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Large scale heat pumps in Europe

16 examples of realized
and successful projects



This brochure is an initiative of the Industrial & Commercial Heat Pump Working Group.

ICHP WG (Industrial and Commercial Heat Pumps) addresses the particular need of manufacturers and research institutes in order to advocate for applications, solutions and products of large scale.

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Decarbonisation of society must include a decarbonisation of heating & cooling in industry and commerce

Buildings and processes alike are large scale users of heating and cooling services. Far too often, these are still considered separate and consequently provided by two different appliances. In order to greatly improve efficiency, we need a shift in perspective towards a systematic understanding. Whenever cooling is needed, heat is a by-product, whenever heating is required, cooling can be a by-product. It needs systematic thinking to identify where these energy cycles can be closed and where energetic waste of one service can be the resource of another. **Large heat pumps are the technology of choice to make this vision an efficient reality.**

Large, industrial sized heat pumps can use renewable energy from air, water or ground but also waste energy from buildings and processes to provide heating and cooling. With a proper system design both can be used, turning the one-way road of energy use into a circular energy economy.

While heat pumps are known in residential application, they are much less recognized for their contribution (potential) in commercial and industrial applications. However it is this market segment, where they are quickly becoming hidden champions. Users of heating and cooling in many industrial processes in the food, paper or chemical industries (list not exhaustiv) can benefit economically from a most efficient use of energy while providing a significant benefit towards emission reduction and air quality.

The brochure provides examples of successful large heat pump applications. We hope that it finds the interest of you, the reader and triggers your imagination for further heat pump applications, even in areas not covered in this report. If you know of such applications, or require expert advise on an area in which you consider the use of a heat pump, please do not hesitate to contact EHPA in Brussels or any of the experts of our large and industrial heat pump working group.



“Heat pumps in industry
have the ‘potential for an
industrial revolution.’” [1]

The technical potential of large and industrial heat pumps

Heat pumps are considered large if they exceed capacities of 100 kW. They can easily reach the one to several megawatt range with the largest units providing 35 MW in a single machine.

Currently available heat pump technology can provide heat up to 100°C with a spread between source and sink temperature of approx. 50 K per stage.

Using heat pumps for applications above 100°C is still a challenge. While the underlying principles are known and prototypes for these temperature levels exist, they are not yet available in standard products. The current level of research and development projects as well as increased interest by new players to engage in the segment of large

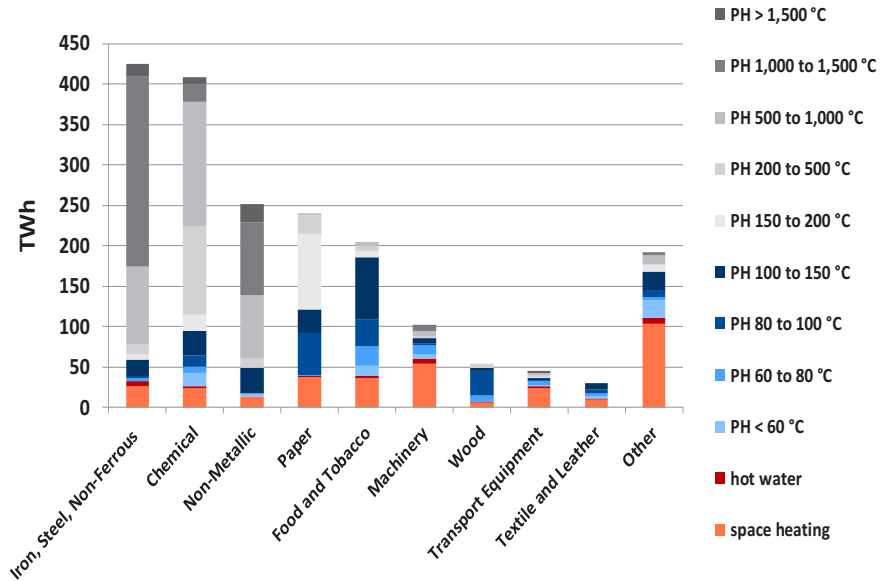


Figure 1: Distinction of heat demand in industry by sector and temperature range. [1]

heat pumps leaves room for optimism. New and improved products are expected in the market.

Without existing solutions for heat pump applications for temperature levels above 150°C this segment has not been included in

the current potential assessment. With this in mind, available data from Eurostat was evaluated to determine the potential for the application of heat pumps in industry.

2012 data for EU-28 reveals, that the industry is using 3200 TWh of final energy and has a demand for heat of approx. 2000 TWh. Figure 2 shows the split of this heat demand.

