

# Electrification of Industrial Process Heat

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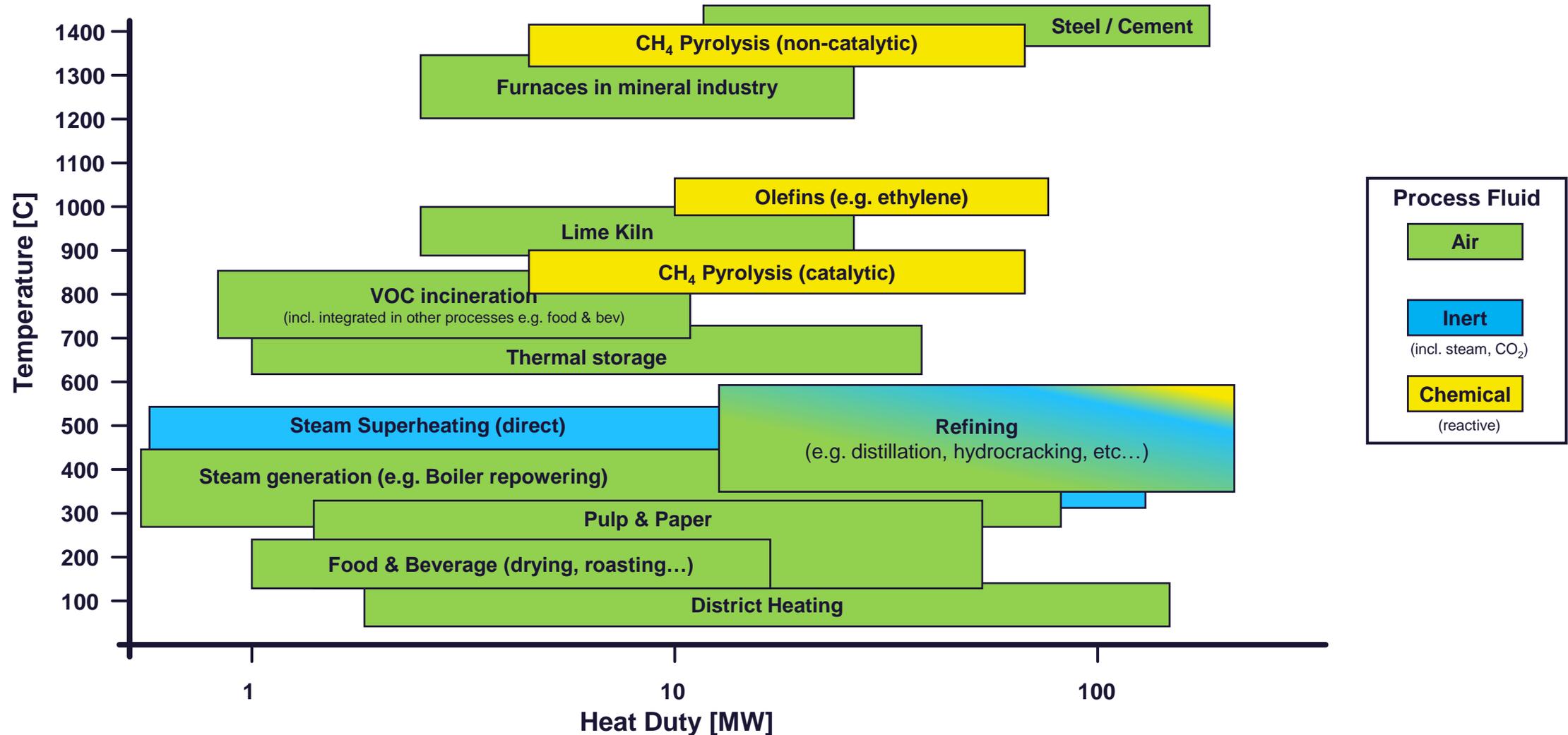
Industrial Process Emissions Reduction  
January 29/30, 2025

Why?

