WEBINAR

Strengthening Industrial Heat Pump Innovation in Europe

29-10-2020

DANISH TECHNOLOGICAL INSTITUTE

NTB Interstaatliche Hochschule für Technik Buchs

SINTEF

AIT AUSTRIAN INSTITUTE OF TECHNOLOGY

DTU

TNO innovation for life

UNIVERSITAT POLITÈCNICA DE VALÈNCIA

RI.SE

White Paper

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Have you considered implementing Heat Pumps in your future strategy?

- Yes, we are considering to integrate Heat Pumps in our future strategy
- No, we are not considering Heat Pumps in our future strategy
- We lack sufficient information to consider Heat Pumps in our future strategy

DECARBONIZING INDUSTRIAL PROCESS HEAT

UN Sustainable Development Goals

Most closely related to energy:

- achieving universal access to energy (SDG 7)
- reducing the impacts of air pollution (SDG 3, 9)
- tackling climate change (SDG 13)

European Climate Targets

Key targets for 2030:

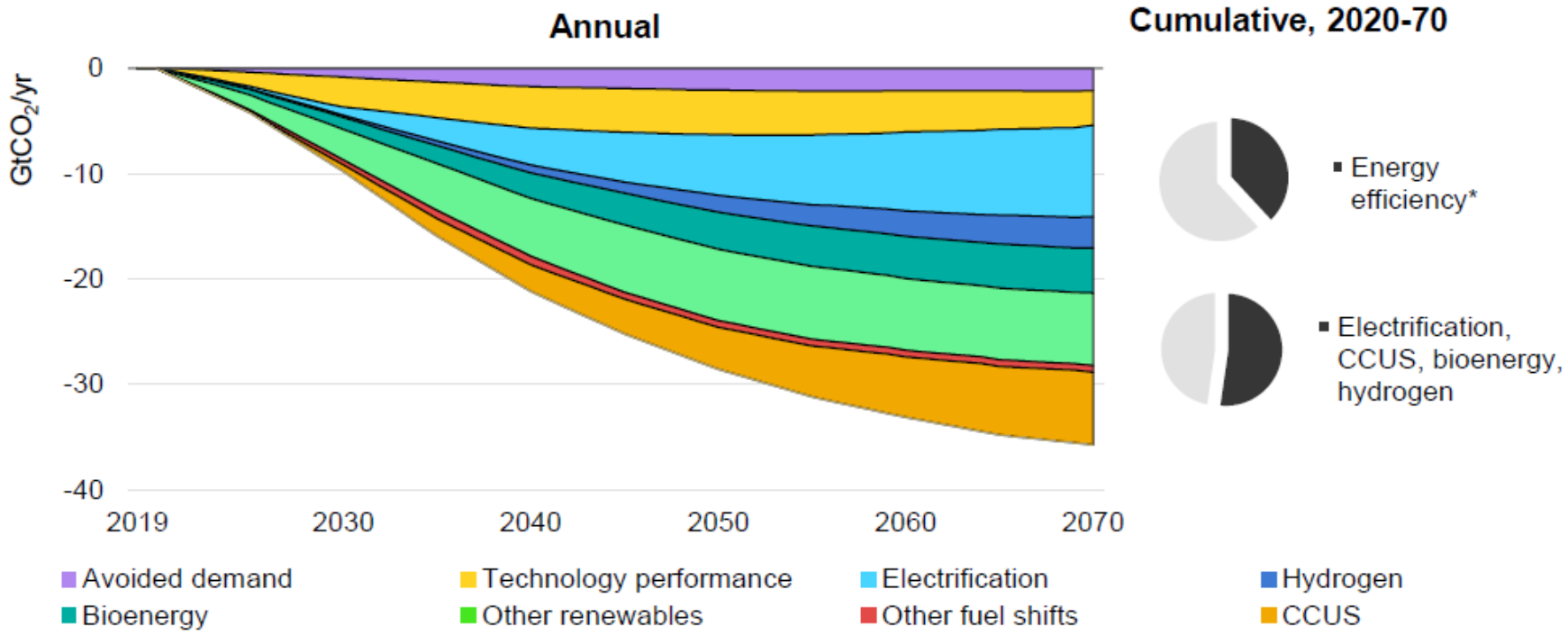
- At least 40% cuts in greenhouse gas emissions (from 1990 levels)
  - Announced to raise it to more than 55%
- At least 32% share for renewable energy
- At least 32.5% improvement in energy efficiency

Key target for 2050:

- **Become climate-neutral**

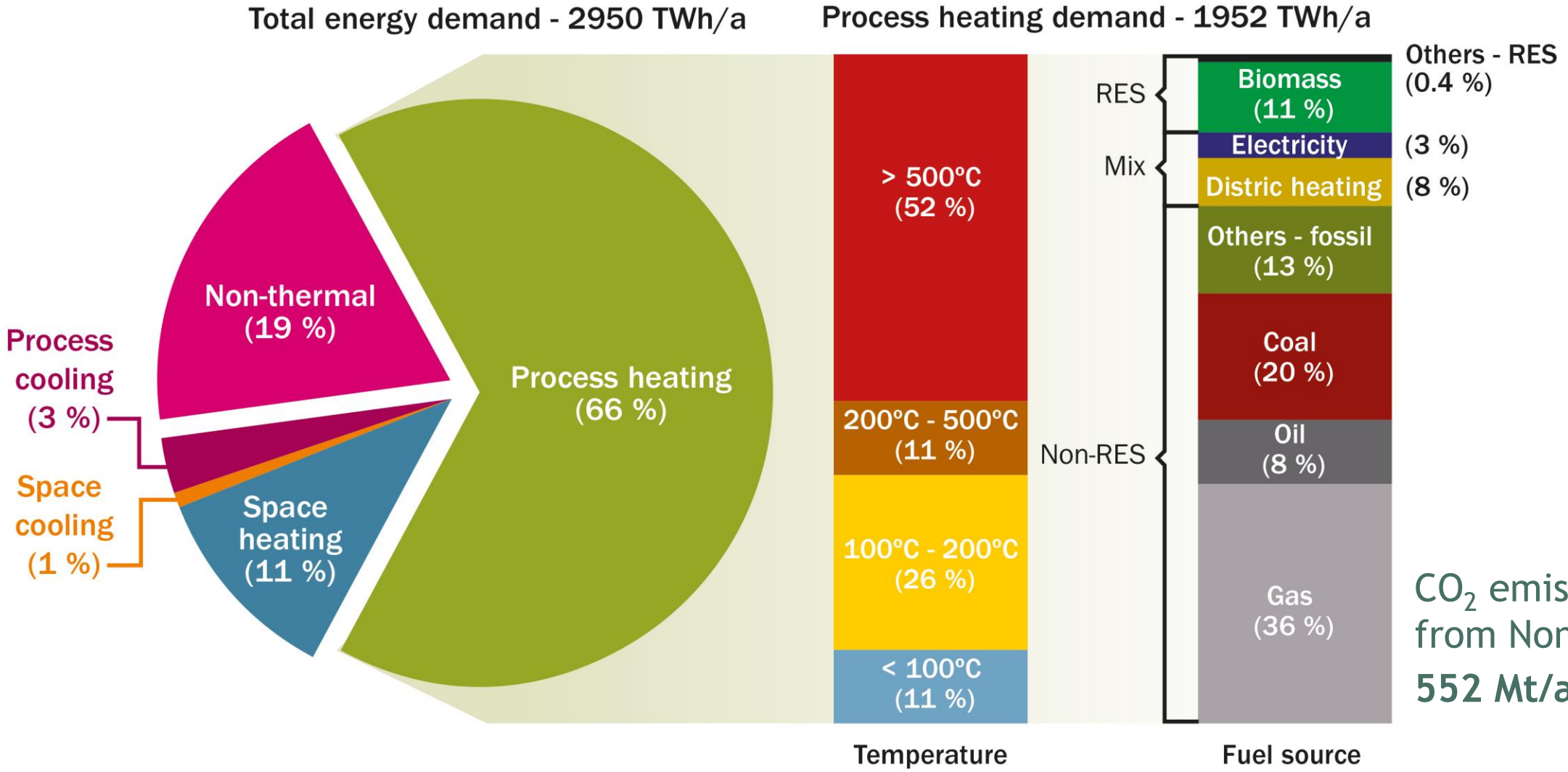
IEA Energy Technology Perspectives 2020

- Global energy sector CO_2 emissions reductions by measure in the Sustainable Development Scenario relative to the Stated Policies Scenario, 2019-70



* Energy efficiency includes enhanced technology performance as well as shifts in end-use sectors from more energy-intensive to less energy-intensive products (including through fuel shifts).

Industrial Energy Consumption



CO_2 emissions from Non-RES:

552 Mt/a

Efficient Processes with Heat Pumps

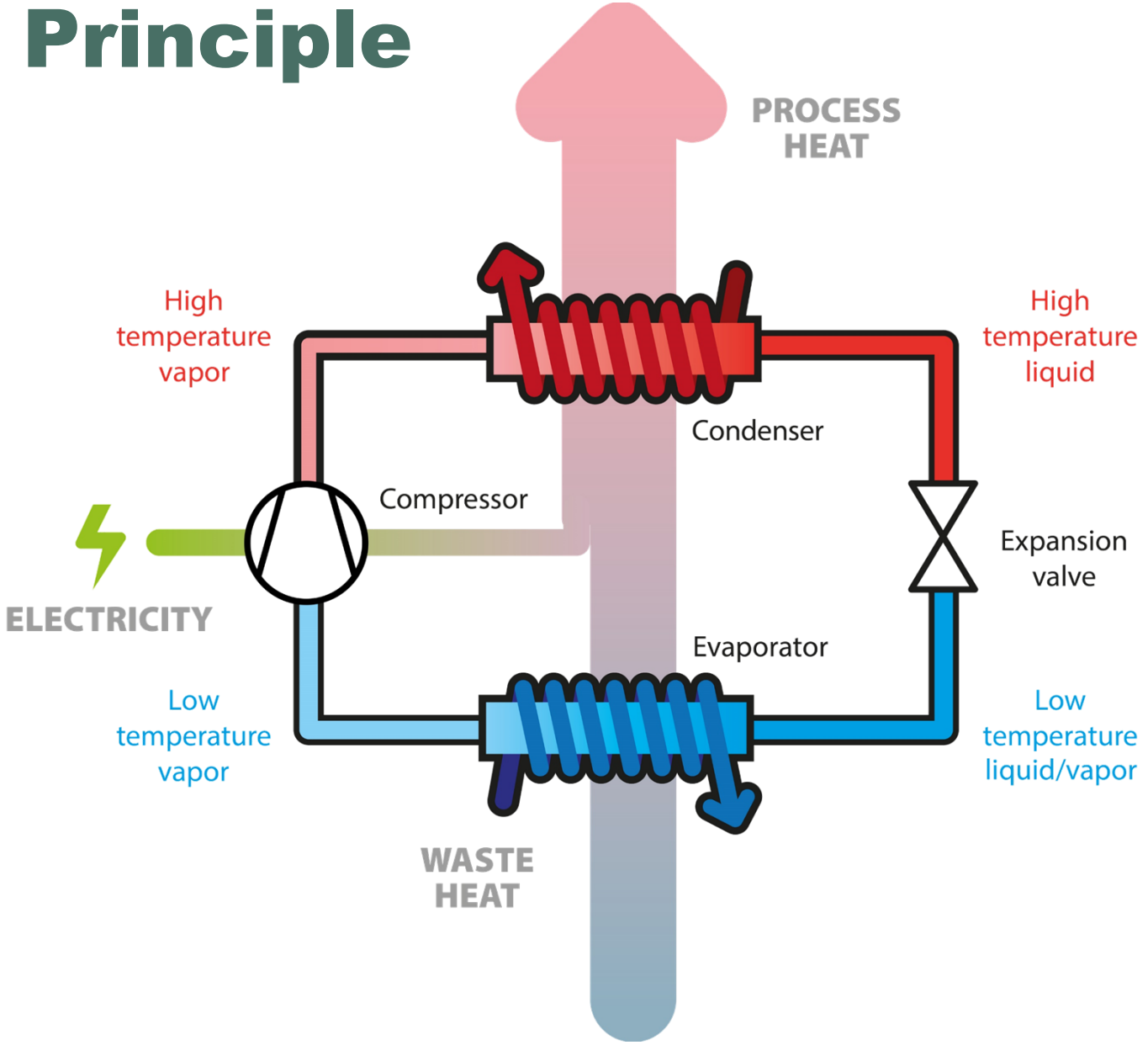
29 539 TWh
industrial energy
supply (2012)

