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Welcome

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Electrification potential of milk powder production

Sustainable Dairy

02.06.2021, Billund

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Agenda

- Why electrification?
- Process integration
- Development of high-temperature heat pumps
- Conclusions

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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

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Potential for electrification and HPs

Denmark aims for reducing greenhouse gas emissions by 70 % by 2030 compared to 1990.

Klimarådet. *suggests that industry contributes by reductions equivalent to 1.9 mio. tons of CO_2 emissions per year. 0.5 mio. tons per year are to be obtained by "Electrification and heat pumps", mainly implemented between 2025 to 2030.*

Source: "*Kendte veje og nye spor til 70 procents reduktion – Retning og tiltag for de næste ti års klimaindsats i Danmark*", Klimarådet, 03/2020

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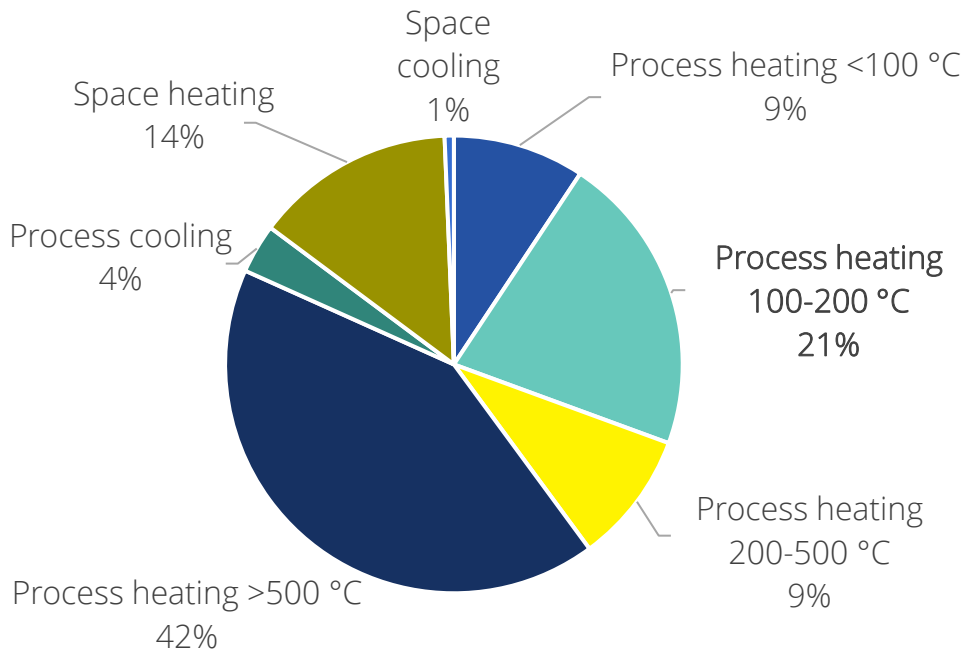
General potential for HTHPs

Energy demand for heating and cooling in industry in EU28 in 2015



https://heatroadmap.eu/heating-and-cooling-energy-demand-profiles/

- Large heat demand between 100 °C - 200 °C
- Relevant processes:
  - Heating/Cooking
  - Drying
  - Evaporation
- Alternative heat supply technologies
  - Natural gas (incl. CO_2 compensation)
  - Electrical heater
  - Biomass
  - Green hydrogen

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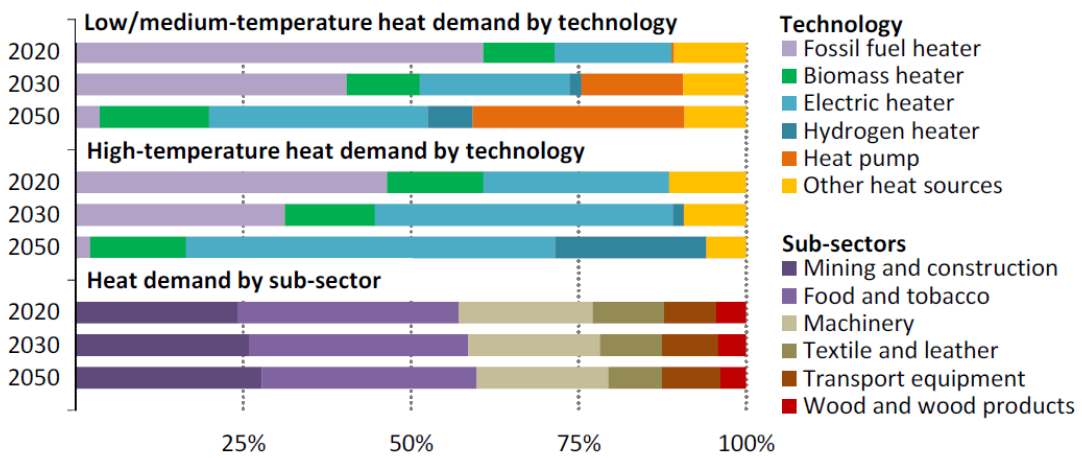
Net Zero by 2050 – A Roadmap for the Global Energy Sector

Light Industries:

- Electricity accounts for around 40% of heat demand by 2030 and about 65% by 2050.
- For low- (<100 °C) and some medium- (100-400 °C) temperature heat, electrification includes an important role for heat pumps (about 30% of total heat demand in 2050).
- In the NZE, around 500 MW of heat pumps need to be installed every month over the next 30 years.

Figure 3.20 ▷ Share of heating technology by temperature level in light industries in the NZE



The share of electricty in satisfying heat demand for light industries rises from less than 20% today to around 40% in 2030 and about 65% in 2050

Notes: Light industries excludes non-specified industrial energy consumption. Low/medium-temperature heat corresponds to 0-400 °C and high-temperature heat to >400 °C. Other heat sources includes solar thermal and geothermal heaters, as well as imported heat from the power and fuel transformation sector.

Source: "*Net Zero by 2050 – A Roadmap for the Global Energy Sector*, International Energy Agency, 05/2021, https://www.iea.org/reports/net-zero-by-2050