This assessment reveals a practically reachable potential for heat pumps in the temperature range up to 100°C of 68 TWh, mainly in the chemical, paper, food/tobacco and wood industries (see blue shaded bars in fig. 2). Adding the sectors of hot water and space heating reveals an additional 74 TWh (see orange shaded bars in fig. 2). With technical progress, an additional potential of 32TWh in the temperature range from 100 to 150°C can be made accessible (see darkest blue bar in fig. 2).

In total, 174 TWh or 8.7% of all heat demand in industry can be provided by heat pumps. The higher temperature ranges shown in grey in the graph above remain inaccessible for heat pump technology.

The result of this assessment shows the realistic potential of heat pump applications. The technical potential is much larger, but can often not be fully used due to practical considerations.

A more refined, model based analysis executed by Wolf and Blesl comes to the

conclusion, that the technical potential of heat pump use in industry across the 28 EU member states is 1717 PJ (477 TWh), with only 270 (75 TWh) or 15% of it being accessible if economic and practical considerations are applied. [2]

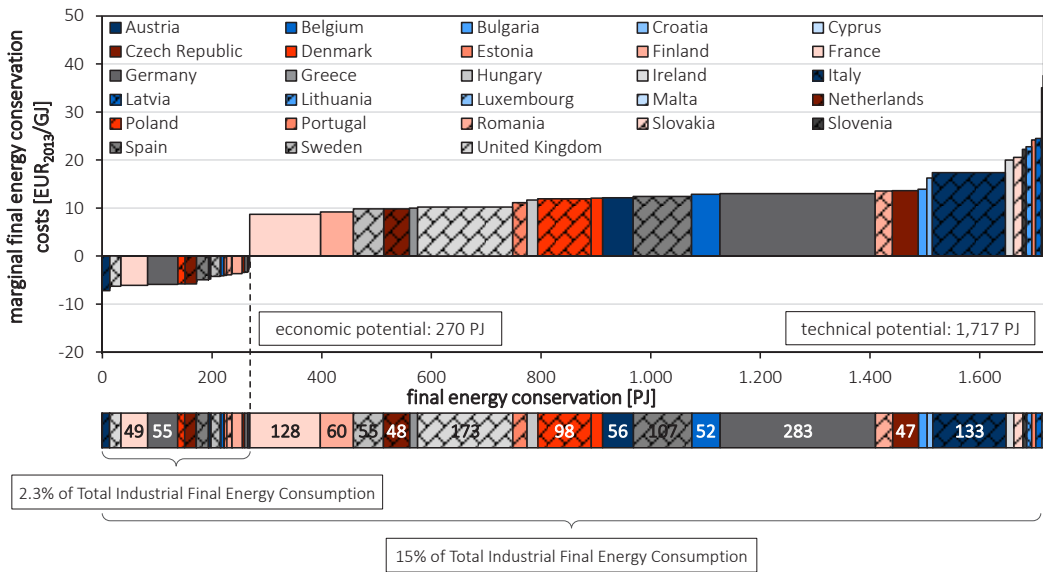


Figure 2: Industrial heat pump potential in EU-28 [2]

Thus the model based approach leads to a larger technical potential, but to a much lower economic potential.

Main factors influencing the economic perspective of heat pump operations are

- Cost of fossil fuels
- Cost of electricity
- Interest rate
- Efficiency of the heat pump system
- Simultaneous availability of heat supply and heat demand, simultaneous demand for heating and cooling
- Investment cost differences.

Operation cost savings from heat pump use are possible, if the relative cost of fossil fuels and electricity are smaller than the efficiency of the heat pump system. With a rather distorted energy price, this is more and more difficult, as many governments recover the cost of greening the electric system via electricity cost itself. At the same time the price for fossil fuels does not reflect the negative environmental impact of its use. Thus relative cost of heat provision points in favour of fossil fuels.

Since there is a direct relation between energy demand reduction and CO₂ emissions, extending the economic potential of demand reduction will also reduce CO₂ emissions from the industrial sector. The study concludes a total CO₂ emission reduction potential of 86,2 Mt with 21,5 Mt (25%) of it economically viable.

Obstacles, challenges and opportunities

Main obstacles limiting the use of heat pump in industry are as follows:

- Extreme requirements on a return of investment, often not more than 2 years are accepted. This is further complicated by a comparatively low price for fossil energy.
- Risk aversion, in particular vs. heat pumps which are not trusted, but perceived as a new, unproven technology.
- Limited or no availability of best practise examples that could create trust in new solutions.

- Structural barriers in the industry
 - High transaction cost for the conversion of processes, as many old processes are based on steam
 - Need to integrate competences and responsibilities to realise a systems perspective in order to energetically optimise industrial processes and commercial applications

Both the energy savings and CO₂ abatement potential of heat pumps in industrial applications is still largely unused. Creating more favourable political framework conditions will allow to reverse this trend. These include

- Adding a price signal to the use of fossil fuel
- Reduce the burden from tax and levys on increasingly clean electricity
- Provide low interest rates and loan guarantees to energy efficient investments using low carbon emission technologies such as heat pumps

- Increase research and development on standardized heat pump solutions for the identified industrial sectors
- Provide more best practise examples.

