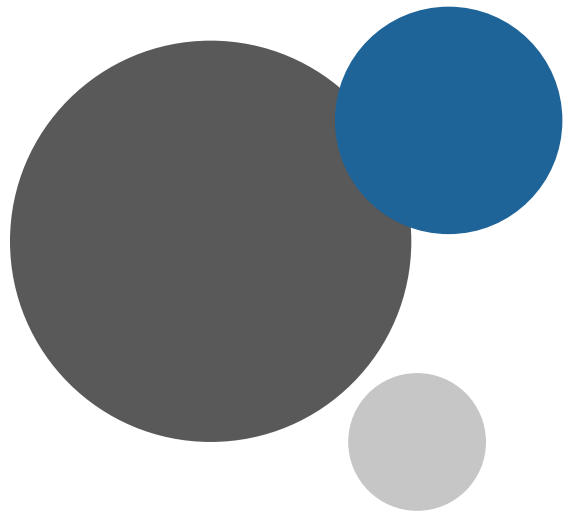




EPCON®
EVAPORATION TECHNOLOGY

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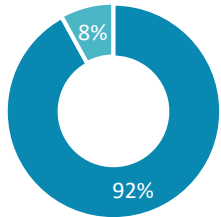
29.09.2026 OST – Steam supplying Heat pumps (Webinar)



Executive summary

EPCON supplies turnkey **MVR evaporation** and **MVR-HP** plants within several industries based on Mechanical Vapor Recompression. We are a **system integrator**, making the difference where we can dive into the clients' process and **optimize the clients return on investment** with our **custom-made** solutions.

