

# Thermal energy storage



# for industry decarbonization

## 1 Context

- Problem: global warming and climate change
- International efforts: decarbonization targets (CO<sub>2</sub> emissions reduction)
- Solution: development of renewable energy sources (especially wind and solar)
- Fact: power varies with weather conditions
- Effect: power system problems, low adequacy and stability
- Increasing risk of blackouts and outages
- Solution: use of energy storage systems

## 2 Technology overview

- Innovative technology for thermal energy storage
- Developed by the Italian company Magaldi Power
- Energy is stored as sensible heat ...
- ... into a fluidized bed of solid particles ...
- ... enclosed in a metal container, called «module»
- Module walls have thermal insulation for minimal heat loss

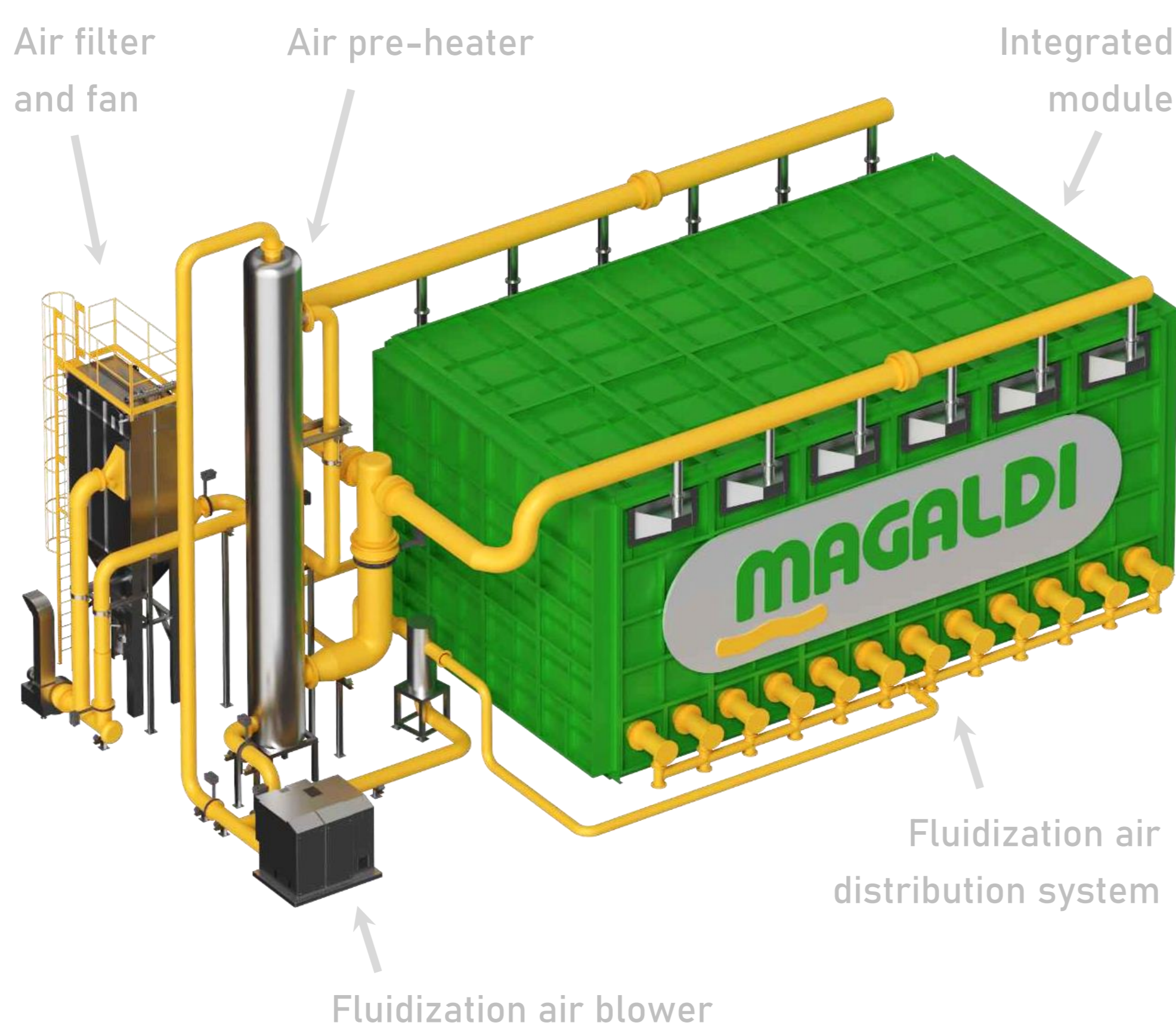
## 3 System components

- The system can exchange
  - ✓ electric energy («Power»)
  - ✓ thermal energy («Heat»)
- ... depending on the components included
- A. Electrical heaters for electric energy input
- B. Serpentine tubes for thermal energy input or output (through a heat transfer fluid)
- In many applications the heat transfer fluid is superheated steam
- C. Steam turbine and generator for electric energy output (through Rankine cycle)

## 4 System configurations

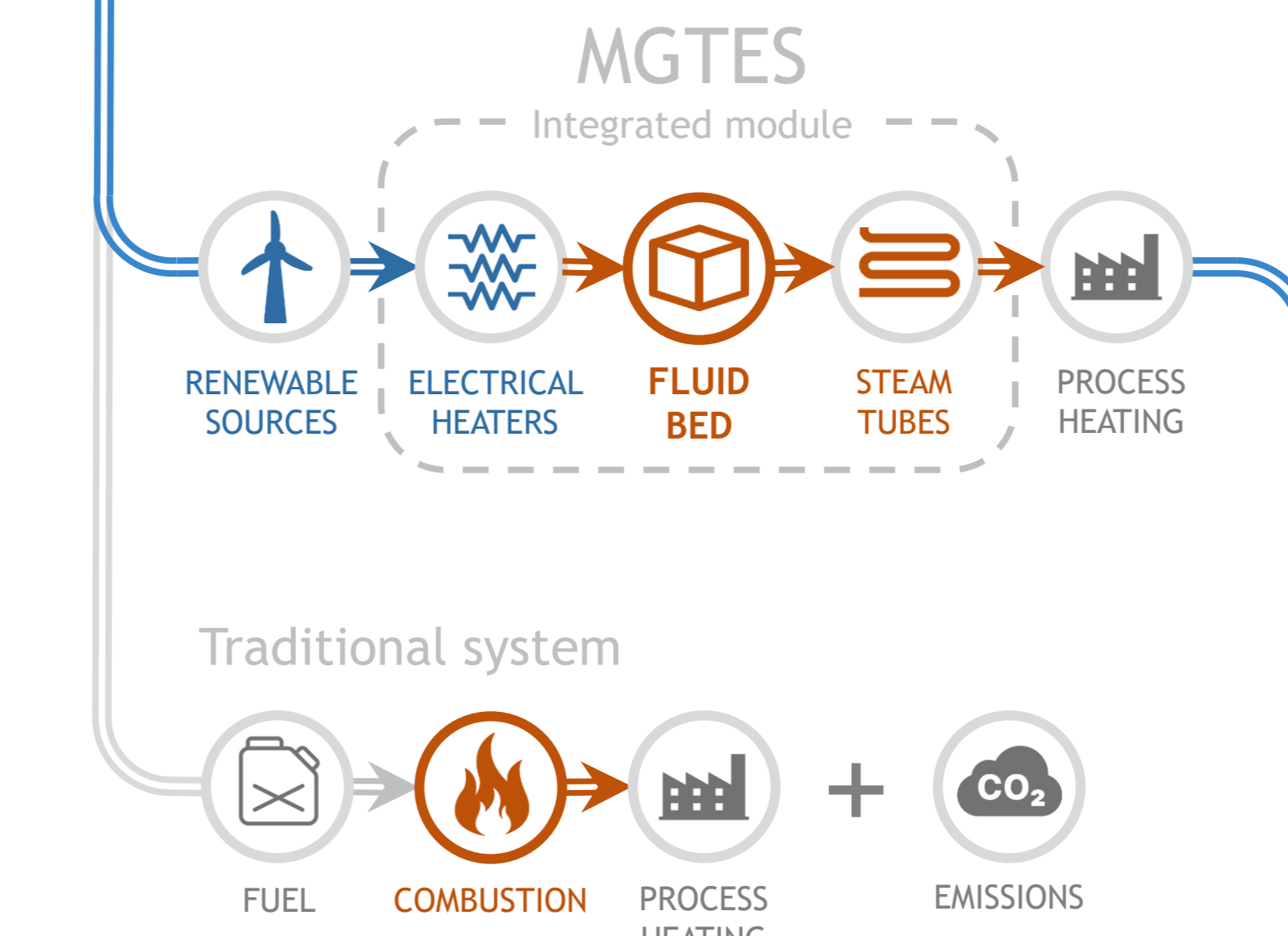
- With all the components, the system is a **hybrid energy hub** with 2 inputs and 2 outputs
- In many applications, only 1 input and 1 output are needed