14 474 TWh = 49% used

15 065 TWh = 51% losses
ca. 60% = waste water, gases
ca. 40% = radiation, friction, resistance, etc.

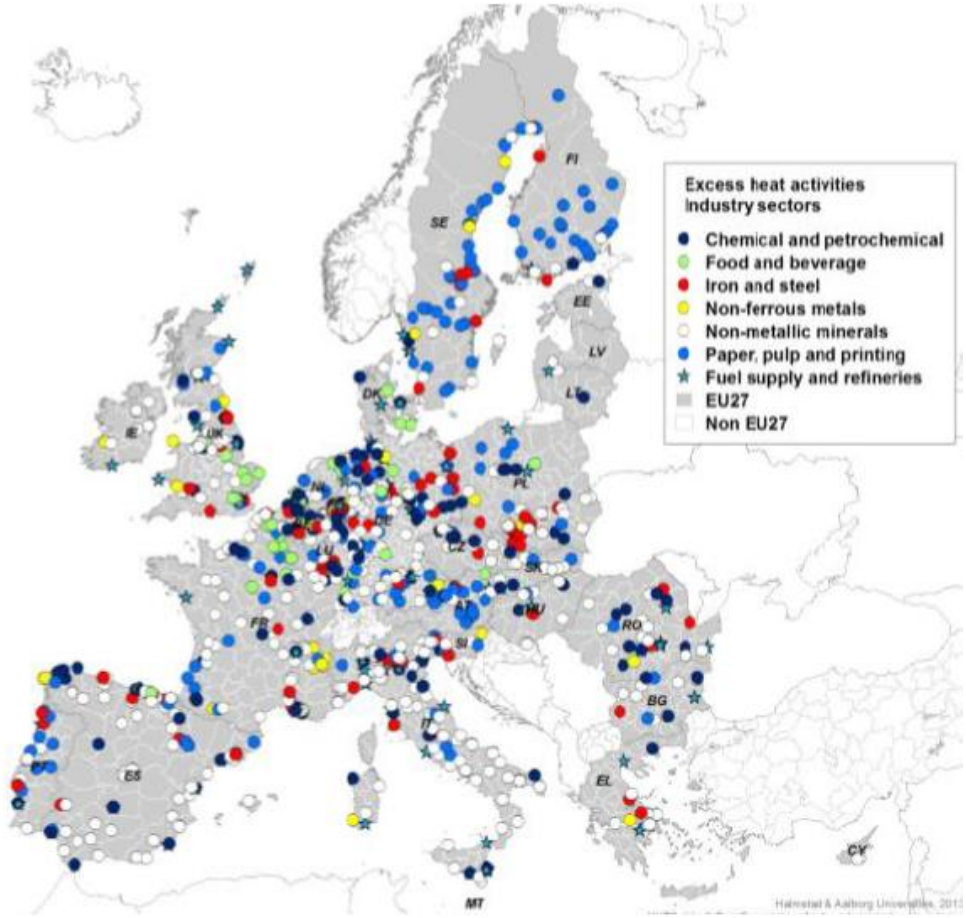
Ref: Forman et al. Estimating the global waste heat potential, Renewable and Sustainable Energy Reviews 57 (2016) 1568-1579

Working Principle



Waste Heat Recovery

- Efficiency increase plays an important role to reach the climate goals
- Heat pumps allow for efficiency increase and electrification of industrial processes, thereby integrating more renewable energy in industry
- Complex industrial processes require intelligent solutions for waste heat recovery



Energy intensive industries producing considerable excess heat
From: Connolly et al. (2013). Heat Roadmap Europe 2: Second Pre-Study for the EU27. Department of Development and Planning, Aalborg University.

