POST HBO
KOUDETECHNIEK

Warmtepompen in de industrie

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Innovation Manager GEA HRS

30 juni 2022

Ontstaan Post HBO Koudetechniek

- Start 1963 als Applicatiecursus:
  - Locatie HTS Den Bosch (zaterdagen)
  - Lesinhoud van de Technische Hogeschool Delft
  - Docenten van Grenco
  - Auspiciën van de NVvK

Opleidingsaanbod

Post HBO Koudetechniek:

- 1 jaar theorie: Product, Systeem en Componenten
- ½ jaar Afstudeer Project

Masterclasses

- CO_2 Transkritisch, Ede (4 dagen met prakticum en software)
- Industriële Warmtepompen, Woerden (2 dagen)

Koppelcursus

- ½ jaar, Apeldoorn: vanaf MBO4 instromen naar Post HBO

Start nieuwe opleidingen

- Post HBO koudetechniek: **september 2023**
- Koppelcursus (MBO4): **januari 2023**
- Masterclasses WP + CO_2: **november 2022**
- Opgave: www.PostHboKoudetechniek.nl

GEA Truck
Een jaar lang toeren door heel Europa met als motto “Rolling out innovations”

GEA Truck

Our applications

In touch with GEA every day

DAIRY FARMING & PROCESSING

Approx. one quarter of processed milk comes from GEA production systems

FOOD

Every third chicken nugget is produced using GEA technology

Approx. every third process line for instant coffee was installed by GEA

BEVERAGES

Approx. every second liter of beer is brewed with the aid of systems and process solutions from GEA

PHARMA

Every fourth liter of human blood for making plasma-derived products is processed using GEA equipment

CHEMICAL

More than one third of all polymer producers are using GEA drying technology

HEATING & REFRIGERATION

Each industry we serve utilizes industrial refrigeration technology from GEA

MARINE

Every second container ship in the world sails with GEA marine equipment on board

GEA IS THE ENGINE BEHIND ALL THIS... AND HAVE A MORAL RESPONSIBILITY TO DE-CARBONIZE

Masterclass Warmtepompen Industrie

Warmtepompen raken steeds meer ingeburgerd in de gebouwde omgeving. Echter de industrie is nog maar recentelijk met deze techniek begonnen. Aan de industriële warmtepompen worden andere eisen gesteld dan aan die in de woningbouw. Ook is de inpassing van warmtepompen complexer, veel meer gevarieerd qua bedrijfscondities, zoals de temperatuurrange van 50°C tot 150°C. De warmtebronnen zijn veel meer divers.

Er bestaan opleidingen in warmtepompen voor de gebouwde omgeving maar geen specifieke opleiding voor industriële warmtepompen die ingaat op de specifieke condities in de industrie. Om deze reden biedt de Stichting Post HBO Koudetechniek (SPHBOK) de opleiding "Warmtepompen voor de industrie" aan.

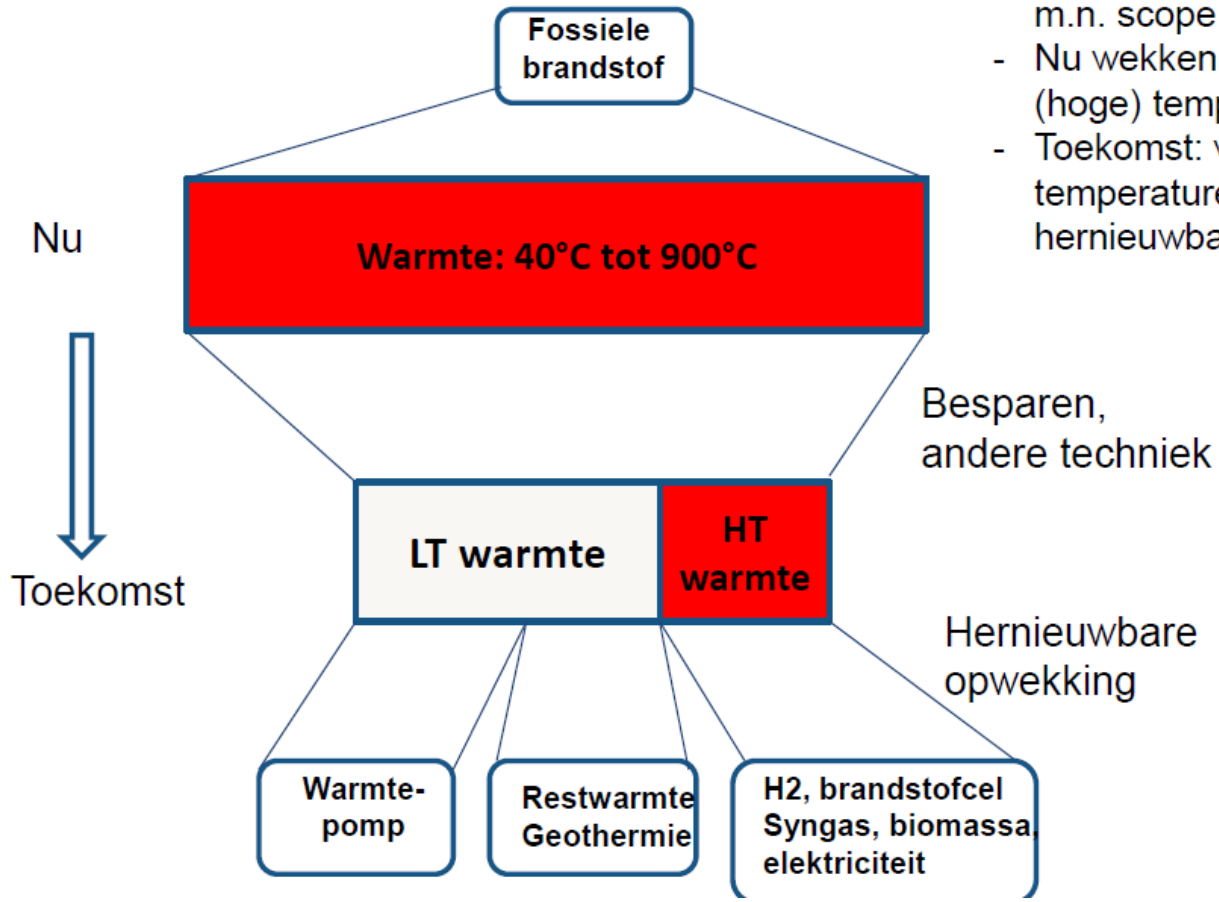
Warmtevraag industrie en T

Table 1-5: Estimates of industrial heat consumption per temperature range per industrial sectors

Heat demand 2018 (PJ)	Total heat demand	Steam from CHP	<100 °C	100-250 °C	250-500 °C	>500 °C
Food industry	61	12	30	30	0	0
Paper Industry	17	7	0	17	0	0
Chemical industry	247	44	12	28	66	141
Industrial gasses	7	0	0	0	0	7
Steam crackers industry	160	0	0	4	47	109
Ammonia and N-fertiliser	28	0	0	0	3	24
Wider chemical ind	33	0	12	24	16	1
Steel	31	2	0	1	7	23
Refineries	119	10	0	2	50	68