## MGTES Magaldi Green Thermal Energy Storage



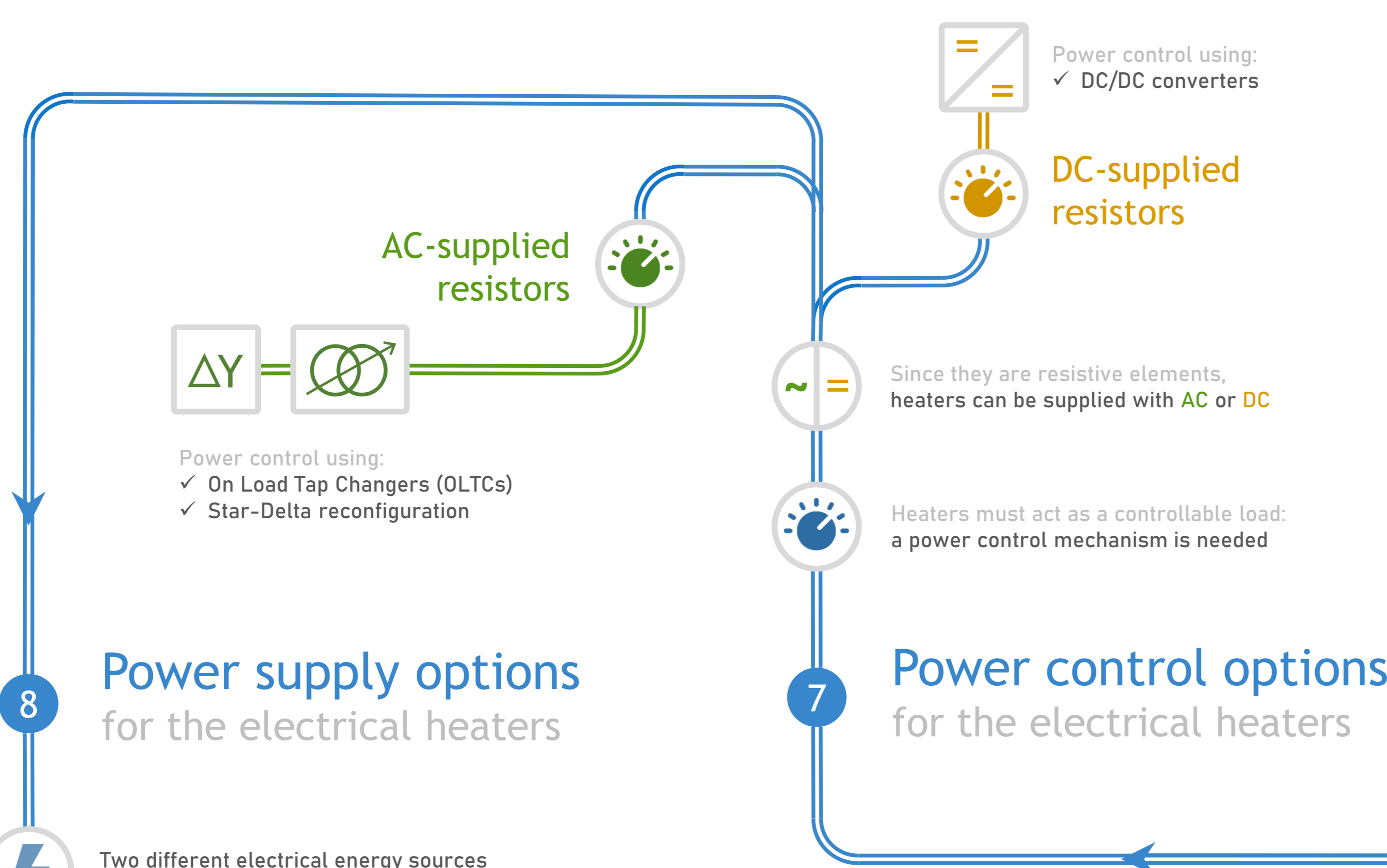
## 5 Power-to-Heat applications

High decarbonization potential for energy-intensive industrial plants



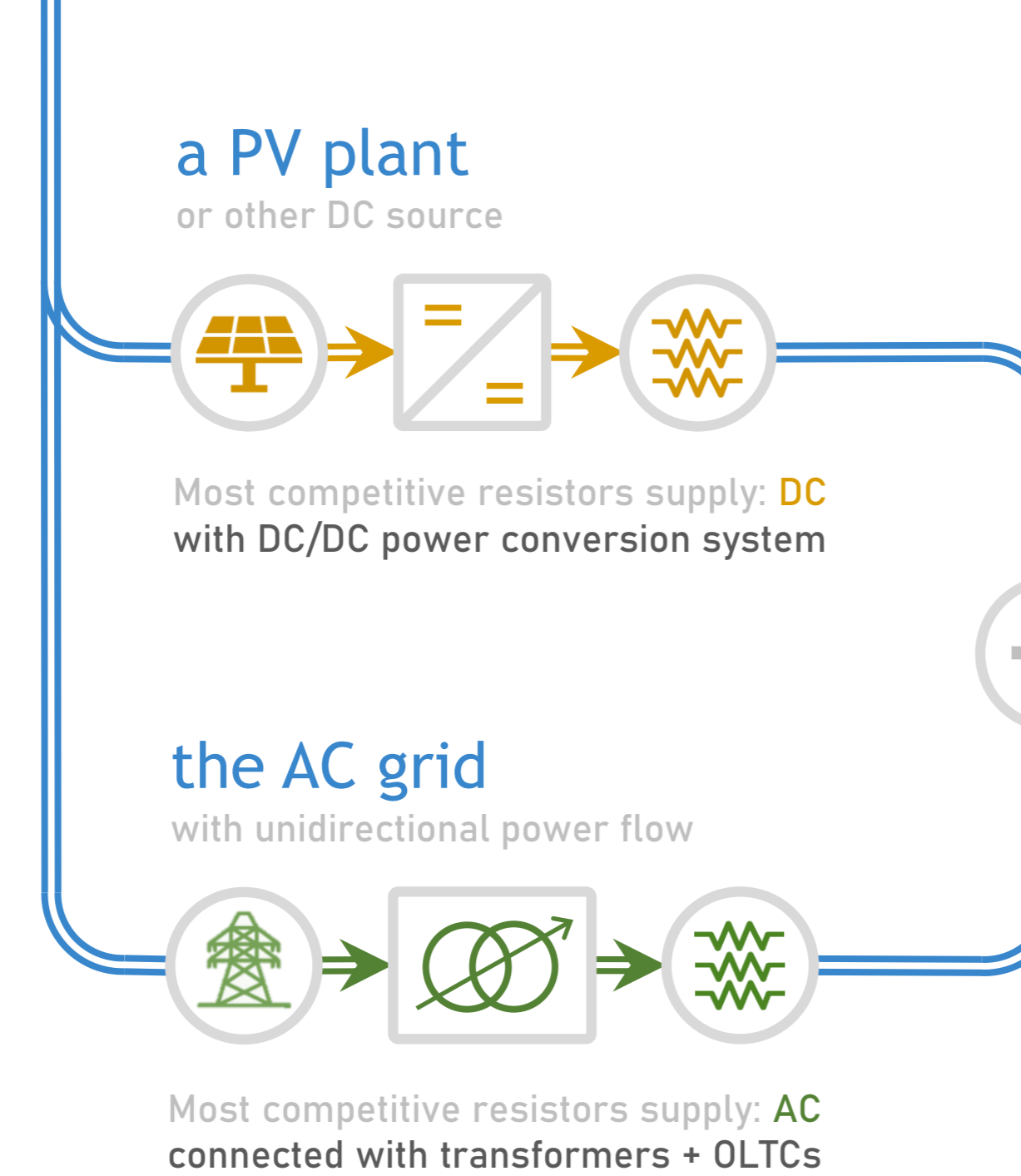
## 6 Features and benefits

- Provides grid services to the power system, through demand side response
- Cost-effective, since uses poor and easy-to-find materials
- Modular system, multiple modules can be used together
- Safe operation, no dangerous or poisonous materials
- Eco-friendly, with low impact on environment