RESULT
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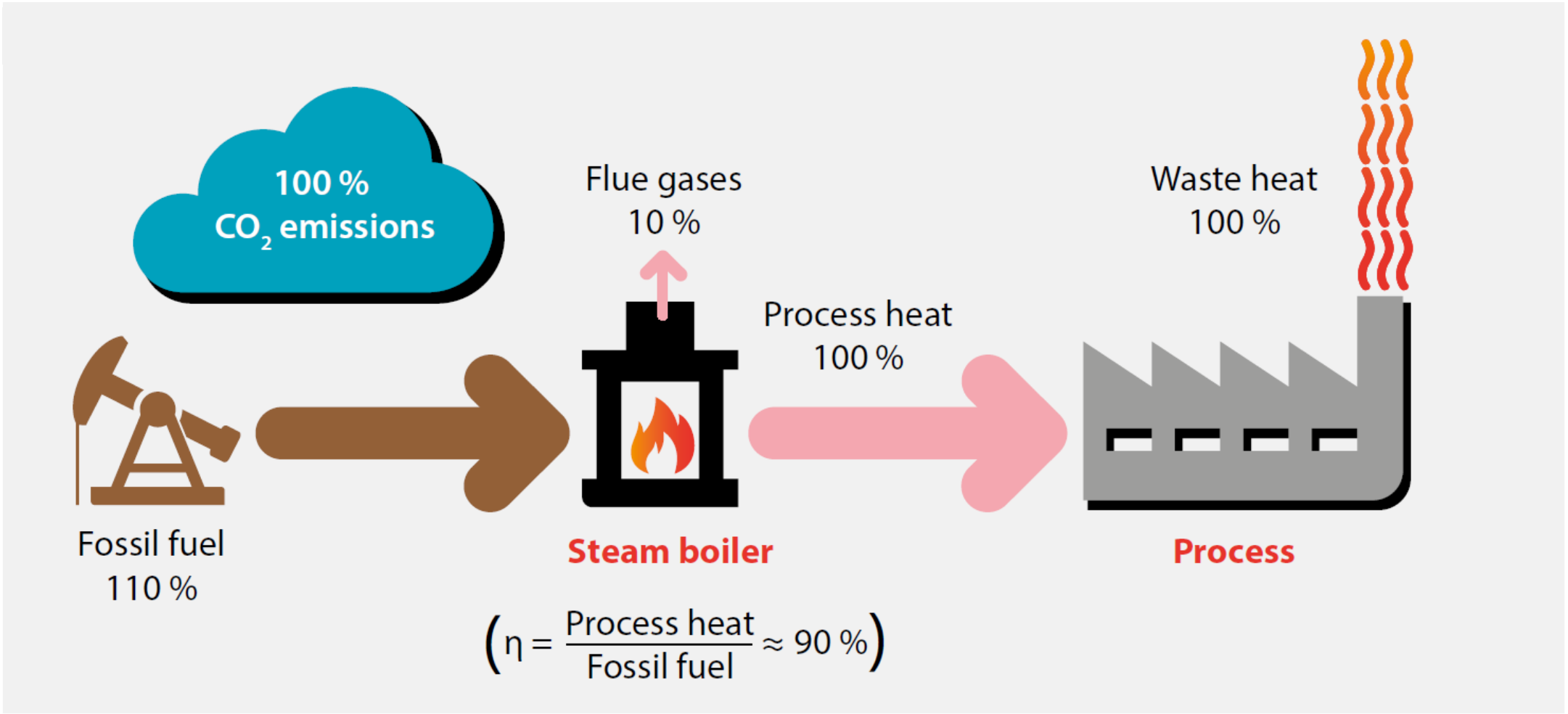
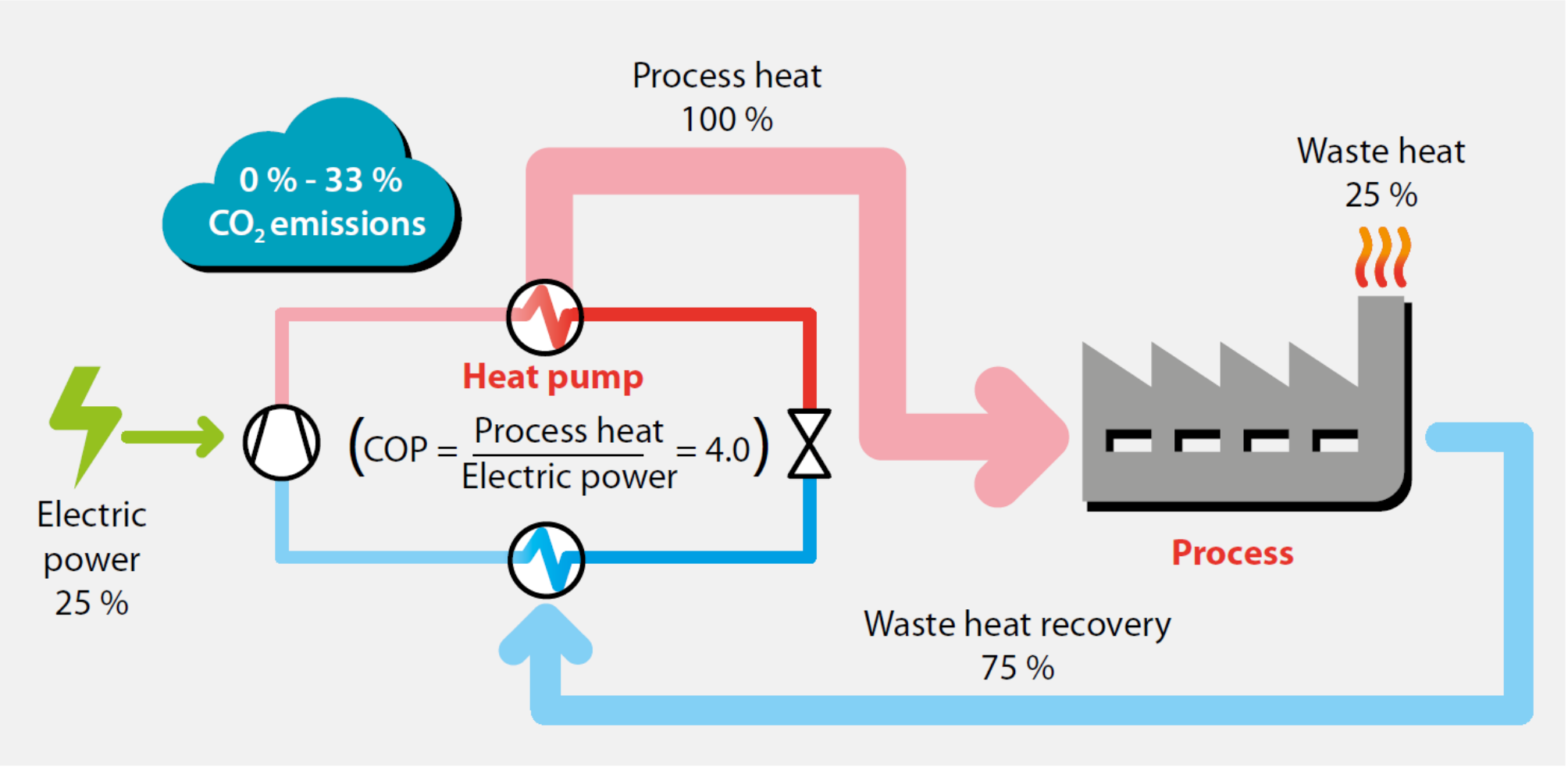
THE ROLE OF HEAT PUMPS IN A SUSTAINABLE INDUSTRY