Shareholder structure



- Vilokan AB
- Key management/employees

Market segments



BIOMARINE



BIOFUEL



FOOD



PROCESS INDUSTRY

Key facts

170+ plants

delivered since the start in 1986

Trondheim

Located in the center of technology in mid-Norway

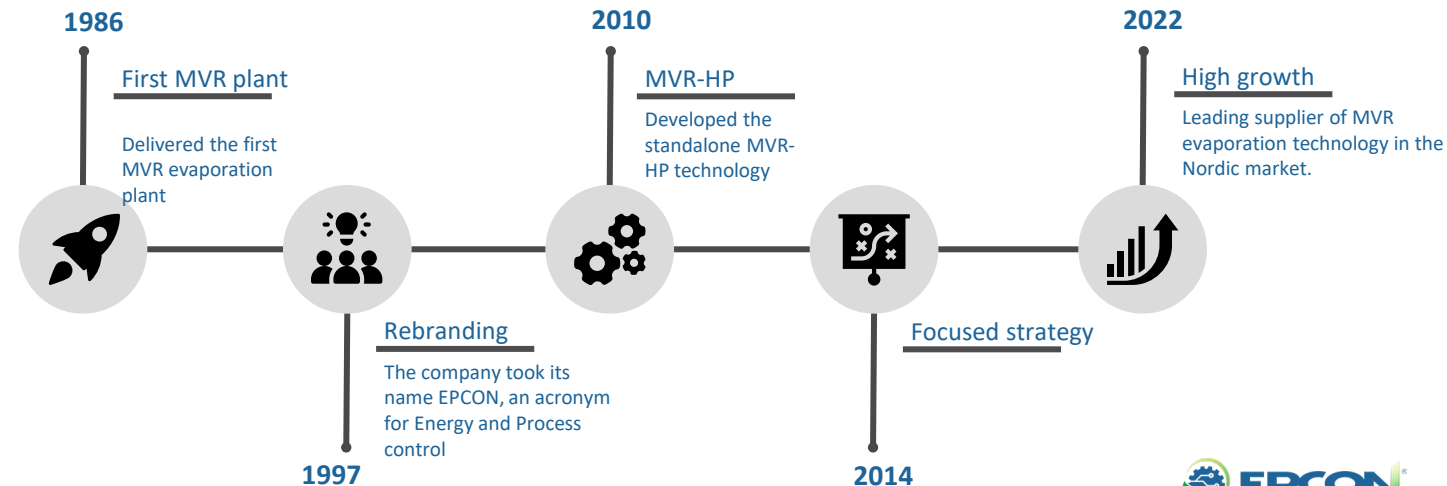
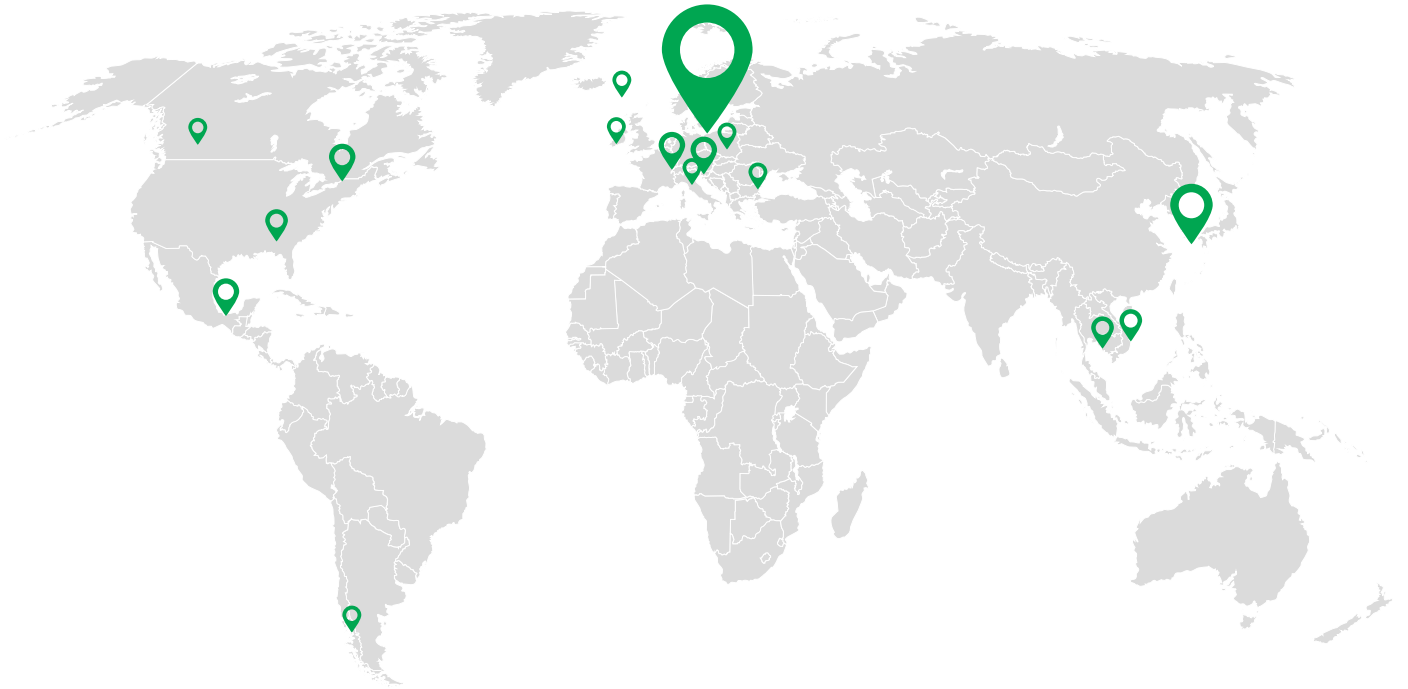
25+ Employees

with background from process and mechanical engineering, chemistry and material technology

1 – 100 MW

Wide capacity range

References and milestones



MVR-HP

MVR-HEAT PUMPS

EPCONs unique MVR heat pump solutions enables full reuse and **utilization of waste heat** as energy sources for diverse process applications, significantly **reducing the overall energy consumption**.

Falling film Evaporators

Low energy consumption for **low and medium viscosity** products.

Epcovap-MVR

Compact evaporator for **small scale production** and concentration.

Forced circulation evaporator

Low energy consumption for **high viscosity products**.

