material handling, products are made to last and perform



Thank you for your attention!

Join this fantastic journey with us

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www.magaldigreenenergy.com

