

Economische aspecten van industriële warmtepompen



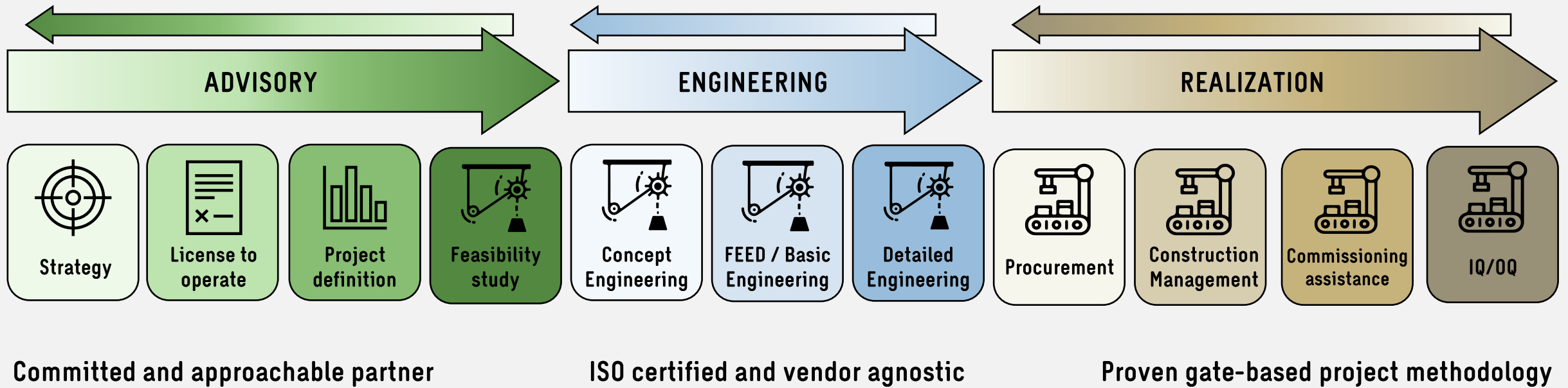
Energik 01/10/2026
Masterclass industriële warmtepompen

Jonathan Orbie



Your partner to transform strategy into reality

Sweco as one-stop-shop EPCm solutions provider



Focus Climate, Energy & Environment

Focus on **advisory services** and **engineering** up to and including **permit** and **financial investment decision (FID)**

Energy-intensive industries need a future proofed energy strategy

In today's industrial landscape, rising energy prices, sustainability targets, regulatory requirements, grid constraints and margin pressure demand strategic vision that looks beyond short-term challenges and focuses on long-term resilience.

30% Avg. potential cost reduction via strategic energy management

Active collaborations (selection):



Our services, tailored to your needs

Energy cost reduction: techno-economic advisory

- **Process innovation and asset optimization:** ovens, dryers, distillation/membranes, flue gasses, evaporators, reactors, green molecules
- **Heating/cooling optimization:** pinch analysis, heat source/sink mapping, waste heat recovery, thermal buffering, thermal oil circuits, smart heating grids (private and district), steam/hot water, CHP, chillers, dry/adiabatic coolers, cooling towers, batch process
- **Electrification:** (add-on LT/HT) heat pumps, MVR, e-boilers (resistance/electrode), process electrification
- **Utilities optimization:** compressed air/vacuum, cooling water, pumps/fans/motor, relighting, RES/BESS-integration, HVAC optimization

Electrification and flexibility

- **Behind the meter:** load shifting, peak shaving and day ahead arbitrage at process and site level (BESS/thermal storage/...)
- **Front of the meter:** intraday, imbalance, ancillary services, CRM
- **Grid connection studies and capacity advisory (grid congestion)**
- **Energy management system (EMS)** implementation

Strategic roadmapping

- **Strategic decarbonization roadmap for full-scope 1/2/3** with integrated scenario analysis, electrification and CAPEX planning
- Sweco in-house **Futureproofed SaaS for carbon accounting**
- Ensuring **compliance** with regulatory framework and (future) legislation (e.g. ESG/CSRD, EED/VEKA/EBO)

Energy procurement and contracting

- **Energy profile / contract analysis and smart purchasing strategy** based on site consumption and on-site generation
- **Negotiation of energy supply contracts** to reduce costs and risks including monthly energy health check
- **Hedging/clicking advice and PPAs** for long-term price stability

EPCm engineering and permitting

- **Full-scope pre-FEED, FEED, basic, and detailed engineering**
- Procurement and construction management
- Full in-house **environmental impact assessment and permitting** (urban planning and environmental) applications
- **Audits & subsidies:** ETS1/2, ISO50001, ISO40001, eligibilities

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1 CO₂-reductie strategie

Drivers for decarbonization in energy intensive industries

Energy costs are top of mind today



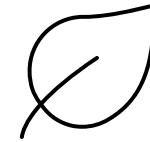
Energy costs are spiking

- › Margins under pressure; competitiveness at risk.
- › Additional cost of CO₂ through ETS (ETS2 for non-ETS from '28 onwards)



Additional regulation

- › EU Green Deal and Fit for 55 package: -55% emissions by 2030.
- › EBO, SBTi, ...
- › Permitting restrictions related to nitrogen emissions
- › Uncertainty regulatory framework (proactive vs. reactive)



Customer demand for sustainability

- › Expectation/requirement from client to commit for decarbonisation
- › Reputation and sustainable branding (cfr. premiums)

Challenge: making decisions in uncertainty, company seeks predictability (both on costs and security of supply)

Pillars for a successful decarbonisation strategy

Overview 5 pillars



Maximum focus on **energy efficiency, heat integration** and **process innovation**

Passive energy recovery most cost effective (pinch analysis)

Heat buffering and dedicated hot water grid temperature levels for cost effective integration

Process innovation e.g. switching distillation column or evaporator for membrane technology, superheated steam drying, ...



Focus on **upgrading available waste heat** to usable temperature through **heat pumps** and **MVR**

At the lowest possible and dedicated temperature levels

Tailored to the characteristics of the application



Use **high-quality energy carriers** such as direct electric heating and biogas/hydrogen only for the highest temperatures, specific processes and peak loads

Direct electrification e.g. hybrid baking oven

Integrate flexibility in design, e.g. through thermal storage



Maximize **energy flexibility** and pay attention to your **energy procurement strategy**

Behind-the-meter

Front-of-the-meter

Profile analysis / forecasting –
Energy contracts – Hedging strategy – Click strategy – Tender negotiation – PPA's



Take future **electrification** into account into the site's **mid term development plans**

Access / contractual / physical capacity

Grid tariffs DSO/TSO

Grid studies

2 Gunstige condities en drivers voor economisch haalbare warmtepomp toepassing

Bending the road towards alternative solutions

Context/driver examples

NH₃ add-on heat pump on cooling installation in food industry

- › Revamp NH₃ cooling installation dedicated to process: obsolete 2-stage piston compressors and evaporative condenser
- › Company decarbonization targets
- › Baseload process cooling using natural refrigerant and hot water system nearby with continuous load
→ HP opportunity

Heat pump (NH₃ or CO₂) integrated on dynamic bed dryer

- › No natural gas present on site and limited apatite given sustainability ambitions and insurance technical risk
- › High OPEX reference case of full electric heat supply
- › Company decarbonization targets
- › Heat source and sink on same installation (simultaneity) and high latent heat content in moist dryer outlet
→ HP opportunity



HeatPAC HPX with panel-mount

Where are heat pumps more likely to be installed?

Company-side signals

- 1 Has favorable **price ratio electricity / gas** (e.g. companies connected to Elia HV-grid have lower grid costs).
- 2 Large entities part of EU Emissions Trading System (**ETS**) – also non-ETS companies face additional cost for CO₂ from '28 onwards (**ETS2**)
- 3 Has explicit **sustainability goals** and decarbonization roadmap (e.g. SBTi targets, corporate decarbonization goals)
- 4 Committed in **EBO** (energy policy agreements) - energy study required for new installations in context of OVA (permit application)
- 5 Has (option for) **on-site electricity generation & storage**

Where are heat pumps more likely to be installed?

Process-side signals

Large energy consumption

High thermal demand (preferably $> 0,5 \text{ MW}_{\text{th}}$) makes savings material, larger power/dimensioning becomes profitable more easily given economies of scale.

Temperature lift is moderate

Relatively low temperature level of heat demand enables for more cost-effective solutions. Higher lifts require multiple stages and become more costly.

Aged assets requiring replacement

Natural inflection point to switch technology. Opportunity when investments are required anyhow for business continuity / reliability.
→ Relevance of roadmap / mid-term masterplan

Waste heat available (and nearby)

Waste heat, ambient, river/sea water or a complementary cooling demand on site. Limited **pipng costs** enables for better business case.

Sufficient running hours

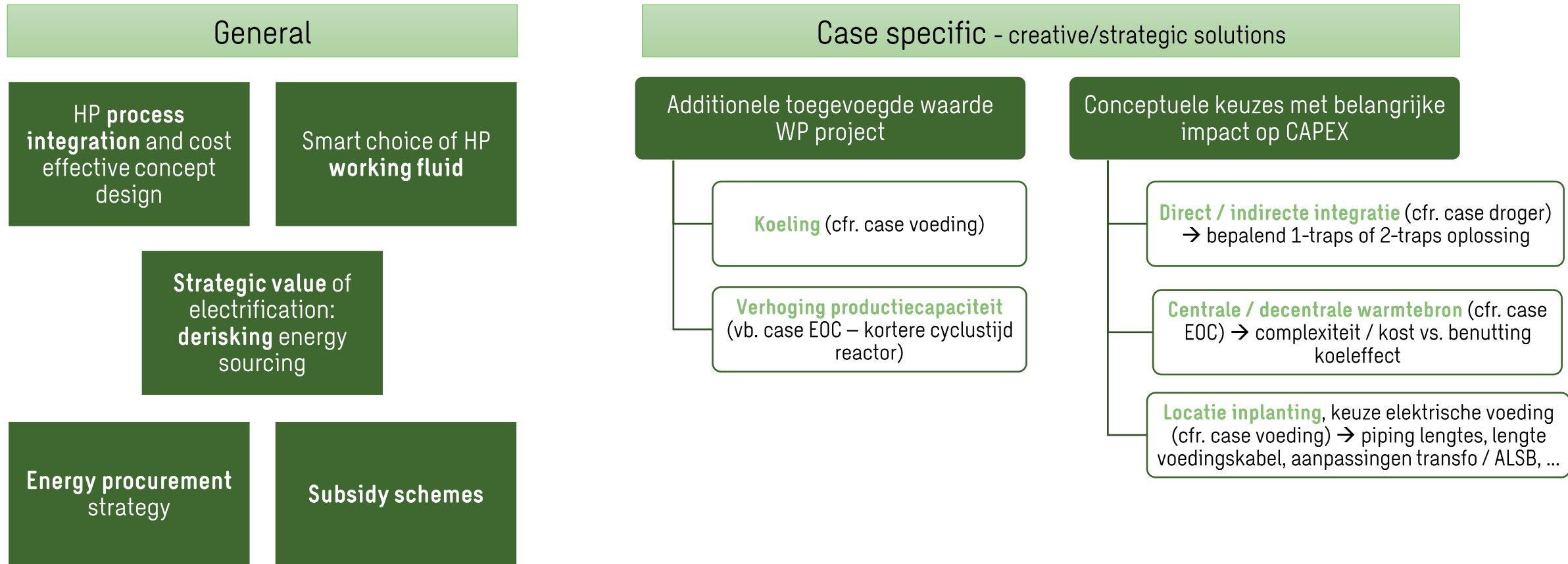
High utilization is required to justify the investment. **Simultaneity** of waste heat source and heat sink (preferably continuous/baseload on both sides) and avoiding additional cost of large buffers.

Complementary heating and cooling demand

Can be coupled in a single highly efficient system, or cooling at intermediate temperature can increase overall COP.

Key drivers/differentiators for HP feasibility

General and case specific aspects – sometimes game changers for economic viability



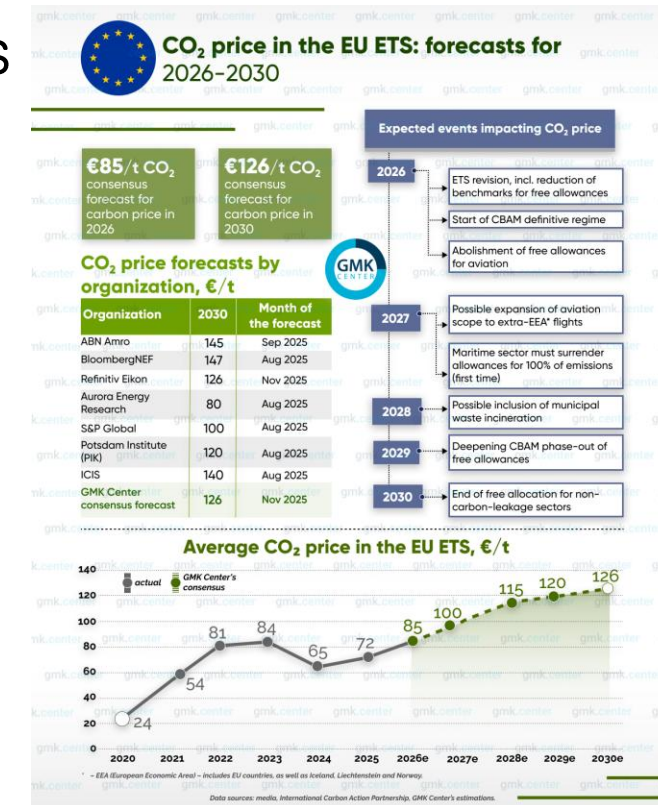
Challenge: electricity / gas price ratio

Proper spark spread will be enabler for further roll-out of heat pumps

- › **Spark spread** (electricity vs. gas) and COP together determine savings for large extent (O&M, ..)
- › Avoid calculating with the average electricity invoice price and consider **effective marginal cost**
- › Improved by **Contract for difference** subsidy schemes

