Electrification of the aluminium recycling route

OTTOJUNKER SOLUTIONS

82nd AMAP colloquium

Daniel Rader

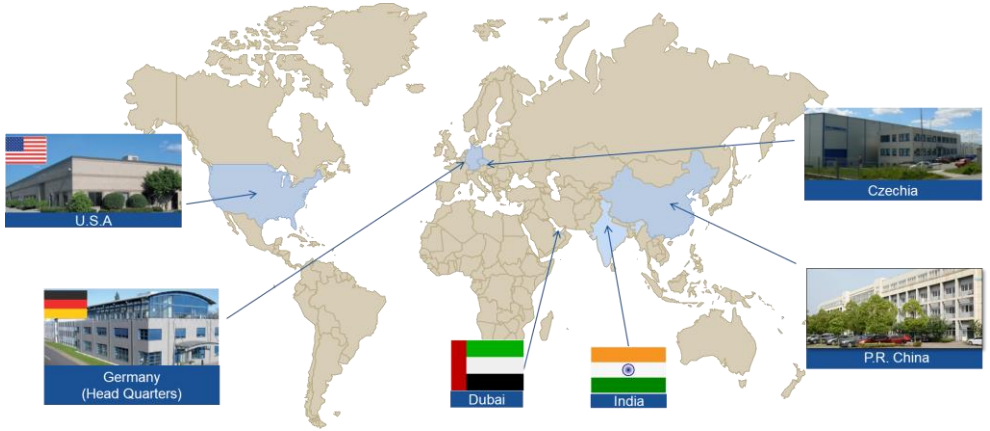
Dr. Tobias Mertens

Otto Junker main facts