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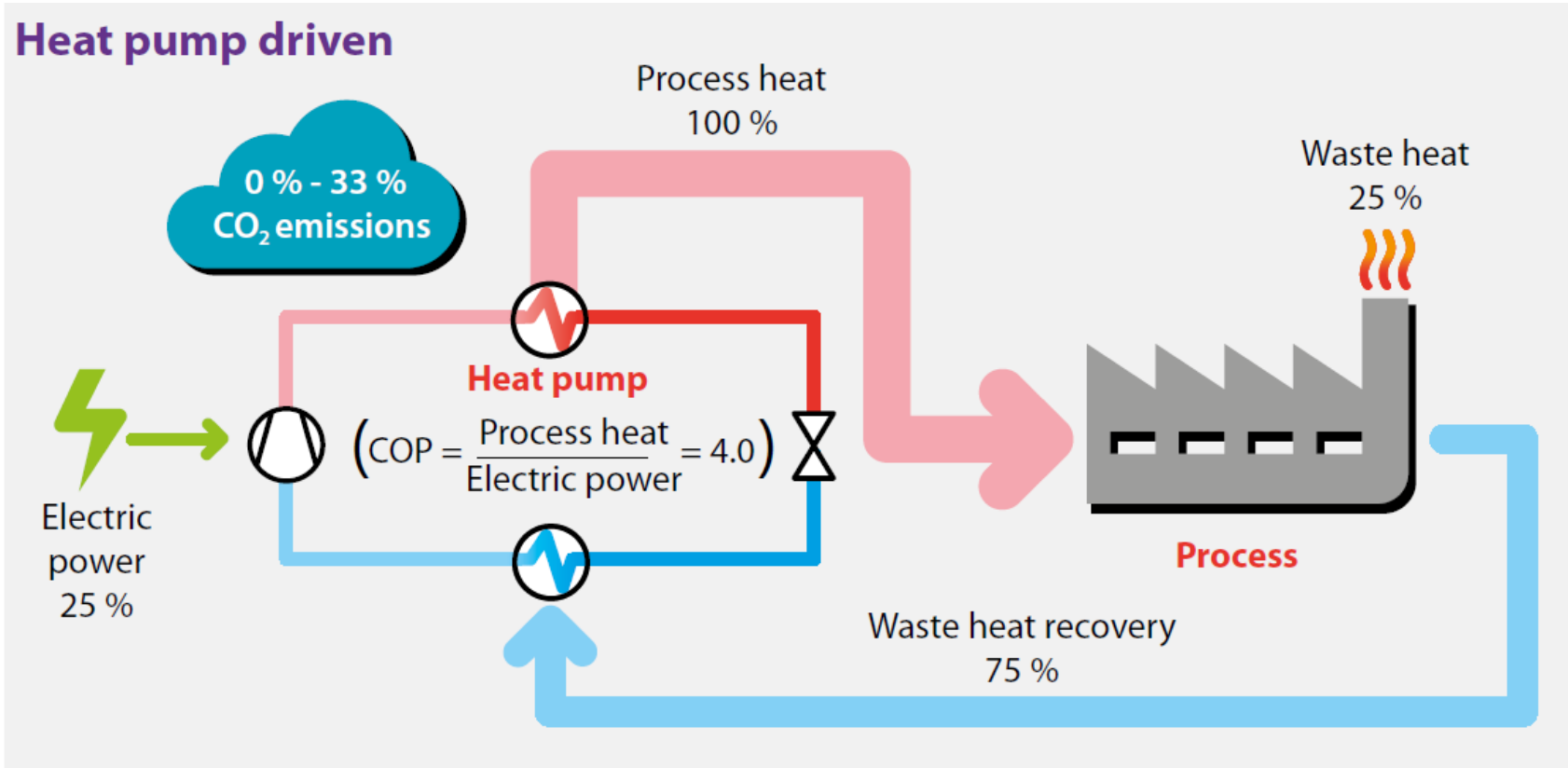
Heat pump benefits



White Paper:
Strengthening Industrial Heat Pump Innovation – Decarbonizing Industrial Heat
&
Webinar

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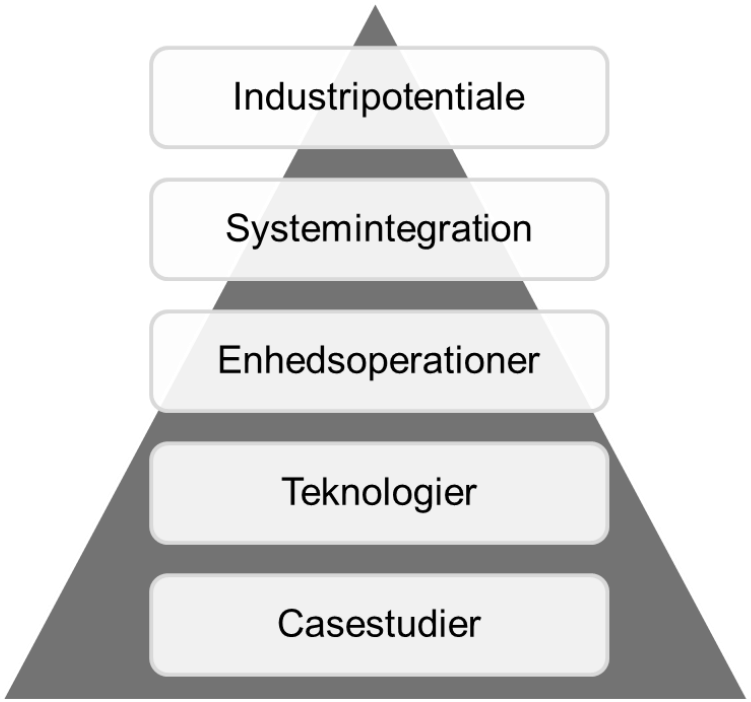
ELIDI-Project – Electrification of processes and technologies in the Danish industry