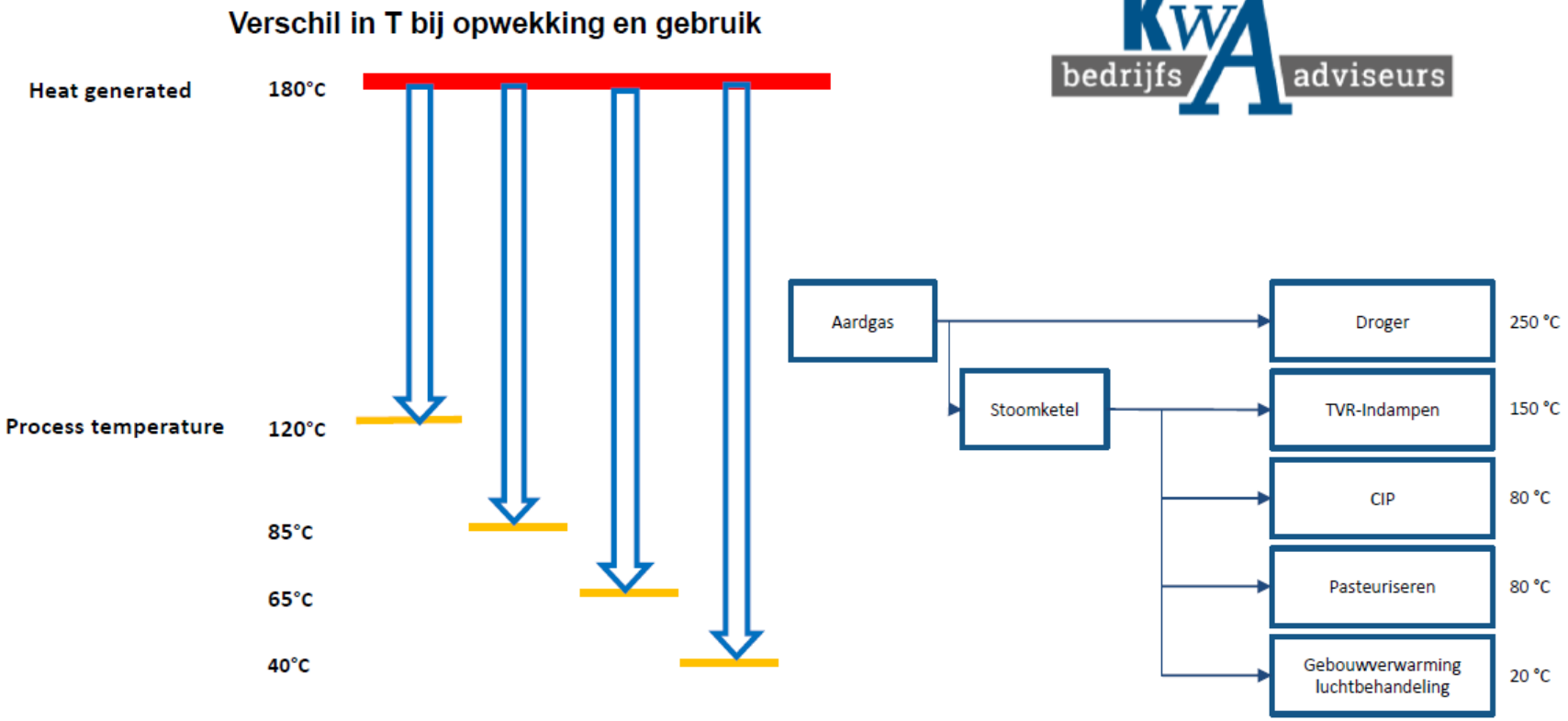
Bron RHDHV-PDC, 2020

De warmtetransitie



- Warmte is de grootste verbruiker en is m.n. scope 1
- Nu wekken we alle warmte op met één (hoge) temperatuur
- Toekomst: warmte op meerdere temperaturen rendabel, met hernieuwbare energie opwekken

Conventionele Energie-infrastructuur



Heat pumps in industrial refrigeration

We all have one, its just called a refrigerator..

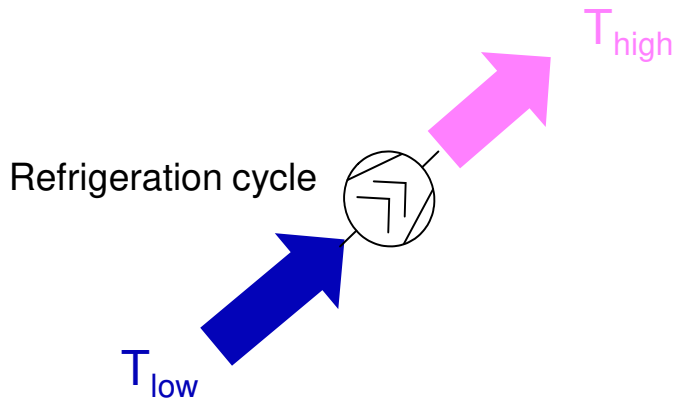
Heat pump: What is it?

They transport heat from a lower to a higher temperature level

Heat pumps allow us to use this heat to cook

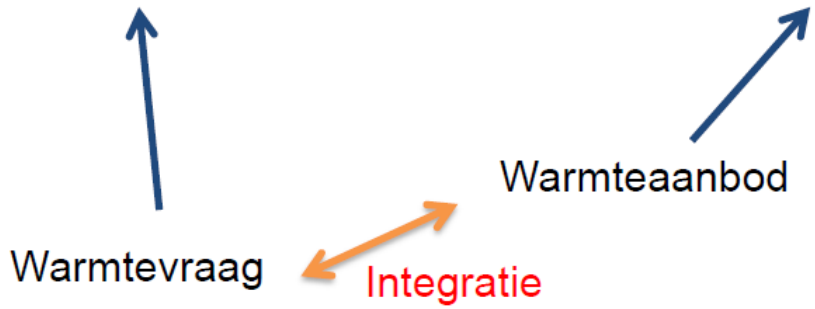
All refrigeration systems are basically heat pumps.

Our refrigerator absorbs the heat from our food, boosts it in temperature and this heat (+the power) warms our kitchen/home.



Warmtevraag sectoren en warmteaanbod uit condensors*, studie KWA/RVO 2016

Sectoren met koeling en energiegebruik	Warmte vraag	Elektriciteit finaal	Elektriciteit voor koeling	Condensor warmte 40° C
	PJ/j	PJ/j	PJ/j	PJ/j
V&G industrie	60	23	6	24
Industrie	496	116	13	56
Diensten, overheid en agrarisch	54	42	10	47



*Compressie koelmachines

Combineren

understanding our thermal needs!

	Product Intake		Defeathering		Chilling		Final Product
POULTRY		+38 °C		+52 °C		+2 °C	 +2 °C
DAIRY BEVERAGE		+2 °C	Pasteurisation 	+74 °C	Chilling 	+2 °C	 +2 °C
VEGETABLES		+20 °C	Blanching 	+80 °C	Freezing 	-18 °C	 -22 °C

Heat pumps

understanding our thermal needs!