Combined evaporators

Combining benefits from falling film and forced circulation evaporators

Flash Coolers

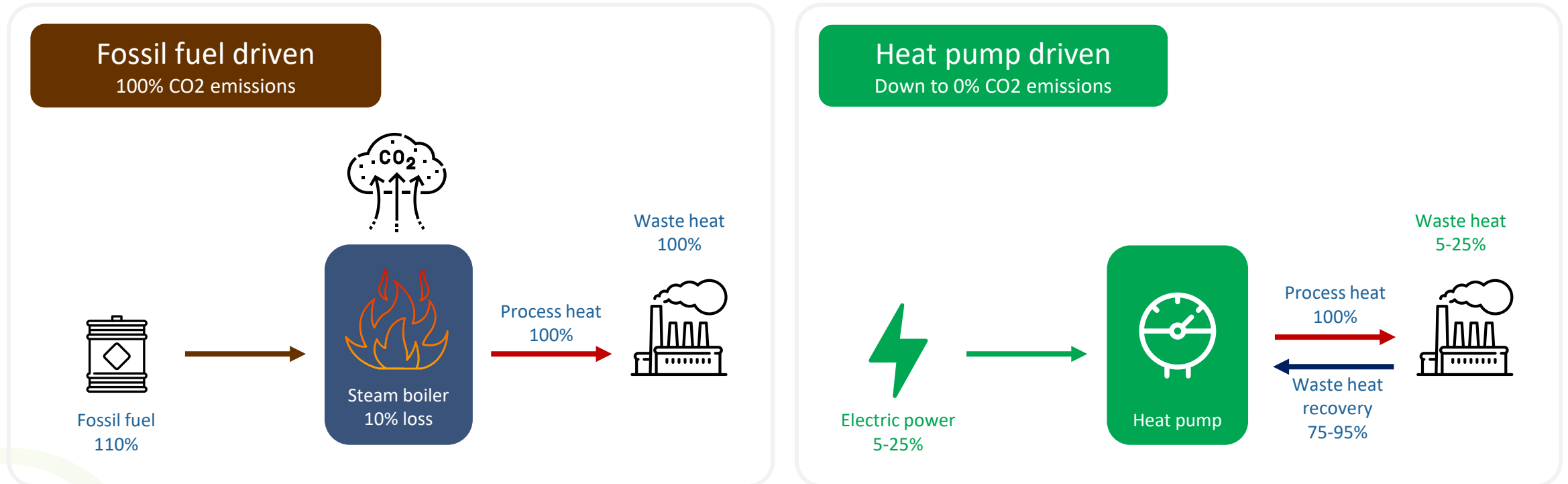
Suitable for viscous and sensitive liquids, often with a high content of dry solids. Rapid cooling ensures **high quality** of the final product.

Biogas reject water treatment plants



Our MVR-HP technology replaces fossil fuels and reduce energy consumptions

MVR-HP principle



Water (R718) as refrigerant

in high temperature and/or steam supplying heat pump

Advantages:

- **Environmental friendly** (GWP = 0, ODP = 0, non-toxic, non-flammable)
- **Excellent thermodynamic properties:**
 - Very high latent heat of evaporation (~2257 kJ/kg at 100°C).
 - A small mass flow can transfer a large amount of heat.
 - Particularly attractive for large industrial heat pumps and MVR systems.
 - High COPs
- Ideal for HTHP and steam-supplying HP
- «**No-cost**» for refrigerant
- Widely used in boiler applications and clients have experience with this «refrigerant»
- Demonstrated and **well suited for industrial process heating**
- Practical experience from MVR applications which can be transferred to heat pump applications

Disadvantages

- low operating pressure below 100°C (??)
 - Practical limit for excess heat temperatures at 50-60 °C
 - Vacuum tight equipment required
 - Air leakages must be handled
- **High volumetric flow rates**
 - Large volume flow for compressors
 - Larger heat exchanger and piping
- **High de-superheating during compression**
 - Requires multistage compression

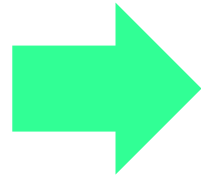
→ MVR-fans (in series) with high isentropic efficiency are the preferred choice (ref. volume flow, pressure ratio, efficiency) and result in Carnot efficiencies of higher than 70-80%

EPCON serves clients processes by upgrading low-temperature energy sources

Applications

Typical sources [$>50\text{ }^{\circ}\text{C}$]

- Air from dryers
- Steam from distillation columns, steam turbines etc.
- District heating
- Humid air/gas
- Boiling processes
- Energy from traditional heat pump
- Hot water
- Combination of several of the above

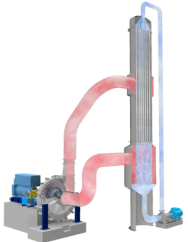


Heat output:
1000 kW to $>100\text{ MW}$

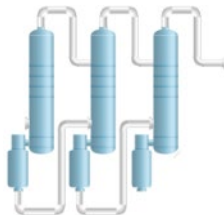
Typical sinks [$<210\text{ }^{\circ}\text{C}$]

- Reboiler/boiler/reactor
- Steam grid
- District heating
- Evaporator
- Direct steam injection (mixer/extruder)
- Drying process
- Hot water
- Combination of several of the above

