

Danfoss Climate Solutions

Industrial Heat Pumps

ENGINEERING
TOMORROW



Dekarbonisering af industrien: løsninger for proces køling og varme i industrielle applikationer

Varmepumpedagen

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Decarbonizing industry

Where to start?

Currently available heat pump technologies coverage

Available prototypes of heat pumps with **very high TRL**

Heat Consumption (TWh/a) EU-28		
Space heating	297	16%
Hot water	25	1%
PH <60 °C	55	3%
PH 60 to 80 °C	53	3%
PH 80 to 100 °C	89	5%
PH 100 to 150 °C	192	11%
PH 150 to 200 °C	80	4%
PH 200 to 500 °C	151	8%
PH 500 to 1'000 °C	376	21%
PH >1'000 °C	504	28%
Total Heat Consumption (TWh/year)	1'821	100%
Total Process Heat <60 °C to >1'000 °C (TWh/year)	1'499	
Total Process Heat 90 °C to 160 °C (TWh/year)	237	16%

Process Heat Consumption (TWh/a)		
Industrial sector	PH 100 to 150 °C	PH 150 to 200 °C
Iron and steel	19.8	7.3
Chemical	19.3	15.4
Non-ferrous metal	2.7	1.0
Non-metallic minerals	36.5	0.0
Food and tobacco	68.0	8.8
Paper, pulp and print	10.0	39.4
Machinery	6.9	2.9
Wood and wood products	0.2	0.7
Transport equipment	1.2	0.2
Textile and leather	6.9	0.0
Other	19.1	4.2
Total	191	80

Summary process heat demands split by temperature and segments EU-28 (Arpagaus, High Temperature Heat Pumps Update 2024)



In this presentation: outline **which heat pump technologies are relevant for cooling & process heating, including high temperatures** (sinks > between 100°C and 150°C)



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Mature and market available heat pump solutions for sinks < 100°C

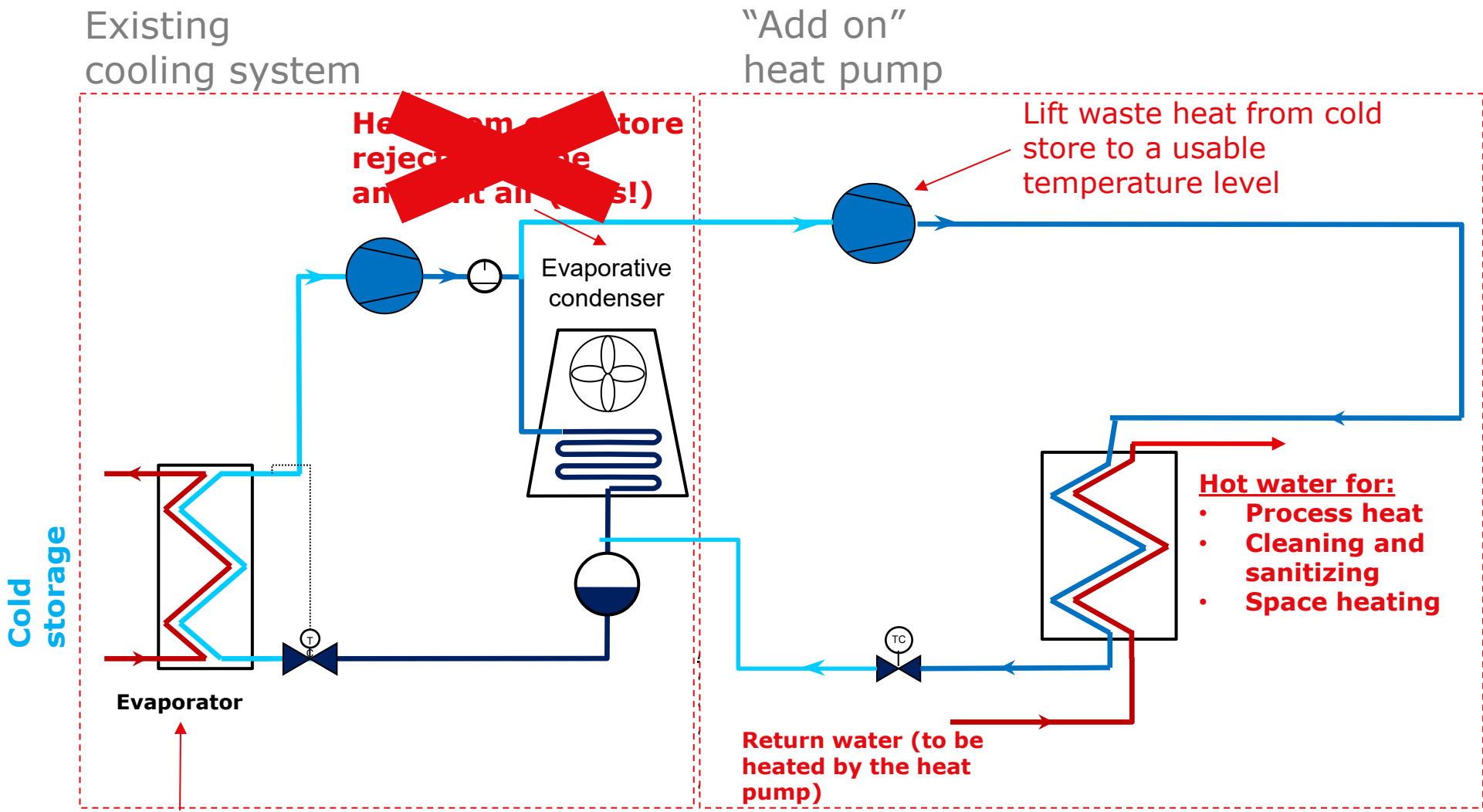
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Very high technical readiness on prototypes for sinks 120-130°C