- **Founded:** 1924 in Lammersdorf
- **Employees:** ca. 680 (worldwide)
- **Turnover:** approx. 150 Mio. €

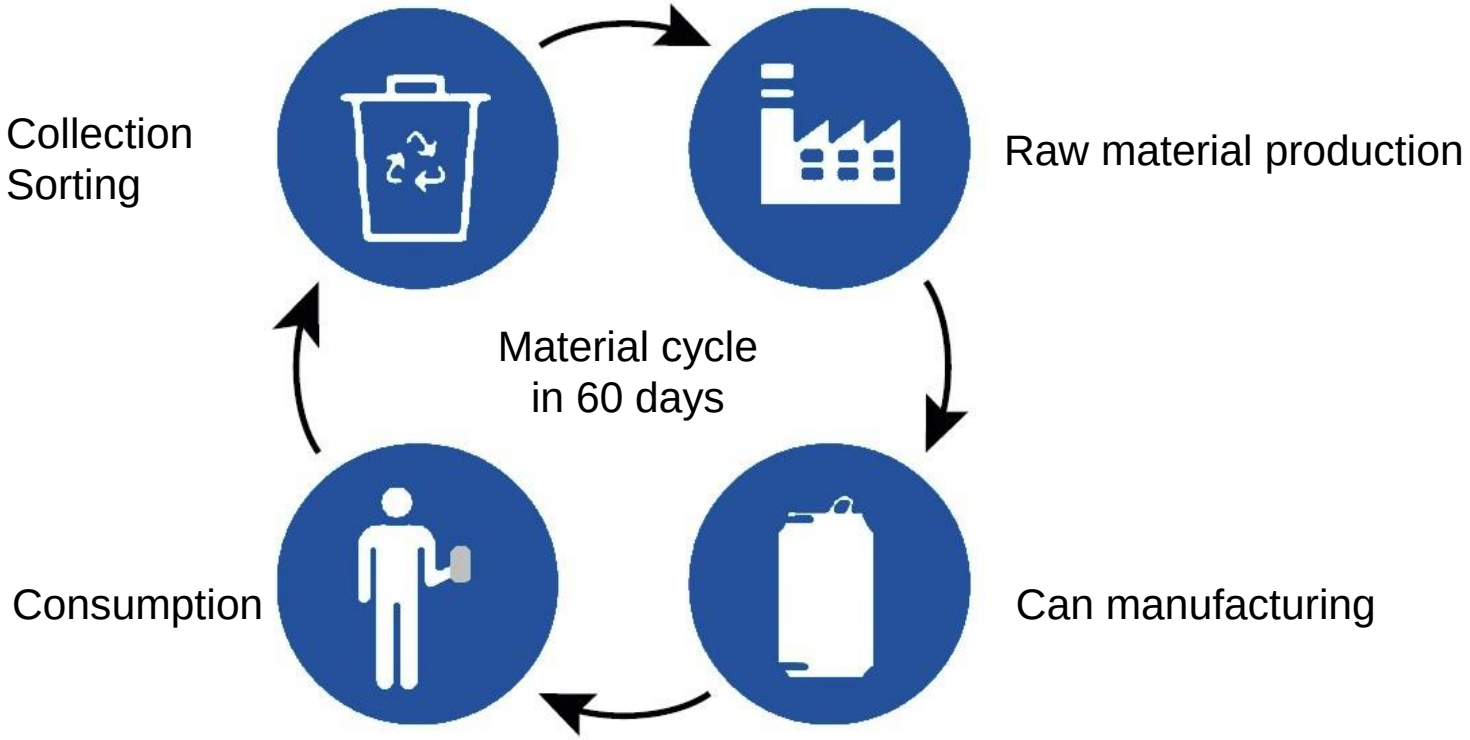
Three business units:

- **Melting and heat treatment furnaces**
- **Service**
- **Stainless steel foundry and machining**



Material cycle

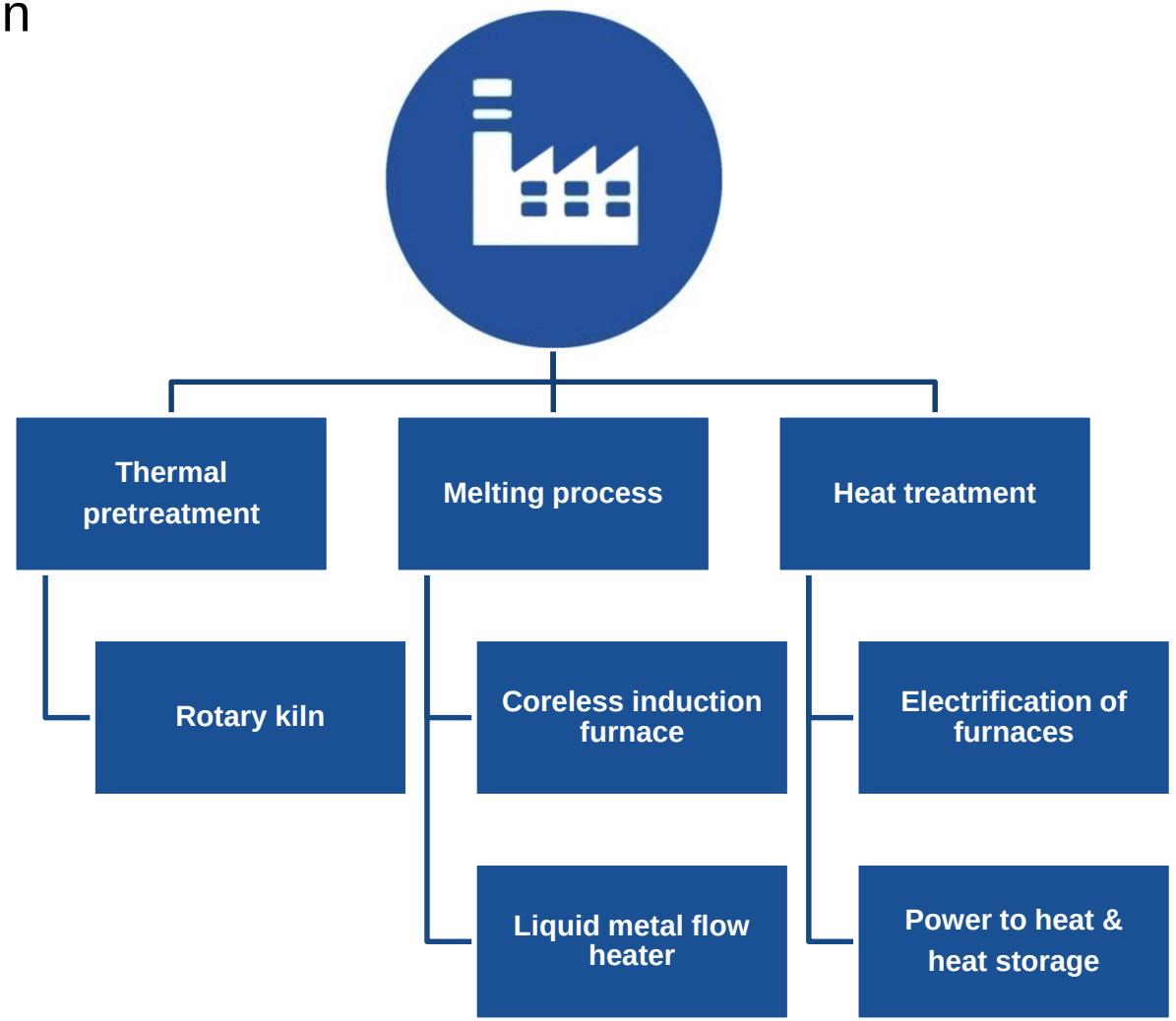
Beverage can



Source: [Rosenhagen et. al. 2020] Nachhaltiges Recycling von Aluminium-Getränkedosen in einem vollintegrierten Aluminiumrecyclingwerk