Evaporators



Multiple Effect Evaporators



Waste Heat



Reactors / cookers



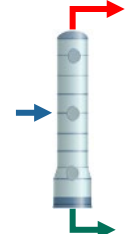
District Heating



Dryers



Distillation Process

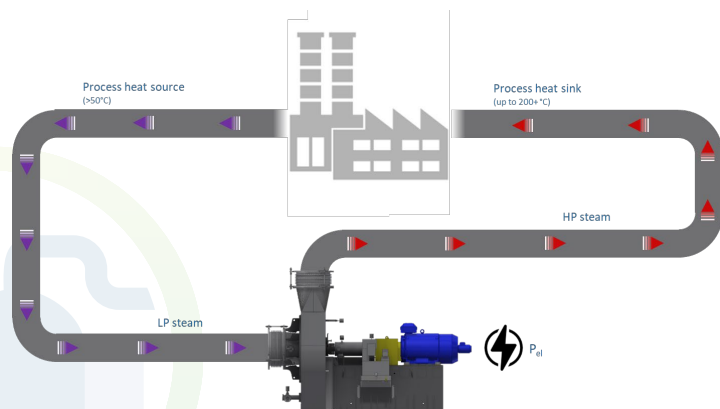


Different HP configurations developed to fit clients' specific process

MVR-HP Configurations

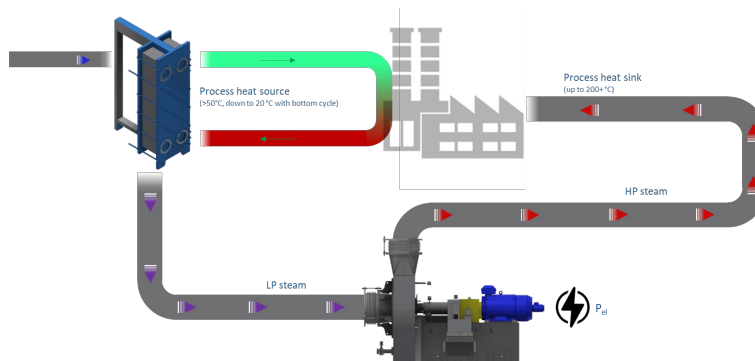
Direct MVR-HP

- + Direct compression needs less electrical energy to run the MVR fans, giving higher COP.
- + No necessity of energy recovery heat exchanger and accessories
- Composition of vapor must be considered
- Safety measures and material requirements



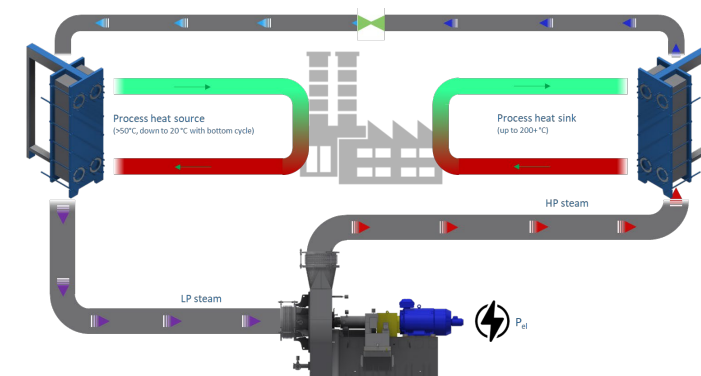
Indirect MVR-HP

- + Easy to work with pure water as working medium.
- Requires a heat exchanger to capture the heat source energy
- Need for extra equipment



Closed MVR-HP

- + Suitable when neither heat source or heat sink is steam.
- + No impurities in the heat pump working medium cycle
- Requires heat transfer equipment on both source and sink.
- Need for extra equipment



MVR-HP: 4 stage, 4.8 MW (max.)