POULTRY

DAIRY BEVERAGE

VEGETABLES

Product Intake

+38 °C

+2 °C

+20 °C

Defeathering

+52 °C

Pasteurisation

+74 °C

Blanching

+80 °C

HEAT/ENERGY **IN**

Chilling

+2 °C

Chilling

+2 °C

Freezing

-18 °C

HEAT/ENERGY **OUT**

Final Product

+2 °C

+2 °C

-22 °C

..THE SAME HEAT,
just the wrong temperature!

Heating Old and New

80% Efficient Boiler

Heat capacity requirement = 1,000kw (1,594kg/hr, steam)
Temperature of process/water required = +76°C

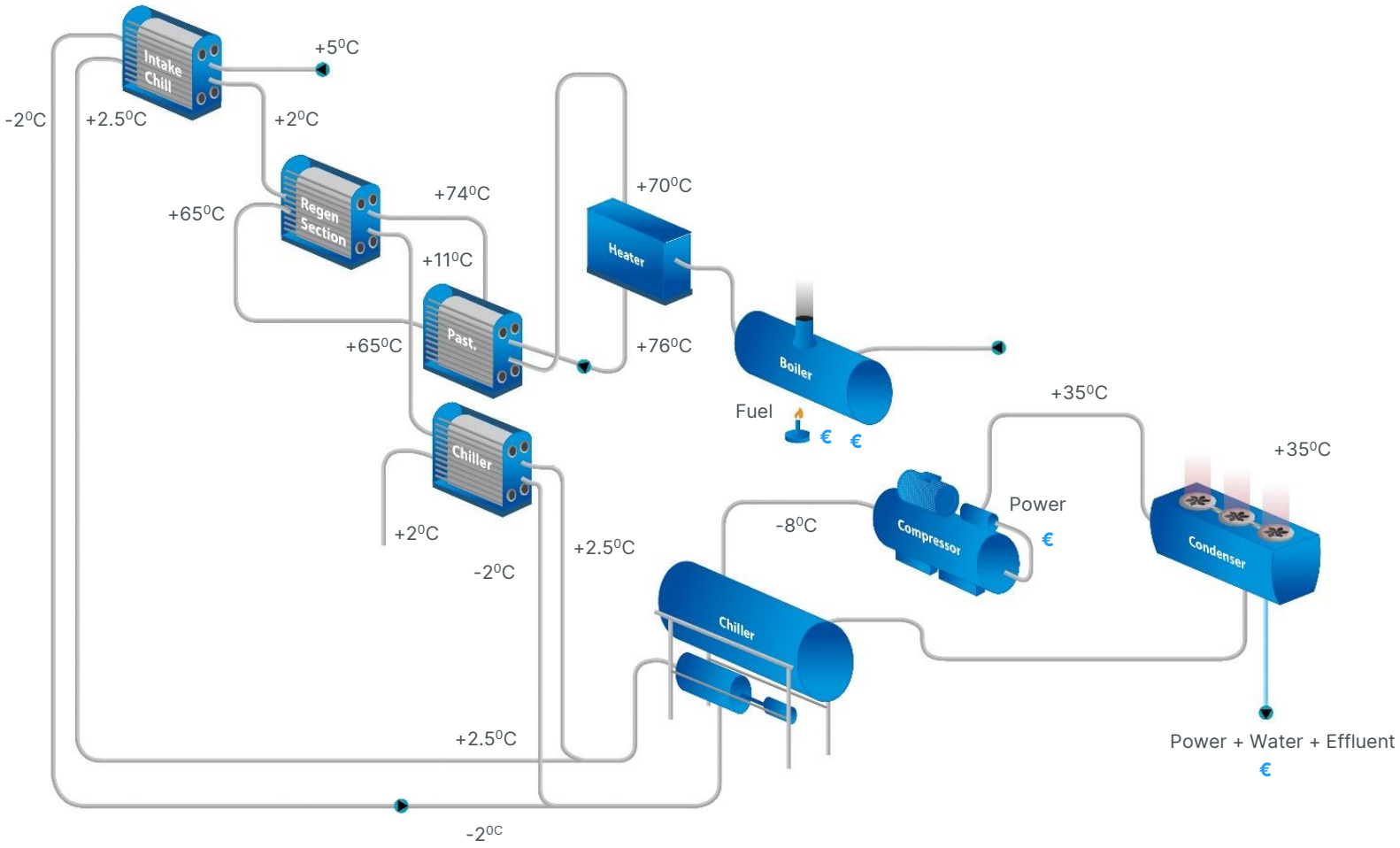
Fuel Burned (NG) = 1,250kw
Cost per hour (0.02p/kwhr) = £25 (excl. carbon tax)
Carbon emissions (0.227kg/kw)= 283kgCO_2/hr

740% Efficient Heat pump (+35/76°C)

Heat capacity requirement = 1,000kw
Temperature of process/water required = +76°C

Power (Electrical) = 135kw
Cost per hour (0.1p/kwhr) = £13.5 (excl. carbon tax)
Carbon emissions (0.232kg/kw. 2020 UK grid)= 31kgCO_2/hr

Heating/Cooling in Traditional Dairy



9.5 Million ltr/wk Fresh Milk

Heating Cost
72,000kwhr/wk Natural Gas (7 day/week):
x 52 = 3.74 million kWh/year energy (fuel) used