DTU Mechanical Engineering
Department of Mechanical Engineering

viegand maagøe
energy people

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DFD

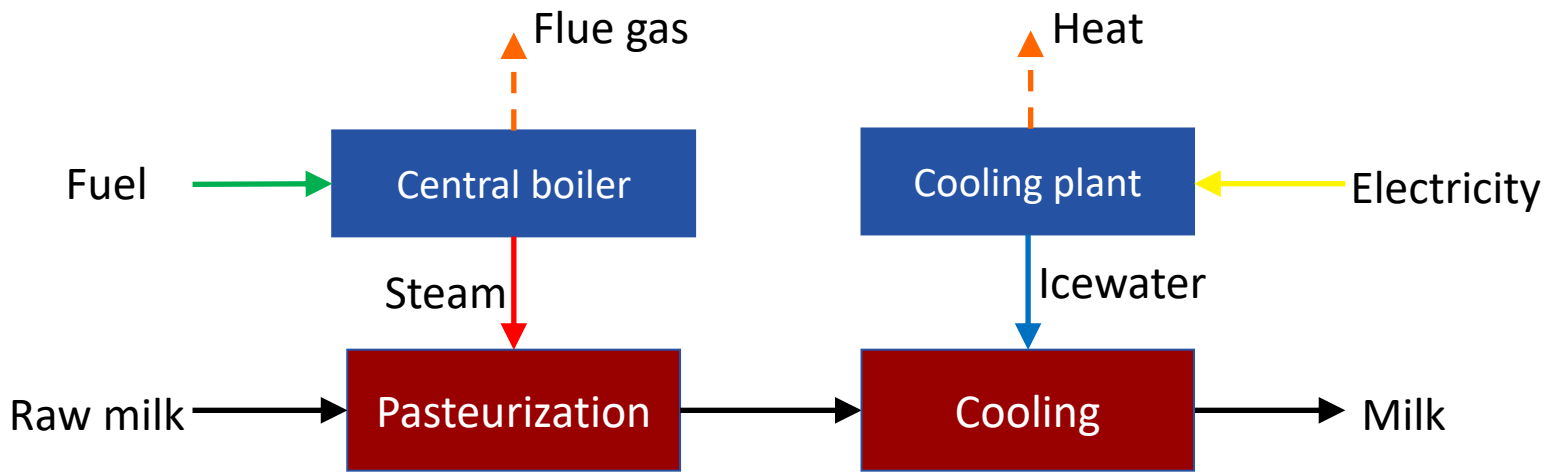
SAN Electro Heat

ELFORSK

Labotek

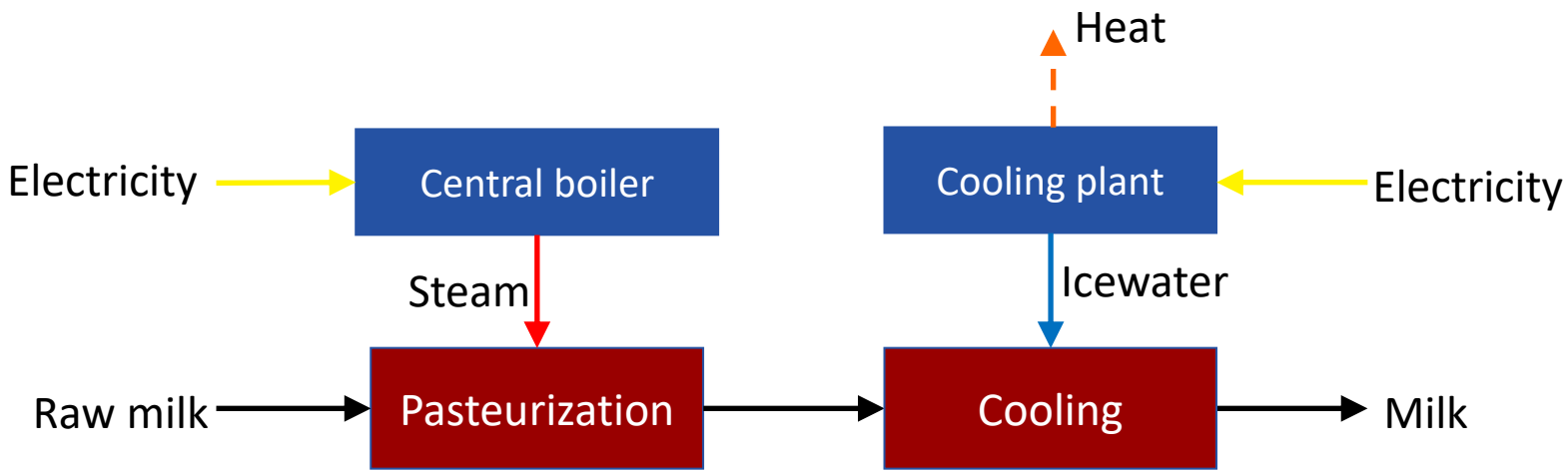
Possibilities for electrification

- Power-2-X (H_2, CH_4, Alcohols, …)



Possibilities for electrification

- Power-2-X (H_2, CH_4, Alcohols, …)
- Central Power-2-heat: Process integration, electric boiler, heat pumps



Possibilities for electrification

- Power-2-X (H_2, CH_4, Alcohols, …)
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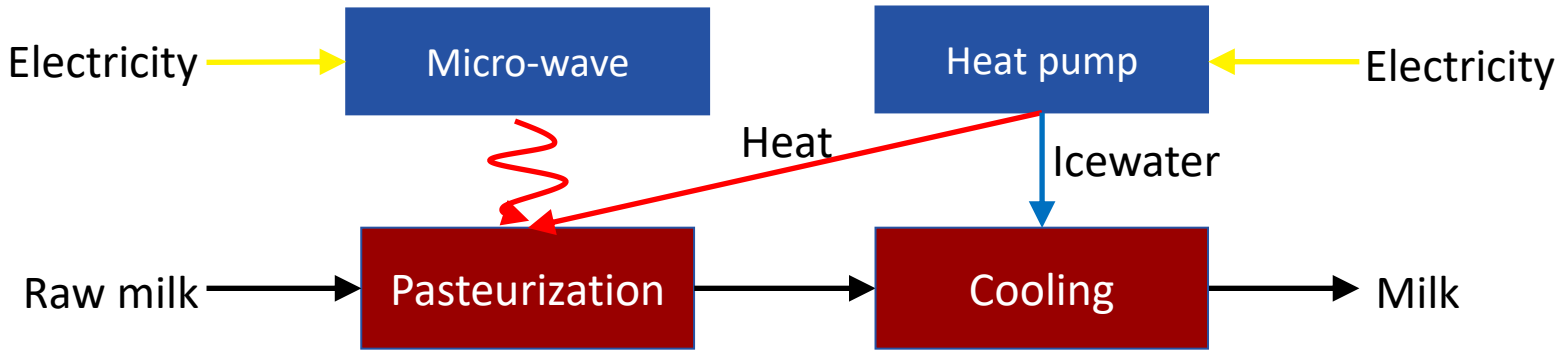
- Decentral Power-2-heat: Heat pump, electro-magnetic, …



Possibilities for electrification

- Power-2-X (H_2, CH_4, Alcohols, …)
- Central Power-2-heat: Process integration, electric boiler, heat pumps
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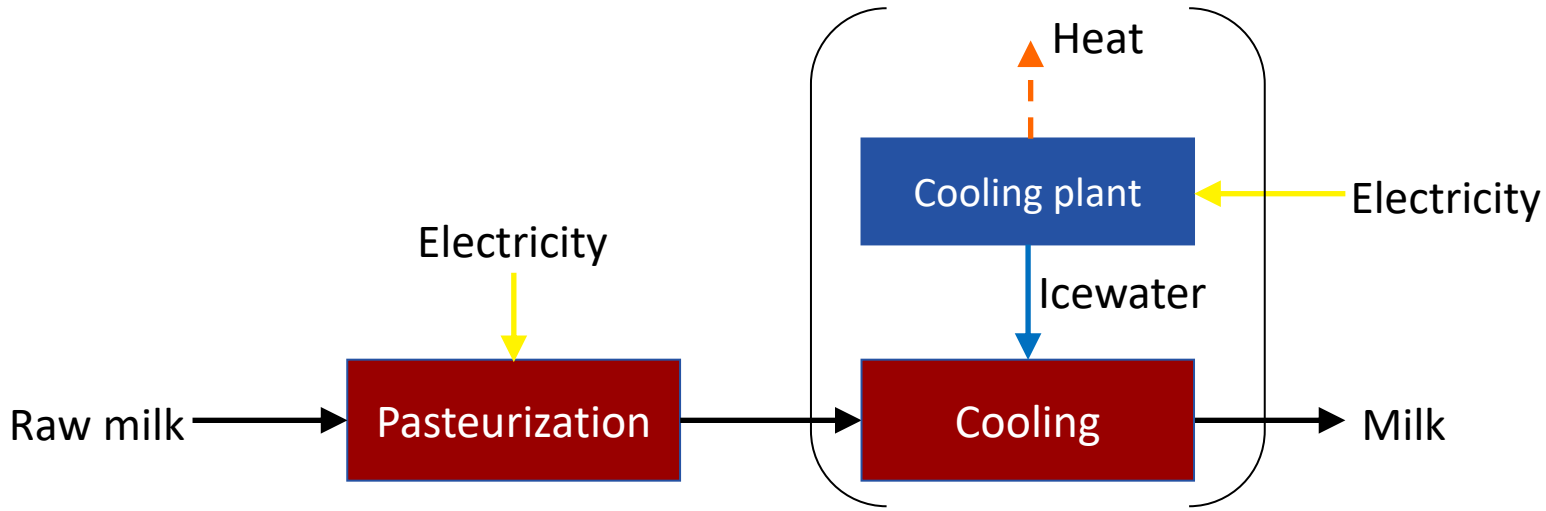
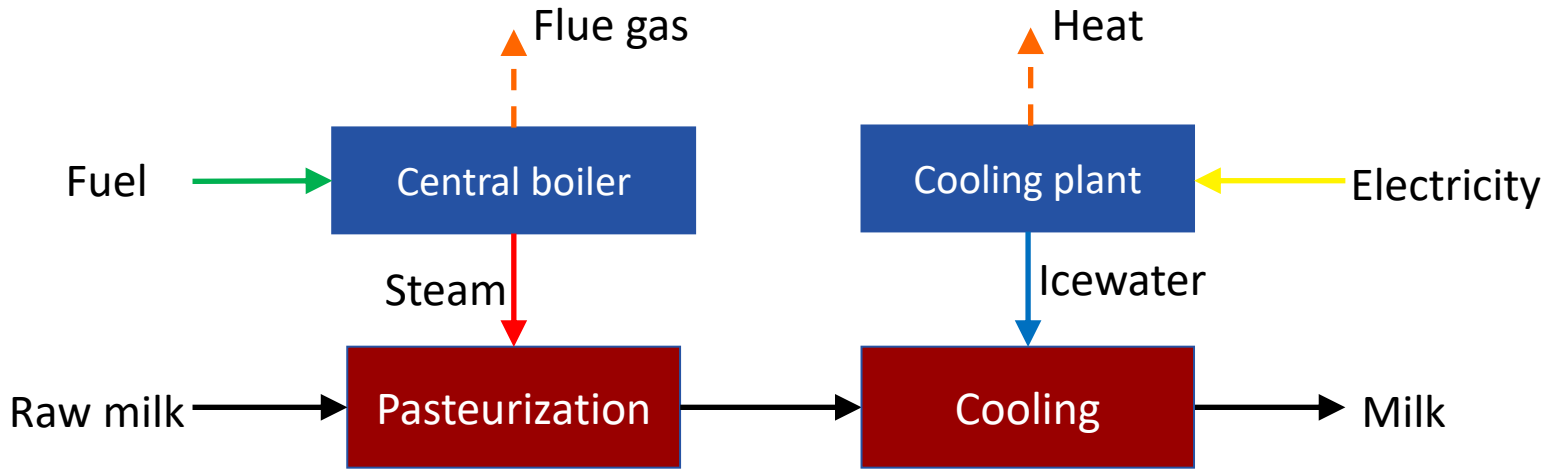
- Unit operations: Presure, freeze drying, microwaves