Raw material production

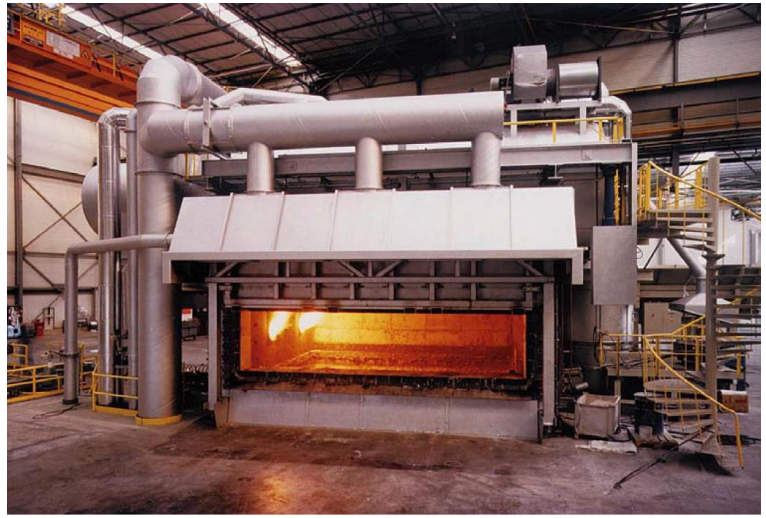
Possibilities for electrification



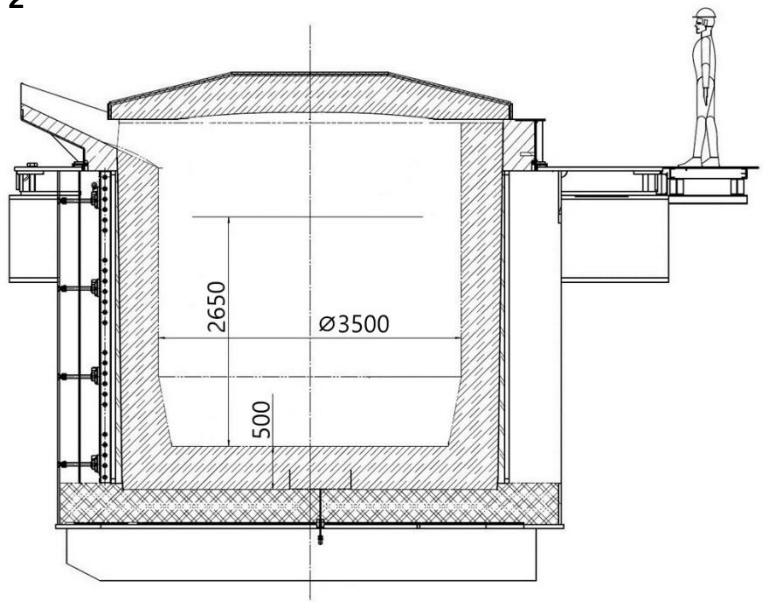
Melting furnaces

Comparison

- **Hearth furnace (twin chamber)**
  - **Max. power: 6 MW**
  - **Melting rate: 5 t/h**
  - **Capacity: 80 t**
  - **CO_2-emissions: 1,2 t/h**



- **Coreless induction furnace (concept)**
  - **Max. power: 9 MW**
  - **Melting rate: 16 t/h**
  - **Capacity: 70 t**
  - **CO_2-emissions: 0 t/h**



➢ **Challenge: Use of material with organic content**

Rotary kiln

Treatment of materials with organic content

- **External thermal pretreatment to remove all organic components in reduced atmosphere**
- **Avoiding oxidation of aluminium surface**
- **Reduction of loss reactions in downstream melting process**

➢ **Increase metal yield**

Rotary kiln

Thermal oxidizer

- **Exhaust gas treatment**
- **Controlled combustion of all volatile organic compounds**
- **Utilization of the energy of organic components**

Rotary kiln

Input Material

Source: [Schwalbe 2011] Grundlagen und Möglichkeiten der Verarbeitung von höher kontaminierten Aluminiumschrotten

Scrap grades	Contamination	Organic content [%]
Aerosol cans	Paints, Lacquers	2 - 3
UBC	Paints, Lacquers	4
Technical foils	Inks, Lacquers	7
Chips	Cutting oil emulsion	< 20
Window profiles	Polymers, Lacquers	21

- **Variation of process parameters**
  - **Residence time of material**
  - **Process gas**
    - Oxygen concentration
    - Temperature
    - Volume flow

R&D center

Rotary kiln & coreless induction furnace

- **Rotary kiln:**
  - **Max. process gas temperature: 600 °C**
  - **Max. throughput: 400 kg/h**