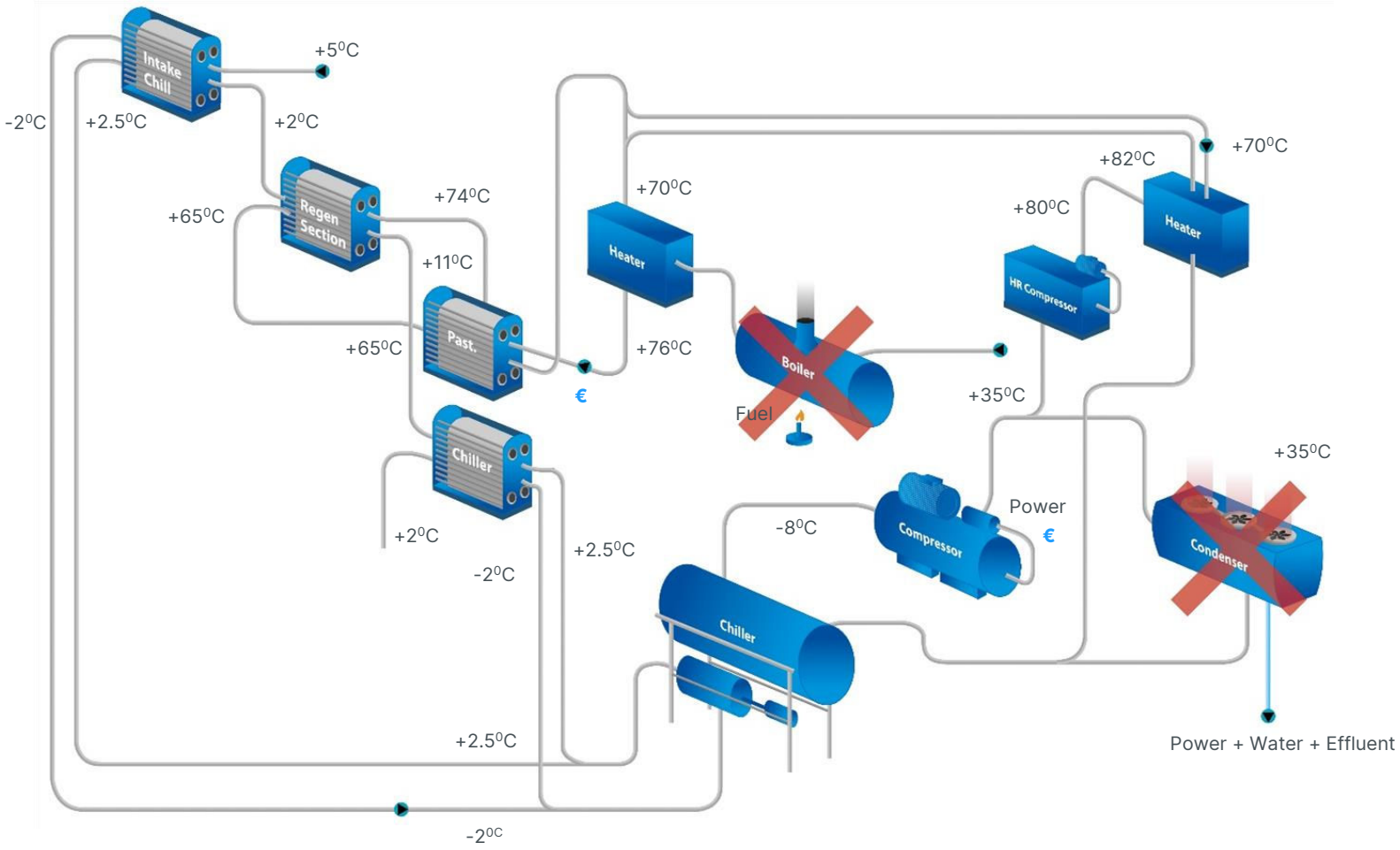
Refrigeration Cost
14,280kwhr/wk (7day/week):
x 52 = 0.74 million kWh energy (electricity) used

Water used
407m3/wk (7day/wk): x 52 = 21k m3/year

Total energy = 4.48 million kWh/year

Emissions = 970 tons CO_2e

Heating/Cooling in Dairy with Heat Pump



9.5 Million ltr/wk Fresh Milk

Heating Cost
6,440kwhr/wk (7 day/week): x 52 = 0.33 million kWh/year energy (electricity) used

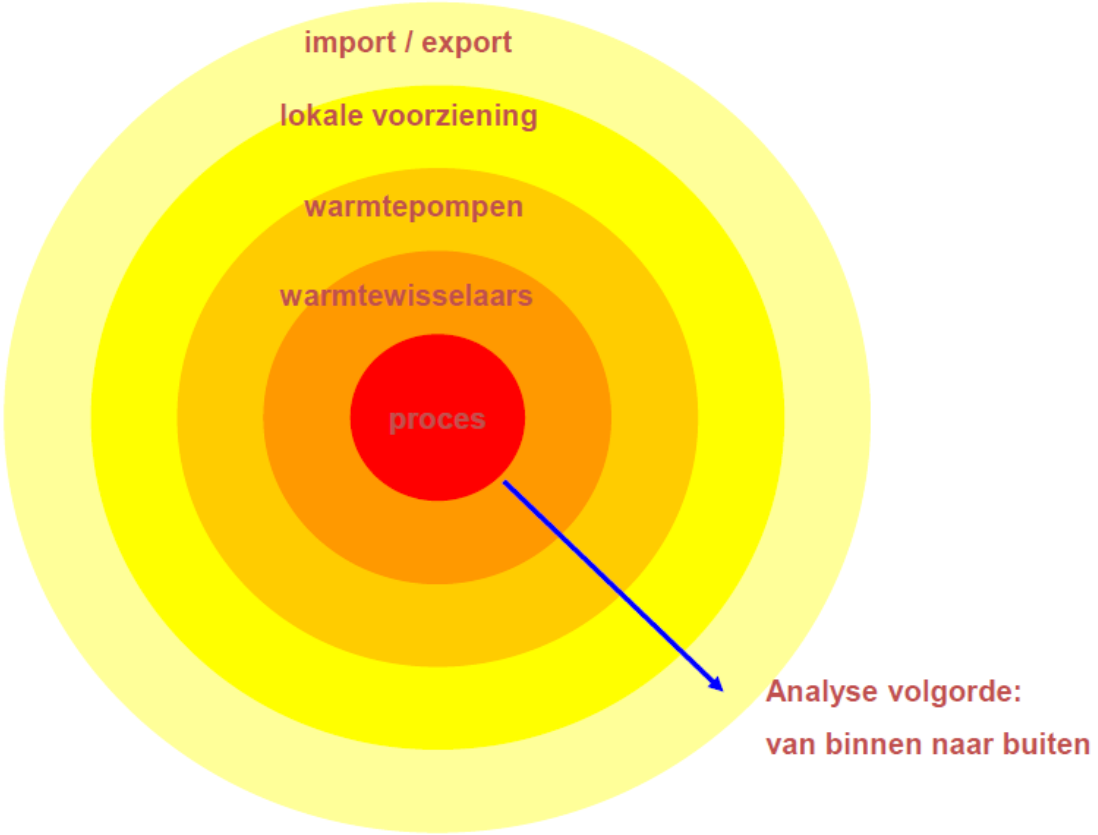
Refrigeration Cost
14,280kwhr/wk (7day/week):
x 52 = 0.74 million kWh energy (electricity) used

Water used
242m3/wk (7day/wk): x 52 = 12.5k m^3/year

Total energy = 1.07 million kWh/year

Emissions = 321 tons CO_2e

Schillenmodel



Heat pump example installations

Carbon-neutral smoothie manufacturing site

THE INNOCENT WAY

GEA - Cooling Matters

400 million bottles per year

Zero carbon **emission** production

Thermal loads:

5,000kw @ -3°C Gycol.

2,970kw @ +7°C chilled water.