Benefits of electrification

- Reduced energy demand
  - No losses and emissions from boiler
  - Higher energy efficiency (HP & MVR) and reduced cooling loads
- Higher product quality and production capacities
- Flexibility for power grid



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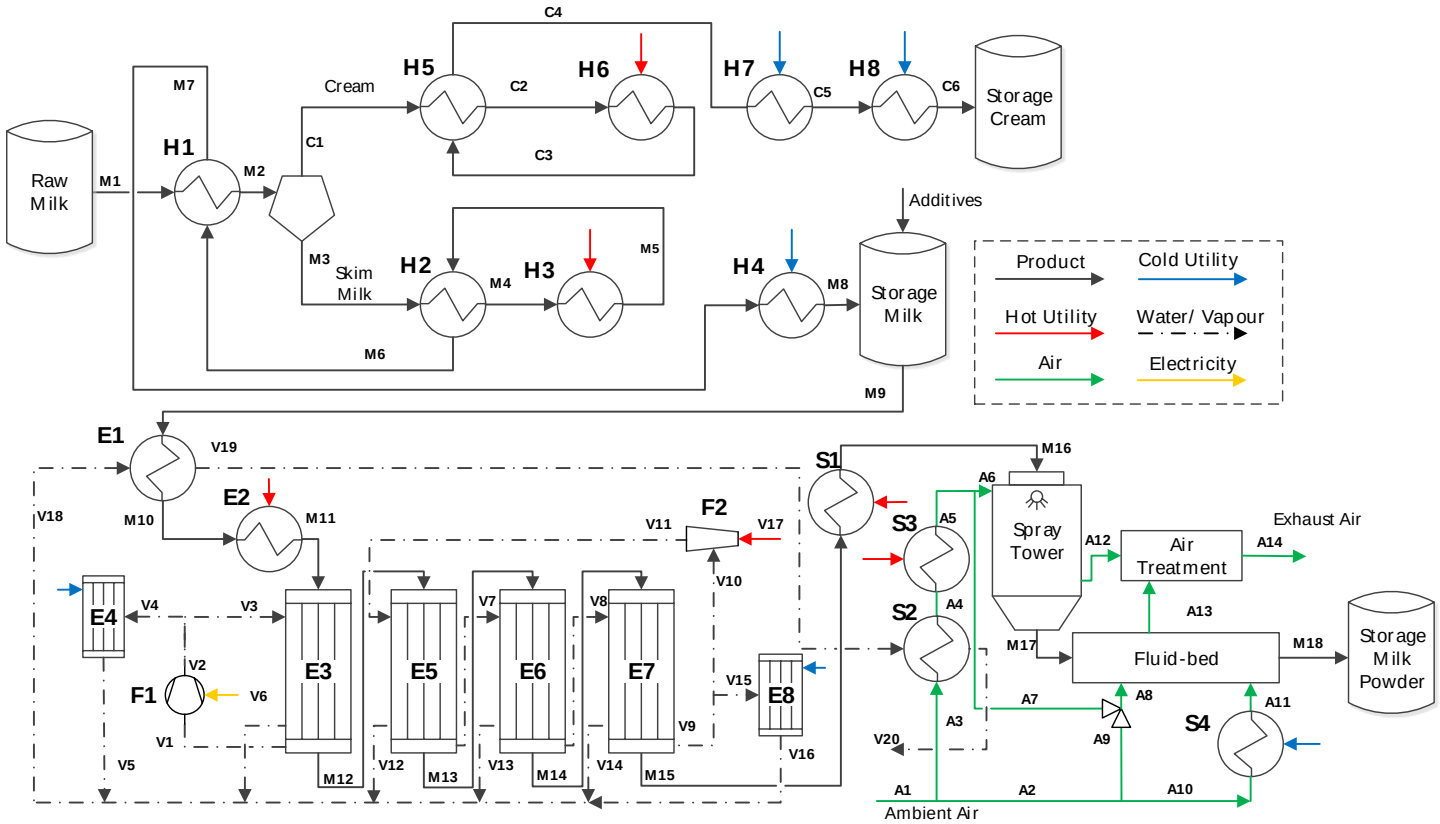
Example for electrification: Dairy



Bühler et al, A comparative assessment of electrification strategies for industrial sites: Case of milk powder production, 2019