There is a joint effort necessary from policy makers and industry alike to develop the technical and economic potential of heat pump applications in industry. It needs both to pull on the same string (and in the same direction) to fully unleash the potential.

Sources:

- [1] Nellissen, P.; Wolf, S.: Heat pumps in non-domestic applications in Europe: Potential for an energy revolution. Presentation given at the 8th EHPA European Heat Pump Forum, 29.5.2015, Brussels, Belgium.
- [2] Wolf, S.; Blesl, M.: Model-based quantification of the contribution of industrial heat pumps to the European climate change mitigation strategy. In: 2016: Proceedings of the ECEEE Industrial Efficiency Conference 2016. Berlin, 12.-14.09.2016. Stockholm, 2016



Rotterdam. Source: Municipality of Rotterdam

Bergheim district heating systems I

The town of Bergheim is situated in the west of Germany and has a population of approximately 2000 inhabitants, with a density of less than 100/km².



A lignite mine is located in the proximity of the town, where the sump water is extracted from the mine to prevent the ground water to seep into the pit.

This water was used by the cooling towers of a nearby power plant, and the rest was dumped into a nearby river. As this water has a temperature of 26°C, it is now collected by two heat pumps to cool it down to 10°C, and the heat is used to supply a local district heating system. The two heat pumps use the R134a refrigerant, which is a hydrofluorocarbon with low GWP, and provide supply temperatures of approximately 55–60°C, whilst achieving a COP of 4,4. The first unit was commissioned in March 2014, and given it's success, the second unit was installed at the beginning of 2015. Now, the system is providing heat to the offices of Ertfverband, which house approximately 500 employees. Based on an energy demand of 1200 MWh, the local non-profit water supply and distribution association saves 58 000 Euro/year.



Left: Viessmann Vitocal heat pumps.
Right: The local water association.
Source: Viessmann

Technical details of the application

Heating capacity: 2 x 293 kW

COP: 4,4

Refrigerant: R134a

Heating source: Water

Supplied temperature: max. 73°C

By **VISSMANN**
climate of innovation

Bergheim district heating systems II

Technical details of the application

Heating capacity: 865 kW

COP: 3,1

Refrigerant: R744 (CO₂)

Heating source: district heating water

Supplied temperature: 90°C

By



LEADING IN PRODUCTION EFFICIENCY

Left: Thermeco2 HHR 1000
Middle: Thermeco2 HHR 1000
Right: Sump water heat exchangers
Source: Dürr thermea GmbH

The second heat pump project in the town of Bergheim is a communal district heating network, which supplies heat to approximately 10 buildings.

Since these buildings needed a new heating source, the solution took shape in the form of a CHP which supplies 314 kWe and 220 kWth, along with a high-temperature 865 kWth thermeco2 heat pump. The heat pump uses the 26°C sump water from the mining pit as a heat source.

The electric output of the CHP can supply 100% of the electricity for the heat pump and together they feed almost 1 MW

of heat into the network. This solution was chosen as the CHP-heat pump system features a fuel utilisation coefficient of 167%, compared to 90% for a boiler. Since the communal district heating network works at a temperature of 80–93°C, this scenario proved suitable for a CO₂ heat pump which is designed to work at high, transcritical temperatures. However, since this heat pump requires a low return temperature, the district heat was adjusted to provide

a return water temperature of max. 50°C, allowing the heat pump to achieve a COP of 3.

The system also contains two 12,6 m³ storage tanks which can be filled up in approximately 2 hours and can supply the heat in the district heating network for several hours. For peak loads, a gas boiler is used, kept from the previous system. Overall, the CHP-heat pump system reduced the fuel demand by 26%, and the CO₂ emissions by 32%.





Drammen district heating

The world's largest low GWP refrigerant heat pump in district heating

The municipality of Drammen has over 63 000 inhabitants and is located in the capital area of Norway. The city has a population density of 421/km², and it is known for receiving environmental and urban development awards, including for their large heat pump and district heating grid. Their system takes advantage of the low prices of electricity in Norway and it has been operational since 2010. The three heat pump units use the 8°C deep sea water from the fjord to deliver heat at a temperature which can reach 90°C, and by doing so, the plant still manages to achieve a COP over 3. The refrigerant used is ammonia, which enables a greater efficiency than other synthetic refrigerants and does not present any global warming potential. The heat pumps manage to cover 85% of the district heating demand, the rest being covered by oil boilers during the peak loads. With the use of this heating system, the plant reduces the CO₂ emissions by approximately 15 000 t/a, as the electricity comes from renewable sources, and saves up to 6,7 million liters of fuel/year.