Fossil Fuel Driven



Heat Pump Driven



Alternatives for Process Heat Supply

- CO_2 emissions
- Increasing carbon emission taxes

Natural gas

- Limited roundtrip efficiency
- Suitable for high temperatures

Hydrogen

- Carbon neutral (if certified)
- Limited availability
- Suitable for high temperatures

Biomass

Process

Heat Pump

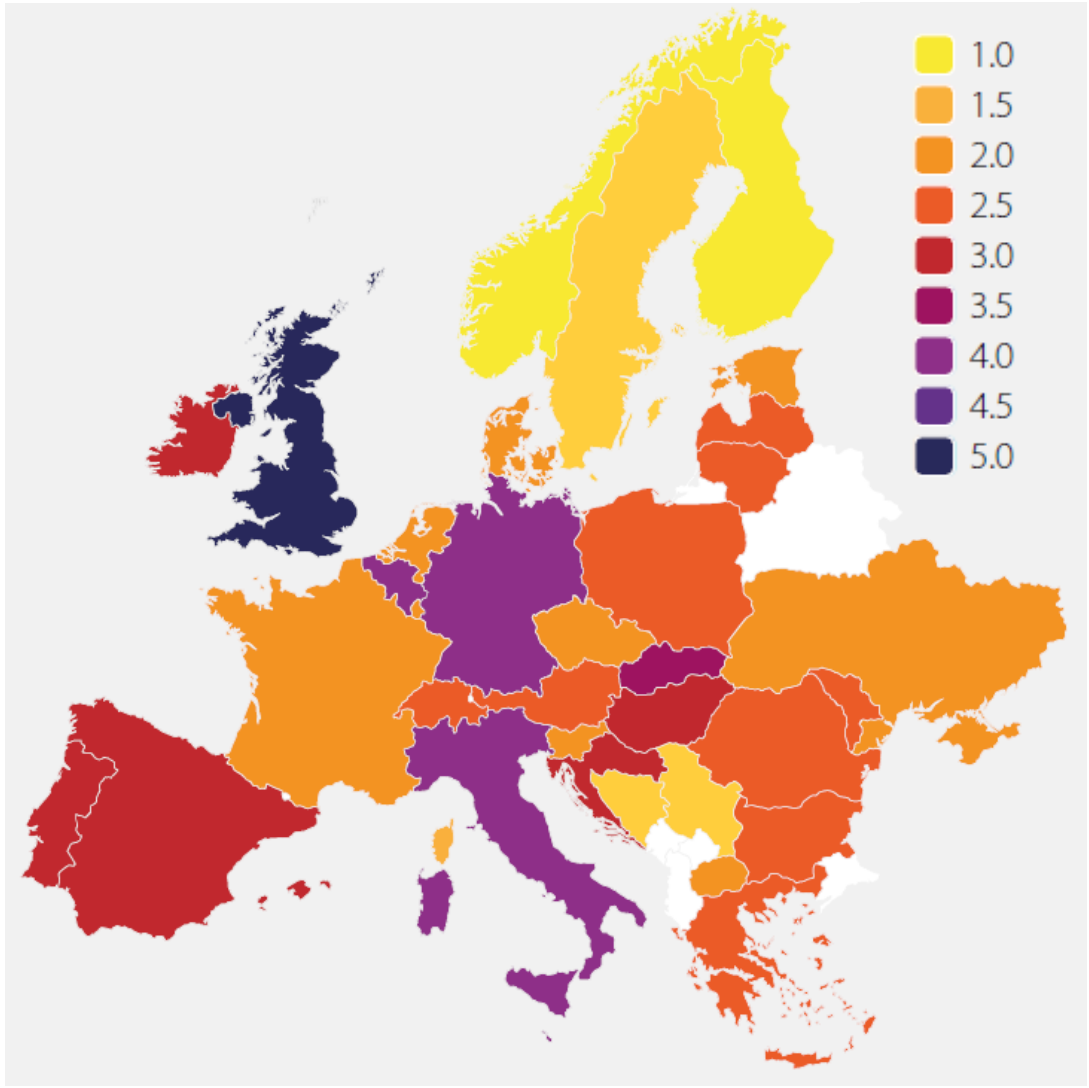
- Highest efficiencies
- Electricity-based and potentially emission free
- Proven principles

Electric boiler

- Limited efficiencies
- Electricity-based and potentially emission free
- Low investment

Business Case for HPs

- $\mathrm{COP} = \frac{\text{Supplied Heat}}{\text{Consumed Power}}$
- Business case dominated by cost for electricity and alternative fuels
- Fuel cost is subject to taxes, subsidies, …



Ratio of electricity to gas price for small scale industrial end-users (2 GWh/a to 20 GWh/a electricity)