Gunstige ontwikkelingen m.b.t. energiekosten

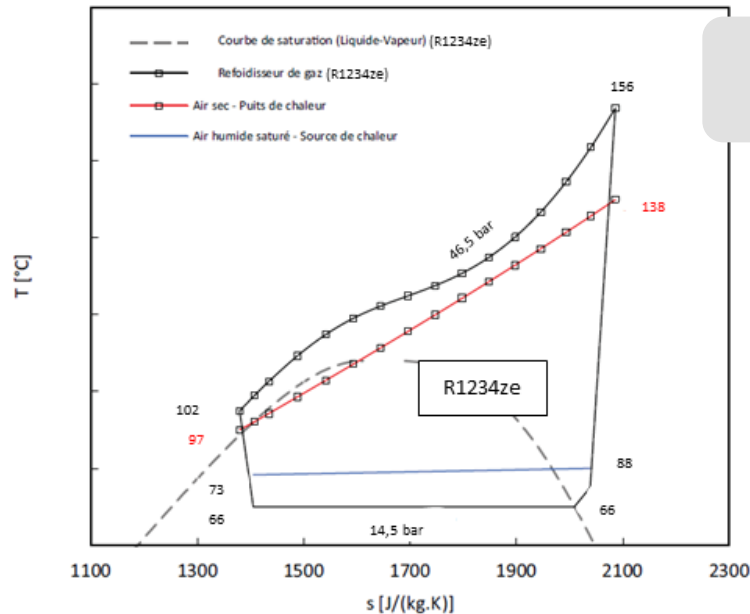
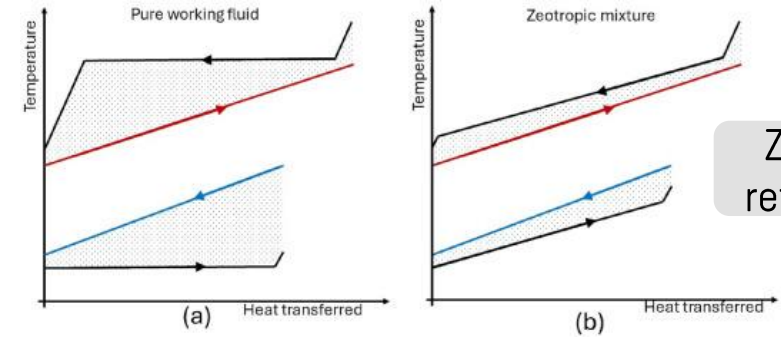
- › TSO vs. DSO: lagere **nettarieven**
 - Minder gunstige evolutie bij DSO 1,4 k€/MW_p/m (2024) → 4,4 k€/MW_p/m (2025) (**x3!**)
 - Perspectief 'time-of-use' tarieven (>2029)
- › **ETS2** (>2028)
- › **Taxshift** / accijnshervorming (1 aug 2026 → 2030)
- › **Marktevoluties**
 - Mogelijk verdere daling elektriciteitsprijs door meer hernieuwbare energie op systeem (lage marginale kost)
 - Mogelijk verdere stijging CO₂ prijs ETS door reductie vrije allocaties



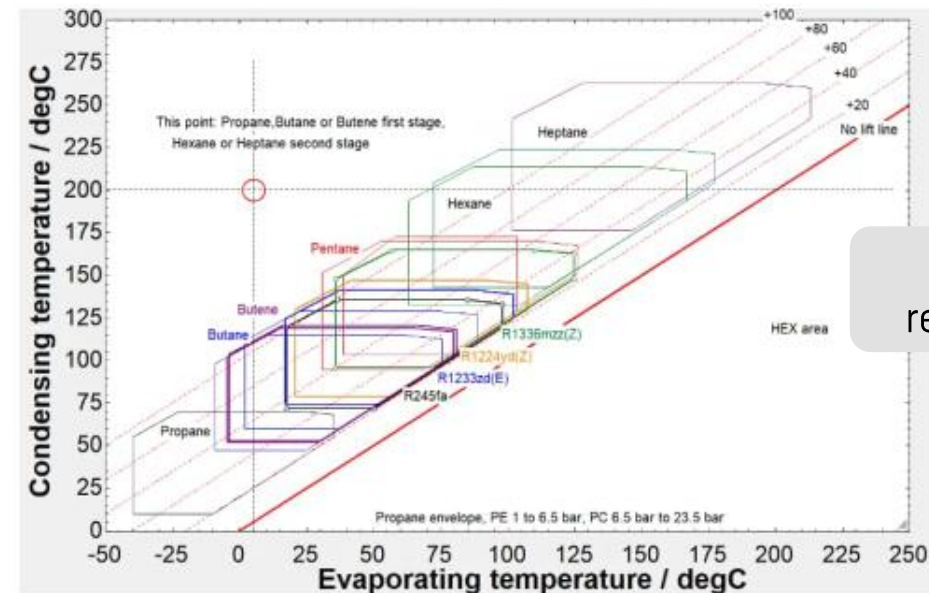
Evolutions in heat pump technologies

Now: working fluid shift & control optimization

- › New refrigerants (natural, low GWP, low ODP)
- › Increased efficiency
- › Better control & flexibility
- › Increased temperature range



Transcritical



Natural refrigerants

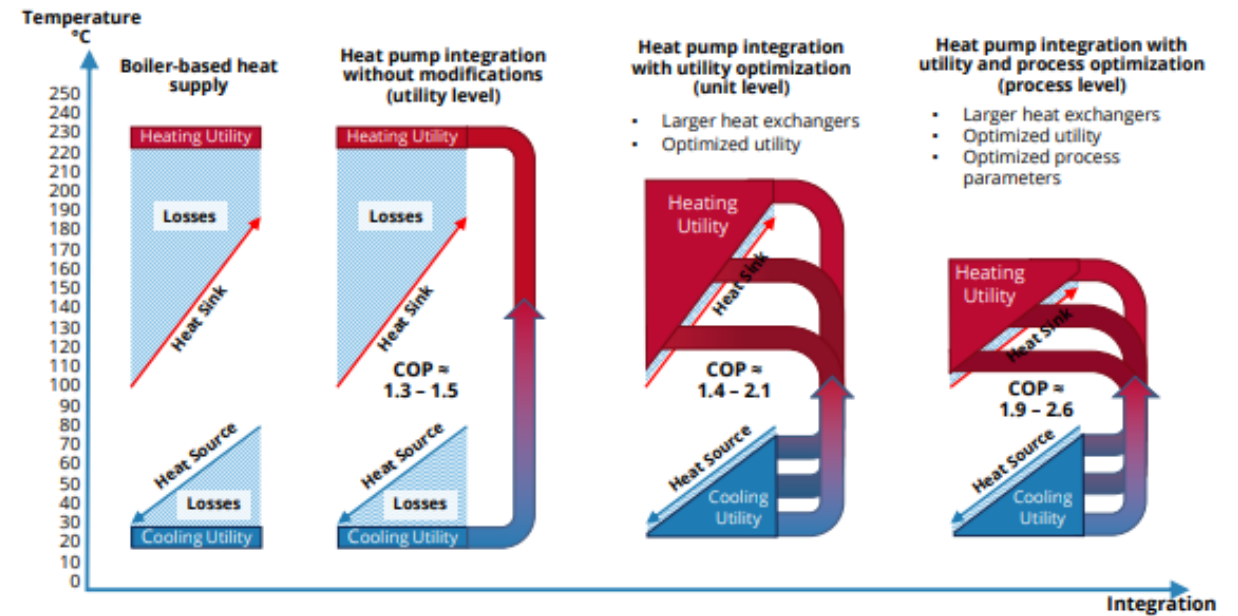
3 Startpunt: WP procesintegratie

WP procesintegratie

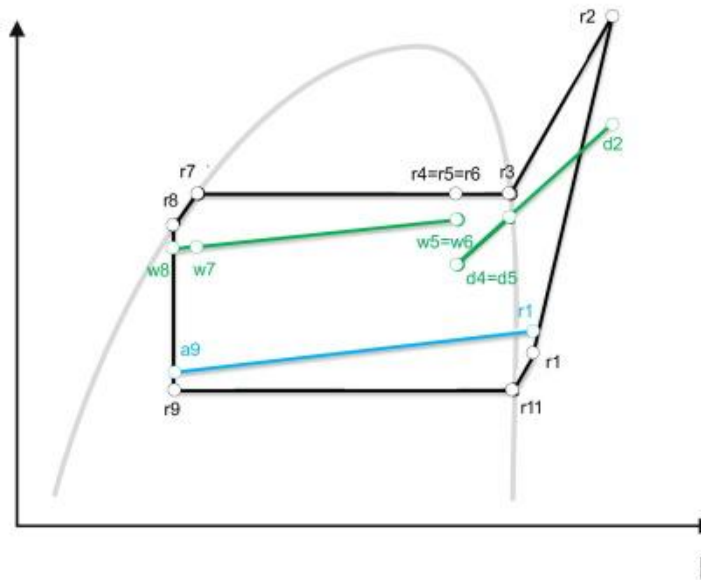
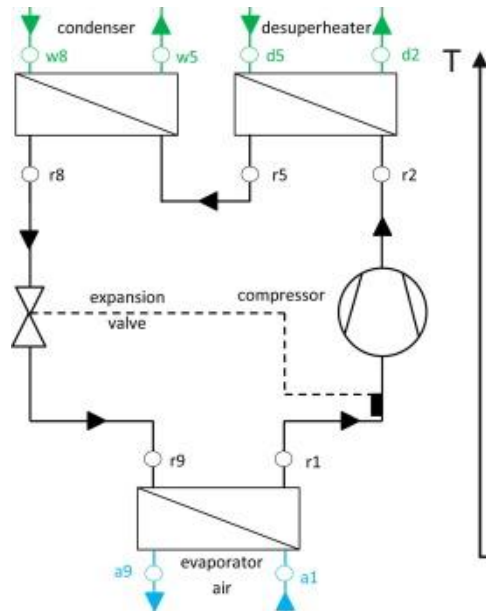
Sleutelement voor WP performantie

Performantie sterk afhankelijk van mate van **procesintegratie**:

- › Temperatuurniveau's & deltaT's;
- › Typologie multi cycle / serie-opstelling;
- › Architectuur (ECO, cascade, ...);
- › Subcooler & desuperheater;
- › ...



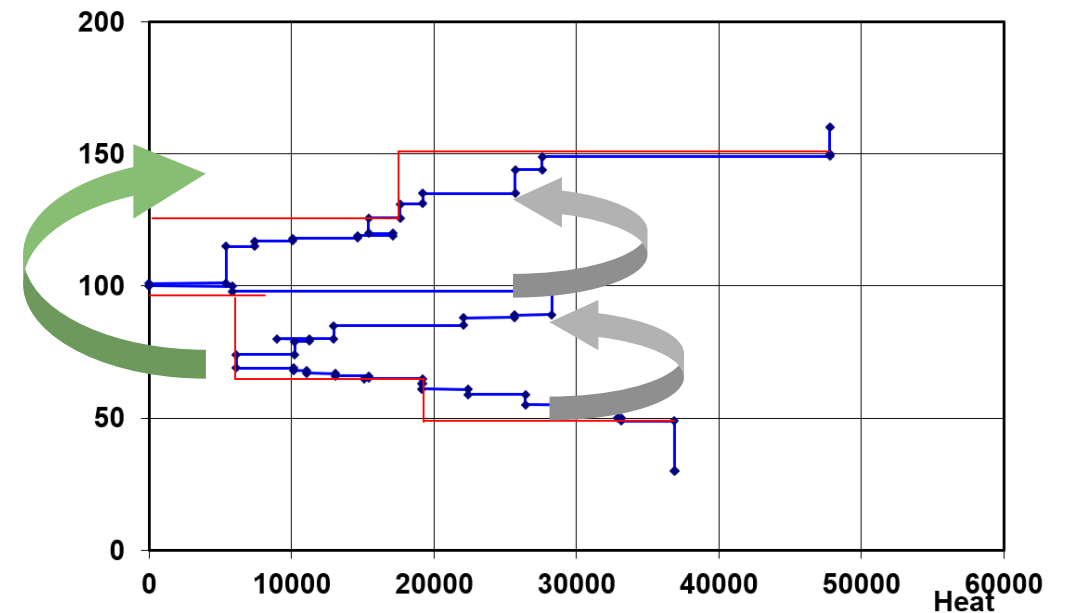
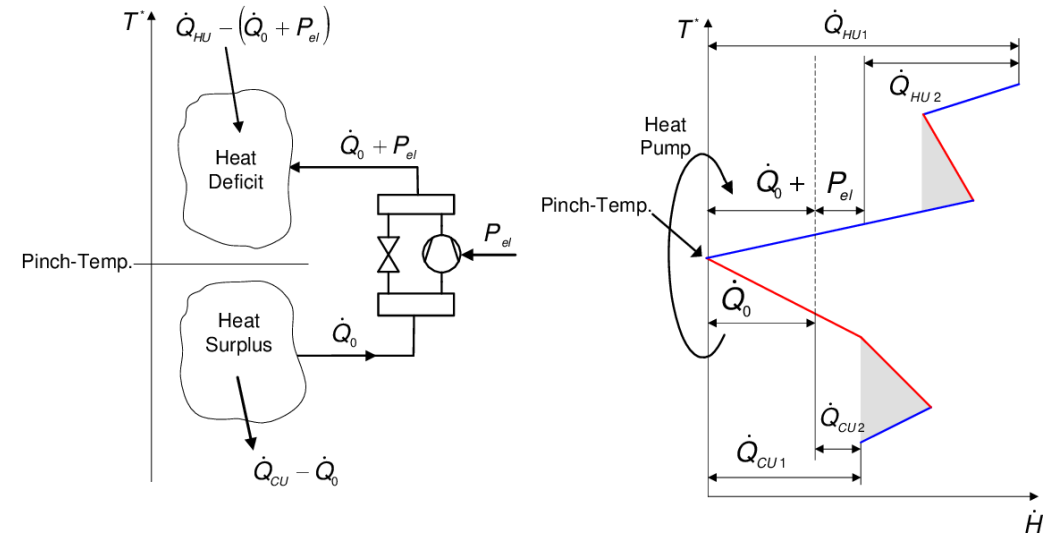
Heat supply **temperature level** should be determined by the process (which is often lower than the historical energy supply temperature level)
 → often **conversion of steam to heat water distribution system** required