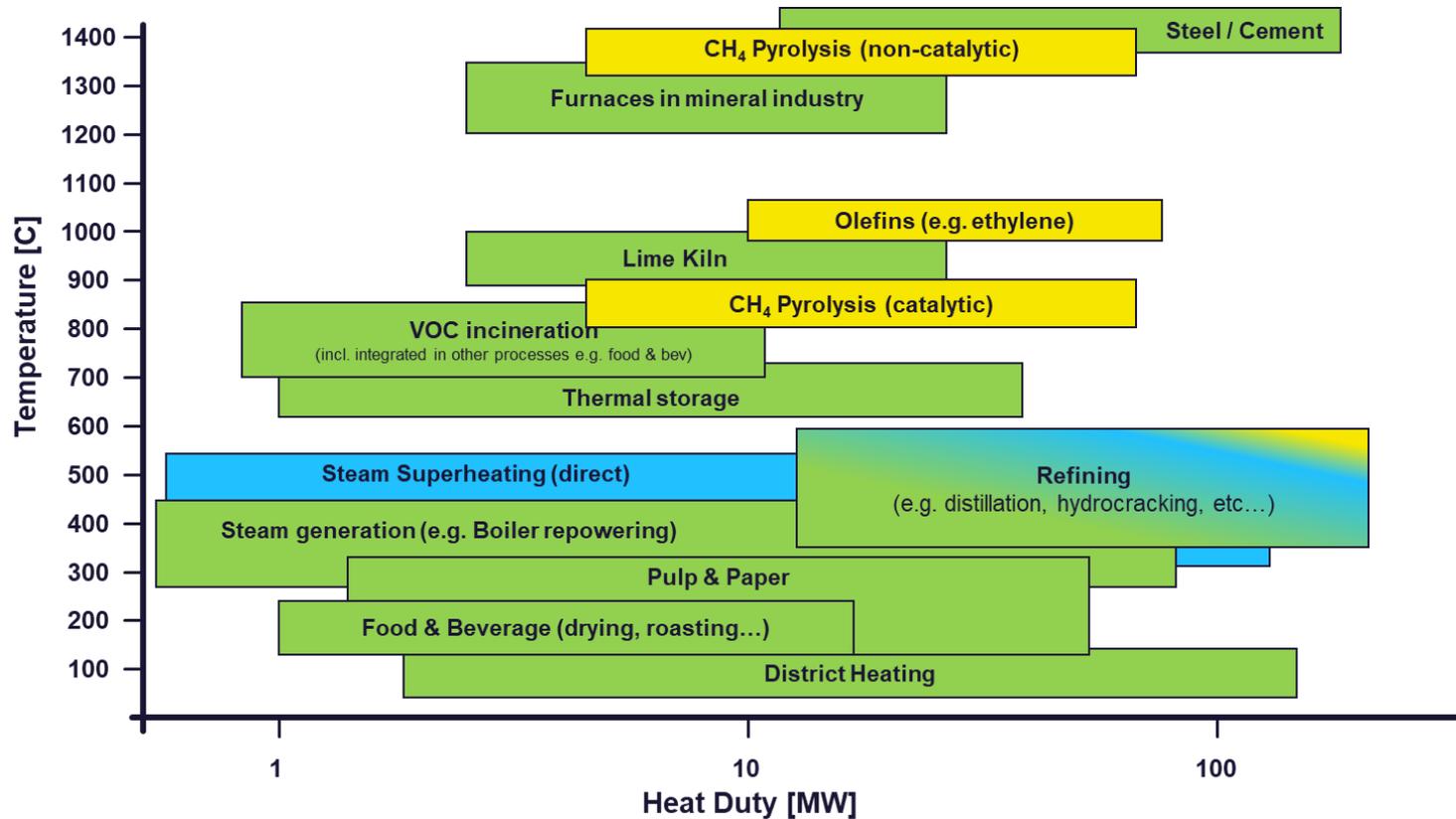
Energy Efficiency

Reducing Carbon Emissions

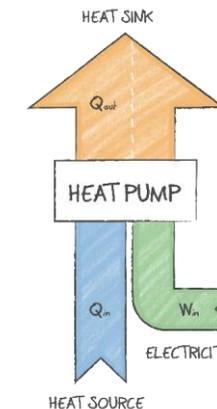
# Industrial Heat Ranges



# Options Vary with Process Temperature



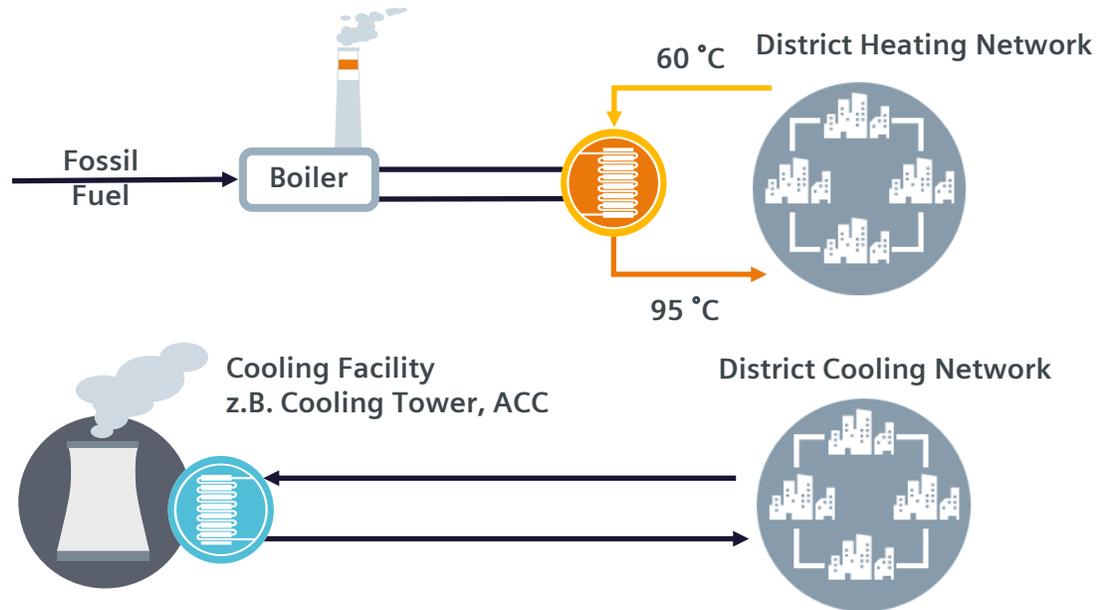
No potential to leverage CoP > 1



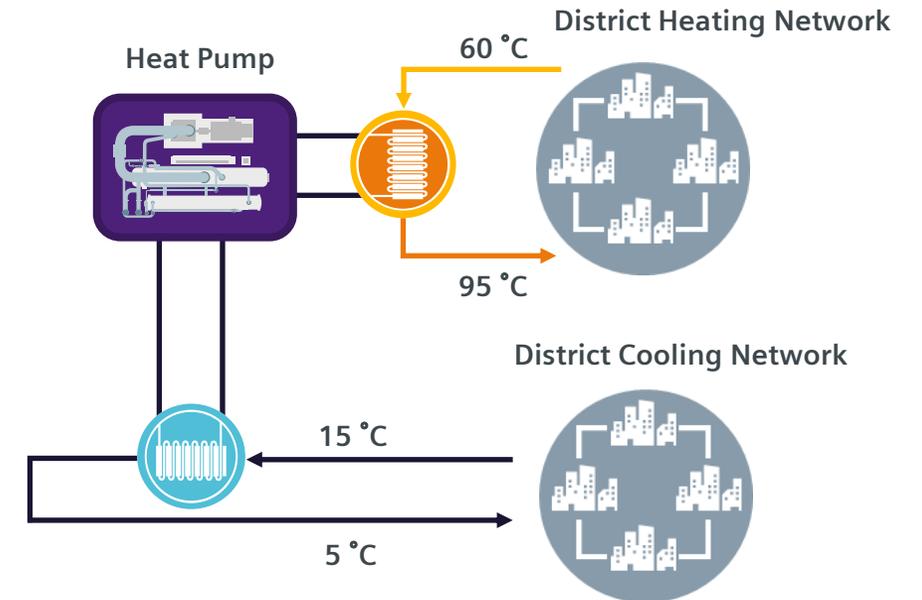
Potential to leverage CoP > 1