Competitive Economic Performance

Alumina production

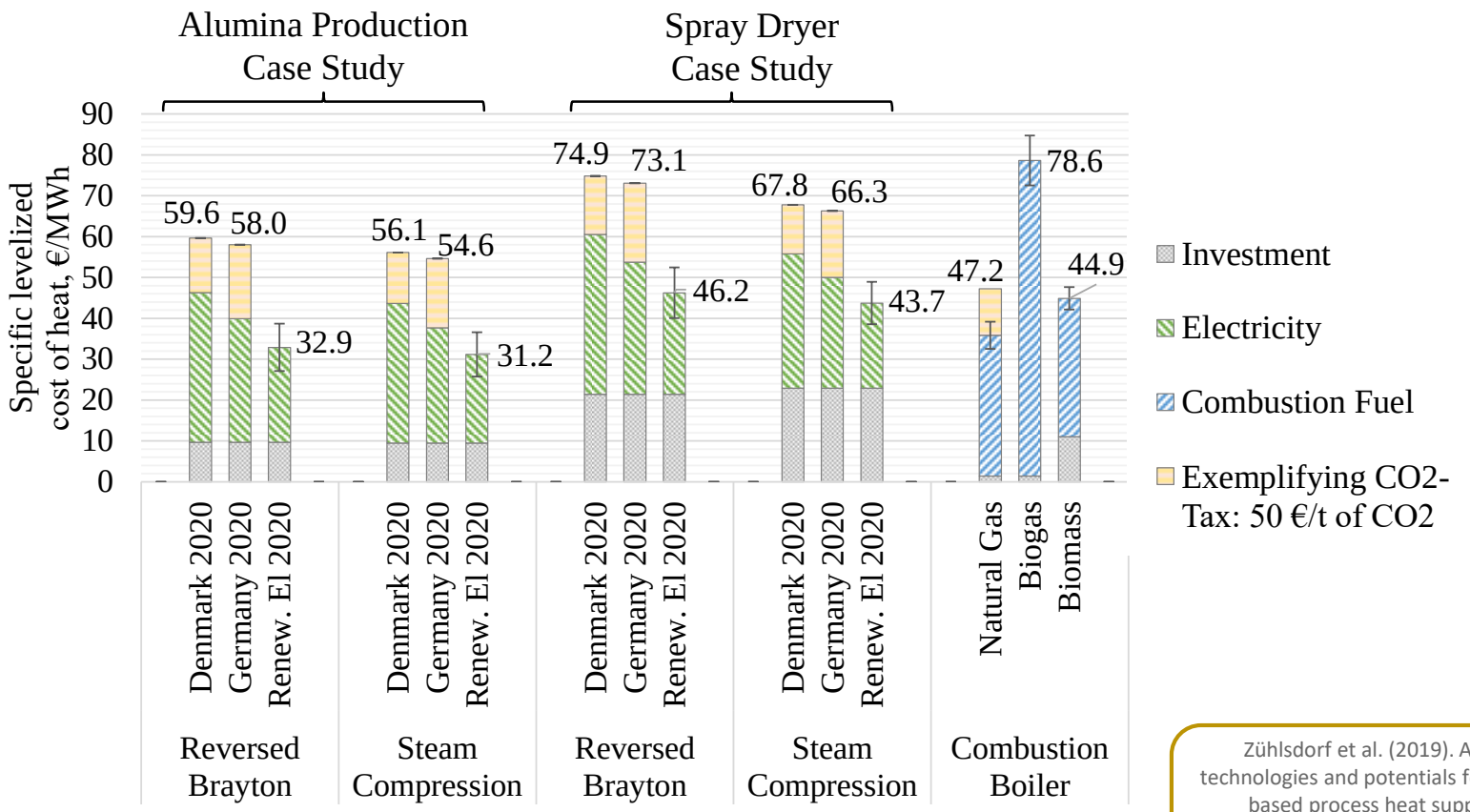
- $\dot{Q}_{\text{Demand}} = 50$ MW
- $n = 8000$ h/year

140 °C → 280 °C
60 °C ← 110 °C

Spray dryer for milk powder production

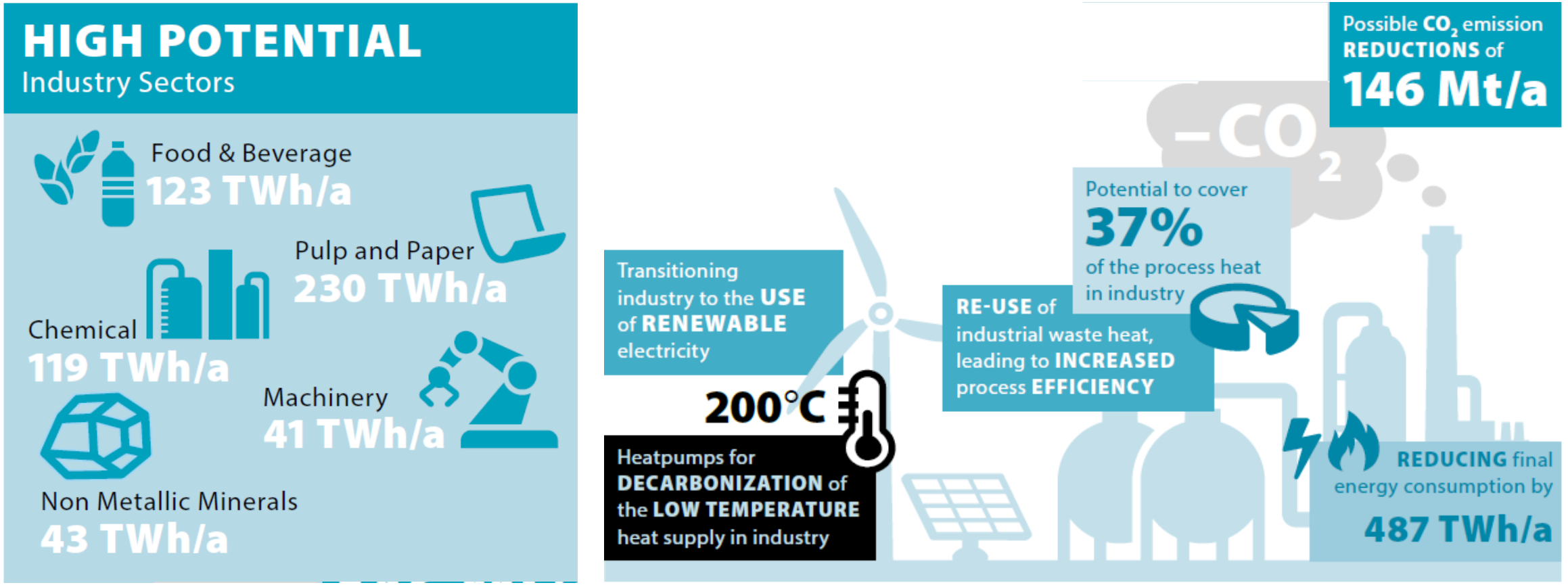
- $\dot{Q}_{\text{Demand}} = 8.2$ MW
- $n = 7000$ h/year