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Food & beverage sector – most heat processes are within reach!

Heat pumps: mature solutions to decarbonize the food industry



Heat pump technologies available today:

- Hot water < 100°C – **completely market available:**
 - CO2
 - NH3
 - Hydrocarbons
 - Low GWP (HFO)
- Hot water < 130°C for steam generation, **high readiness prototypes available:**
 - Hydrocarbons
 - Low GWP (HFO)

Example Food & Beverage site

Brewery process diagram



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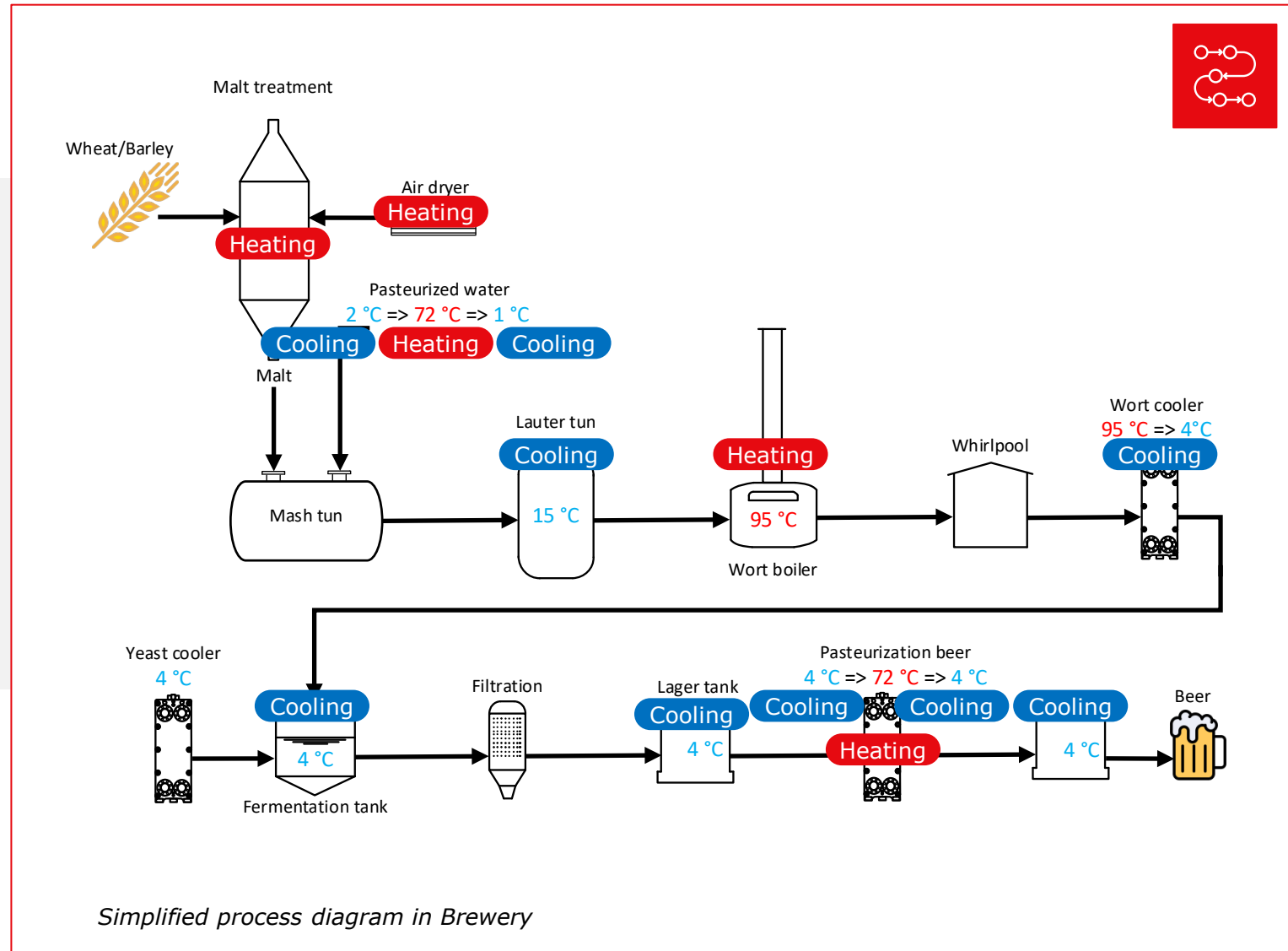
Multiple consecutive cooling and heating processes

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Traditionally: cooling & process heating disconnected. Fossils are burned for process heat

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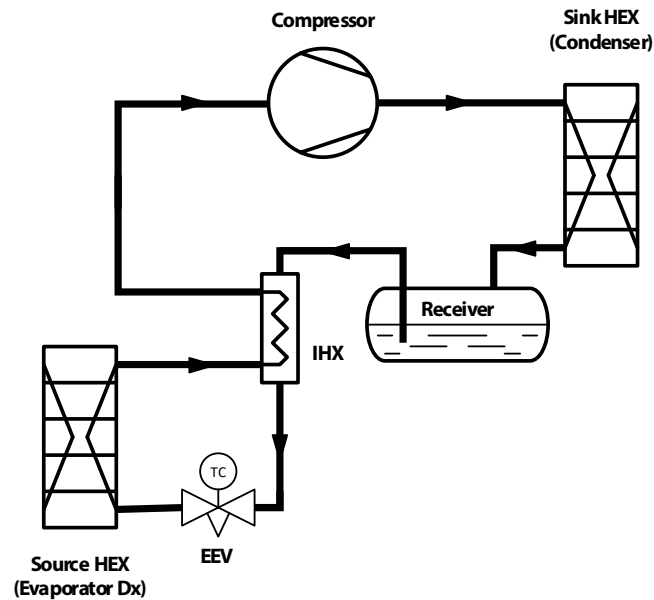
Decarbonize: We can connect cooling and process heat, and disconnect from fossils!