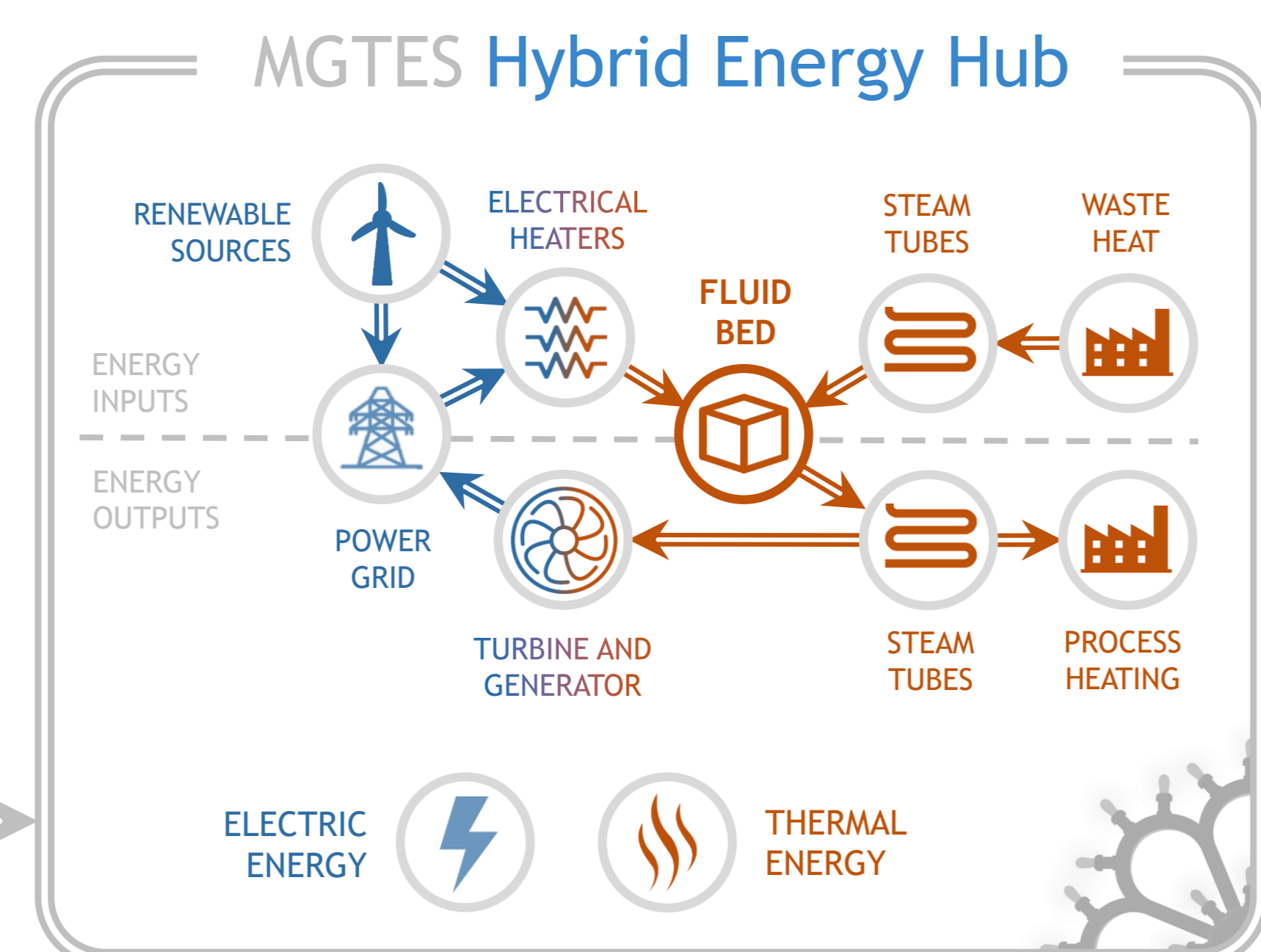
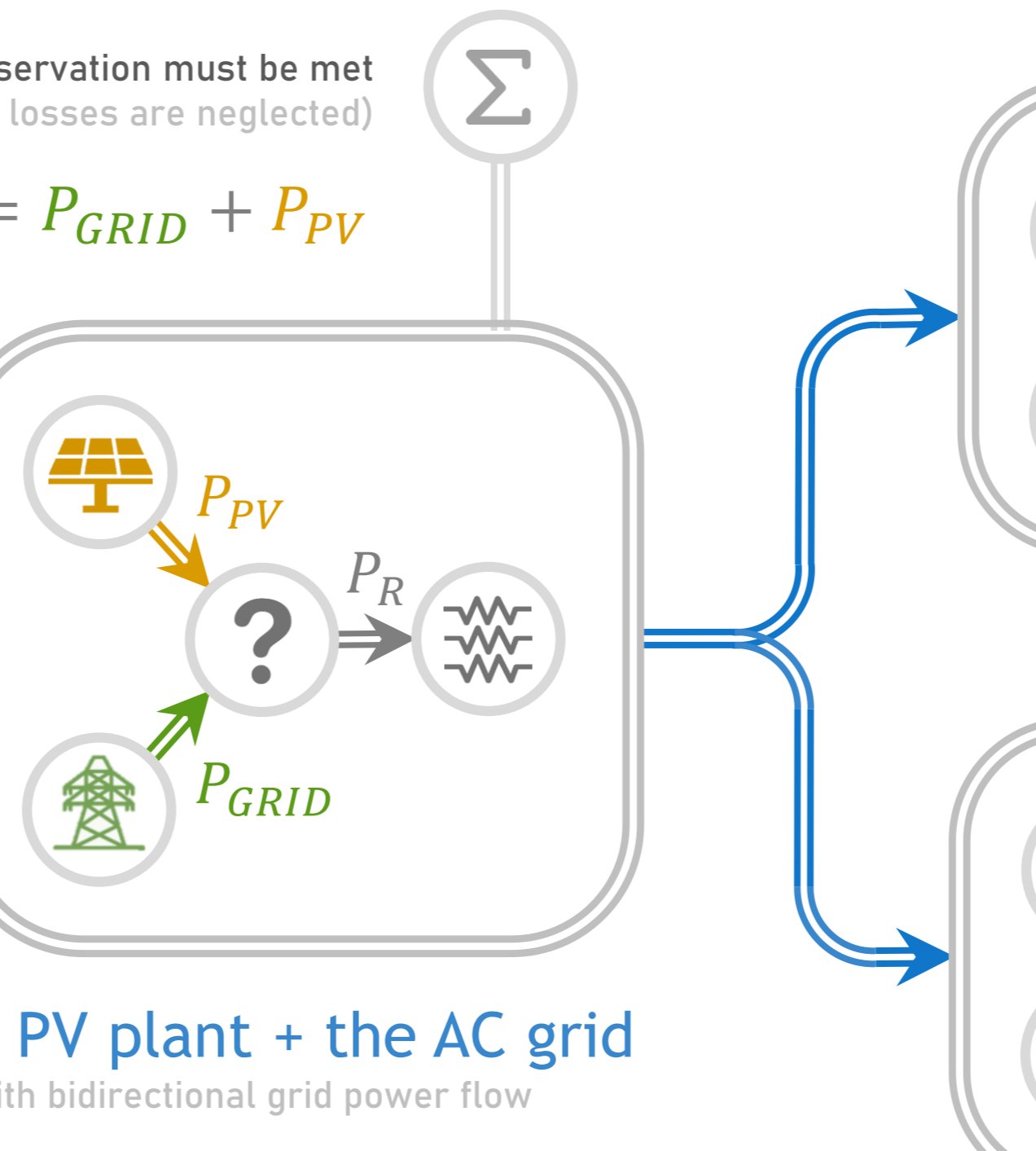
## 8 Power supply options for the electrical heaters