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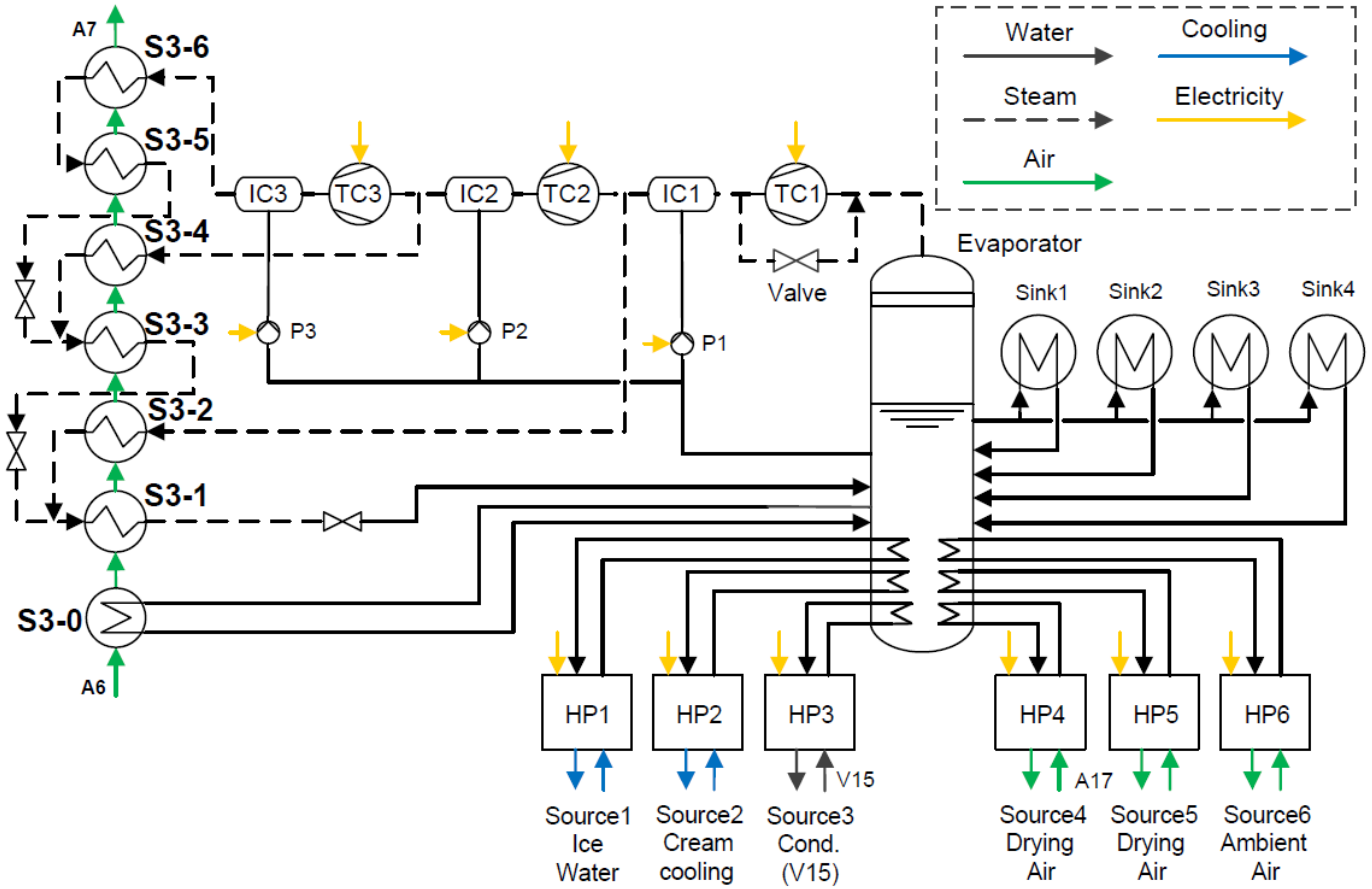
Example for electrification: Dairy



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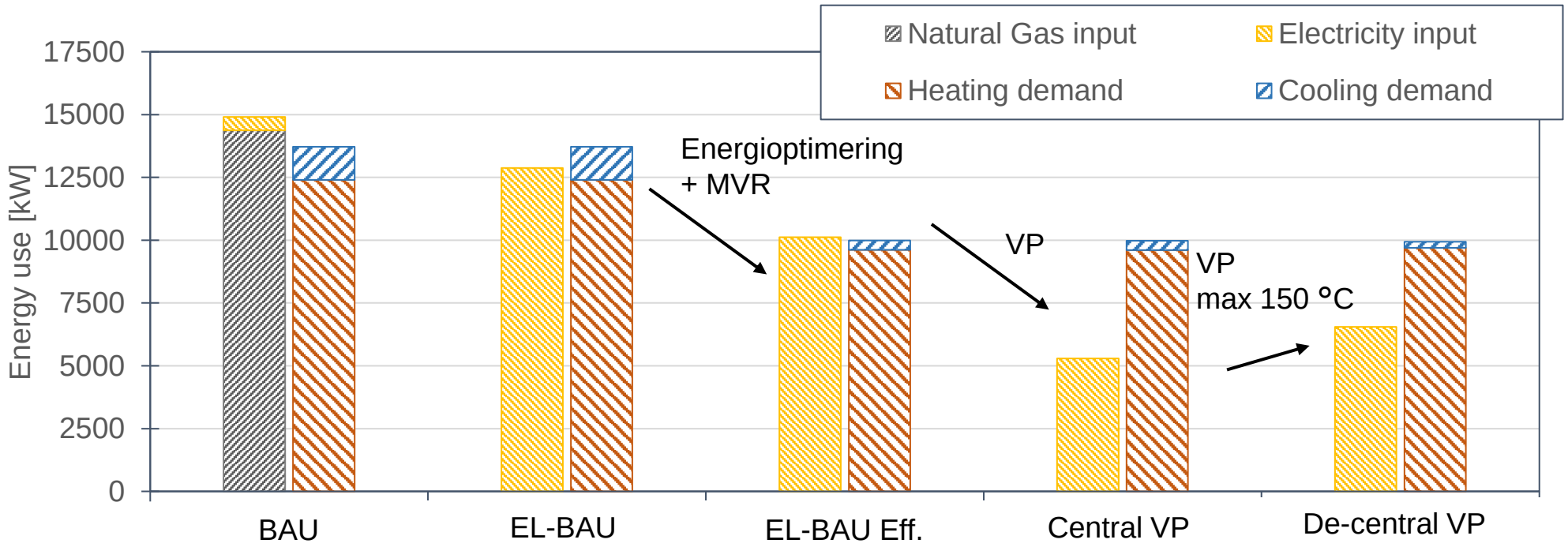
Example for electrification: Dairy