Indirect MVR-HP circuit

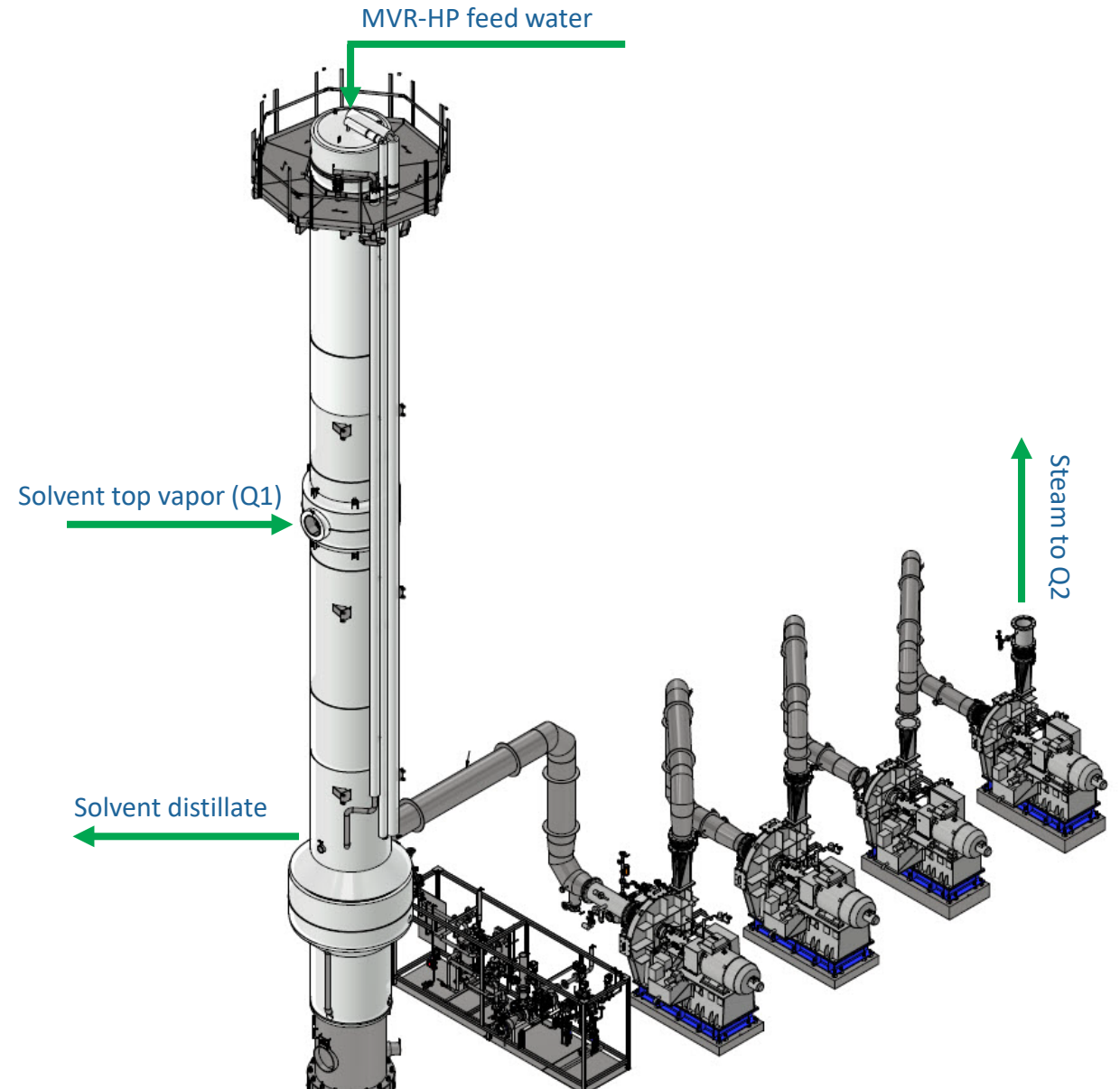
Heat source: Distillation process

Process:

1. Solvent top vapor (Q1) is recovered in heat exchanger by water evaporation on cold side (FFE)
2. Water vapor is recompressed in serial connected MVR fans by use of electrical energy
3. Pressurized steam (Q2) is delivered with direct injection to bottom of column2

Main design data:

- EPCON unit type: IHP-MVR-4S
- Feed water: 7800 kg/h
- Top vapor (Q1): 4500 kW @87°C
- Energy cons. (Pel): 620 kW
- Energy supply (Q2): 4800 kW / 7800 kg/h
- Energy supply at: 1.55 barA / 112°C (incl. pressure loss)
- COP: 7.7