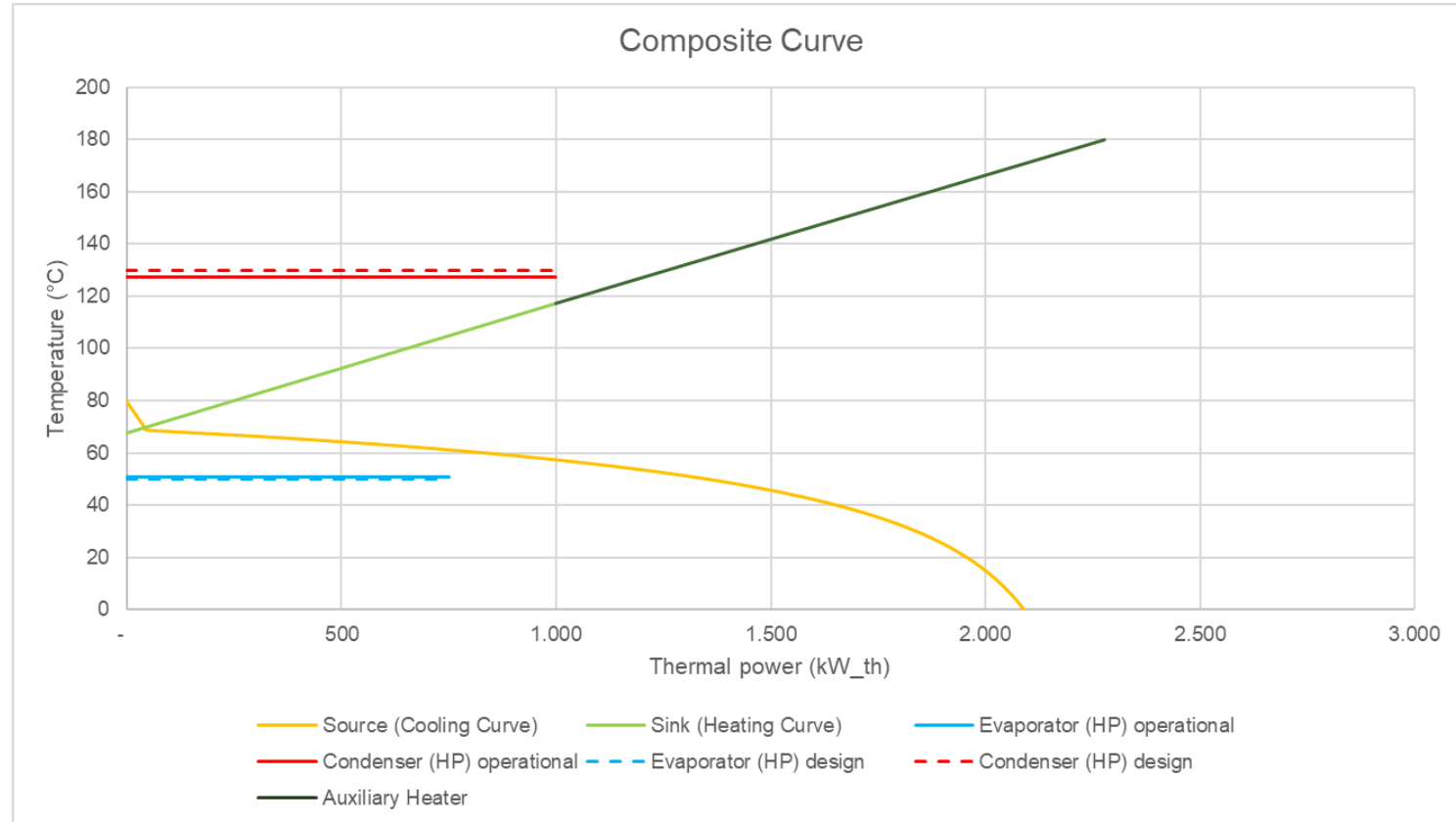
Pinch analyse

Startpunt van warmtepomp design

- › WP koppelt warmte-overschot onder en warmte-tekort boven pinch
- › Pinch levert:
 - Bron: welke restwarmtestromen zijn echt bruikbaar (temperatuur + beschikbaarheid)
 - Sink: welke warmtevraag kan je best voeden met warmtepomp/MVR
 - Optimale lift: elke °C die je níét hoeft te liften verdient je 2x terug
- › Start met optimalisatie van passieve warmte-integratie, maar houd rekening met exergie-verliezen
- › WP kan volledig boven/onder pinch geplaatst worden
 - Vb. destillatie (pocket)
 - Minimaal energieverbruik
 - Overtreding pinch geboden



Use case – HP integration on dryer with recirculation



4 WP koudemiddel: een veelzijdige kwestie

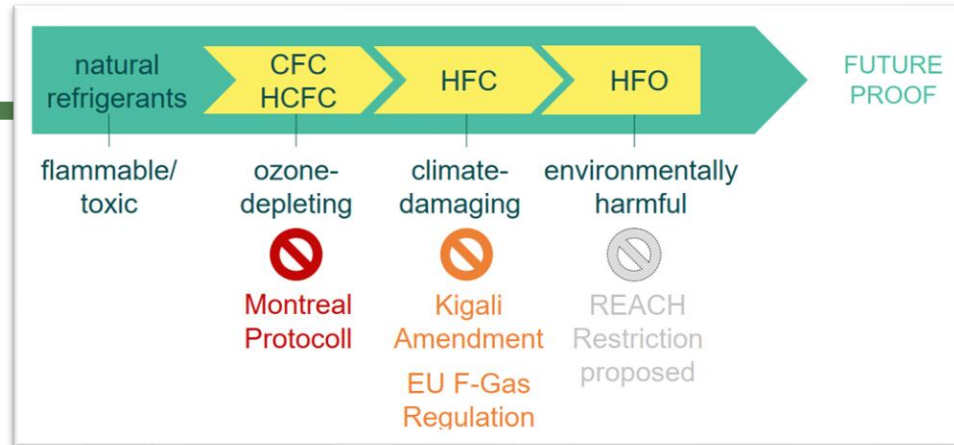
Heat pump refrigerants

Natural refrigerants: futureproof choice of preference

Hydrofluorocarbons/olefins

Synthetic refrigerants (HFC/HFO/HCFO)

- › **HFOs and HCFOs** (such as R1234ze, R1233zd, ...) are F-gases often recommended by suppliers for their low Global Warming Potential (GWP), Ozone Depletion Potential (ODP), safety and non-toxicity
- › However, they are classified as “**forever chemicals**”



Source: Deutsche Umwelthilfe (DUH)

- › **EU PFAS Ban Proposal (REACH):** Registration, Evaluation, Authorisation, and Restriction of Chemicals
- › Includes bans on HFCs and HFOs

NH₃, H₂O, CO₂ and hydrocarbons

Natural refrigerants

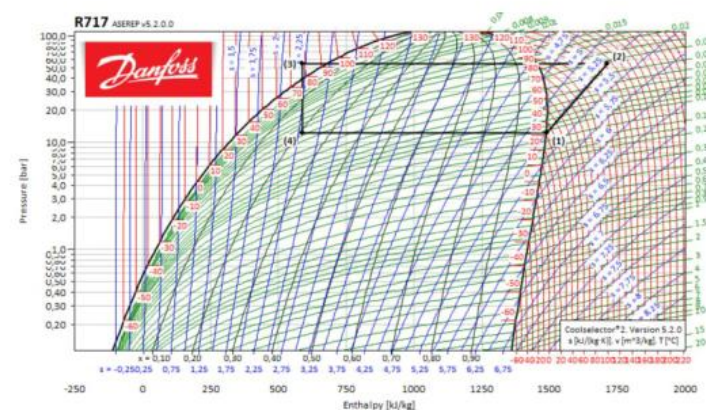
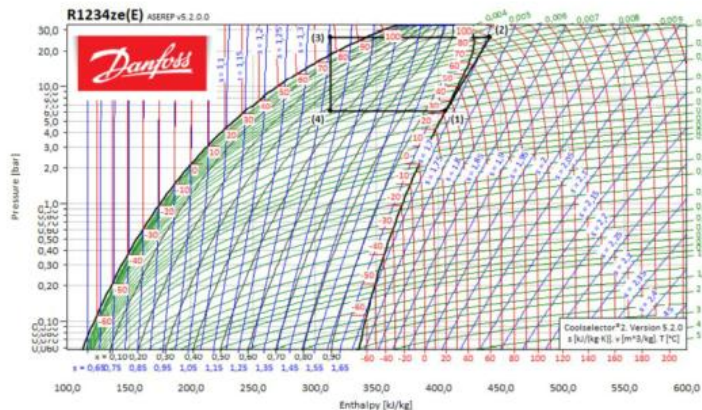
- › Futureproof choice of preference
- › Ammonia NH₃ (R717), CO₂ (R744), propane (R290), pentane (R601), butane (R600) and iso-butane (R600a)
- › Excellent thermodynamic efficiency
- › Attention for toxicity ammonia and high flammability (A3) hydrocarbons (fire safety measures)

Het ideale warmtepomp koudemiddel

Slimme keuze neemt verschillende aspecten in overweging

WP koudemiddelkeuze te maken i.f.v.

- › **Thermodynamic suitability:** temperatuurbereik, drukniveaus (zowel min. / max. / verschil)
- › **Performantie:** COP
- › **Veiligheidsaspecten:** toxiciteit en ontvlambaarheid
- › **Klimaat / milieu:** GWP/ODP/PFAS (future proof!)
- › **Marktbeschikbaarheid:** constructeur gamma capaciteiten/vermogens en temperaturen



Transkritische CO₂ warmtepomp

Opportuun voor grote deltaT aan afgifte

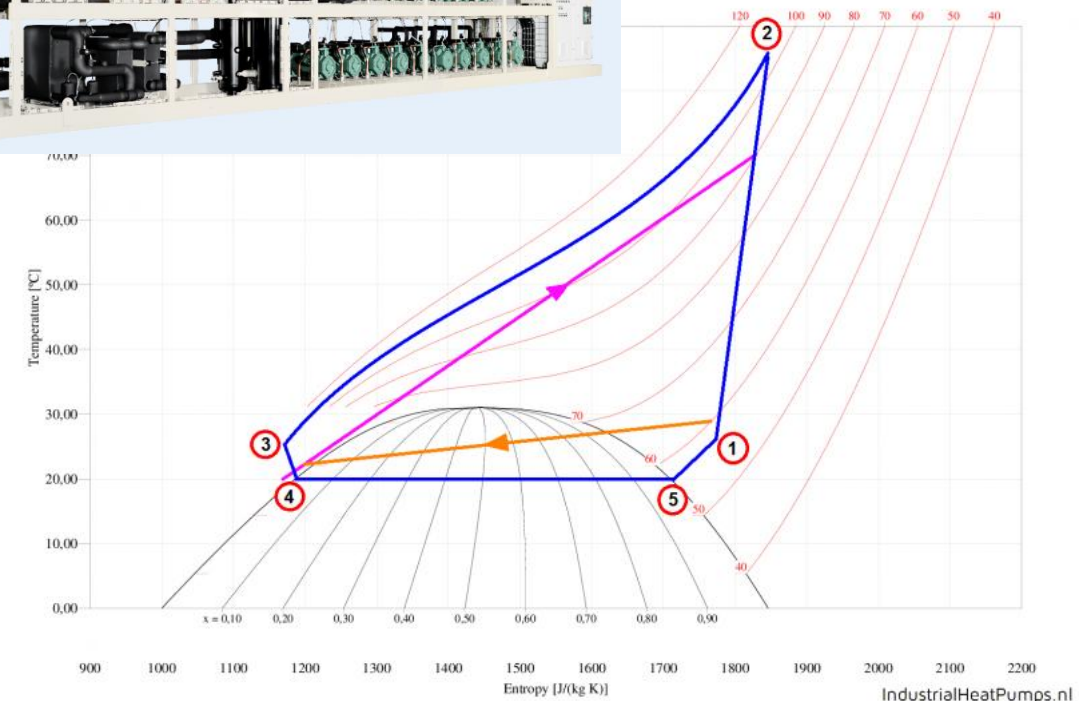
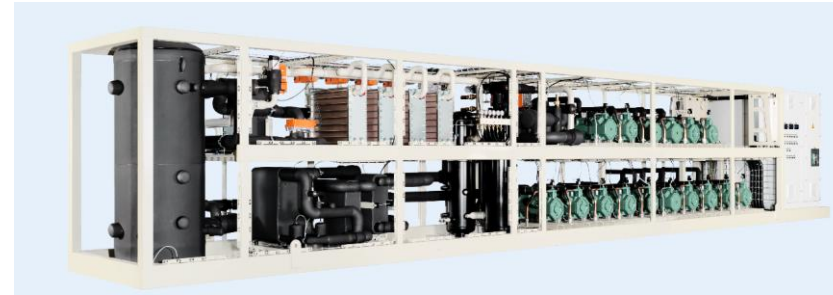
- Werkingsmiddel CO₂ opportuun voor droogprocessen
 - › Haalt relatief goede COP's bij grote deltaT aan afgifte door **match T-profielen / T-glide** (beter dan met vaste T condensor - Carnot) → fit met droogtoepassing
 - › **Natuurlijk en future proof:** low GWP, ODP, niet-toxisch/brandbaar (A1), geen PFAS
 - › Goeie warmteoverdracht eigenschappen (vol.)
- Fundamentele verschillen met klassieke WP
 - › Hoogste drukken voor bepaalde T i.v.m. andere koelmiddelen → specifieke equipment
 - › Gascooler i.p.v. condensor → ingaande i.p.v. uitgaande waterT bepalend voor COP (belang van **lage retourT!**)
 - › $T_{crit} 31^{\circ}\text{C}$ → verdamper ingangst < 20°C gangbaar
 - › Optimale drukregeling i.f.v. watertemperatuur (onafh.)