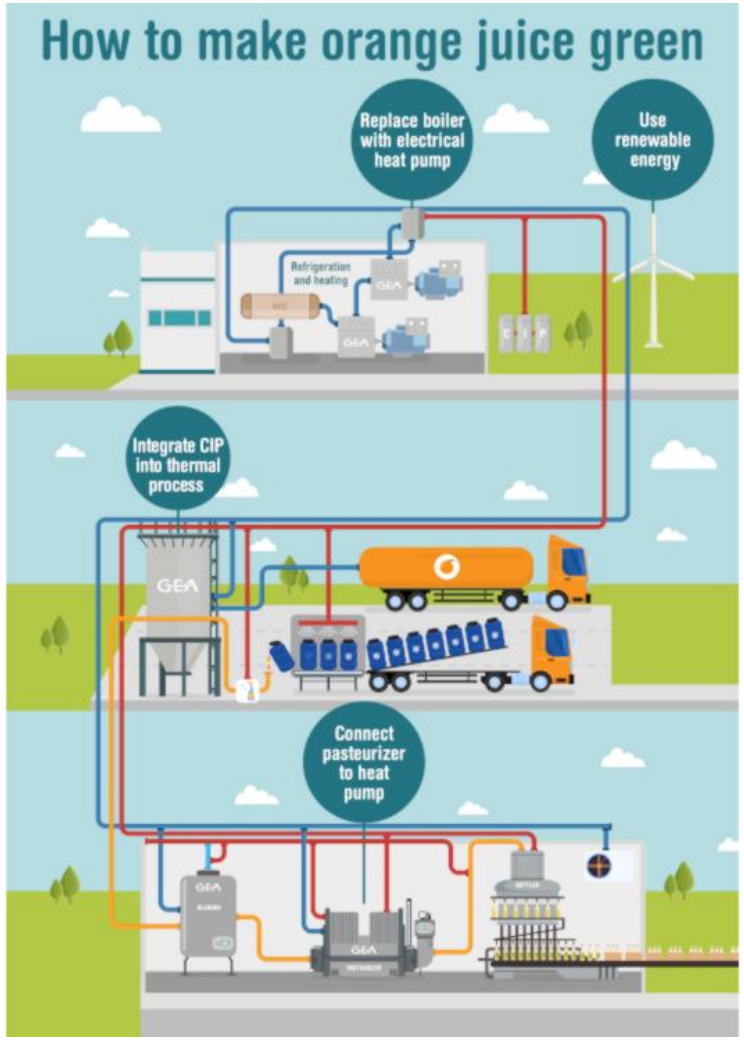
5,000kw THR at +32°C.

4,500kw @ +65°C (melt, sanitize, HVAC etc)

2,500kw @ 90°C (process pasteurization etc)

600kg/hr steam at +140°C (Filling)

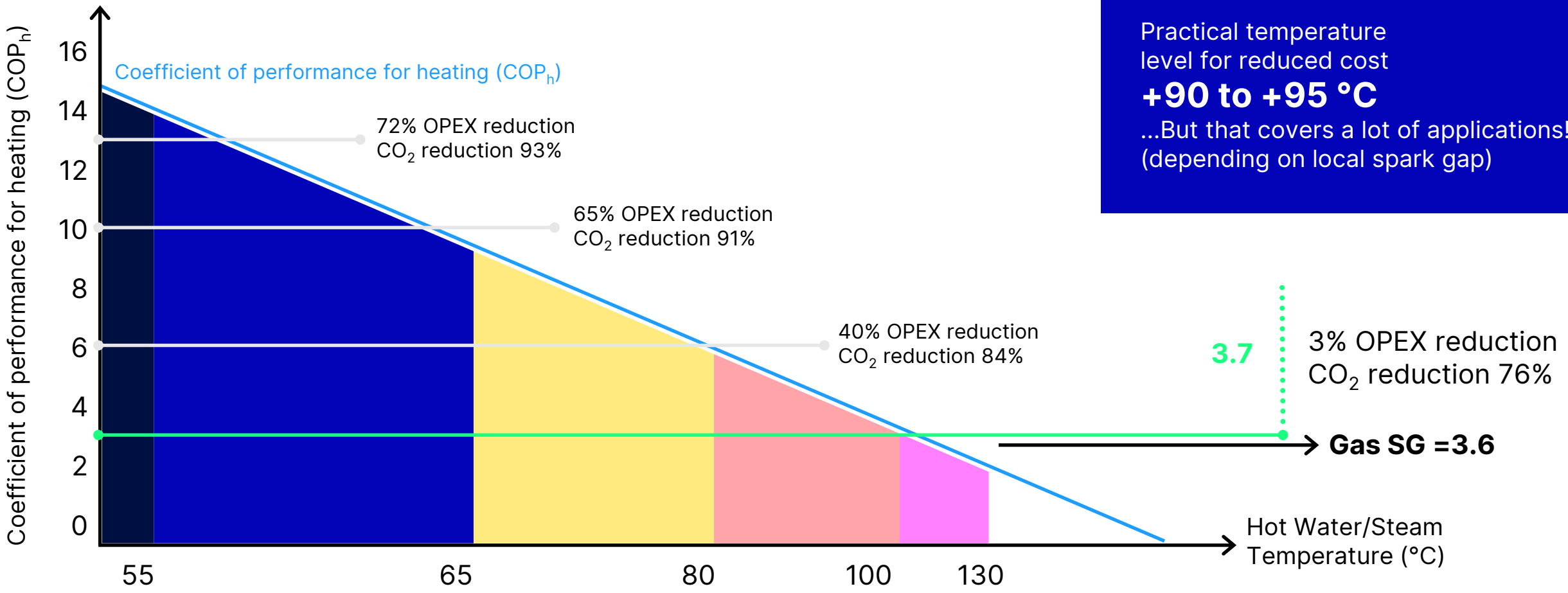
18



Video: How to make orange juice green

Heat pump example installations

Comparison of OPEX and CO_2 for heating via Ammonia heat pumps vs Steam boiler



Practical temperature level for reduced cost

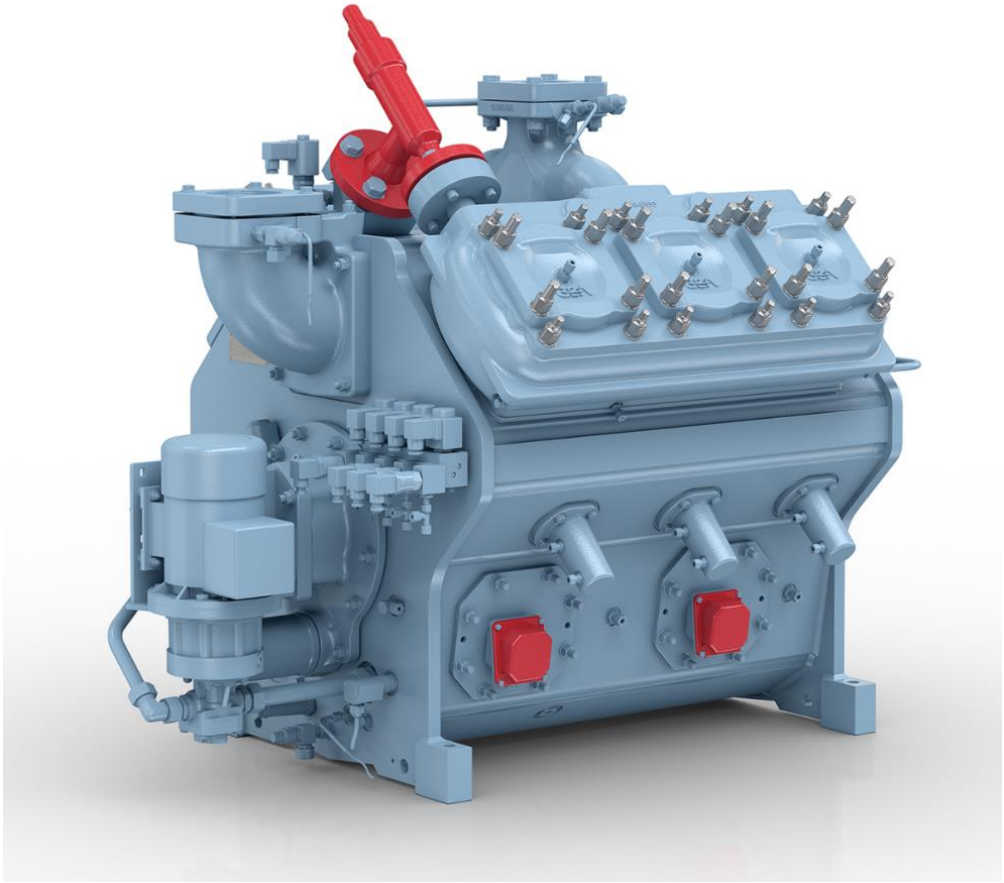
+90 to +95 °C

...But that covers a lot of applications! (depending on local spark gap)