# Industrial Heat Pumps Already Well Established

## SITUATION TODAY



## IMPROVED SITUATION WITH HEAT PUMP



# Low Temperature Range – Heat Pumps Can Do the Job

## TWO COMPLEMENTARY PRODUCT LINES ...



### SHP-STC-XX W/S

HIGH TEMPERATURE HEAT PUMP

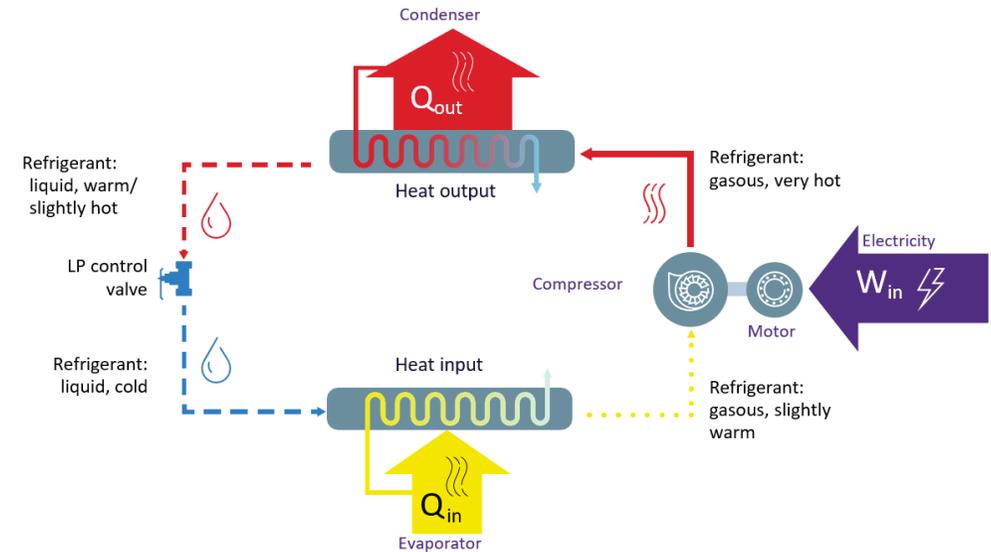
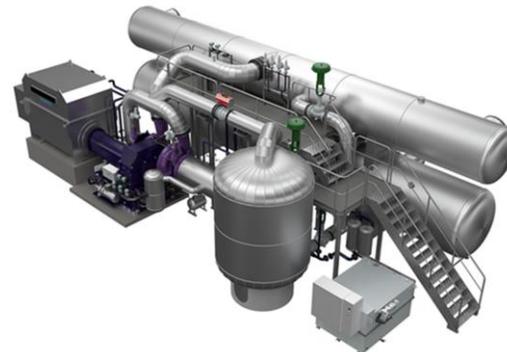
5 – 70 MW, UP TO 150 °C (HOT WATER OR STEAM)



### SHP-C600

BASED ON PROVEN DESIGN (SINCE 1980s)