COP BASED ON WATER INLET AND OUTLET TEMPERATURES^{1,2}

Water inlet temperature (°C)	60	55	50	45	40	35	30	25	20	15
	-	-	-	2.22	2.22	2.22	2.22	2.20	2.16	2.12
	-	-	2.42	2.42	2.42	2.42	2.40	2.37	2.33	2.29
	-	2.67	2.67	2.67	2.67	2.64	2.59	2.53	2.47	2.41
	2.92	2.91	2.90	2.90	2.89	2.85	2.79	2.72	2.64	2.57
	3.17	3.16	3.14	3.11	3.07	3.03	2.98	2.90	2.81	2.72
	3.50	3.46	3.40	3.34	3.26	3.18	3.09	3.06	2.81	2.72
Water outlet temperature (°C)										
55 60 65 70 75 80 85 90 95										

1) Ambient temp. 7 °C, RH 80%, MT evaporation temp. -2 °C
2) Excl. fans & pumps

Ref: Advansor

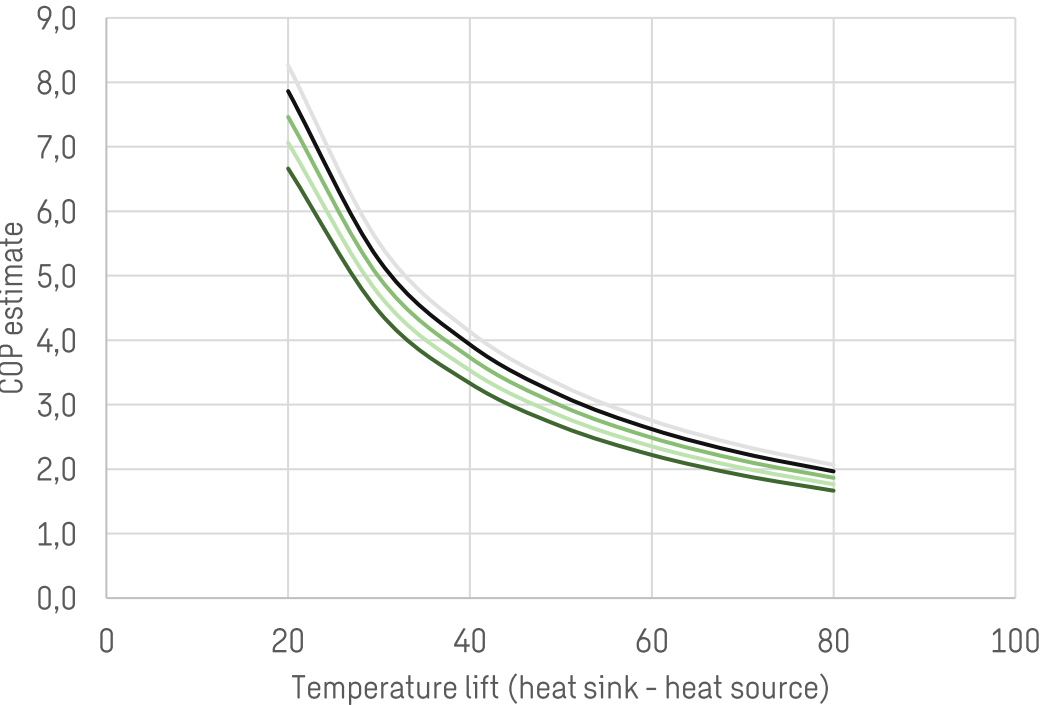


5 WP performantie en investeringskosten

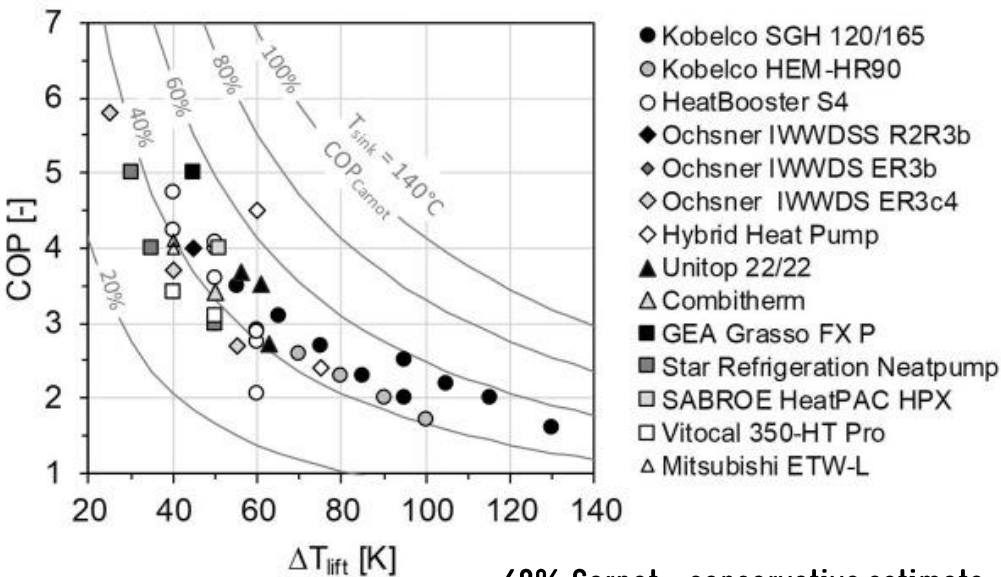
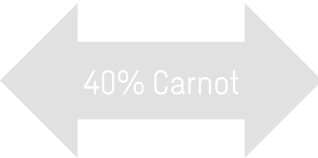
Heat pump performance

Key: temperature lift and supply temperature

COP estimate i.f.o. heat sink temperature and temperature lift
(conservative estimate 40% Carnot)



- T_sink 140°C
- T_sink 120°C
- T_sink 100°C
- T_sink 80°C
- T_sink 60°C



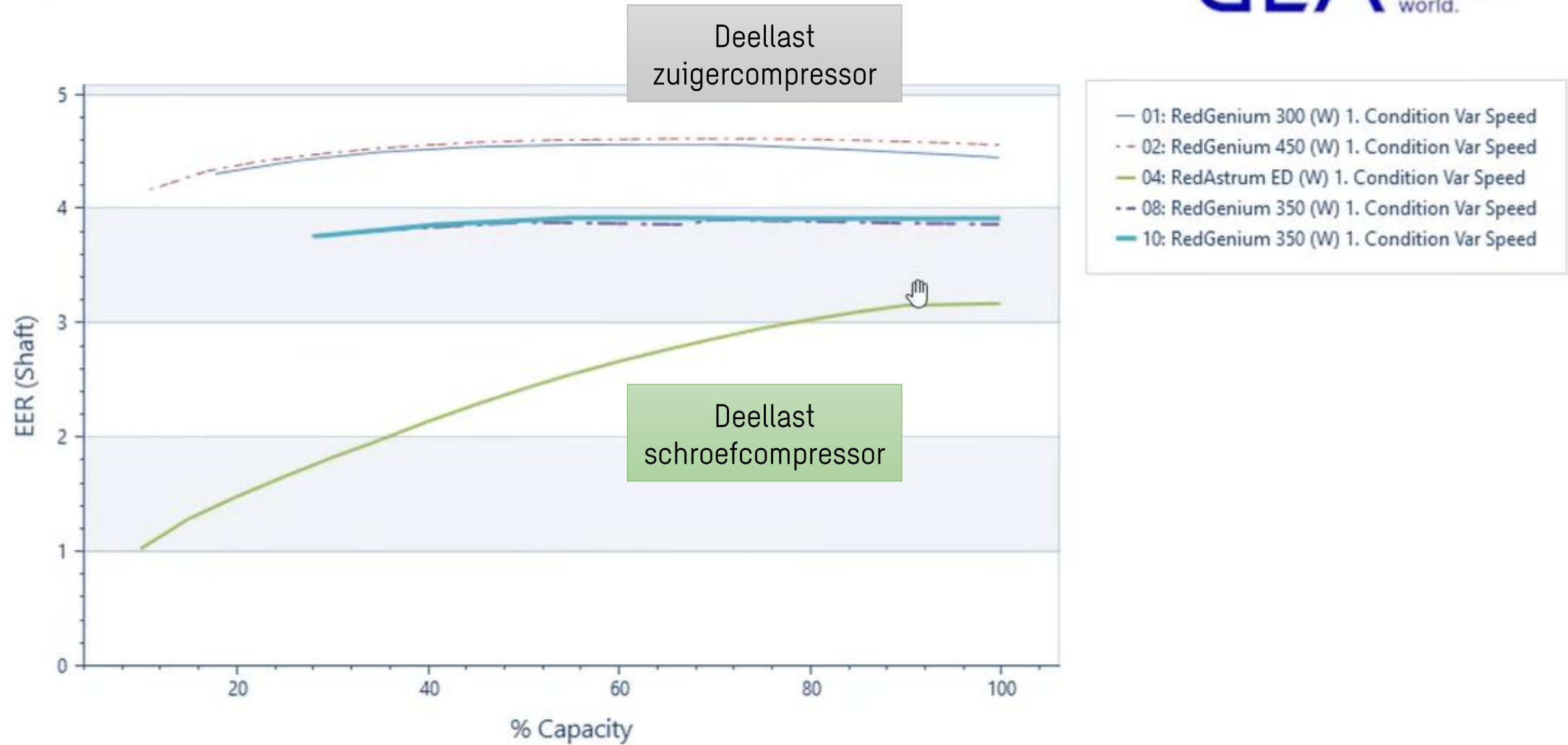
40% Carnot ~ conservative estimate
60% Carnot ~ high performance, NH₃, ...
Alternative approach: Lorenz

COP conservative estimate		T_lift (K)						
		20	30	40	50	60	70	80
T_sink(°C)	140	8,3	5,5	4,1	3,3	2,8	2,4	2,1
	120	7,9	5,2	3,9	3,1	2,6	2,2	2,0
	100	7,5	5,0	3,7	3,0	2,5	2,1	1,9
	80	7,1	4,7	3,5	2,8	2,4	2,0	1,8
	60	6,7	4,4	3,3	2,7	2,2	1,9	1,7

Heat sink: heat pump supply T (cond. outlet)
Heat source: HP source (evap. inlet)
Temperature lift = heat sink - heat source

Ballpark figures only for purpose of preliminary assessment of economic viability. Heat pump performance and COP should be evaluated case specific given impact of refrigerant, compressor type, deltaT/flows etc.
Alternative: online tool for COP estimating: <https://tlk-energy.de/en/phase-diagrams/pressure-enthalpy>

Project Efficiency



$EER (Shaft) = Q_o / P_e$. Calculation is based on the electrical demand of the compressor only

CAPEX — summary of heat pump module cost

Rules of thumb

Ballpark figures only for purpose of preliminary assessment of economic viability. Heat pump project cost should be evaluated case specific given variations in **HP module cost** (impact of refrigerant, compressor type, deltaT/flows and heat exchanger sizing etc.) as well as the entire **BoP** (E&I, civil, piping, ...)

HP type	HP supply temp. range	Specific cost range (euro/kW _{th})	Remarks
Low-T synthetic refrigerants <i>Based on R1234ze</i>	≤ 90 °C	< 300 kW _{th} : 200 - 700 euro/kW _{th} (<i>optimistic / conservative</i>) 300 kW _{th} – 2.000 kW _{th} : 300 – 150 euro/kW _{th}	<i>Large spread < 300 kW_{th}</i> <i>Based on dataset 130 – 2.000 kW_{th}</i>
High-T synthetic refrigerants <i>Based on R1233zd(E)</i>	90–150°C	900 euro/kW _{th}	<i>Based on dataset 130 – 3.000 kW_{th}</i>
Natural refrigerant <i>Based on ammonia (NH₃)</i>	60–90°C	< 600 kW _{th} : 800 euro/kW _{th} > 600 kW _{th} : 500 euro/kW _{th}	<i>Large spread</i> <i>Based on dataset 300 – 6.000 kW_{th}</i> <i>Ammonia: strong reduction in specific cost possible</i>

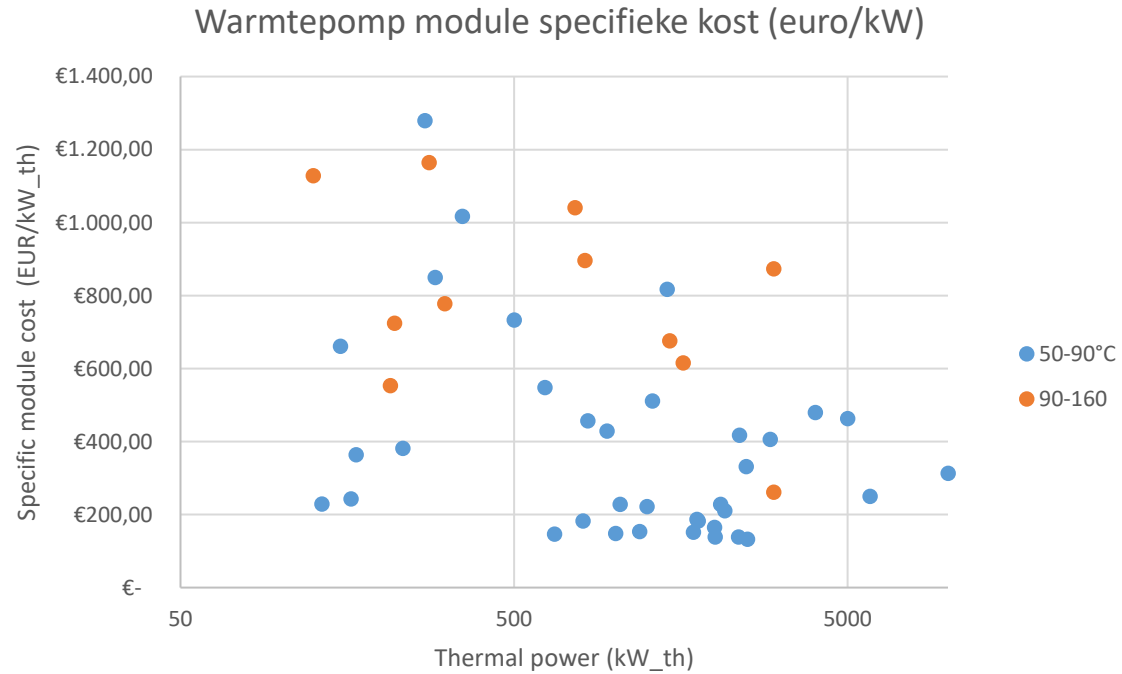
Categories HP type based on Sweco (indexed) price database from vendor quotes

All figures are CAPEX of the **water/water heat pump module only** — implementation costs are site-specific.