Note: Figures based on Gas = 2p/kWh, Electricity = 10p/kWh, Boiler efficiency = 80%, Spark Gap = 3.6

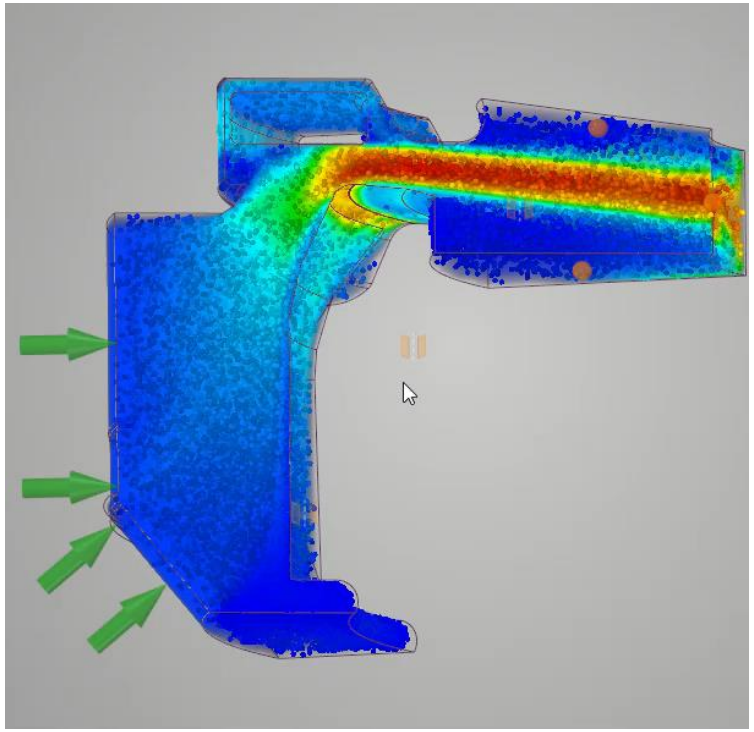
V XHP project scope

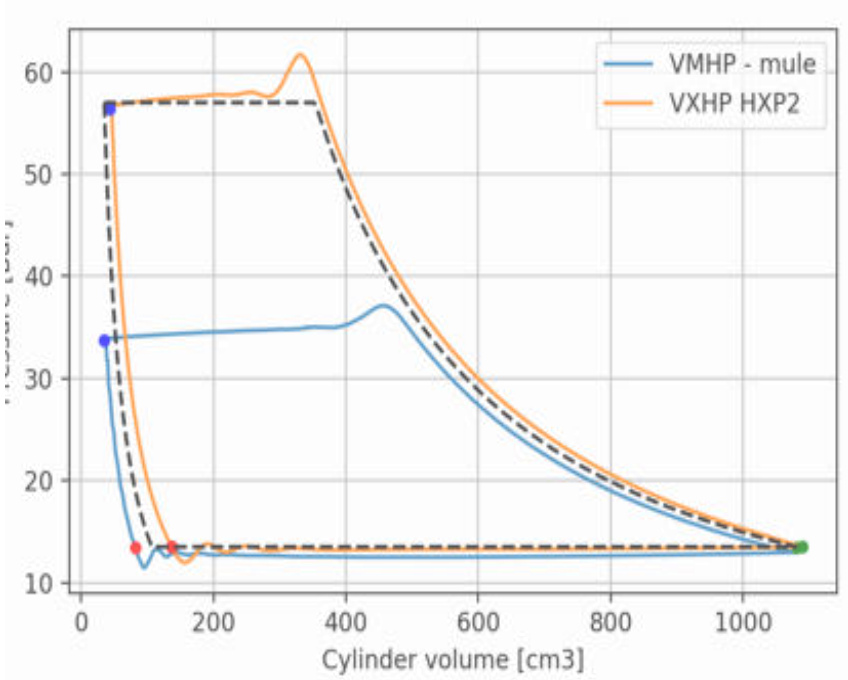
- Ammonia compressor for heat pumps
- Heat sink temperature up to 95°C
- Compressor design pressure 63 bar(g)
- 4 compressor models, 375 to 940 m3/h at 1500 rpm
- Heating capacity at evaporation / condensation 35°C/ 93°C: 950 to 2350 kW