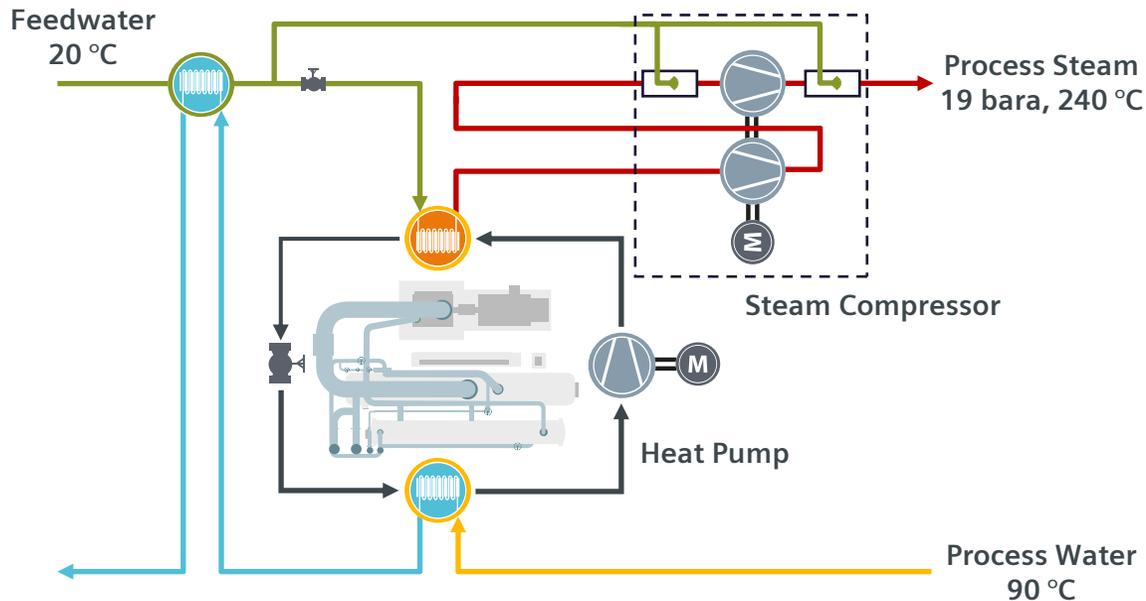
15 – 45 MW, UP TO 100 °C (HOT WATER)



- 5 to 70 MW<sub>th</sub> per unit
- Temperatures up to **150°C** directly from heat pump
- Various drive concepts (**electrical** or **mechanical**)
- Combine with steam compression for **higher temperatures** and **pressures** for process steam production
- Scope of supply – **component** up to **turnkey** supply

# Mid Temperature Range – Couple with Steam Compression

## OVERVIEW



## KEY FIGURES

CAPACITY	36 MWth HP & Steam Compressor = 50 MWth
AVERAGE COP	~ 2.5 (incl. steam compression)
REFRIGERANT	Hydro-(-chloro)-fluoro-olefin (H(C)FO)
ARRANGEMENT	Brownfield (integration in existing building)
HEAT SOURCE	Process water return from reactors (90 → 70 °C)
HEAT SINK	Process Steam (20 °C → 19 bara, 240 °C)
COMPRESSOR	SE geared type radial compressor
LUBE & SEAL OIL SYSTEM	Combined lube and Seal Oil System
HEAT EXCHANGER	Shell & Tube Heat Exchangers (Evaporator, Condenser, Subcooler)
I&C SYSTEM	T3000 compact

## BACKGROUND

- High temperature heat pump utilizes waste heat from process water of reactors to produce saturated steam from feedwater
- Saturated steam is fed to steam compressor (multi-stage intercooled / attemperated)
- Final adjustment of steam parameters by attemperation