Main equipment: compressor room





Main equipment: Evaporator of heat pump





Project as presented by the client

Äänekoski - EUPF-30560-AKI-Distillation MVR integration

Main cost reduction and sustainability improvement project

Scope and Objective

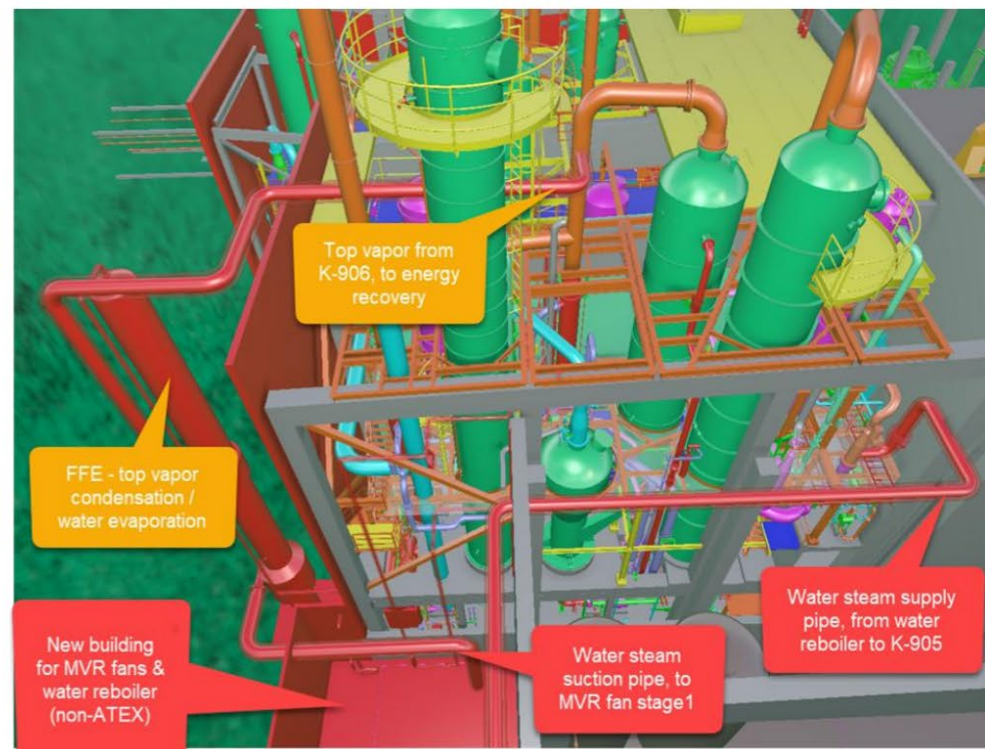
The purpose of this BROC project is to reduce the energy costs of the solvent distillation section of the Äänekoski CMC plant. Mechanical Vapor Recompression (via a Heat pump) increases the energy efficiency of the distillation, lowering variable operational cost.

Highlights

Why: The MVR unit decreases the direct steam usage in the distillation process, thus generating savings by lower need of purchased direct steam and by steam peak-price avoidance for future steam supply needed. Annual steam energy consumption reduction is 115 TJ/a (32 GWh/a), which is about 10% of the total plant steam energy consumption.

Financials

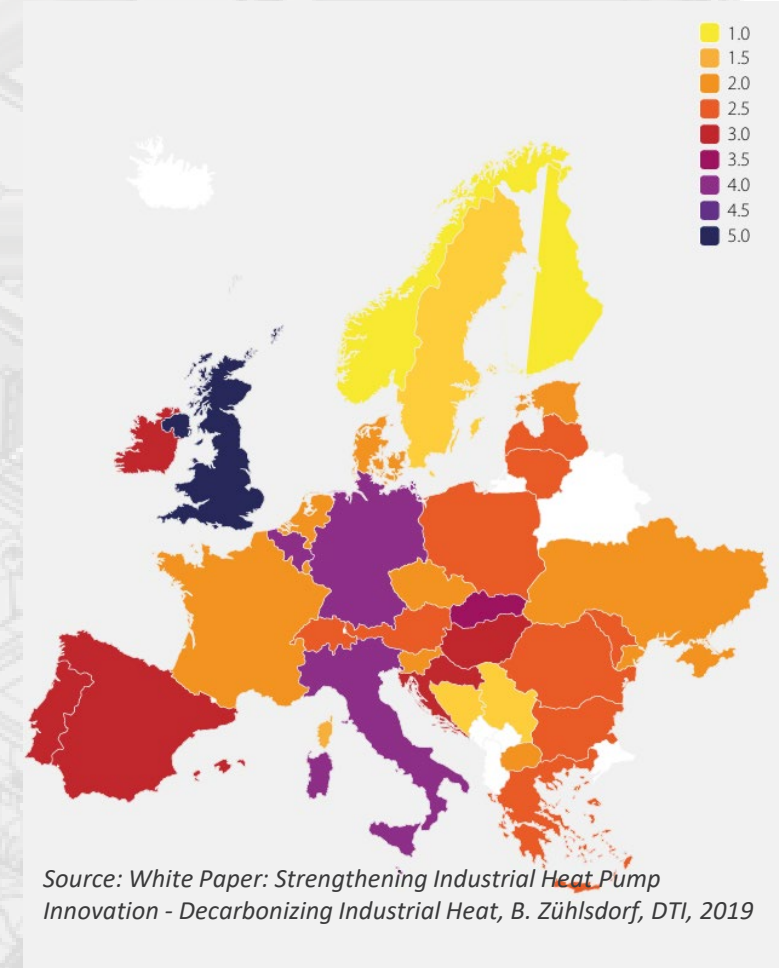
• Net Capex (MEUR)	4.9
• IRR	34.8%
• Payback	3.4 y