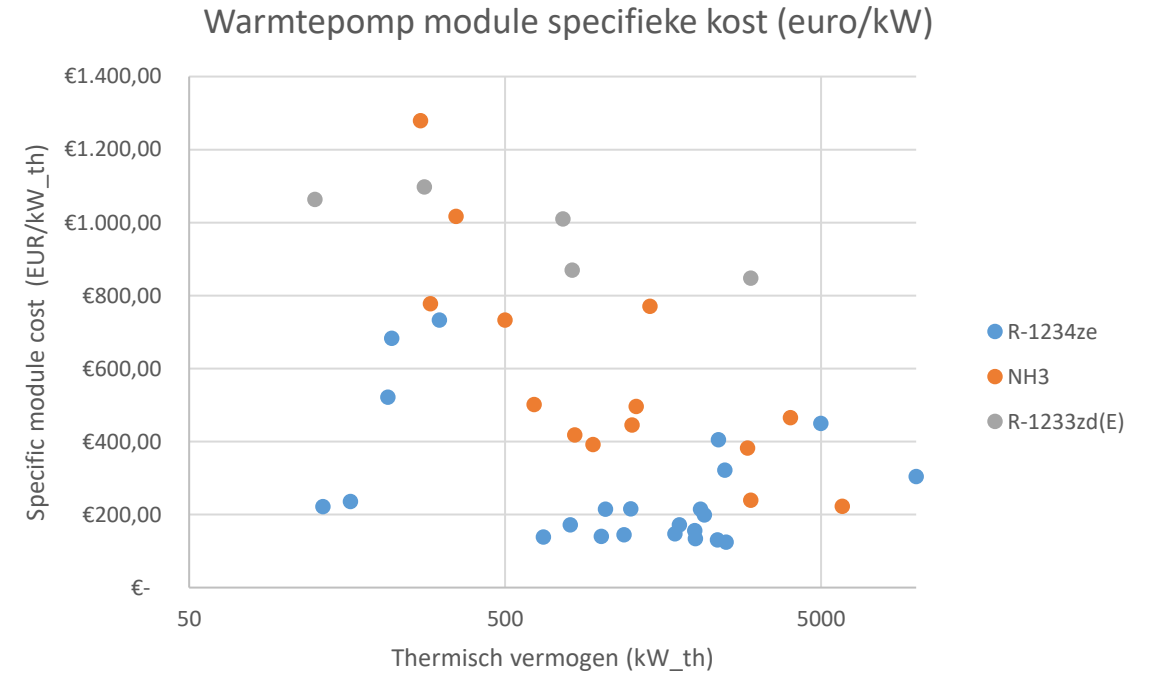
CAPEX — summary of heat pump module cost

Rules of thumb

Temperature filtered



Refrigerant filtered



CAPEX — summary of heat pump module cost

REFERENCE — IEA Annex 68

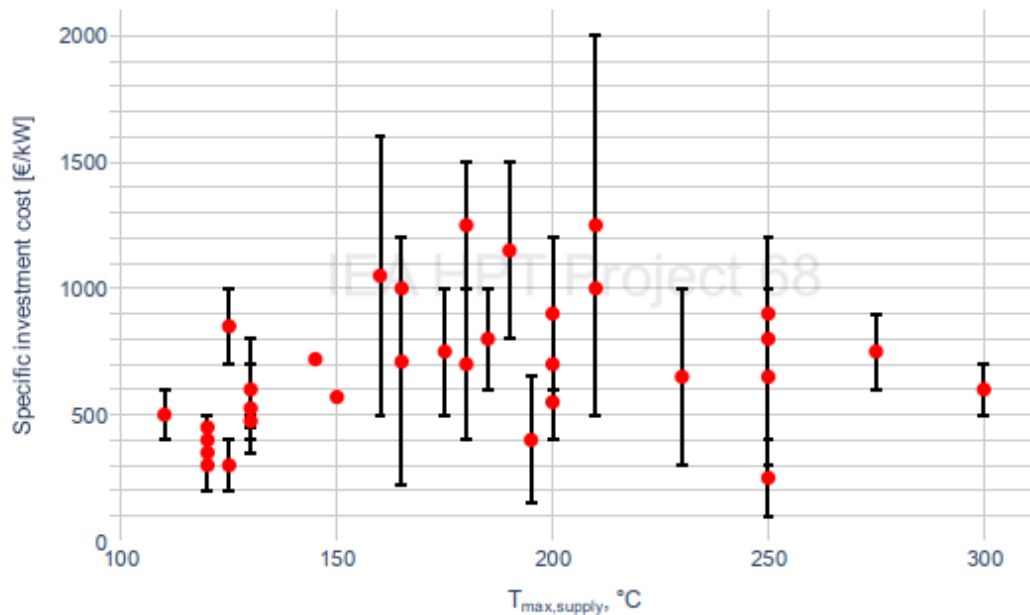


Figure 1-5: Specific investment cost⁵ as a function of maximum supply temperature. The investment cost is for the unit cost without any integration.

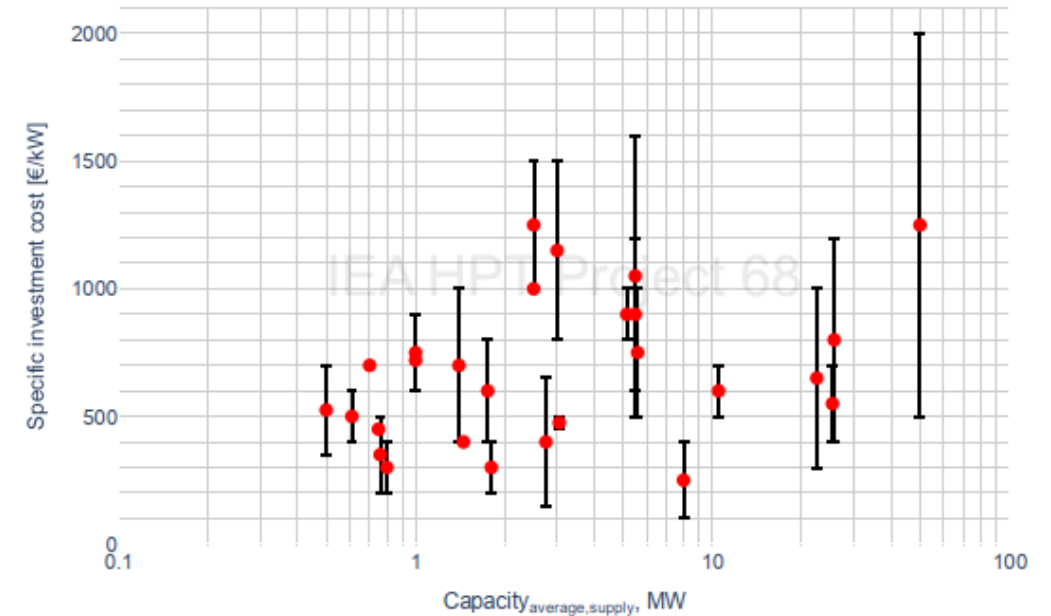


Figure 1-6: Specific investment cost as a function of average capacity.

CAPEX — insight in heat pump module cost dynamics

Ammonia heat pumps

Cost evaluation insights

- › In smaller power range, **piston compressor** is more budget friendly than screw compressors
- › **Bigger module** can lead to significant specific cost reduction (screw larger impact than piston)
- › Same module with **high pressure piston compressor**
 - Higher capacity (+34%)
 - Limited price increase but specific cost reduction
- › Finding commercial solution closest to **required capacity** results in lowest specific cost (avoid nominal selection to deep in part load)

CAPEX — insight in heat pump module cost dynamics

Ammonia heat pumps illustration

	Vermogen (kW_th)						
	beschouwde condities						
Series (manufacturer X)	Selectie (obv data)	Design (full speed)	Stand. gamma	Rel. sizing	Budgetprijs	Spec. kost (euro/kW)	Prijs- toename
Model 1	270	287	307		345.500 €	1.204 €	
Model 2	350	429	461	150%	356.150 €	830 €	3%
Model 3	500	575	615	200%	366.800 €	638 €	6%

Input/variabele

Output/resultante

Series (manufacturer Y)	Compressor type	Design pressure (barg)	Compress or type	Source T (°C)	Sink T (°C)	Selected capacity (kW_th)	Budget price (euro)	Full load capacity (kW_th)	Spec. cost* (euro/kW)	Rpm sel.	Rpm sync	Load sel.
Model 1	screw	40		27/22	50/70	300	504.578	521	968	2.331	3.600	58%
Model 2	screw	40		27/22	50/70	600	523.391	685	865	3.570	3.600	99%
Increase							4%	16%	-11%			
Model 3	piston	40	V HP	27/22	50/70	600	506.863	723	701	1.245	1.500	83%
Model 3	piston	60	XHP	45/35	75/90	600	515.759	970	532	928	1.500	62%
Increase							2%	34%	-24%			
Model 1	screw	40		27/22	50/70	300	504.578	521	1.682	2.331	3.600	58%
Model 1	screw	40		27/22	50/70	521	504.578	521	968	3.600	3.600	100%
Increase							0%	0%	-42%			

*Reference to full load capacity except for Model 1 final comparison (reference to selected capacity)

CAPEX — insight in heat pump module cost

Ammonia heat pump compressor type cost behavior



Cost evaluation insights

- › **Piston compressors** physical capacity limitations: lower structural volume limit ~ **1.000 m³/h**. For larger heat pump capacity, add **more cylinders or compressor packages** → multiplies the cost of valves, piping, oil separators and controls in a more steep relation.
- › **Screw compressor** economies of scale: can scale to massive capacities in a single machine ~ **10.000 m³/h**. For larger heat pump capacity, **scale up the physical size of the internal rotors and housing** rather than multiplying the overall unit count → strong economies of scale, reducing specific investment cost (€/kW) as the unit grows.

	Piston/reciprocating compressors	Screw compressors
Low capacity cost (< 500 kW)	Lower initial CAPEX	Higher initial CAPEX
High capacity cost (> 1–2 MW)	Significantly higher (requires multiple units)	Lower per kW (achieved with a single large unit)
Cost curve scaling	Steeper (increases more rapidly with capacity)	Flatter (benefits from significant economies of scale)
Application sweet spot	Intermittent duty, high pressure, smaller industrial heat recovery	Continuous duty, large industrial processes, district heating

CAPEX — from HP module to total investment cost

Balance of plant (both general and heat pump specific)

Balance of plant - general

Heat pump unit typically contains compressor/motor/drive, oil separator, evaporator/condenser, expansion and pressure-control valves, safety equipment, electrical cabinet and all controls & instrumentation. **BOP:** piping, pump skids, buffers, electrical connection, civil works, HVAC, ...

Balance of plant - heat pump specific

Ventilation and leak detection, machine room **EN378-3V1 2** (example separator containment, quick closing valves, ...), **fire safety** for hydrocarbon refrigerants (A2L/A2/A3), ATEX, **noise protection**, location of **electrical cabinets** in context of refrigerant leakage, ...

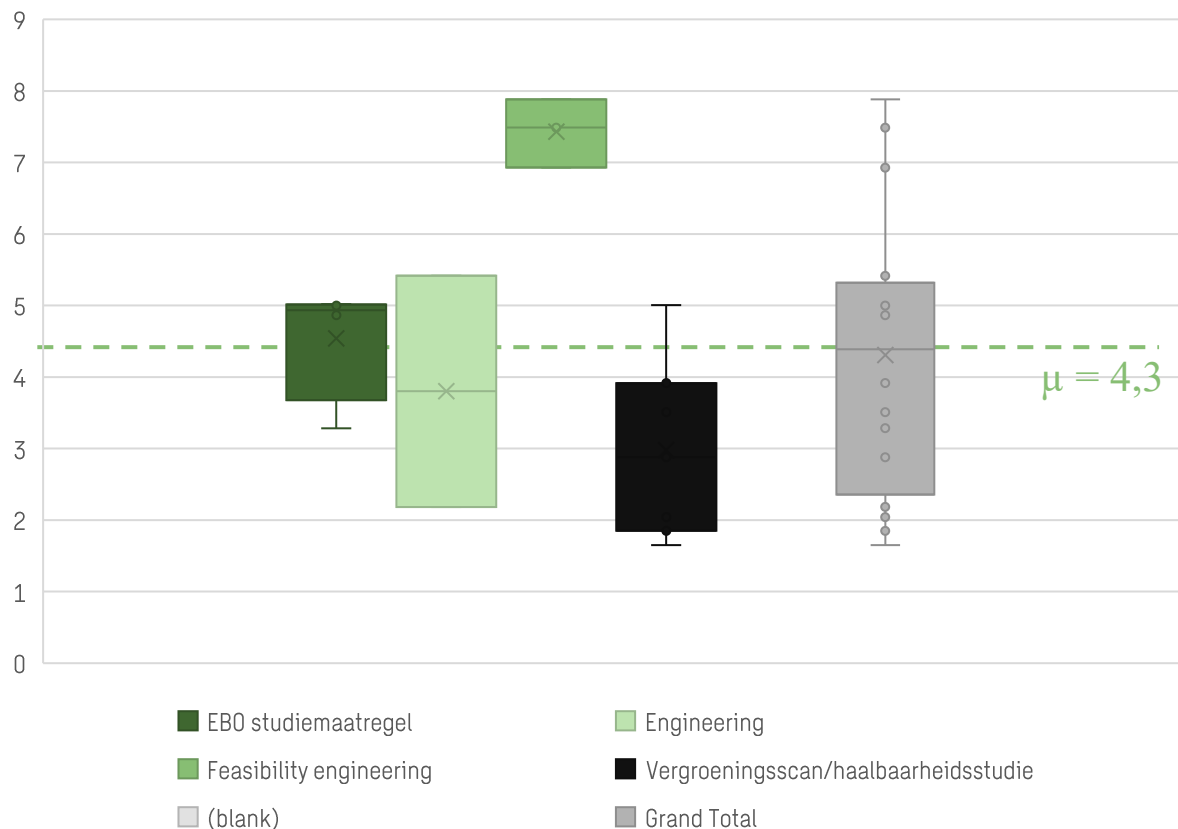
Attention for possible additional cost for **grid connection reinforcement** (incl. “vermogenrecht”) installed vs. available capacity (physical connection / grid)

Other practical aspects: footprint, part load capabilities, operational stability, ...