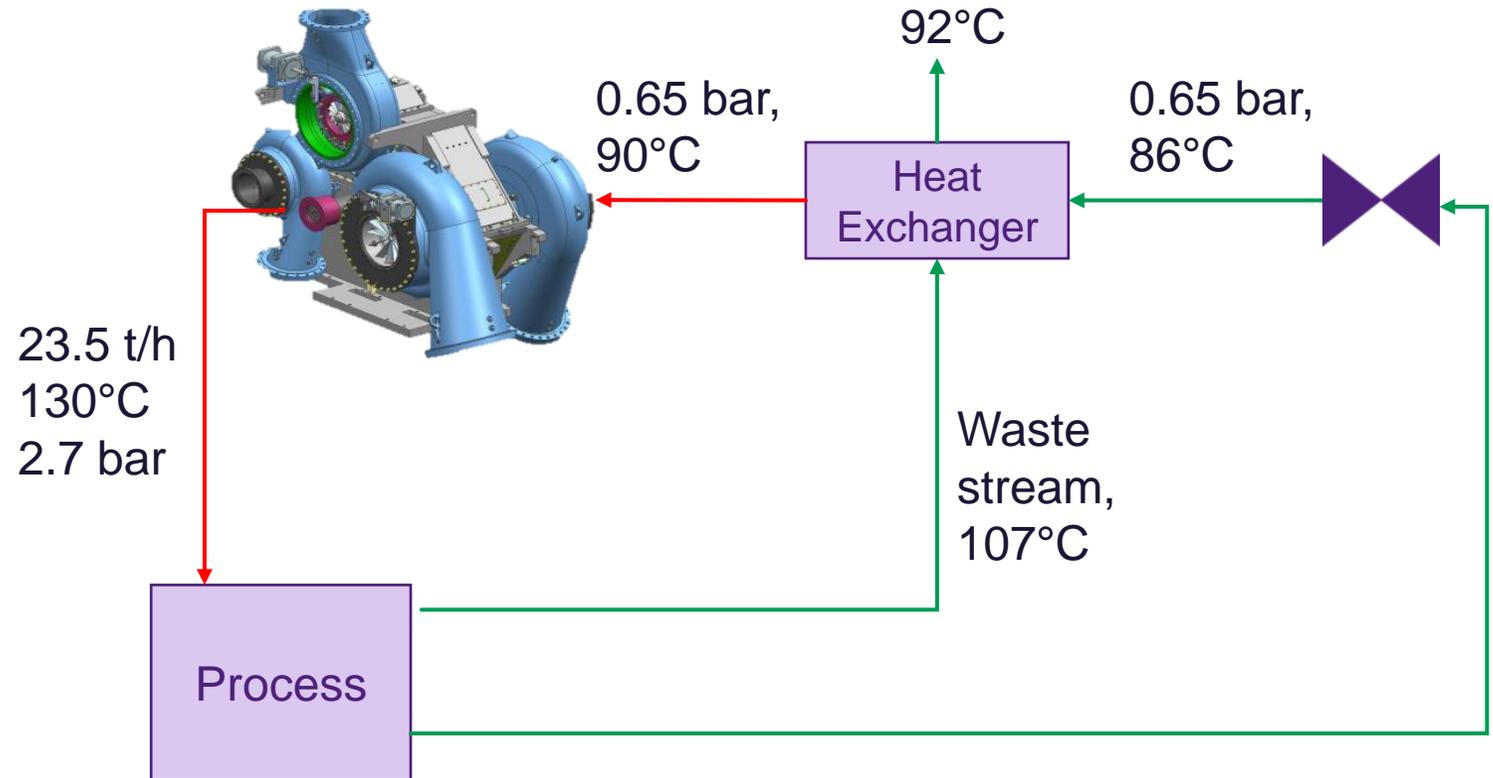
# Also, Mechanical Vapor Compression

## Description

- Water evaporates below 100°C with sub atmospheric pressure, therefore, low pressure steam will be generated with waste heat temperatures
- Subsequent required steam temperature and pressure levels is achieved with steam compression

## Benefits

- Low temperature waste heat streams can be used without heat pump
- Good COP
- Reduced CAPEX and OPEX
- Reduced CO2 emissions



Steam compressor power requirement: 2.1 MWe  
Thermal energy saved: 14.9 MWth  
COP: 7.1

# Introducing the Turbo Heater technology



**SIEMENS**  
ENERGY



Decarbonize high-temperature heat at scale for hard-to-abate industries



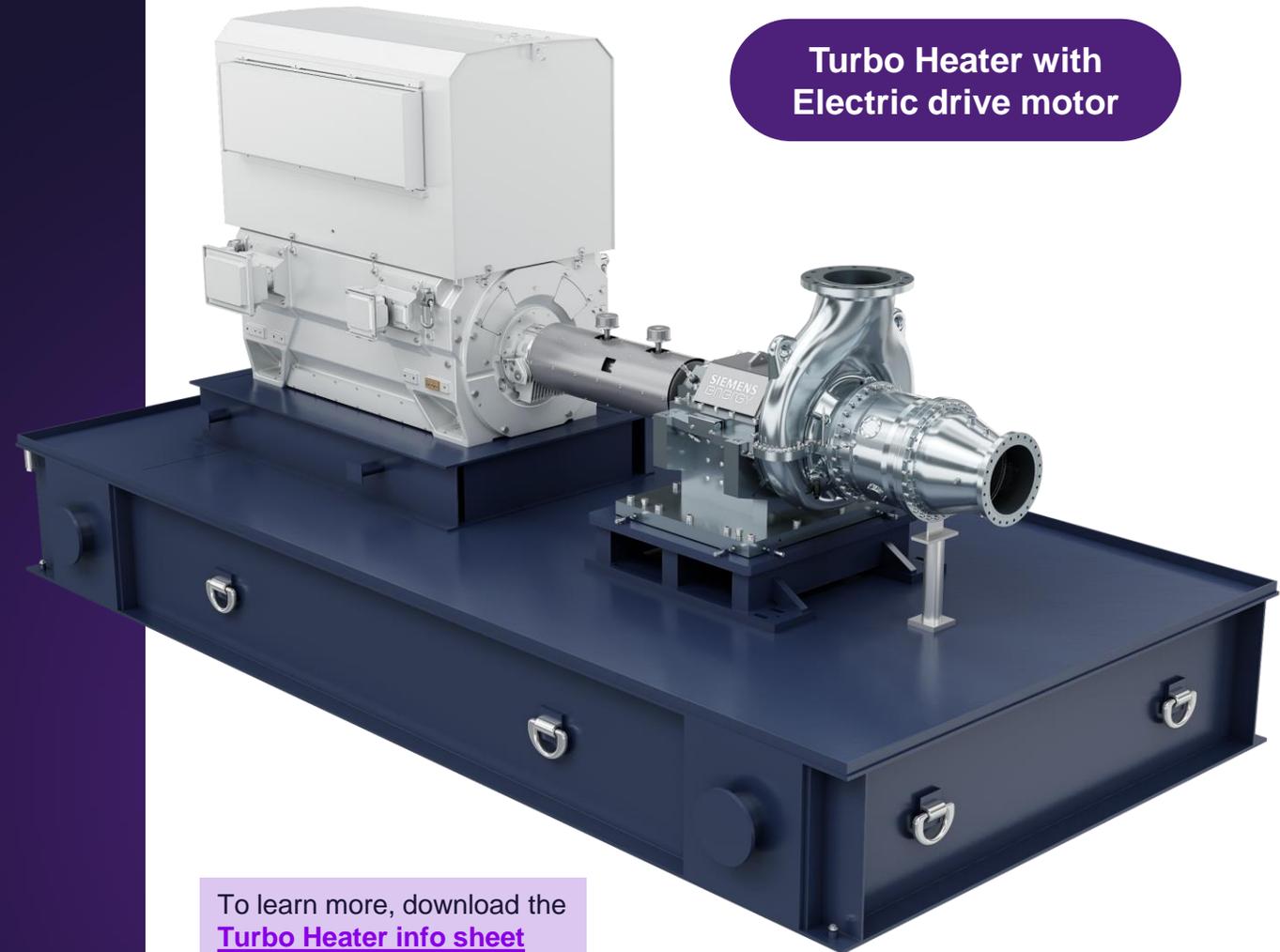
- **Eliminate fuel** burn (electrification)
- **Highly scalable** Turbomachinery technology (double & triple -digit MW)