Key takeaway from this MVR-HP

- Reliable **multistage MVR-HP integration** in operation since February 2024
 - Integration: Indirect MVR-HP (semi-open loop)
 - More than **15 000+ operational hours** so far, with **availability almost as a boiler**
 - **Design COP of 7.8** has been reached (Carnot efficiency: 65%)
 - **Further energy optimization** to maximize MVR benefits
 - Project stayed **within +/- 3 % of budget**
 - System supplies around **37 GWh of steam per year** (re-uses 32 GWh of excess heat)
- **Top level Business Case / ROI** for this MVR-HP
- this around 2.5 to 3 million € annual savings
 - Electricity demand: 0.15 to 0.5 million € per year (depending country)





Lessons learned from several MVR-HP projects and operation

- **Design principles** from MVR-Evaporators can be used to design and operate MVR-HP or steam supplying heat pumps
 - MVR-HP can utilize excess heat low than 100°C
 - Non-condensable can be handled as in any other MVR-installation
- **Serial connected MVR fans are reliable** in similar manner as MVR evaporators, i.e. handle unstable main process conditions as well as droplets / de-superheating
 - Compressor technology in multistage arrangement has proven to be robust
- The **operational envelop** of MVR-HP compare to conventional HP is narrower. Variations in heat sink and source temperatures of more than 10 Kelvin require compression stages
- **Training of operators** is key to success and acceptance of this technology
- **Heat supply is limited by amount of excess heat** available (can be “surprise” if operators are used to boiler operation)
- Heat source: **Energy recovery unit is often customized** to the clients production process