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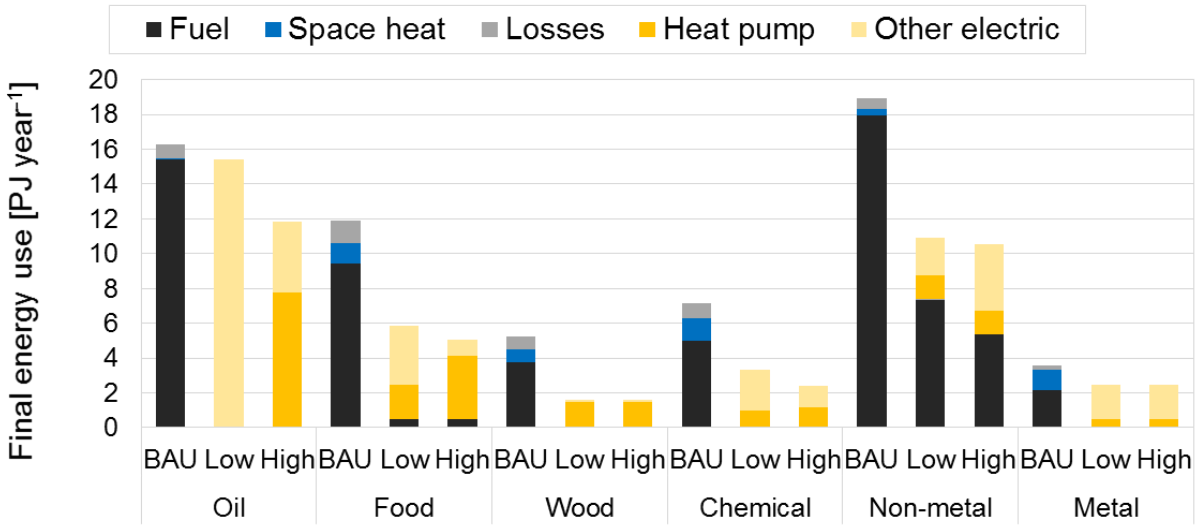
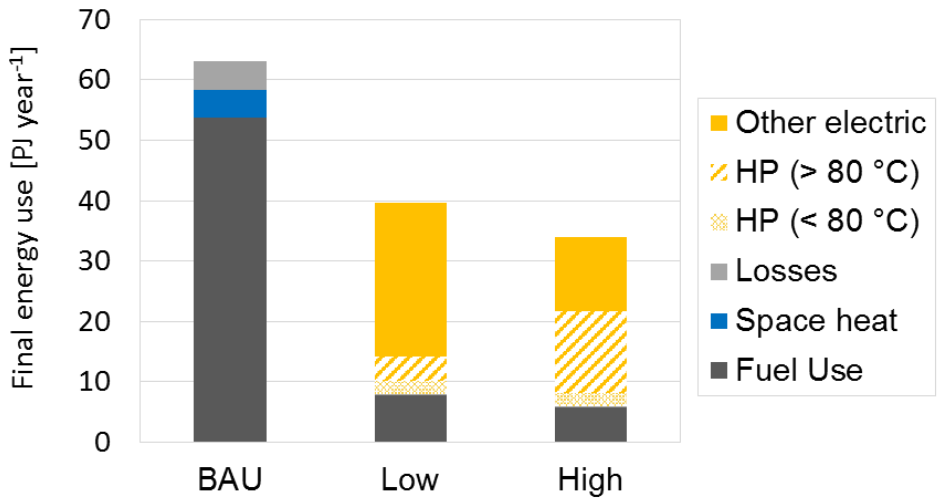
Electrification potential in Danish industry





Source: Bühler, F., Müller Holm, F., & Elmegaard, B. (2019). Potentials for the electrification of industrial processes ECOS 2019

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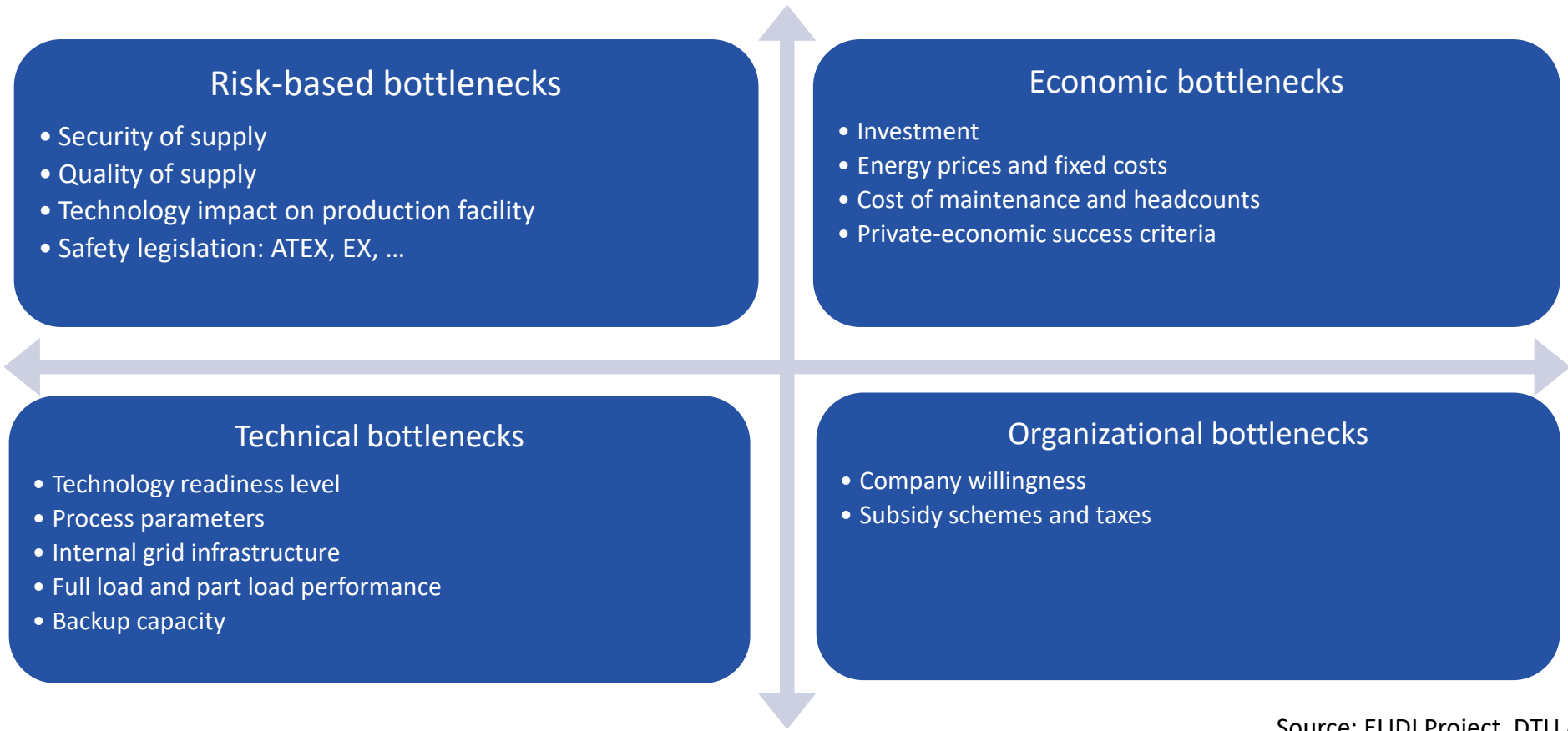
Bottlenecks