- **Direct heating** of process flow to elevated temperatures via shock wave
- **No heat exchangers** → size & operating gains



- MW-scale **demonstrator tested** (> 700 °C)
- Higher temperature in development with **capability > 1000 °C**



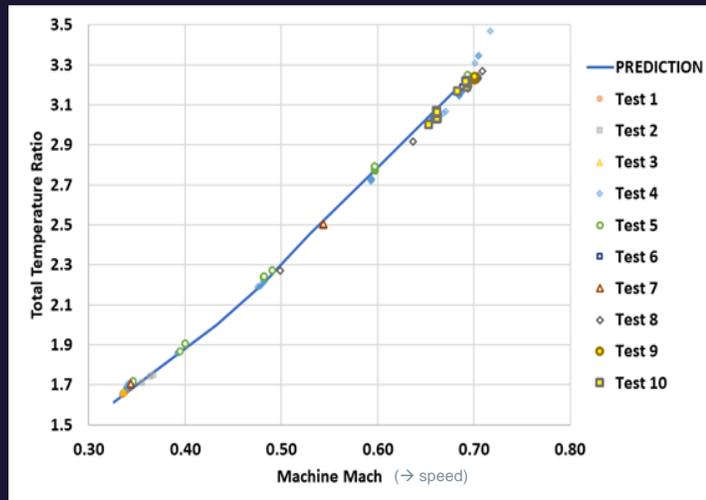
Turbo Heater with Electric drive motor

To learn more, download the [Turbo Heater info sheet](#)

# Aero Demonstrator Test Completed

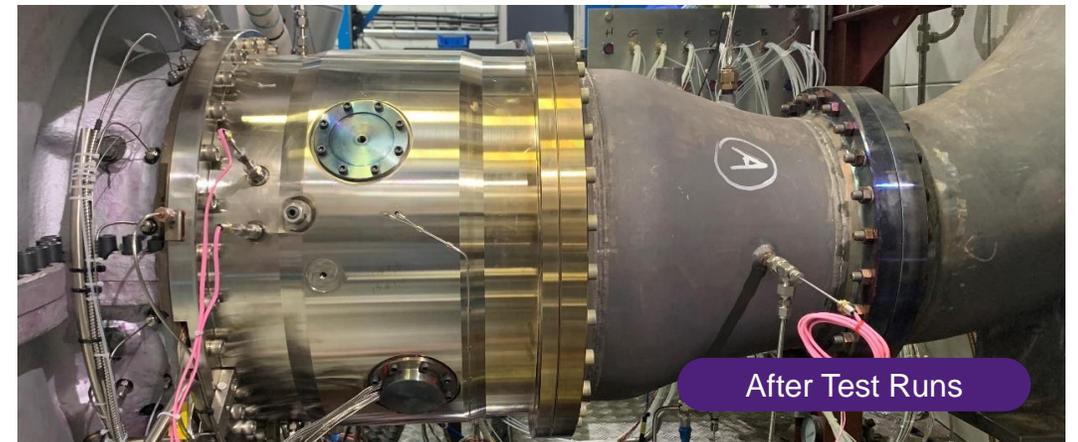
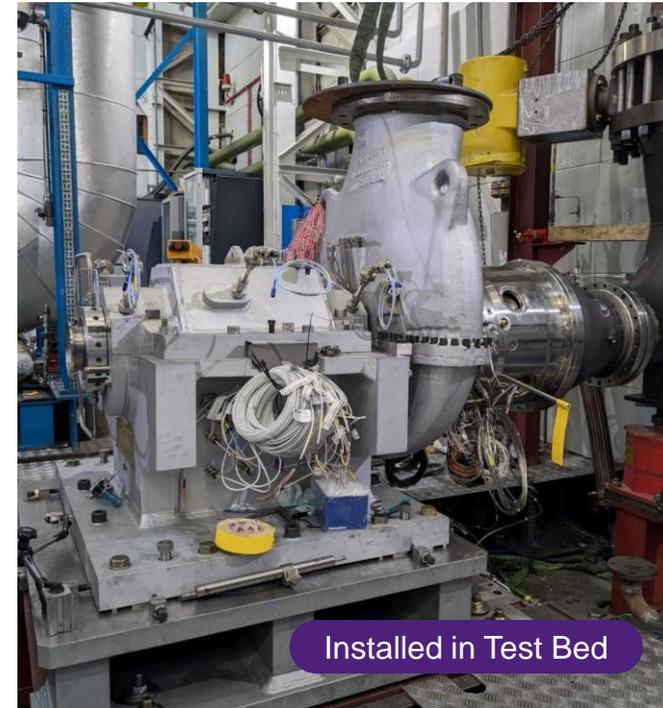
## Successful Campaign @ Siemens Energy Test Rig

- Prototype unit 1.6 MW (5.5 MMBTU/h)
- Air heating to > 700 °C (1,300 °F)
- Nominal air flow 2.2 kg/s (3,880 scfm)
- Demonstrated Total Temp. ratio >3 (air)