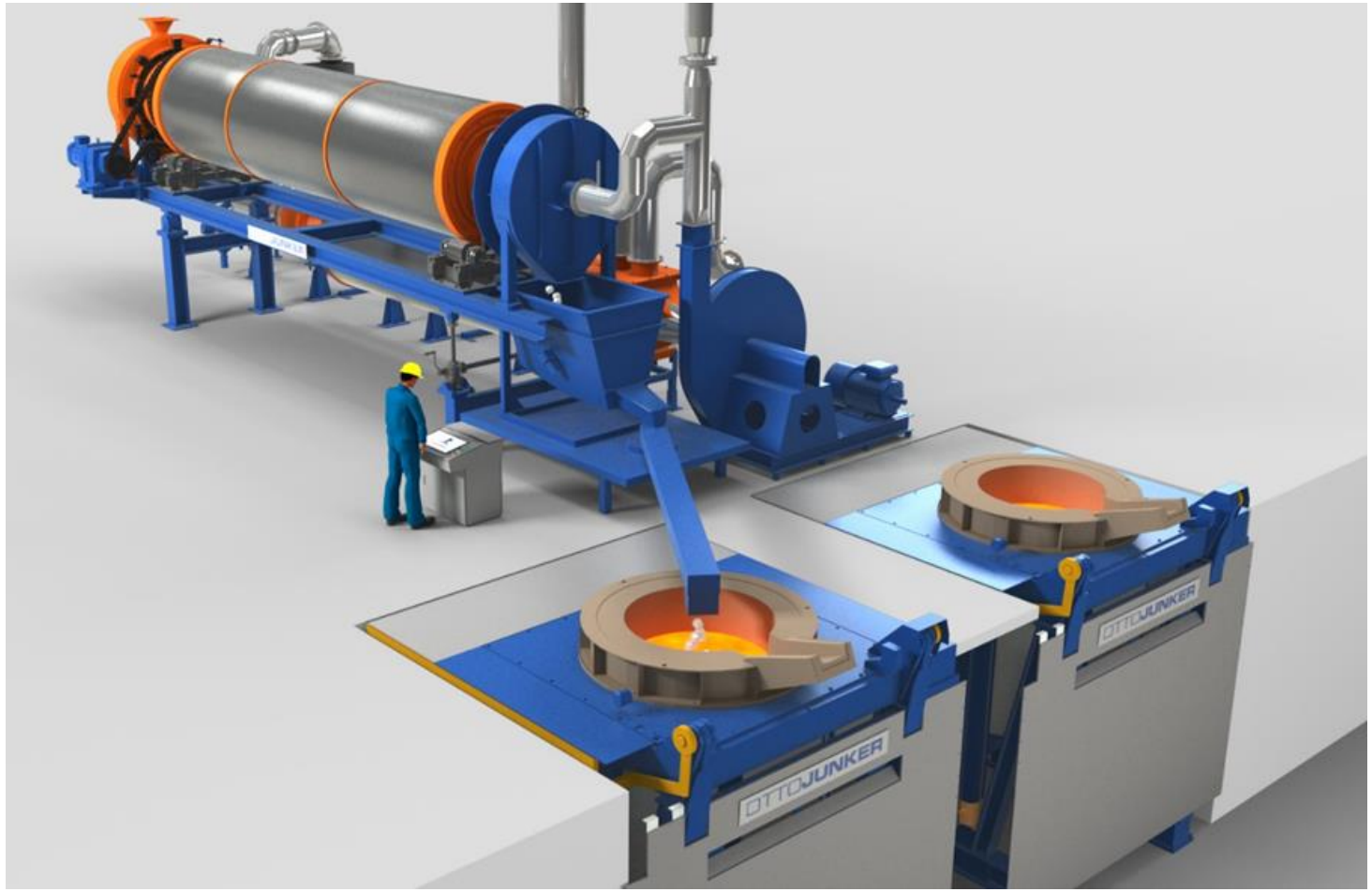
- **Coreless induction furnace:**
  - **Power: 600 kW**
  - **Capacity: 600 kg**
  - **Operating frequency melting mode: 100 Hz or 200 Hz**
  - **Operating frequency stirring mode: 30 Hz to 100 Hz**

➢ **Determining the optimum process parameters for thermal pretreatment and melting**