Cooling & process heating in a brewery

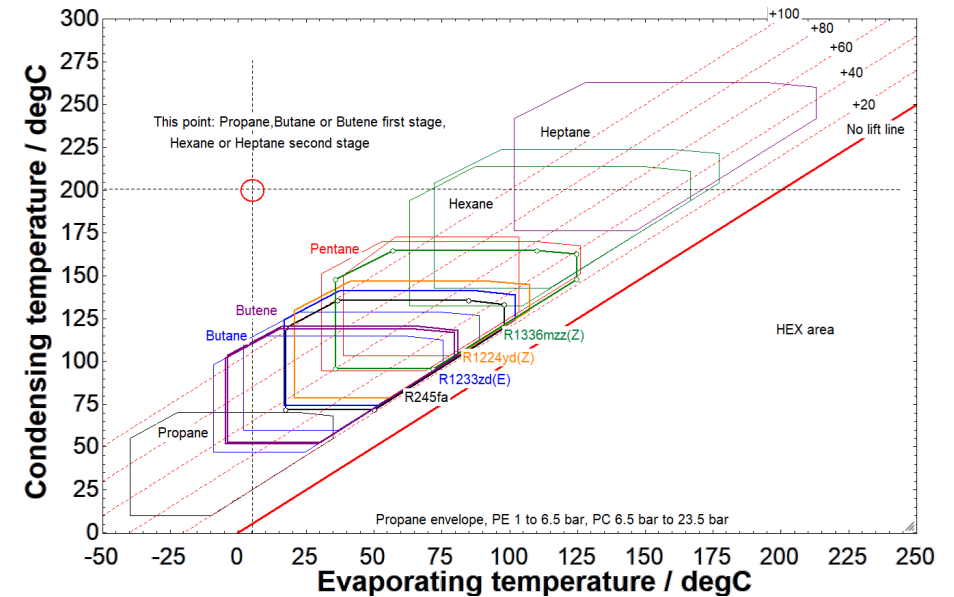
How to connect cooling and process heating systems?

Generic one-stage system



- Typical max lift 80-90 K
- Combinations are necessary to cover cooling and heating processes

How to combine cascades?



Flexible solutions for new projects

Reference new project

Brewery application – process cooling, heating and steam generation



Facts box:

Application: Process cooling & heating, including steam generation **up to 130°C**
Refurbishment of a 50-years-old NH3 system for glycol cooling and **replace use of natural gas**

3 pcs of Heat pumps installed in 2024 with a capacity of 500kW each.

Refrigerants: Hydrocarbons (R290, R600a and R600)

COP heating: 2,06 with 80K lift (from source to steam).

End user: Gulpener (Netherlands)

OEM and installer: Servex (Netherlands)

Preliminary results: **savings of natural gas of 75% (measured)**

Danfoss components:

- Bock compressors
- Line components

Reference new project: Hydrocarbon system only

Brewery application – process cooling, heating and steam generation

End user: Gulpener (Netherlands)