### Extensively instrumented for validation

- Aero & Mechanical as expected
- Fully stable in operating range 60% – 100%
- Robust rotor dynamics
- Blade vibrations well within limits
- Successful Mechanical Run test (API procedure)



# Technology Development Roadmap



<sup>1</sup> Joint development partner Technip Energies



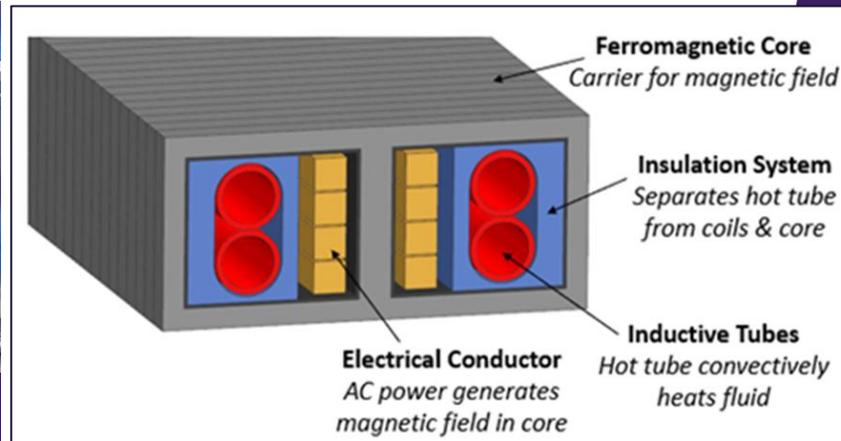
End-user partnering opportunity

# Inductive Heater Alternative

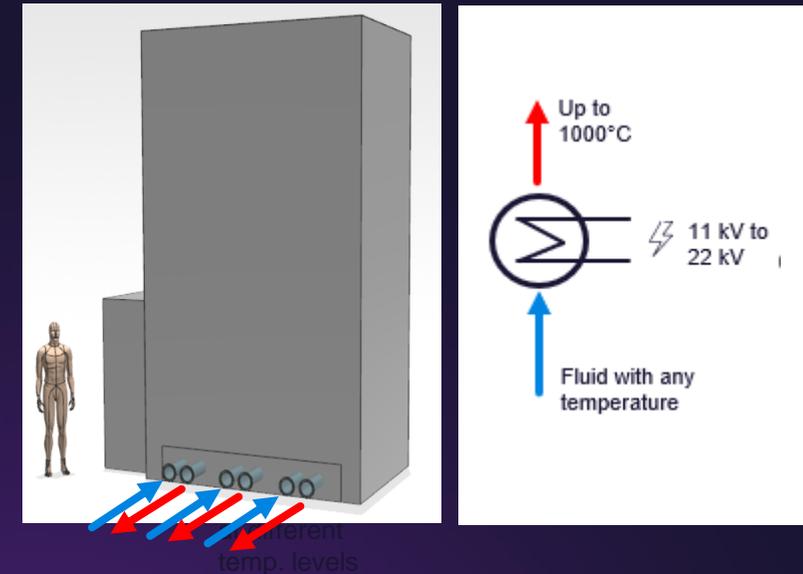
- ✓ Only technology with broad application to **Medium Voltage**
  - ❖ Enables scalability to MW thermal power ranges
- ✓ Only **non-contacting technology**
  - ❖ Separates critical MV electrical components from high temperatures & process fluids
  - ❖ Increases reliability and lowers OPEX costs
- ✓ **Modular** and easily **scalable with High Power Density**
  - ❖ Cost competitive and smaller footprint
- ✓ Flexibility to **heat a wide variety of process fluids**
  - ❖ Same topology heats both gases and liquids
  - ❖ Allows for phase change or heating of multi-phase mixtures
  - ❖ Currently developing capability to generate steam



500kW Demonstrator used to successfully heat Air and Oil



## Siemens Energy Electric Heater for heating fluids up to 1000°C



- ▶ **Unique inductive technology** based on well proven Siemens Energy generator and transformer technology
- ▶ **Input Voltage range: 11kV to 22kV**
- ▶ **Power range per unit: 5 to 100 MW**
- ▶ **Thermal/electrical efficiencies: > 99%**
- ▶ **Design covers wide range of thermal applications with modular approach**
- ▶ **Pressure limit on process fluid side: > 250 bar**
- ▶ **Temperature limit on process fluid side: → 1000°C**