➢ **Scaling to customer-specific requirements**

Rotary kiln & coreless induction furnace

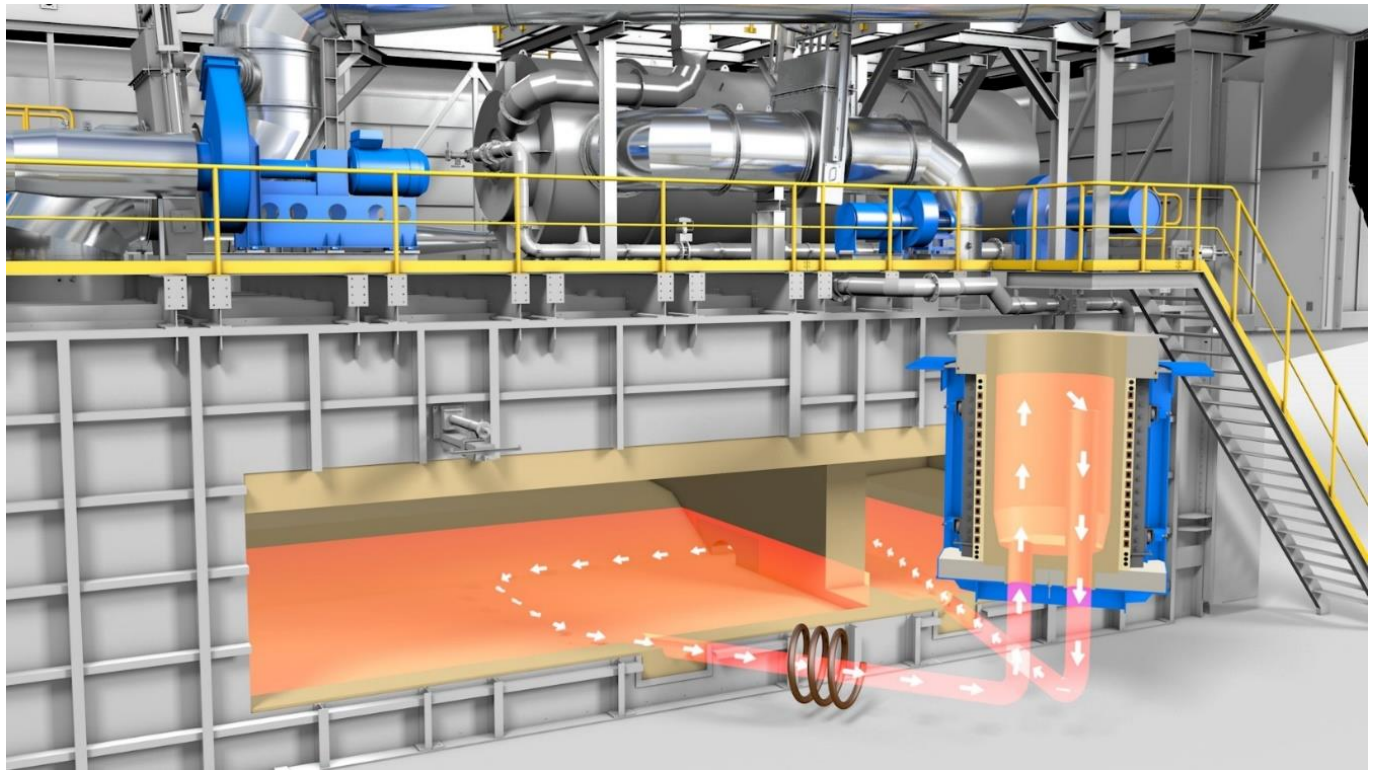
- Thermal pretreatment of organic containing material in rotary kiln
- Melting process in coreless induction furnace
- Preheating material up to 400 °C
- Up to 37 % energy savings in melting process
- Material throughput scalable from 0,1 t/h to 20 t/h
- Metal yield UBC: 98,5 %