Source: ELIDI Project, DTU & Viegand Maagøe

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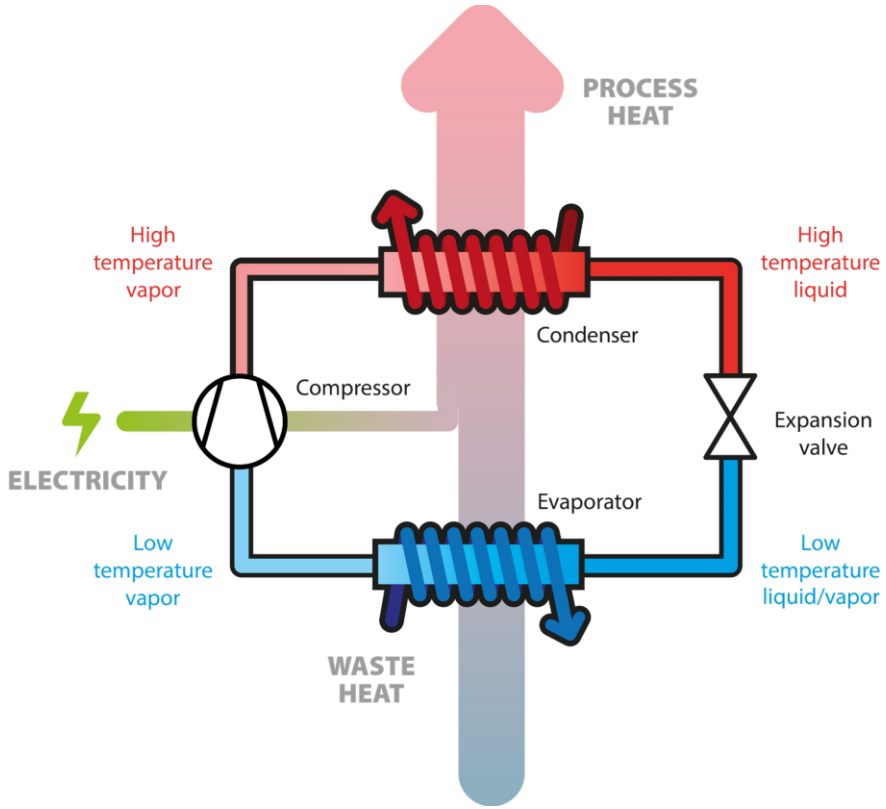
State of the Art for HTHPs



- HTHPs for supply > 100 °C require compressor developments

Compressors from process industries
Advanced technologies | Application specific design
Cost intensive | Applications > 15-20 MW

Modified refrigeration compressors
Currently limited to < 90 °C | Standard compressors
Proven technology | Applications < 15-20 MW

Novel and (strongly) adapted technologies
Technologies based on equipment from automobiles, pumps, ...| Capacities of kW to MW

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SuPrHeat at a Glance

SuPrHeat

www.SuPrHeat.dk

Motivation

Strong focus on electrification of industry | Increasing competitiveness of HPs
Large heat demand between 100 °C and 200 °C

Objective

Facilitating the electrification of industrial process heat supply at up to 200 °C by development and demonstration of high-temperature heat pumps (3 x 500 kW)

Scope

Technologies: Steam compression, Hydrocarbons, CO_2
Integration and demonstration in dairy, slaughterhouses, breweries and others

Project facts

09/2020 – 08/2024| Budget: 61.3 mio. DKK | EUDP Project
16 Partners: R&D institutes, system manufacturer, OEMs, end-users, consultants

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Project partners

- System manufacturers
- Component manufacturers
  - Compressors
  - Lubrication system
  - Heat exchangers
  - Valves
  - Steam equipment
- Consortium of end-users, mainly from food industry
- Process equipment suppliers
- Consultants for energy integration at end-users
- Knowledge partners and R&D institutes
- DTU Mechanical Engineering

SuPrHeat

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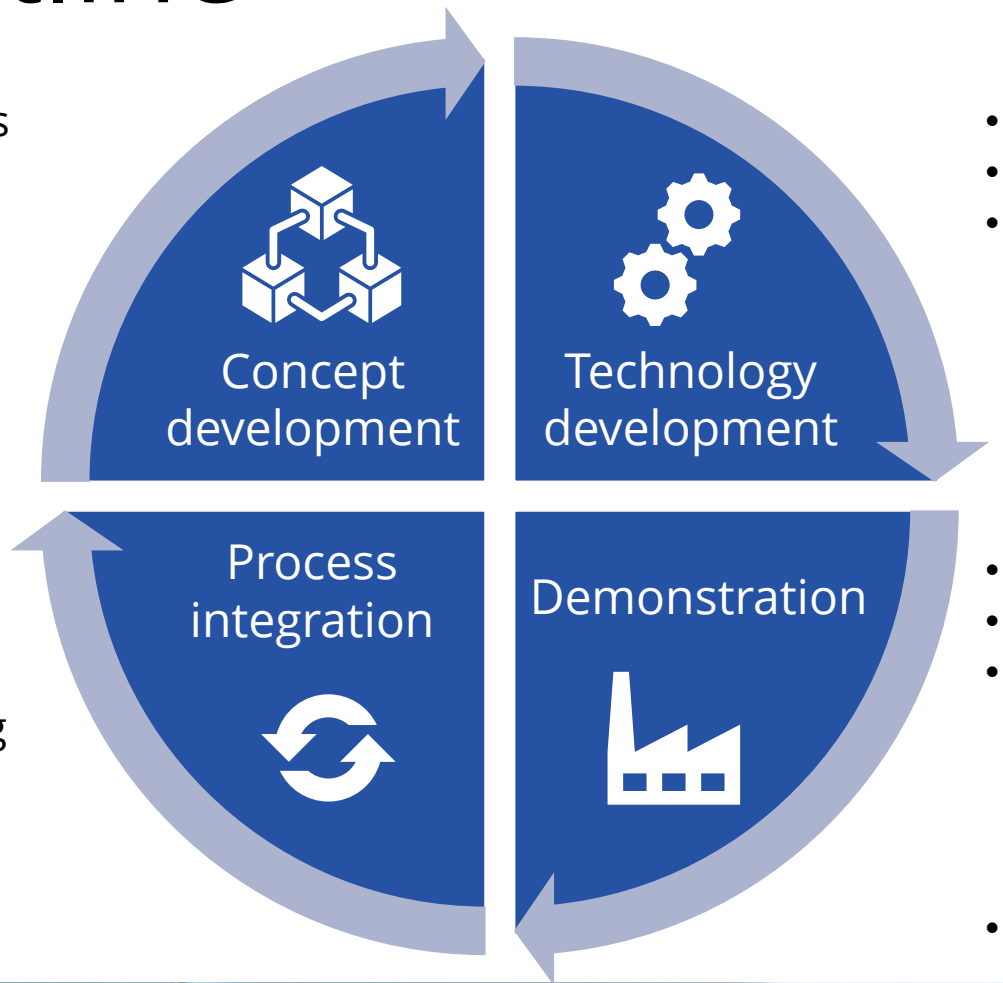
Project outline

SuPrHeat

- 3 supplementary technologies
- R718 | Hydrocarbons | R744
- Modular and combinable technologies



- Component development
- System optimization
- Testing and modifying

- Best practice solutions
- Existing facilities
- New process equipment
- Transition strategies for existing sites

- 3 Demonstration sites
- Long-term testing
- Applications:
  - Dairy
  - Brewery
  - Slaughterhouses
  - …
- Increasing trust in technology