V XHP valves

- State-of-the-art materials
- 1D, 2D and 3D simulations



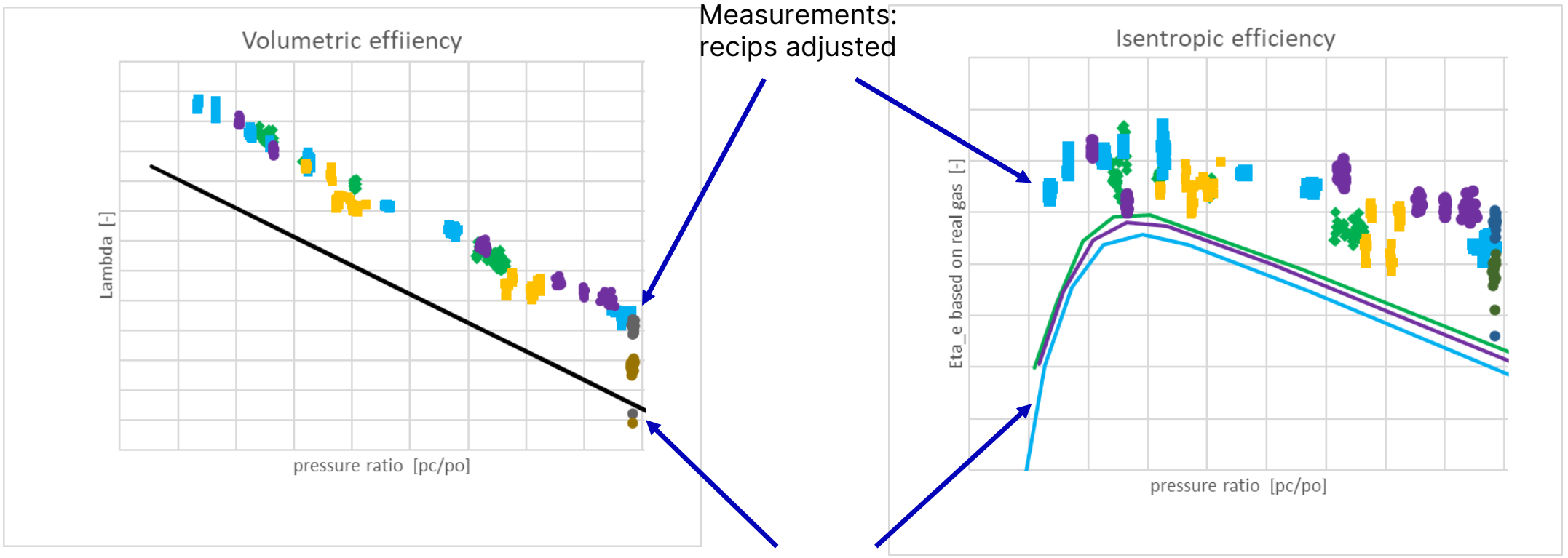


V950 XHP, 10 cylinder model

Test center in Berlin

V550 XHP

Efficiency results



INSTITUT INTERNATIONAL DU FROID
INTERNATIONAL INSTITUTE OF REFRIGERATION

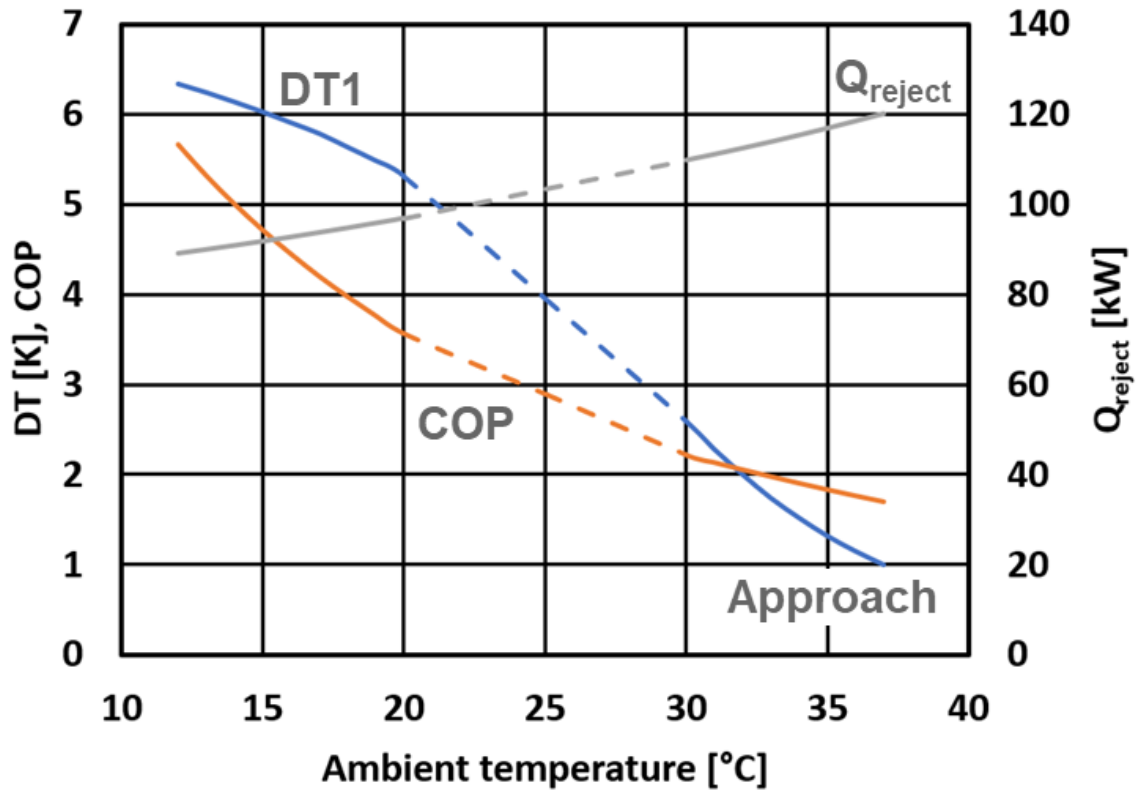
POST HBO KOUDETECHNIEK

Relationship of the *Transcritical* and *Subcritical* performance of an *air cooled CO_2-gas cooler*

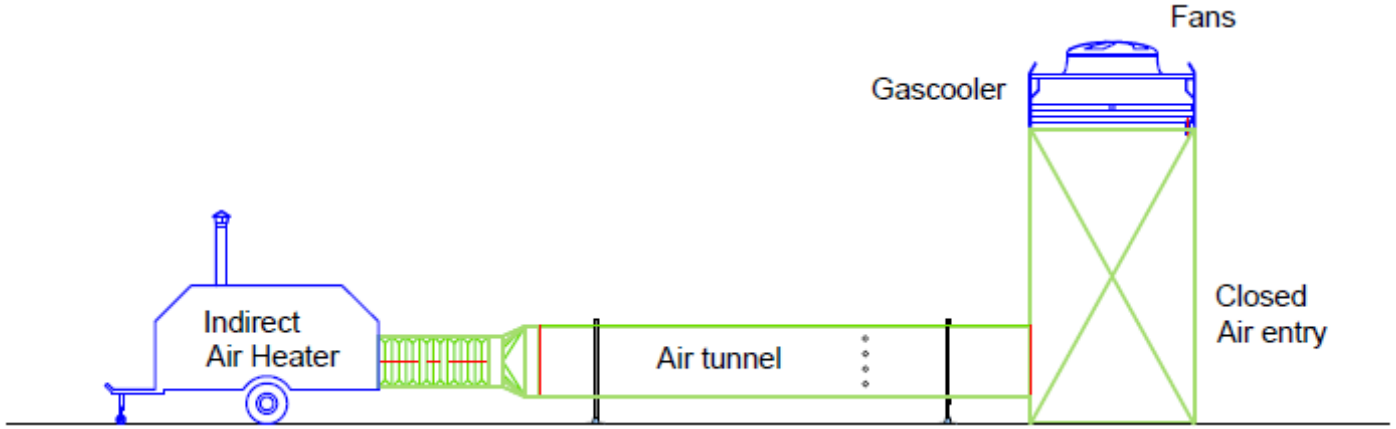
Geert Doornbos* | Post-HBO Koudetechniek (NL)
Kees van Heiningen | Post-HBO Koudetechniek (NL)
Jan Gerritsen | GEA (NL)

Paper 232

Prestaties CO_2 gaskoeler



Experimental setup



Gas cooler set-up:

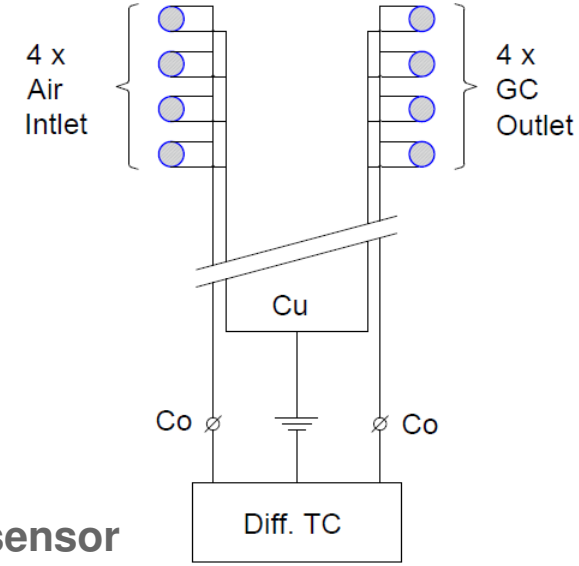
- Closed air supply system
- Air heater to vary ambient conditions
- Air tunnel to measure air flow