64 °C → 210 °C
20-25 °C ← 50 °C



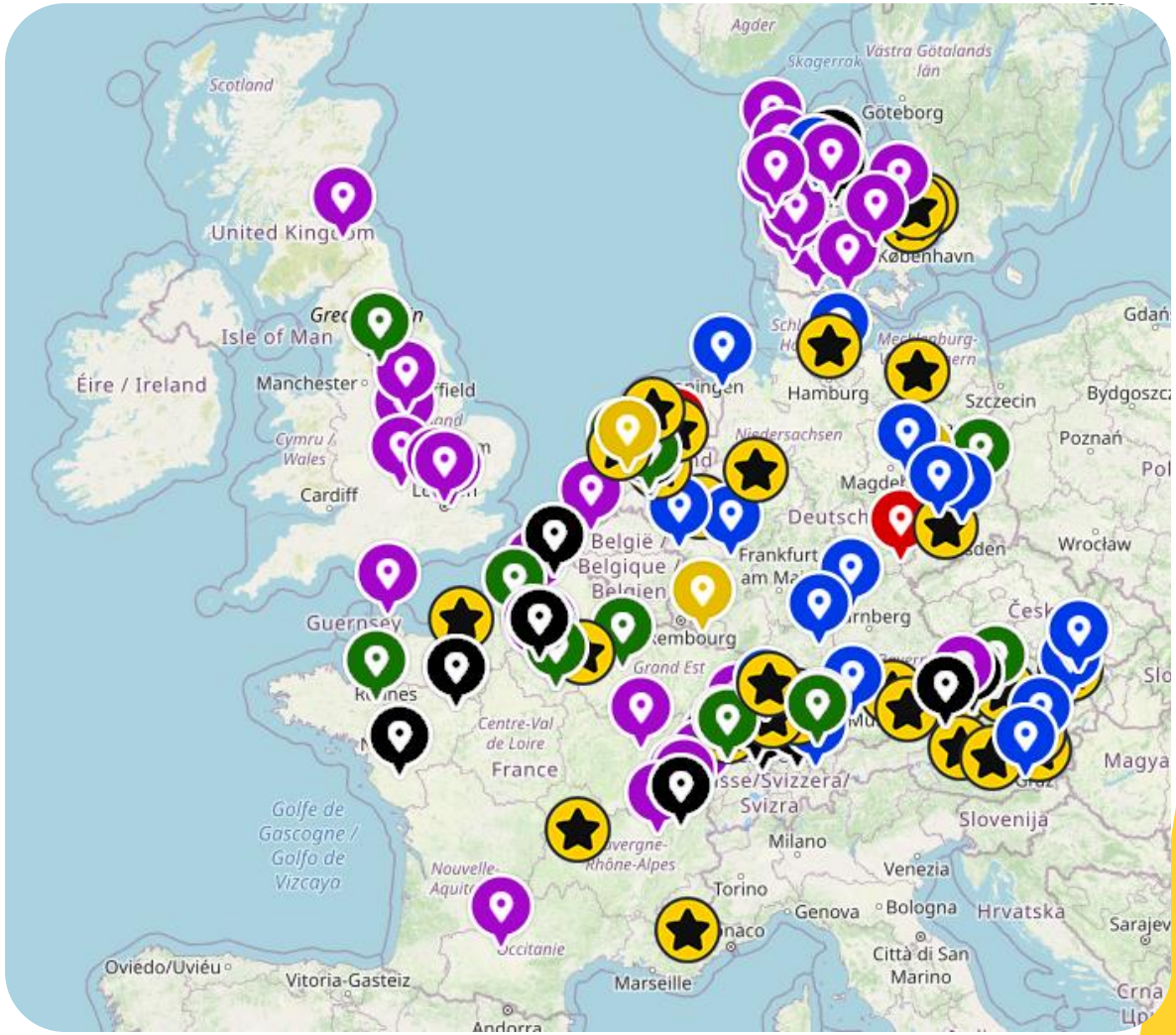
Zühlsdorf et al. (2019). Analysis of technologies and potentials for heat pump-based process heat supply above 150 °C. EC&M, https://doi.org/10.1016/j.ecmx.2019.100011

High Potential Industrial Heat Pumps



Proven Principles

- > 300 cases in IEA HPT Annex 48
- Proven technology < 100 °C
- Proven principles > 100 °C



https://waermepumpe-izw.de/

Examples

Marienhütte, Austria

Heating Capacity:	6 MW to 11 MW
COP:	3.3 – 4.5
CO_2 savings:	11,700 tons/year

Arla, Denmark

Heating Capacity:	1.3 MW
COP:	4.5
CO_2 savings:	1,400 tons/year

What do you see as the most important benefit of using Heat Pumps in Industry?