Electrification of hearth furnace

Liquid Metal Flow Heater

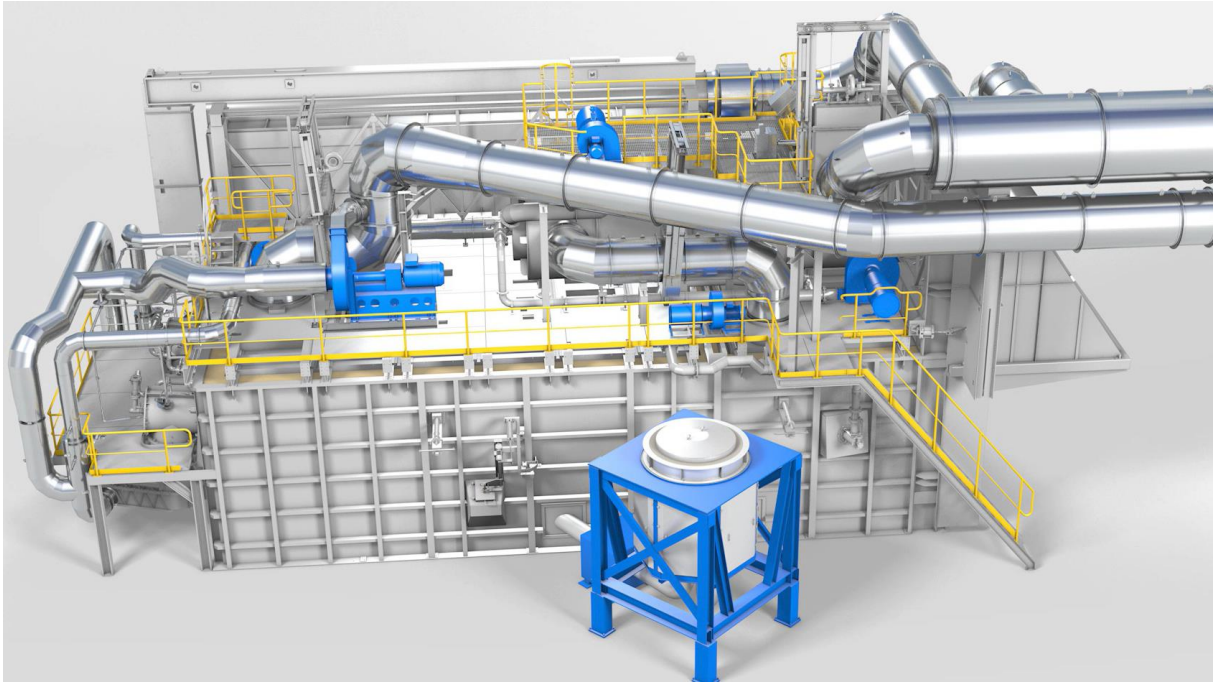
- **Combination of crucible inductor and electromagnetic pump**
- **Melt is pumped into crucible inductor for superheating**
- **Hybrid operation possible**
- **Up to 6 MW power per unit**
- **Chips can be charged directly into the crucible inductor**
- **First industrial application in cooperation with Speira GmbH**



Electrification of hearth furnace

Example

- **capacity: 4000 kg**
- **Power: 1500 kW**
- **Frequency: 80 Hz**
- **Temperature: 700 °C**
- **Temperature rise: 4,4 K**
- **Energy consumption (superheating): 2,5 kWh/t**
- **Superheating throughput: 600 t/h**



Electrification of heat treatment furnace

Source: noxmat.com

Natural gas burner → Resistance heating

Efficiency: 72 % → Efficiency: 98 %

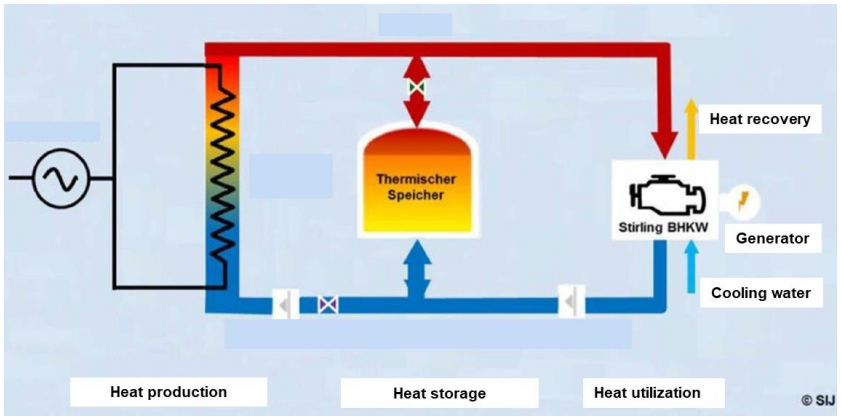
Power to Heat & heat storage

Features

- **Use of low price periods in energy grid**
- **Heating of air up to 1000 °C**
- **Storing thermal energy in ceramic heat storage**
- **No direct CO_2-Emissions**
- **Power density up to 600 kW/m³**