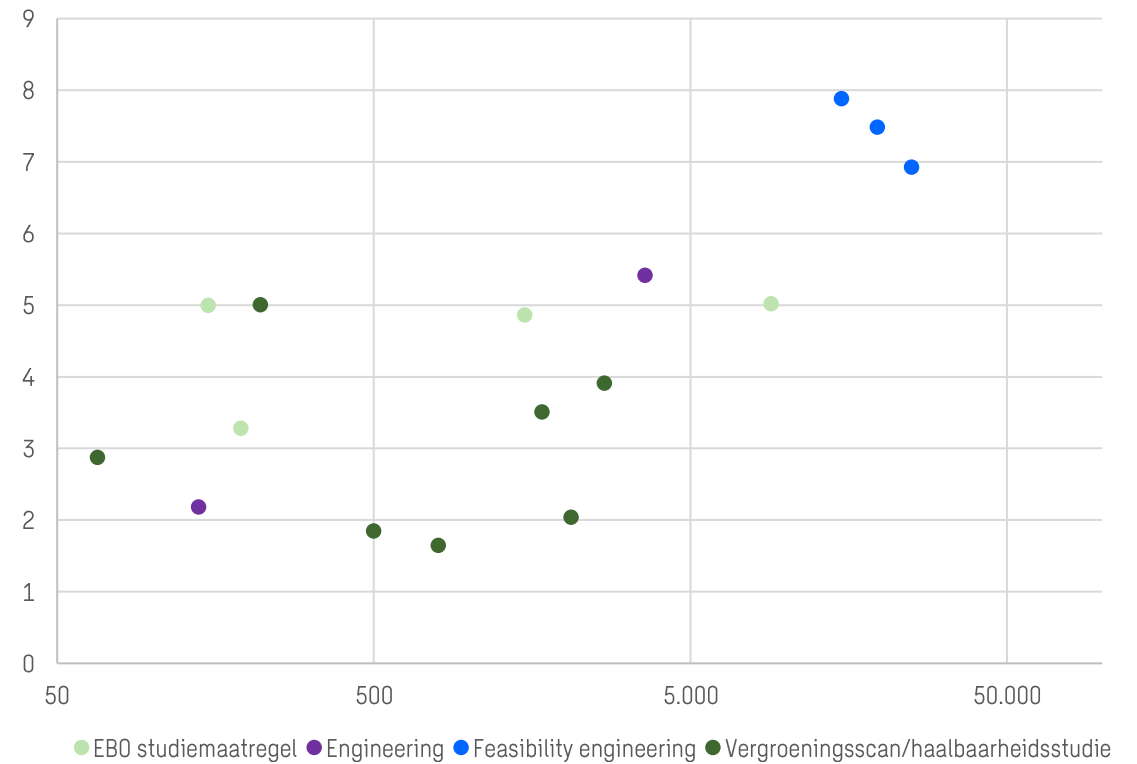
CAPEX — from HP module to total investment cost

Case specific evaluation required

TIC/module cost HP projects



TIC/module cost HP projects



6 Subsidiemechanismen en energy procurement

Uitbreiding compensatie indirecte emissiekosten noodzakelijke stap, maar Vlaanderen moet verder durven gaan

VOKA NATIONAAL

14/07/2026

De Vlaamse regering heeft een belangrijke stap gezet voor de energie-intensieve industrie. Met een principiële goedkeuring van een wijziging aan de bestaande regeling voor de compensatie van indirecte emissiekosten wordt de steun voortaan opengesteld voor een tweede groep bedrijven en sectoren. Dat is positief en noodzakelijk. Maar voor Voka is het tegelijk duidelijk dat deze beslissing geen eindpunt mag zijn. Vlaanderen benut vandaag nog niet de volledige ruimte die Europa biedt, terwijl onze ondernemingen blijven kampen met hoge elektriciteitskosten, toenemende internationale concurrentie en een onzeker investeringsklimaat.

Contactpersoon



Yannick Van den Broeck

Expert Energie en Klimaat

Subsidiemechanismen relevant voor WP

CAPEX of OPEX gebaseerd

Opgelet: verschillen in voorwaarden, toepassingsgebied, steunmechanisme, ... vaak niet onderling combineerbaar

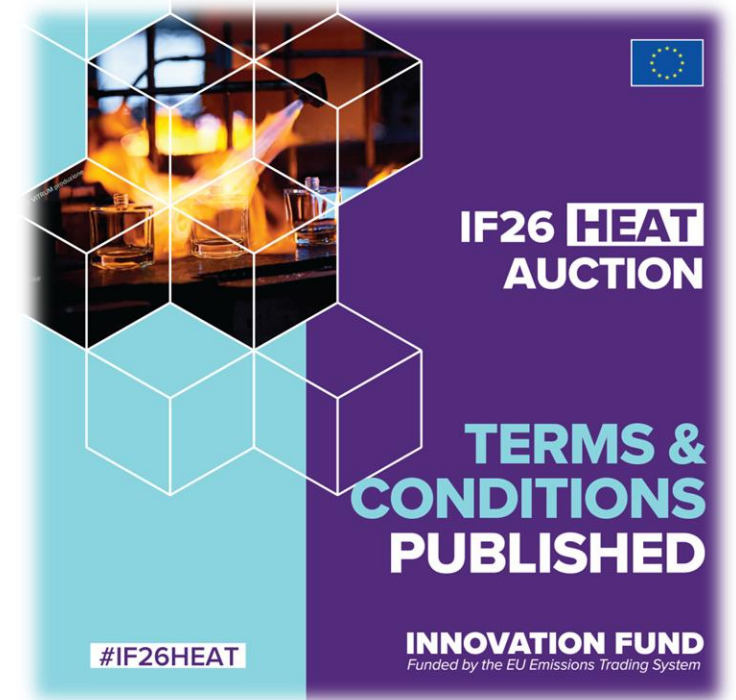
- › VLAIO Ecologiepremie+ en GREEN (tot eind 2026)
- › Verhoogde investeringsaftrek
- › Call Groene warmte ($> 300 \text{ kW}_{\text{th}}$)
- › IF26 EU Heat auction
 - $\text{COP} \geq 1,5$ geldt een bonus van 25% op de rangschikingsprijs
 - $80\text{--}100 \text{ }^{\circ}\text{C}$: € 100 miljoen, vanaf 5 MW_{th}
 - $100\text{--}400 \text{ }^{\circ}\text{C}$: € 600 miljoen, vanaf 3 MW_{th}
 - $> 400 \text{ }^{\circ}\text{C}$: € 300 miljoen, vanaf 3 MW_{th}
- › Klimaatsprong (afgesloten pilootoproep Transitiecontract - CfD)
- › Compensatie indirectie emissiekosten (principeakkoord uitbreiding)
- › ...

Zie ook:

<https://www.vlaio.be/nl/subsidies-financiering/subsidi databank/maatregelen/warmtepompen-steun>

<https://www.vlaanderen.be/procedure-groene-warmte-restwarmte-en-energie-efficiente-stadsverwarming>

https://climate.ec.europa.eu/areas-action/eu-funding-climate-action/innovation-fund/calls-proposals/if26-heat-auction_en



Energy Procurement

Versatile set of topics to be considered

A. Profile analysis

- Analyse current energy usage and detect first possible high-level savings or situations or monthly report
-

B. Hedging Strategy

- Benchmark the existing hedging strategy against our approach
 - Set-up possible hedging strategy taken into account future energy usage
-

C. Click Strategy

- Benchmark the existing click strategy against our approach
 - Set-up a click strategy according client needs and risk management
-

D. Tendering

- Coordinate tender processes for energy procurement
 - Act as the single point of contact for the client in dealings with suppliers
-

E. Contractuals

- Serve as the energy contract expert to ensure alignment with the client
 - Manage Power Purchase Agreements (PPAs) and flexible energy contracts
-

F. Budget forecast & invoice check

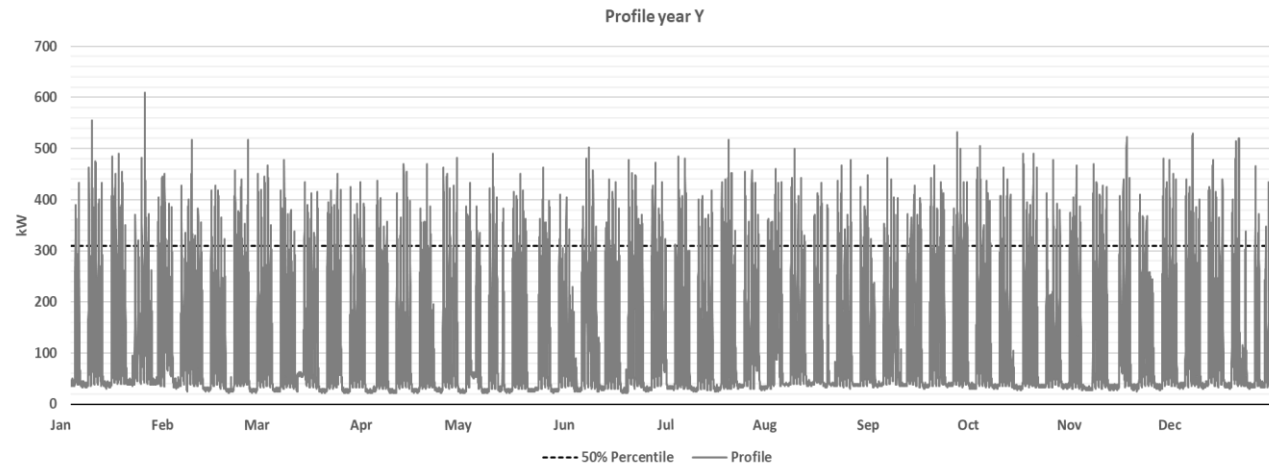
- Prepare energy budget forecasts and verify energy invoices

Energy Procurement

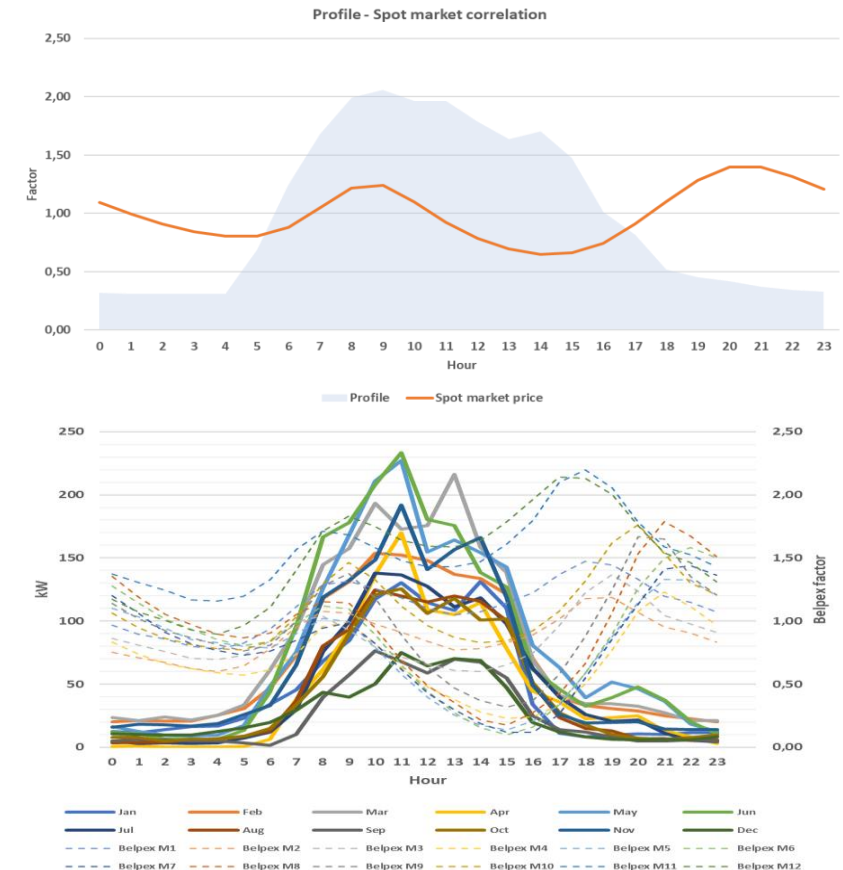
A. Profile analysis



Purpose of this analysis is to develop a comprehensive understanding of how the weight is distributed across the profile. This insight will enable the identification of potential issues, structural imbalances, or other areas that may require further attention



Through this analysis, we develop a thorough understanding of your electrical profile, which provides a solid foundation for initiating the next phase of discussions