Two different electrical energy sources are considered in this work



## 7 Power control options for the electrical heaters

Heaters must act as a controllable load: a power control mechanism is needed



## Work in progress

Development of integrated software tools for:

- |  |  |   |
|--|--|---|
| <b>System simulation and performance assessment</b> <ul style="list-style-type: none"> <li>✓ technical: losses</li> <li>✓ environmental: emissions reduction</li> <li>✓ economical: total costs</li> </ul> | <b>Techno-economic optimization of system design parameters</b> <ul style="list-style-type: none"> <li>✓ to increase: system efficiency</li> <li>✓ to reduce: capital and operational costs</li> </ul> | <b>Optimization of the operation</b> <ul style="list-style-type: none"> <li>✓ to improve: system control algorithms and energy management</li> <li>✓ to find: the best market strategy</li> </ul> |
|--|--|---|

## 9 Research roadmap

- ✓ First ideas and concept design
- ✓ Preliminary studies, based on steady-state simplified models
- ✓ In-depth studies, based on dynamic complete models
- ✓ System simulation for performance estimation
- ✓ Scale-size prototypes at Magaldi factory in Buccino (near Salerno)
- ✓ Experimental tests on prototypes for models validation
- WE ARE HERE**
- System optimization
- Commitment and construction
- System operation, technology use

## Publications

M. Scanzano, M.C. Falvo, A. Scafuri, F. Bassetti, L. Magaldi, "Integration of a new thermal energy storage in electrical grids: power supply and control options", 2021 IEEE International Conference on Environment and Electrical Engineering (IEEEIC21)

M.L. Di Somma, M.C. Falvo, G. Graditi, M. Manganiello, M. Scanzano, M. Valenti, "Integration of renewable energy sources in transmission grids: issues and perspectives", 2021 IEEE International Conference on Environment and Electrical Engineering (IEEEIC21)