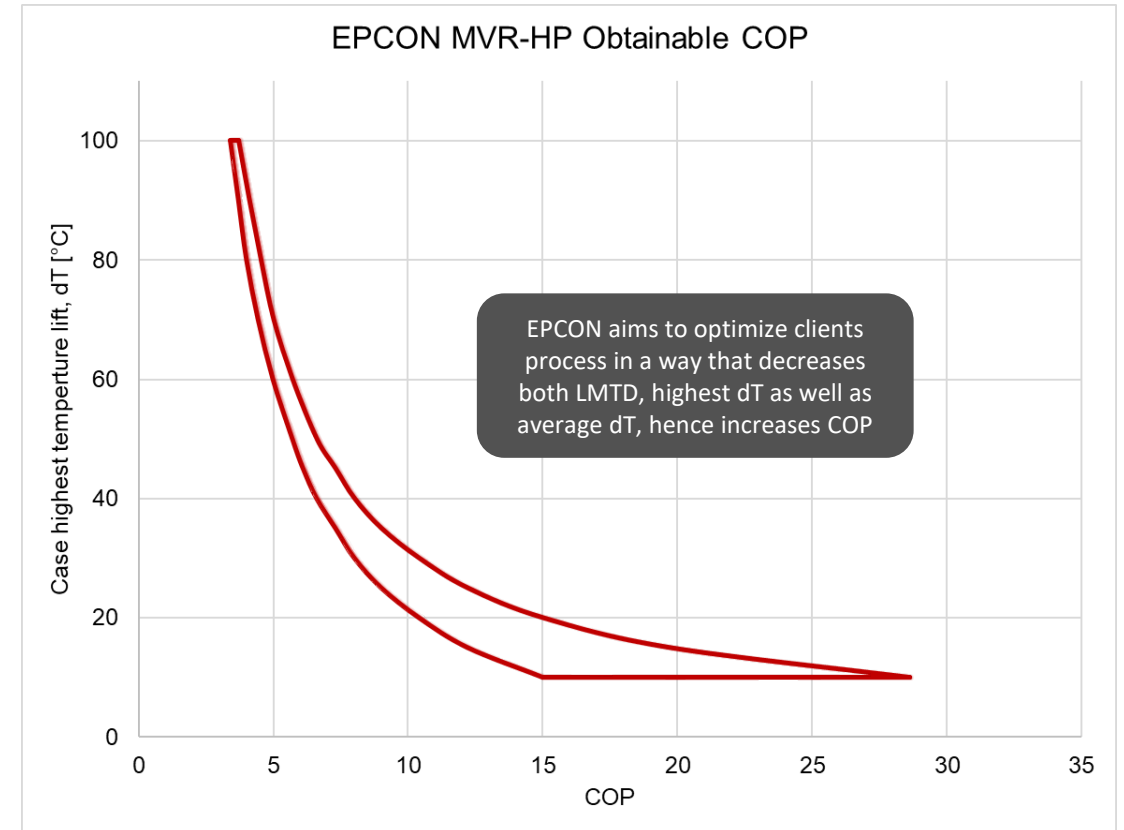
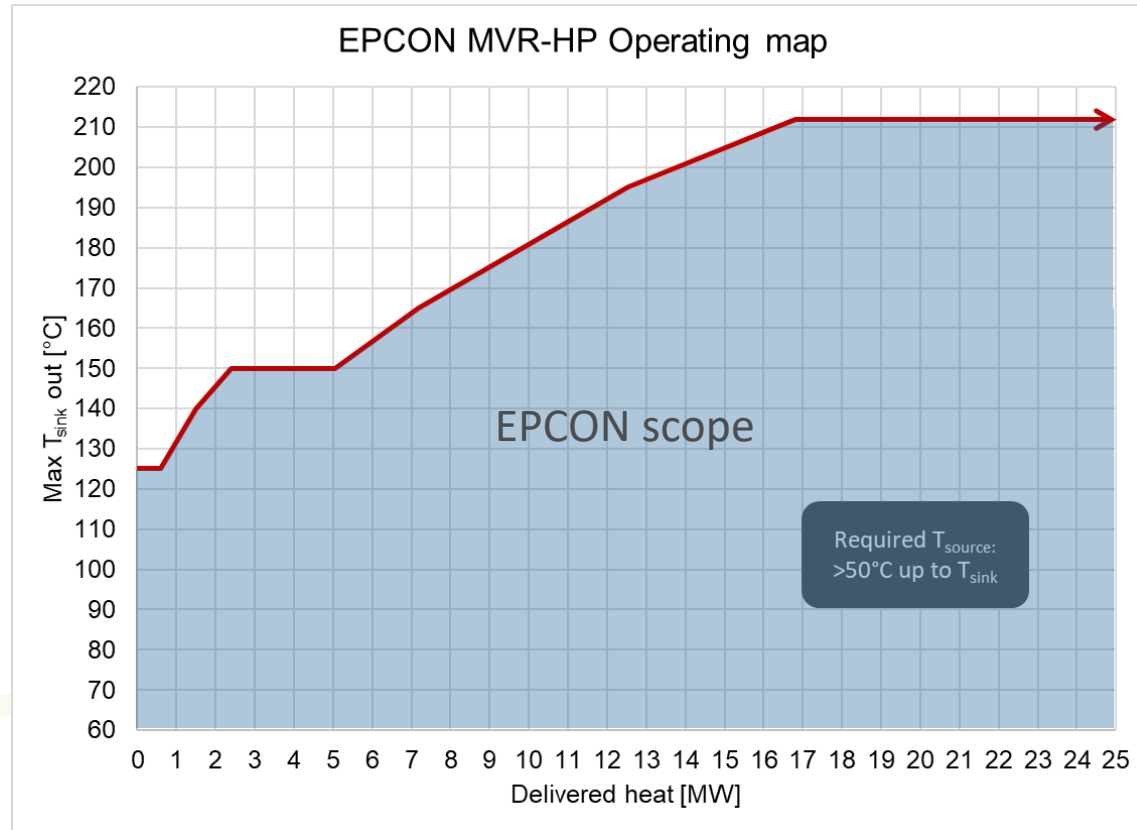


Lessons learned from **several** MVR-HP projects and operation

- **Pre-eng. in close cooperation with end-user** is important for evaluate options, info exchange vs impact of client existing processes as well as the customized MVR-HP technology itself, and selection of suitable MVR-HP integration with low dT / high COP for their factory.
- Utilize the **40 years of experience and knowledge** from MVR thermal separation processes, by make good integration to client existing thermal separation processes as well as the MVR-HP detail design itself, and by this secure good reliability followed up by available experienced service personnel.
- **CAPEX of MVR-HP** project is acceptable even with energy price ratios (el./fossil) of 4
 - High COP and 5000-8000 operational hours per year give acceptable ROI for clients
- **OPEX is higher** than for MVR-Evaporator but similar to OPEX of HTHP
- **Uptime of >98% possible** (comparable to MVR-Evaporators)
 - Two annual services (one main and one minor service) required
 - Start-Up on boiler steam → Recommendation of Back-Up boiler
- It is possible to integrate **MVR-HP with “bottom cycle” heat pumps**, however the project is more complex
- **Flexible integration:** Energy recovery unit (ERU) and compressors are not in the same room; ERU can be installed e.g. outside

Operational envelop of MVR-HP (open, closed or semi-closed integration)

MVR-HP Performance with Carnot efficiencies >70%



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