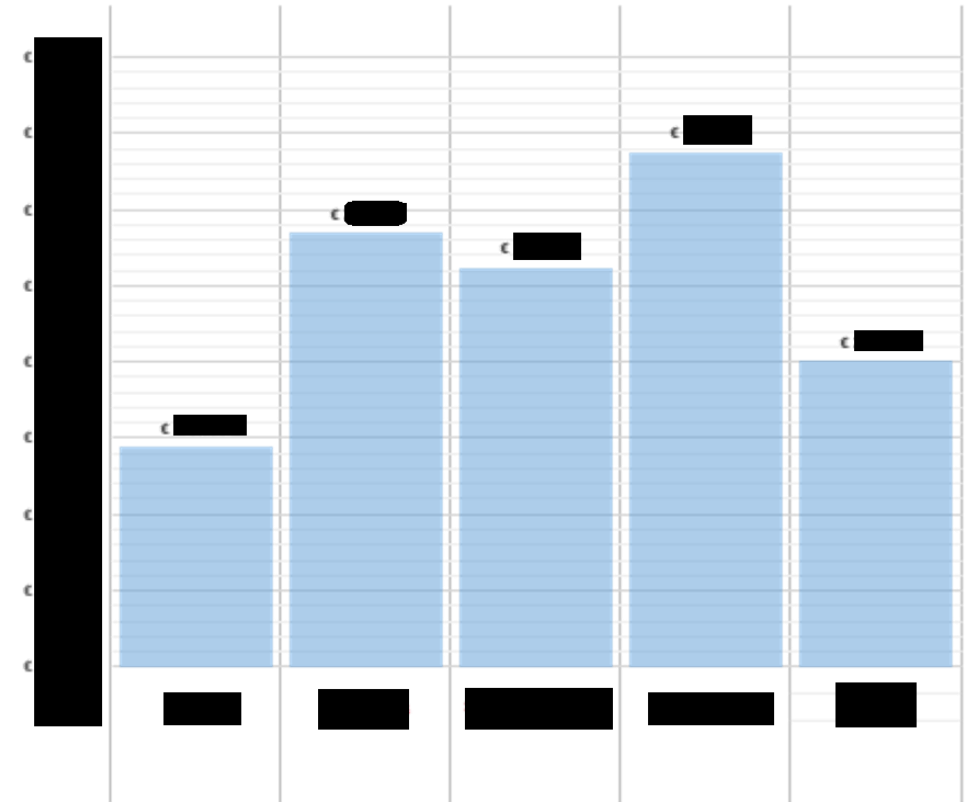


Use case: Energy management and contract support

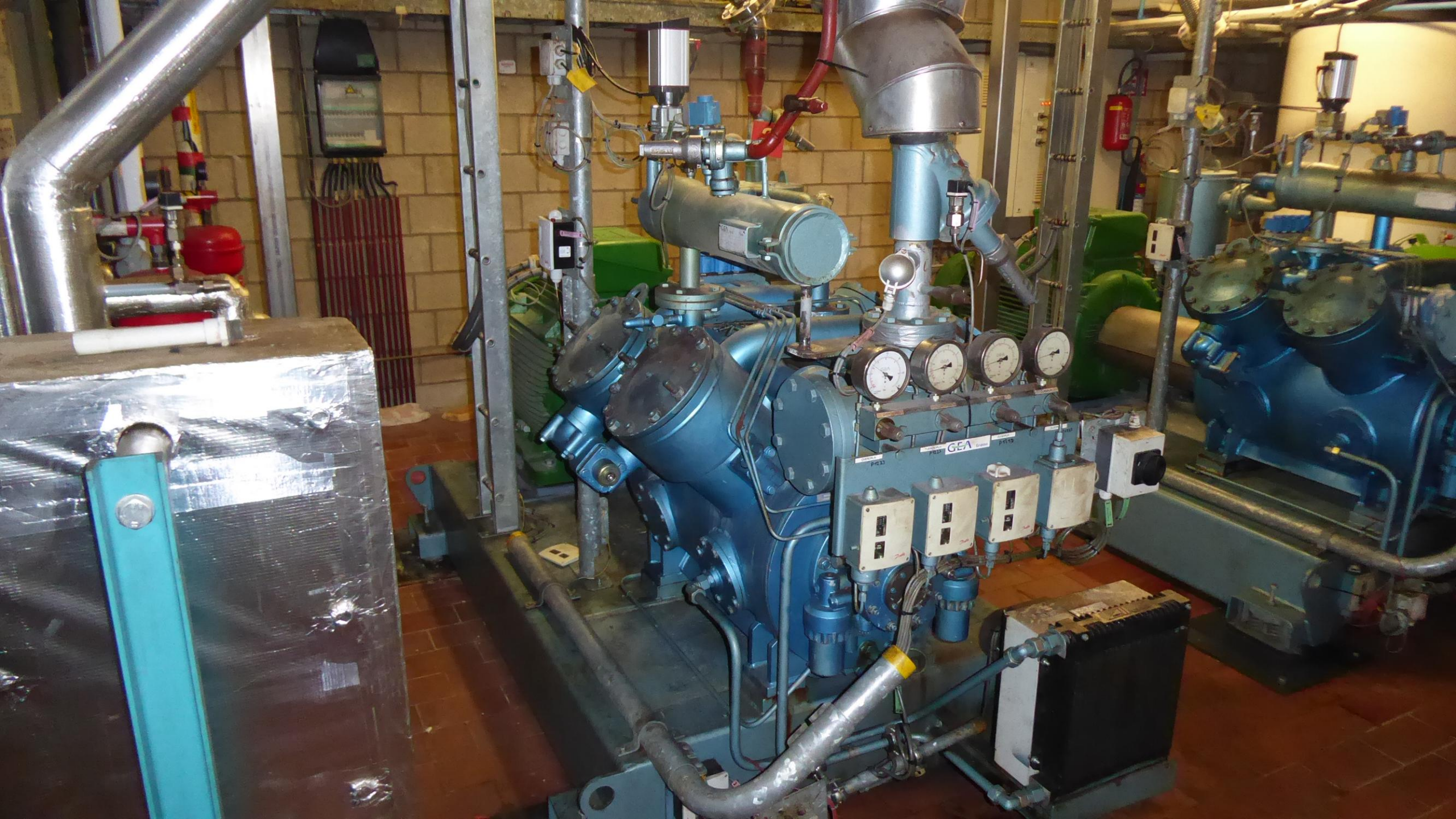


- › Energy administration
- › Budget and invoice control
- › Ownership of the electricity connection
- › Tender for a new electricity contract
- › Energy profile analysis for the current and new storage building
- › PPA support for solar PV and BESS

Significant verschillen puur op commodity
door verschillen in mark-up, onbalans
regeling, bandbreedte, clicking fee



7 Use cases



Add-on heat pump on NH₃ cooling

Key decarbonization opportunity in food industry

■ Project context / drivers

- › Revamp NH₃ cooling installation (obsolete 2-stage piston compressors and evaporative condenser)
- › Company decarbonization targets
- › Baseload process cooling using natural refrigerant → HP opportunity

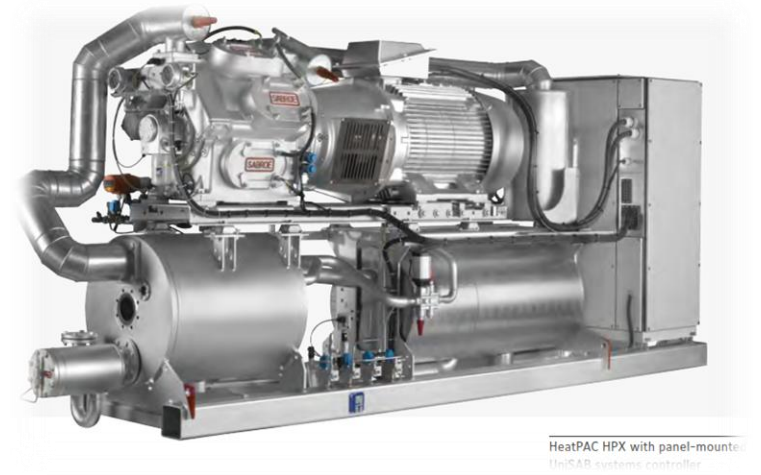
■ Project description

1. Replacement evaporative **condenser**
2. **Add-on heat pump** parallel with condenser, coupled to CV system(s)
3. Replacement 2-stage piston by 1-stage **screw compressors**
4. Switch from decentral monoblocs using CFC's/HFC's to **central cooling at intermediate pressure** (ECO gate & dedicated compressor)

■ Timing study: 2025-2026

■ Sweco's approach

- › Energy balances heat / cold
- › Qualitative selection matrices (condenser type, piston vs. screw compressor, direct/indirect coupling add-on heat pump) i.f.o. KPI's (oil compatibility etc.)
- › PFD, lay-out 2D plotplan, BOP pre-dimensioning
- › Cost estimate (elec, piping, civil, ...) cfr. AACE
- › OPEX analysis (hourly data, part load, O&M, ...)
- › Cost-benefit & sensitivity analysis

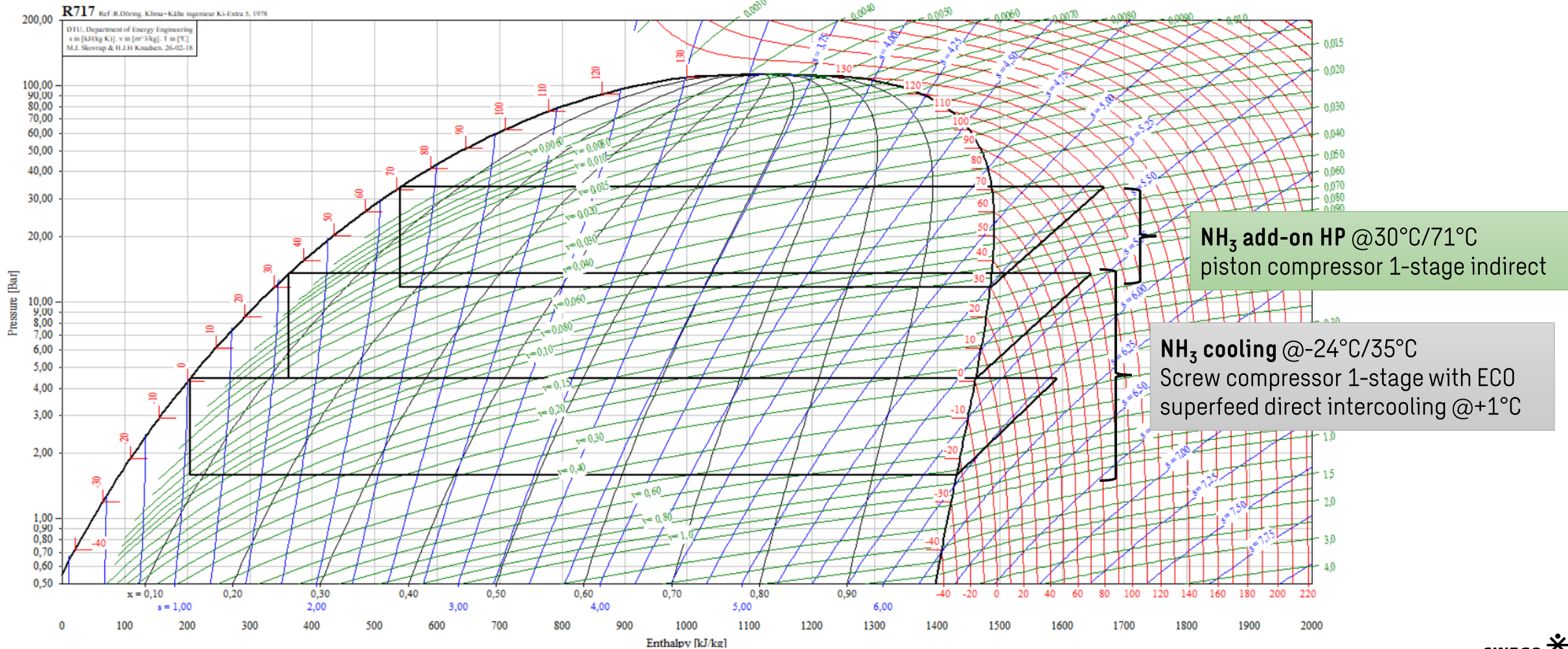


*"Careful study and further design should lead to **cost-efficient, high-performance and reliable integration** of a heat pump into an existing industrial context."*

HP netto COP ~ 5,3 ↔ Price ratio elec./gas ~ 3 (ca. 2,2 incl. ETS2)

Add-on heat pump on NH₃ cooling

Key decarbonization opportunity in food industry



Add-on heat pump on NH₃ cooling

Key decarbonization opportunity in food industry

Cost effectiveness in concept phase

- › Debottlenecking project → **lower HP design temperature** 70°C instead of 85°C → reduced OPEX & CAPEX (cheaper compressor 23 vs. 40 bar)
- › **Passive WHR** (desuperheater, oil cooling)
- › **Location** of machine room and resulting distances (piping, elec, ...)

Operational load range and
part load COP improvement
of piston compressor

Insight in **energy cost structure**
→ don't let HP pay for electrical
peaks of other consumers on site

Economies of scale

50% bigger heat pump
lower specific cost euro/kW_{th}

Higher utilization rate

of waste heat
→ higher netto COP

Points of attention / take-aways

Differentiation **continuity**
and **value** projects
→ avoided costs

Additional cooling users at
intermediate p/T (+ ECO superfeed
direct intercooling) → higher EER and
additional heat source for heat pump

Strategic motivation: “perfect fit”
in key trend in the energy
transition: electrification and
energy efficiency

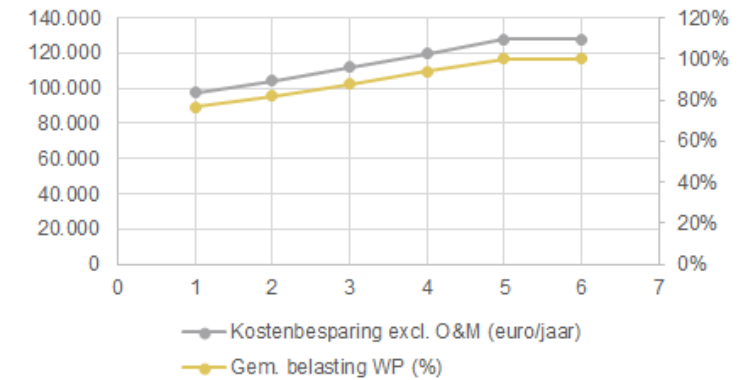
Other drivers / opportunities: impact
of future production increase,
passive WHR, hydraulic optimization,
flexibility, subsidies, ETS2, ...

Risks: hydraulic coupling (flows
and deltaT's collectors),
dynamics heat / cold, ...