- Energy savings
- Cost savings
- CO_2 emission reduction
- I don’t see a benefit

HEAT PUMPS AS THE REFERENCE TECHNOLOGY IN INDUSTRY

Industrial Heat Pump Applications

Benefits

- Reduce primary energy consumption and CO_2 emission
- Offer lower cost (opex) process heating
- Circular use of thermal energy, reduction of waste heat emissions
- Applicable in multiple industrial sectors for sustainable heat supply
- Drive technical innovations – job creation

Industrial Heat Pump Applications

Barriers

- Limited combined knowledge of heat pump technology and industrial processes
- Lack of awareness of heat requirements at end-users
- High payback times, high CAPEX, high Electricity prices
- Limited available technologies for T-levels >100°C
- Limited number of manufacturers
- Uncertainties on energy prices and market development
- Limited number of cases to demonstrate and proof reliability

Ambitions and Objectives 2020 - 2025

Heat pump as reference technology

25 full scale demonstrations

5 pilot scale systems to validate technical feasibility

3 lab scale heat pump technologies: proof of concept

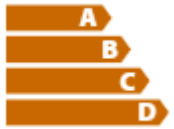
3 new working fluids for 150-250°C heat supply

Establishment of multiple knowledge, component and system suppliers for industrial heat pumps

heat pumps as integral part of standard process equipment to be commercially available

5 projects in the framework of Horizon Europe, which have resolved the key market barriers

Industrial heat pumps recognized as key technology to decarbonize industrial heat demand below 200°C



Testing standards for determining the performance of industrial heat pump units

“To keep its competitive advantage in clean technologies, the EU needs to increase significantly the large-scale deployment and demonstration of new technologies across sectors and across the sngle market, building new innovative value chains.”

European Commission
The European Green Deal

The way forward

- Creating a fair regulatory framework that facilitates the acceptance of industrial heat pumps
- Establishing an information and knowledge base to support the integration of industrial heat pumps at all levels of the value chain
- Development of an EU-wide program which enables cutting edge research, development and demonstration projects with industrial heat pumps

“Today, the costs of some of the advanced low-carbon energy carriers and technologies remain high, and their availability is limited. A massive research, coordinated and innovation effort, built around a coherent strategic research and innovation and investment agenda is needed in the EU within the next two decades to make low and zero-carbon solutions economically viable and bring about new solutions not yet mature or even known to the market.”

European Commission
A clean planet for all

RESULTS
What do you see as the most important benefit of using Heat Pumps in Industry?

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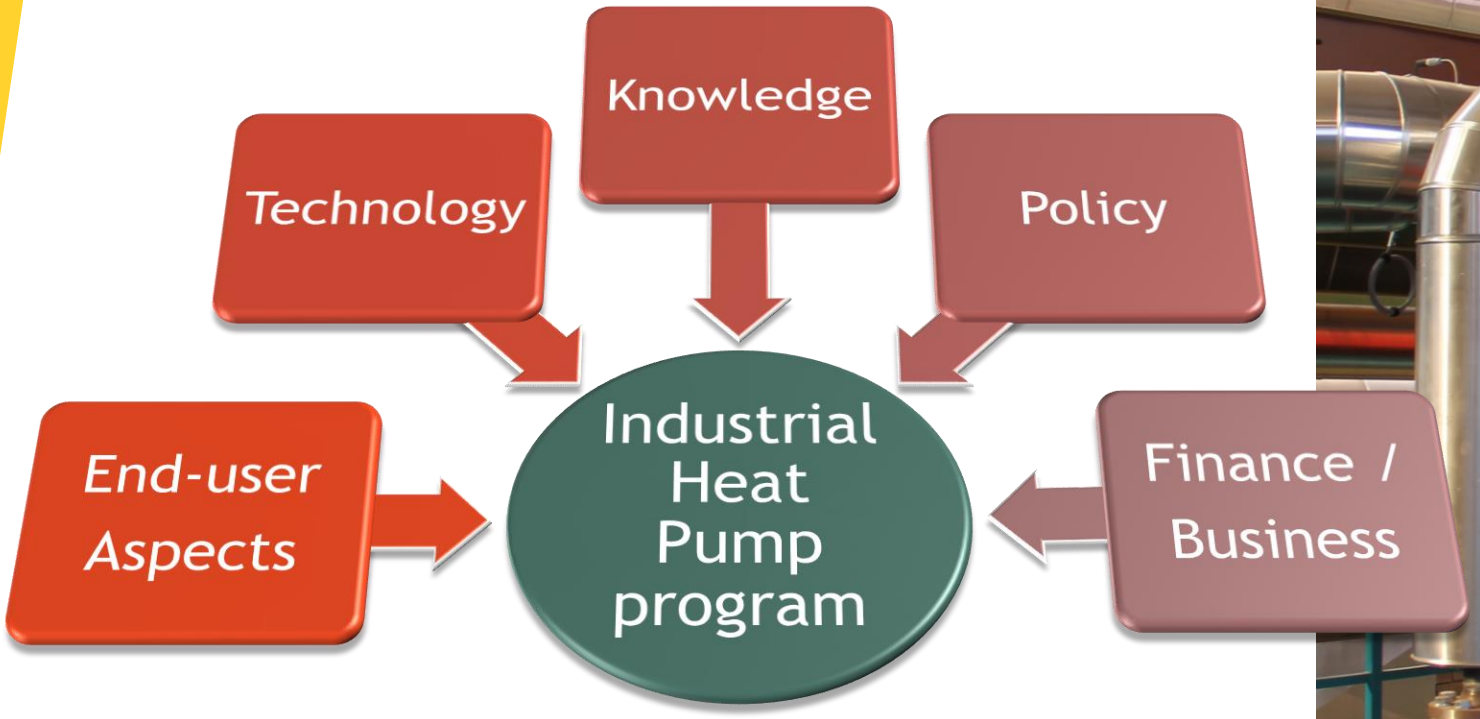
EU RD&D program

Industrial heat pump



WE NEED YOU!

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THANK YOU FOR JOINING

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