Measurement system:

Datalogging system for T-type sensors with:

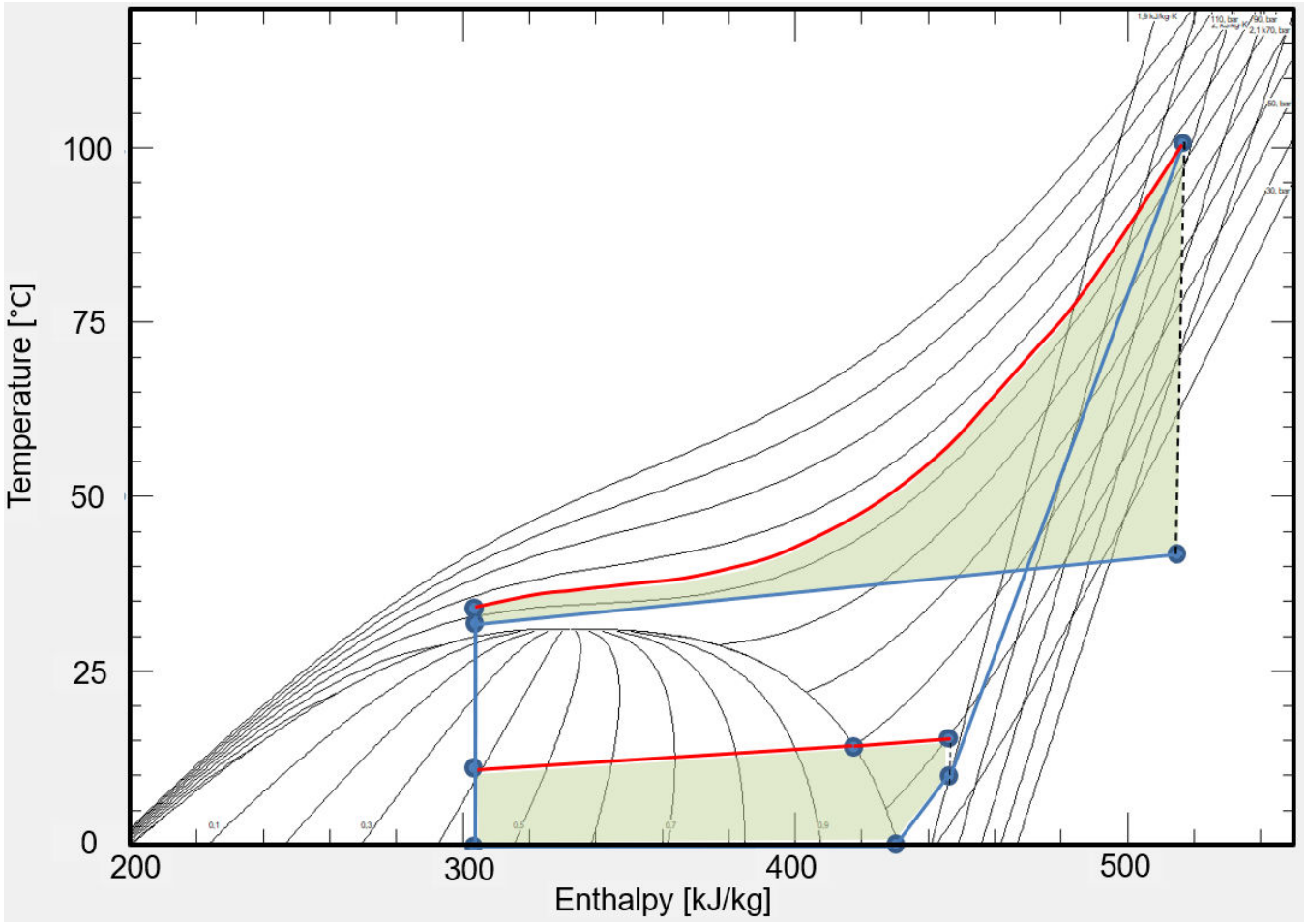
- 8 air temperature sensors
- 19 tube temperature sensors (insulated)
- 1 *approach* temperature sensor

Two precision manometers (inlet/outlet GC)



***Approach* sensor**

Transcritisch CO_2 systeem in T-h diagram



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CO2 warmtepomp – 4 gaskoelers in serie

DOI 10.18462/iir.gl.2018.1107

OPTIMUM HIGH PRESSURE FOR TRANSCRITICAL CO_2 HEAT PUMPS CONSIDERING ISENTROPIC EFFICIENCY AND GLIDING HEAT EXTRACTION

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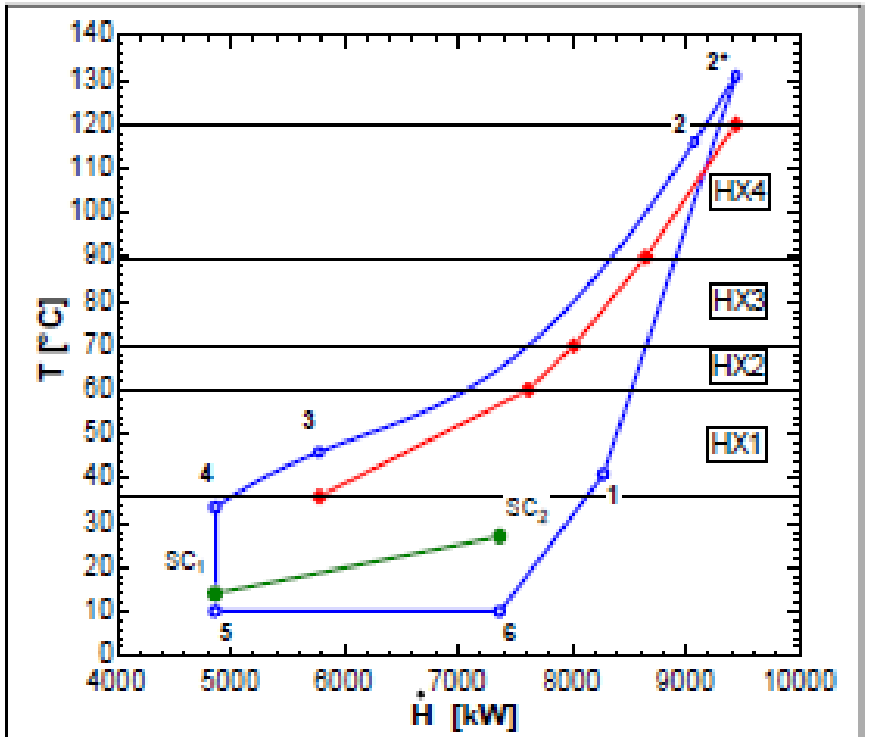

Figure 12: Heat supply and partitioned heat rejection of the heat pump cycle

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