Additional electrical consumption: cooling installation
(higher condenser setting) + distribution pumps
However reduced load on condenser

Savings 7,4% CO₂ emissions (scope 1)
and 46% natural gas consumption for
hot water production

Impact productietoename op WP
belasting en jaarlijkse return



Synergy heat & cold integration

Case in food industry

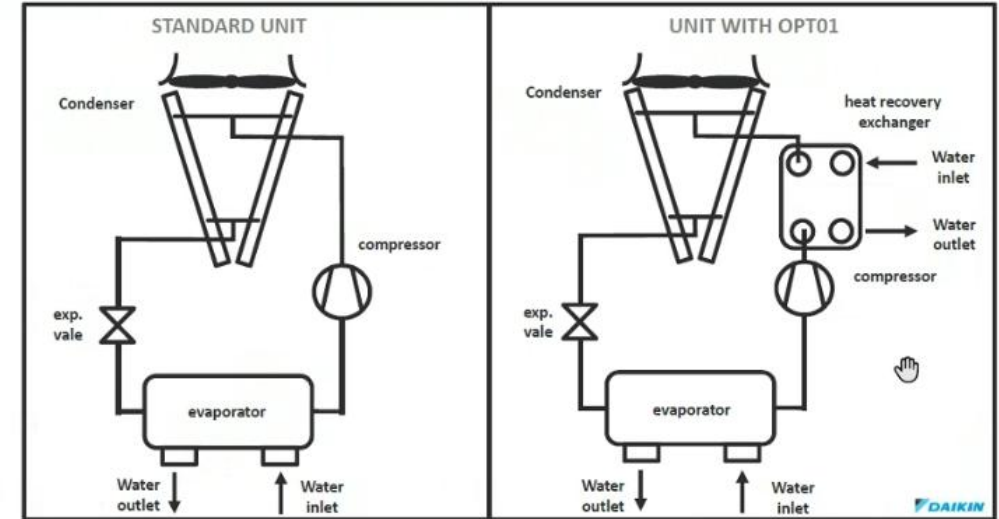


Luchtgekoelde monobloc 600 kW_{th}
(R1234ze) voorzien van WHR ww.

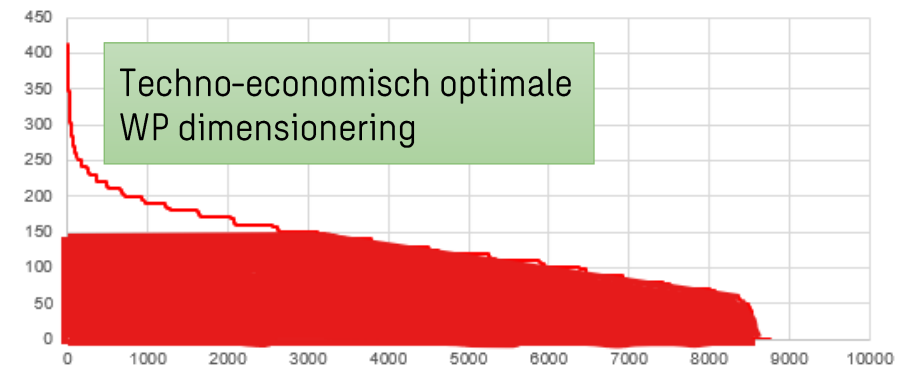
Kaderend in capaciteitsuitbreiding +
uitfasering glycolkoeling
→ Enkel meerkost te beschouwen t.o.v.
standaard monoblocs en gasketels
→ Opportuniteit van uitbreidingen &
vervangingsinvesteringen

Scenario-analyse:
bestaande chiller + add-on warmtepomp
vs.
directe koppeling via 4-pijps warmtepomp

OPT01 – TOTAL HEAT RECOVERY



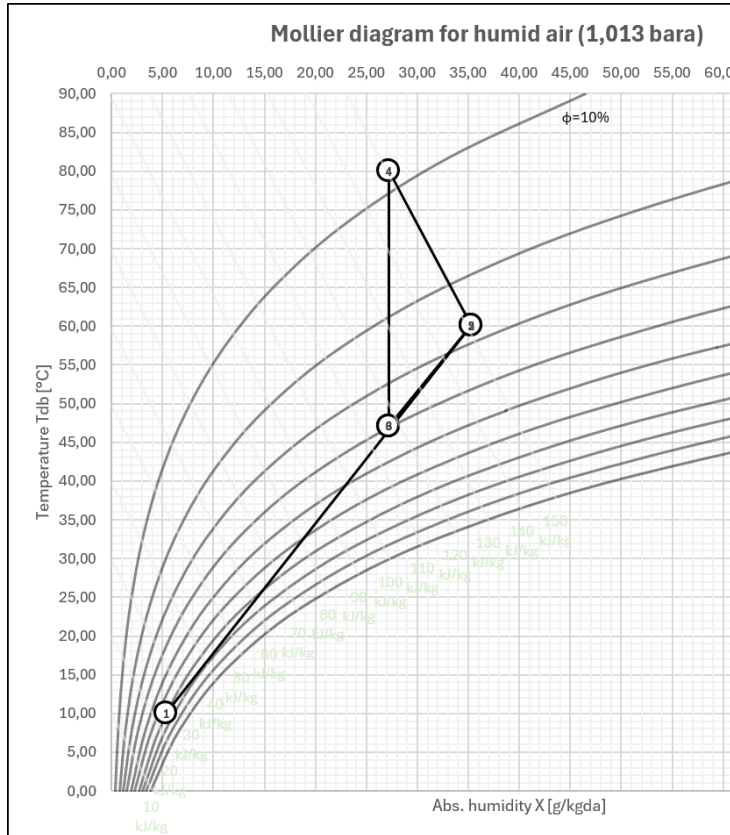
LDC CV Heating Demand (kWh_{th})



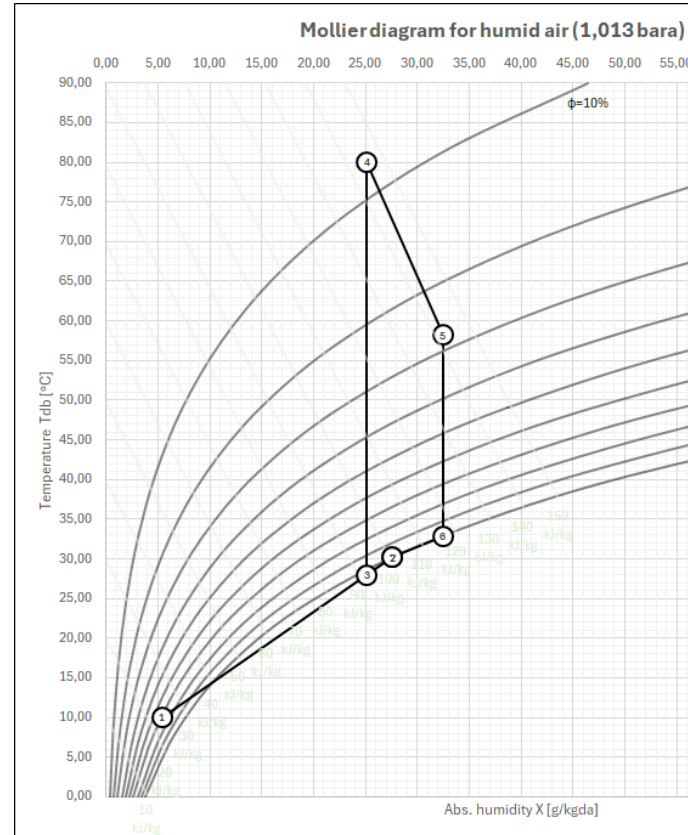
Thermisch model droger met WP

Visualisatie droogproces en WP-integratie

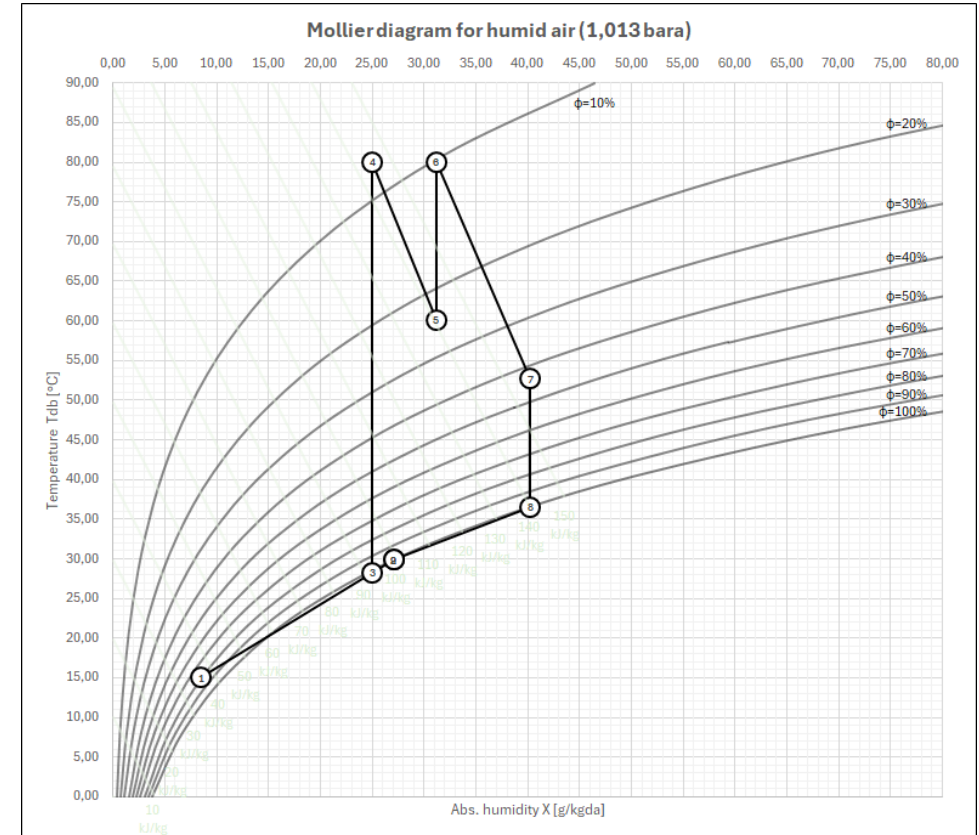
Opportuniteit: **proces/drogerconcept** zelf mee vormgeven met aandacht voor **WP integreerbaarheid** (type droger, droogtemperatuur, aantal zones, bedgrootte, recirculatiegraad, ...)



Constructeur 1 basisvoorstel
1 droogzone - verliesvrij - ϕ_{out} 27%
73% recirculatie - Geen WP



Constructeur 1 met WP
1 droogzone - met verlies - ϕ_{out} 27%
89% recirculatie - Met WP



Constructeur 2
2 droogzones - met verlies - ϕ_{out} 24% / 43%
89% recirculatie - Met WP

Vlaio VGS EOC Oudenaarde

Warmterecuperatie en elektrificatie bij batchreactoren



■ Project context / drivers

- › Reactorcyclus met zowel koeling als verwarming
- › Warm proceswater nodig in afdelingen (12 → 80°C)
- › Uitfasering WKK

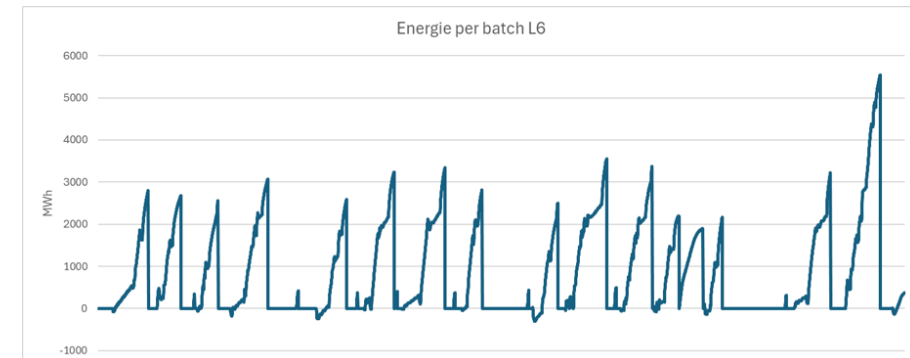
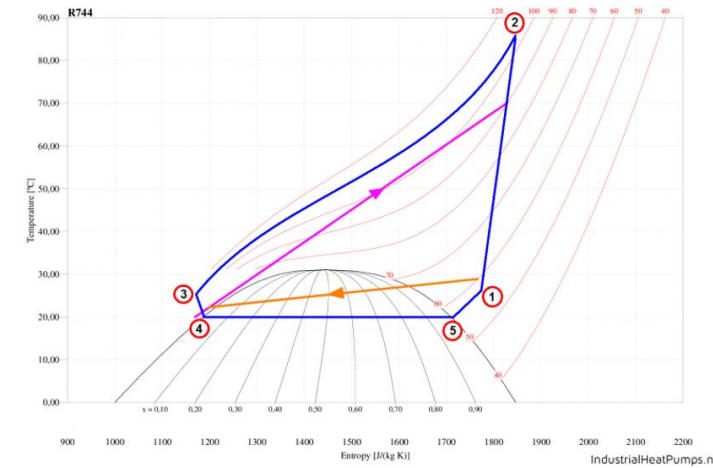
■ Points of attention / take-aways

- › **Superkritische CO₂-warmtepomp** optimaal bij grote dT vraagzijde
- › Integratie warmtepomp met buffering en passieve voorverwarming zorgt voor optimale COP en maximale energiereductie
- › Warmtepomp levert zowel **koeling en verwarming** → maximale proceskoppeling → **buffering** cruciaal bij batchprocessen
- › Extra koeling met ijswater door warmtepomp → kortere koeltijden → hogere productiviteit! (+vermeden extra investering in chiller)

■ Timing study: 2026

■ Sweco's approach

- › Analyse batchcyclus → warmtevraag en restwarmteprofielen
- › Opmaak dynamische warmtebalans
- › Selectie warmte integratiescenario (high level analyse)
- › Dimensionering equipment (buffervolumes, preheat, WP)
- › Contact leveranciers → randvoorwaarden, COPs en kosten
- › **Techno-economische evaluatie van de CO₂ warmtepomp met buffer**



Economische aspecten van industriële warmtepompen

Key take-away

WP case louter beoordelen op een eenvoudige selectie i.f.v. temperaturen, payback en **high level evaluatie**
→ veel WP projecten **onterecht** als **niet haalbaar** van tafel geveegd

General

Procesintegratie,
koudemiddelkeuze,
subsidiemechanismen,
energieaankoop, ...

Evenwel **veelzijdig spectrum aan aspecten** die meespelen om tot gunstige condities voor economisch haalbare warmtepomp toepassing te komen

Case specific - creative/strategic solutions

Gecombineerde verwarming/koeling,
verhoging productiecapaciteit,
directe / indirecte integratie,
locatie inplanting,
aandacht voor kostendynamiek modules, ...

Alle mogelijke **drivers** aanwenden om meer **buy-in** te creëren en tot **verdedigbaar project** te komen

Q&A



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