Power to Heat & heat storage

multiTESS plant in Jülich



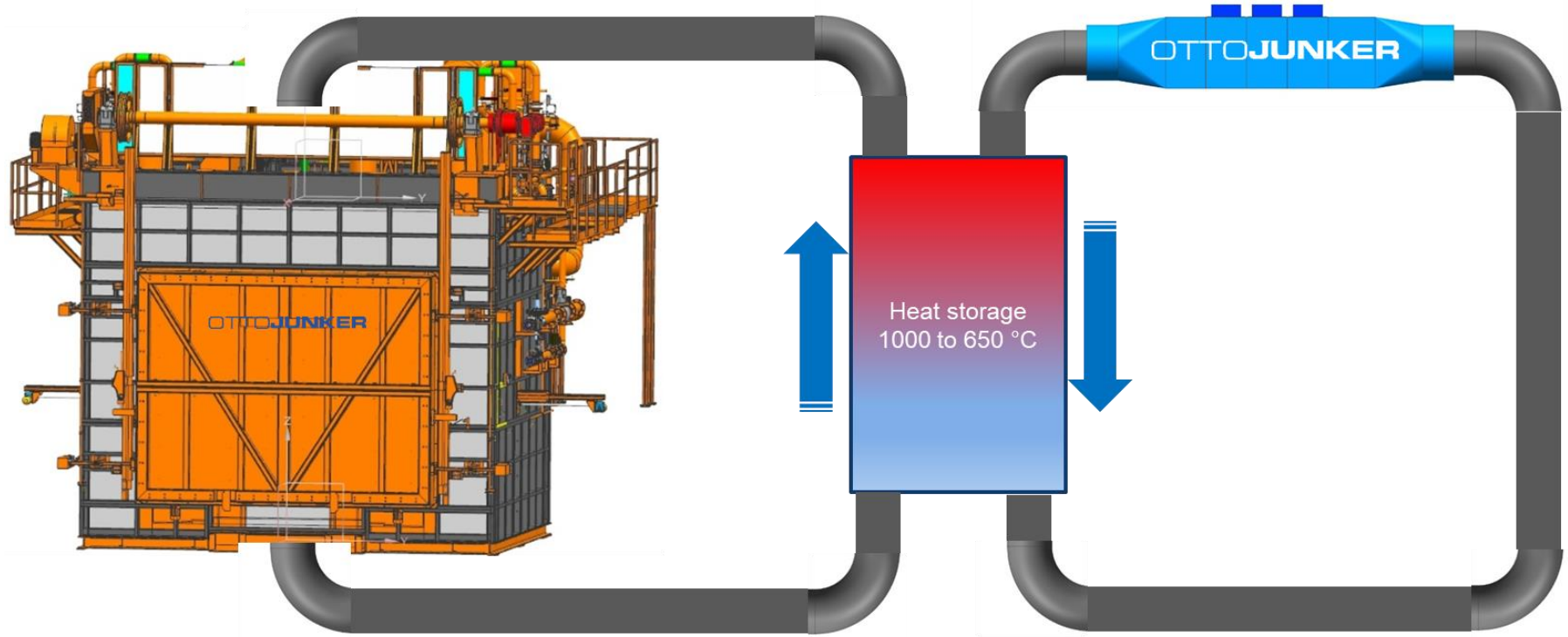
Power to Heat & heat storage

Combination with heat treatment furnace

- **Supply of process heat for heat treatment**

Chamber furnace
Process gas temperature: 600 °C

Power to heat module
conversion of electrial energy to heat



Thank you for your attention!

Questions?

Daniel Rader

Research and Development

Phone: +49 2473 601 358

Mobile: +49 171 7319505

Daniel.Rader@otto-junker.com