# 500kW Demonstrator at Siemens Energy Test Field



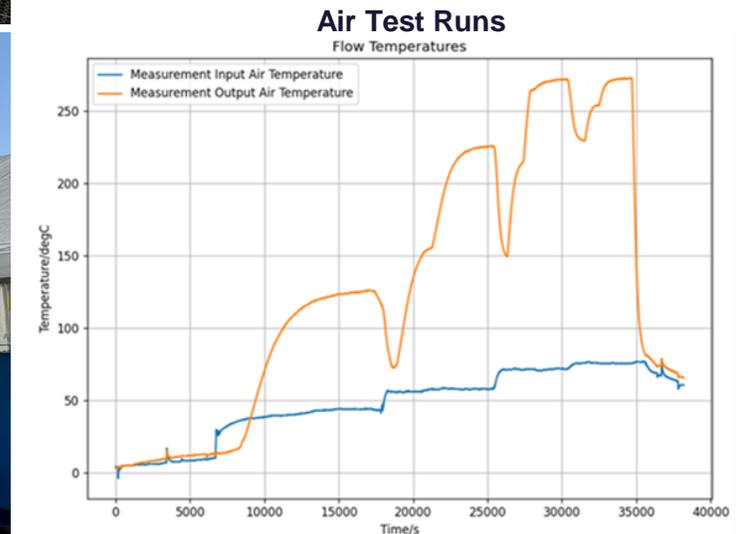
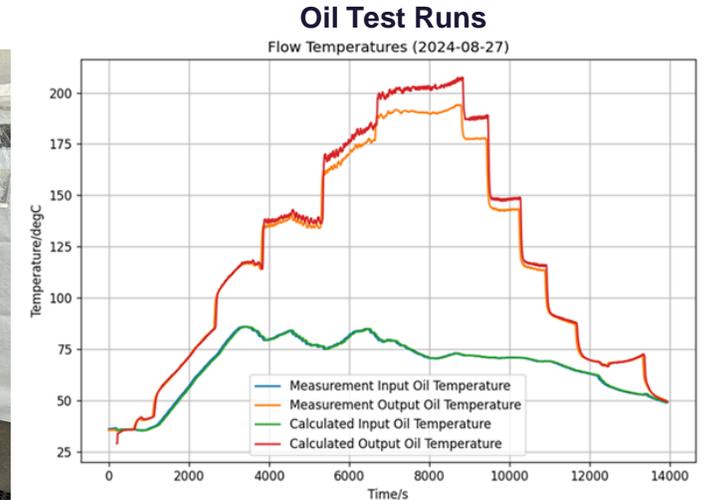
**Utilize low voltage, 20-500 kW demonstration units for early-stage prototype development**

1MW test facility built at **Siemens Energy's Charlotte NC campus** specifically for I-Heater development and testing

**500kW demonstrator for Single Phase Fluids:**

- First test with **air** as fluid completed **April 2024**
- Testing **thermal oil (T-66)** completed **Aug 2024**

- ✓ **Validated heater for both gases and liquids**
- ✓ Good correlation between test measurements and calculations
- ✓ **Validation obtained** to move forward to full-scale applications



# MW-scale, Medium Voltage Customer Pilots



## Pilot #1: 7.5MW Molten Salt heater

Location: U.S. site *TBD*

Test dates: Nov 2025-Mar 2026

Goal: Phase 1: 2025

- Molten salt heated to 565°C. Use molten salt to (1) produce steam and (2) heat oil
- Steam used in Utility heating & cooling system

Goal: Phase 2: 2026

- Add capability for >10MW-hrs of thermal storage at 565°C

## Pilot #2: 1.8MW Molten Salt Heater

Location: University of Evora, Portugal

Test dates: Jan-June 2026

Goal:

- Heat molten salt to 565°C and supply to site CSP storage tank
- Long-term operation

## Pilot #3: 5MW Industrial Steam Production

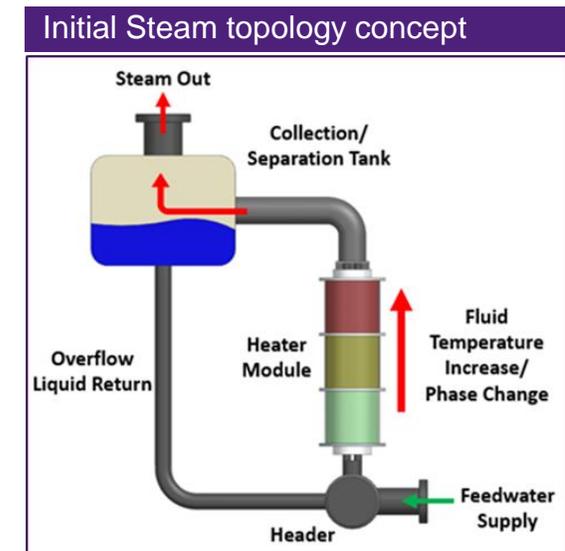
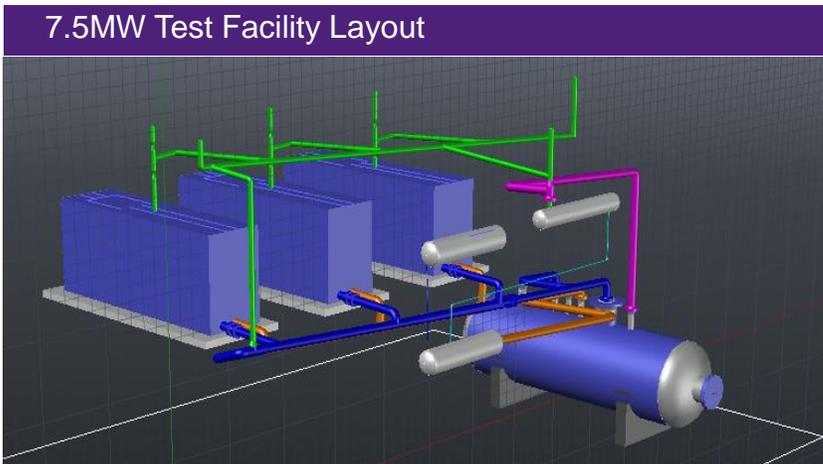
Location: U.S. Pulp & Paper Mill

Demonstrator Test: Oct 2026

5MW Pilot Test: Mar 2027

Goal:

- DOE-funded program starting Oct 2024
- Directly produce steam utilizing Benson Boiler technology at 75 psig/370°F
- Introduce steam to mill steam lines to supplement capacity



# Thank you.

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