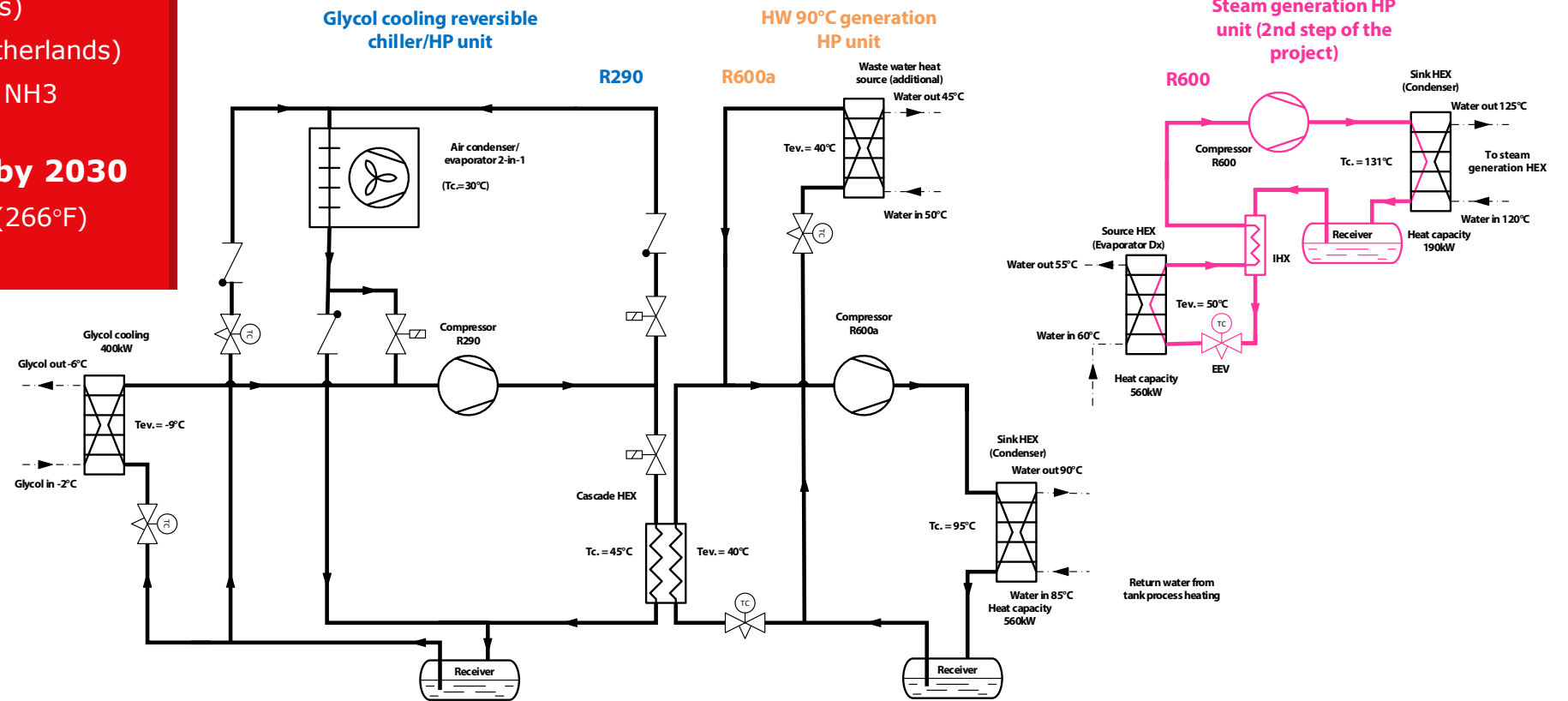
OEM and installer: Servex (Netherlands)

Refurbishment of a 50-years-old NH3 system for glycol cooling

Ambition: fully fossil-free by 2030

Te_{v.} = 50°C (122°F) / T_{c.} = 131°C (266°F)

=> COP_{comp} = 2,05



Industrial Heat Pump technologies

Status & conclusions

No one-size-fits-all solutions - it's all in the details!



Choice is not so simple: COP, TCO, legislation, service, technology availability, skilled personnel, experience, etc.



Other applications suitable for industrial heat pumps: District heating, reversible chiller/heat pumps in HVAC



Hydrocarbons are excellent refrigerants for both refrigeration and process heat. ATEX is not required by law, if units are installed according to safety standards



Reaching sinks of up to 130°C is within reach of present state of components

Conclusions check-list:

- 01 Mature and market available heat pump solutions for sinks < 100°C**
- 02 Very high technical readiness on prototypes for sinks 120-130°C**
- 03 Food & beverage sector – most heat processes are within reach!**



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