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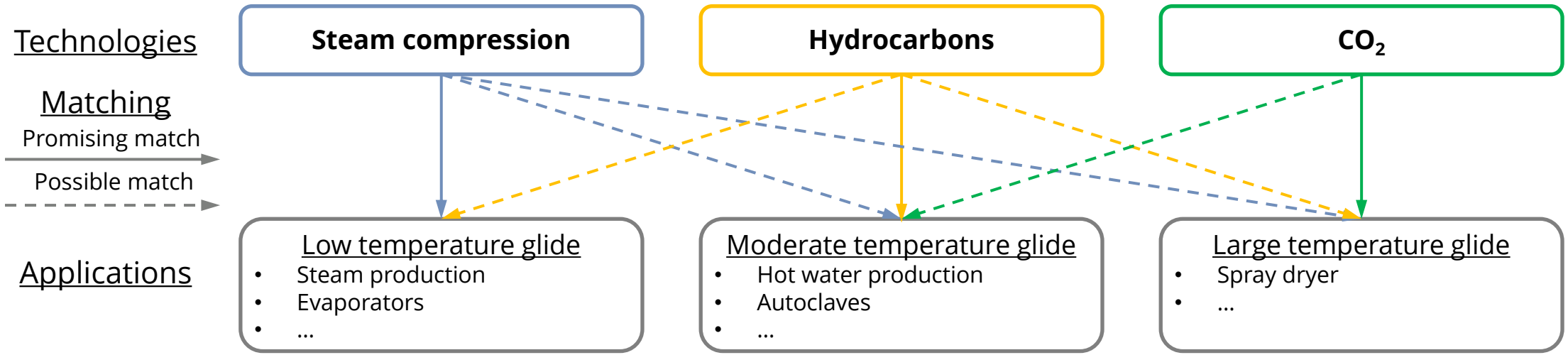
SuPrHeat

HTHP Concept

Development of a concept that covers the majority of processes at highest performances

Suggested concept:



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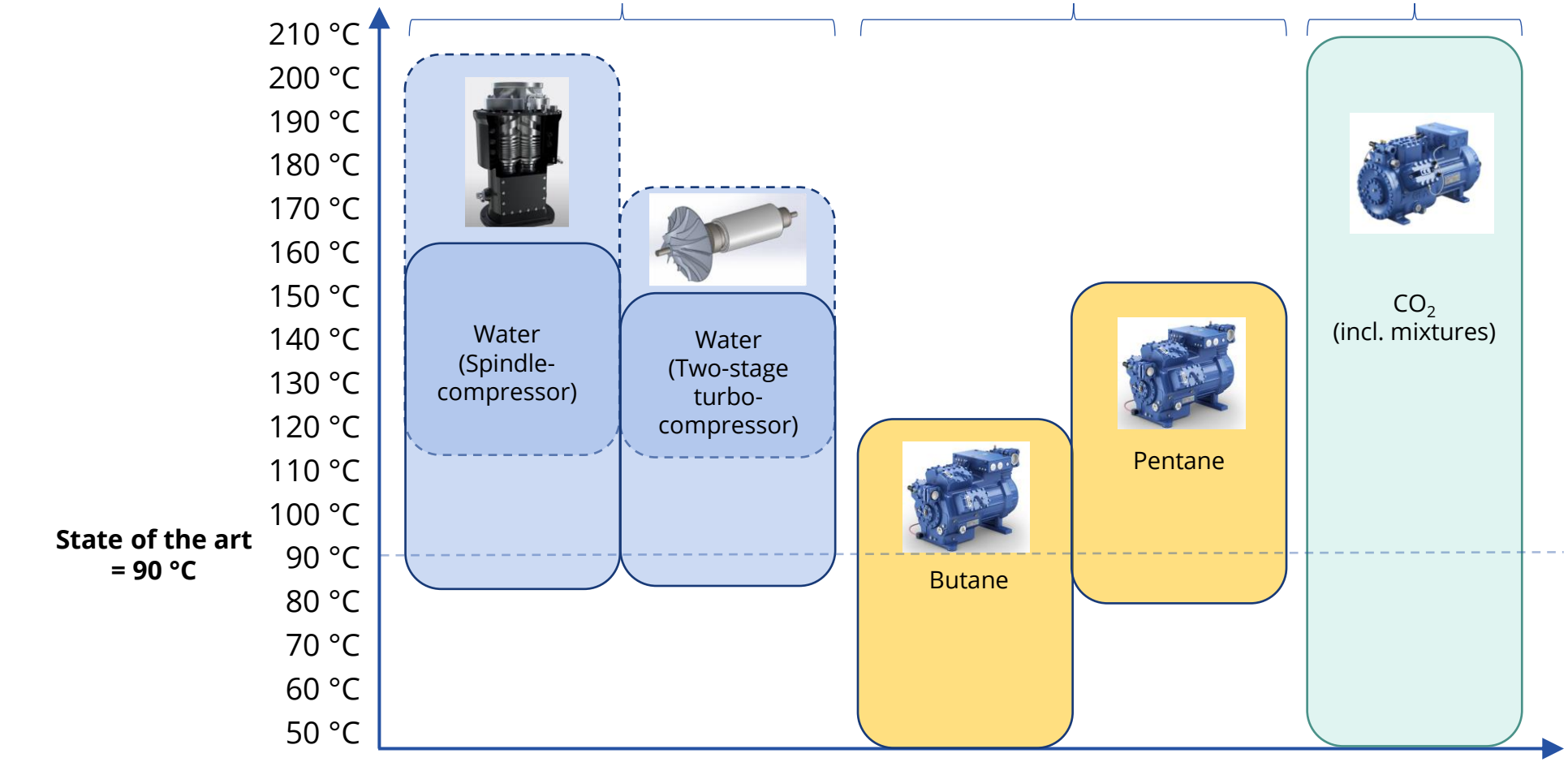
HTHP Demo-Plants (3 x 500 kW)

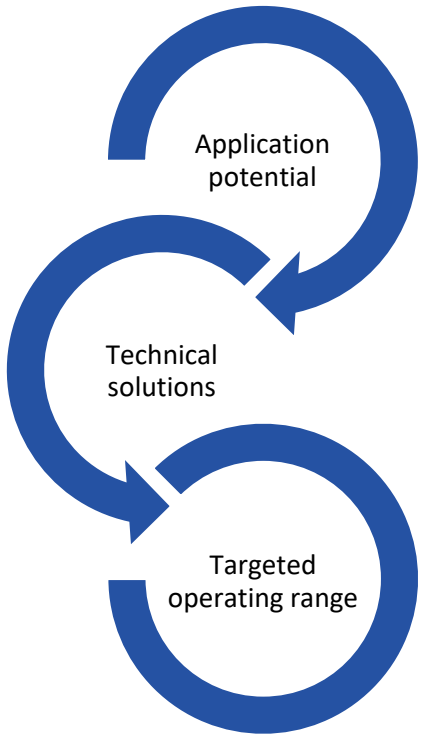
SuPrHeat

Demonstration 1: Steam compression

Demonstration 2: Hydrocarbons (incl. mixtures)

Demonstration 3: CO_2 (incl. mixtures)





Concluding remarks

- Electrification and high-temperature heat pumps have a considerable potential
- Rapid technology uptake expected for 2025 towards 2030
- Variety of technologies required to provide competitive solutions
- Process integration and decarbonization strategies are key to achieving optimal performances and avoiding technology lock-in

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