Top left: Image of Drammen
Bottom left: The 13.2 MW heat pumps
Right: Machine room
Source: Star Refrigeration





Technical details of the application

Heating capacity: 13.2 MW

COP: 3,05

Refrigerant: R717

Heating source: River water
in at 8°C, out at 4°C

Supplied temperature: 90°C flow,
return at 60°C (Hot water)

By  STAR
REFRIGERATION



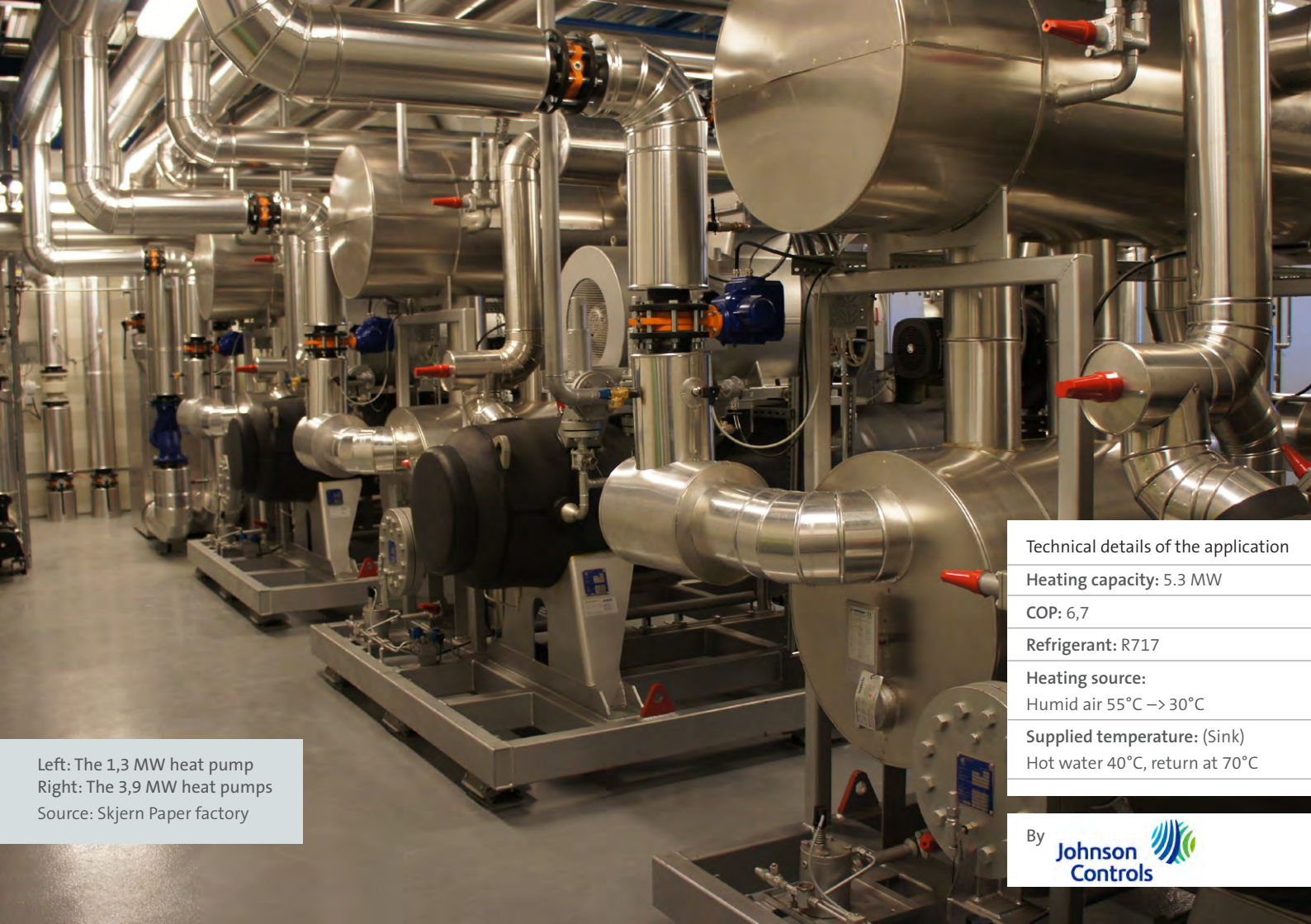
Skjern Paper Factory

Waste heat is used to supply the local district heating system in Skjern using four large scale heat pumps

The town of Skjern is located in West Jutland, Denmark, and has a population of almost 8000 inhabitants. In December 2014, the local paper factory started delivering heat for the local district heating network of the city using three large heat pumps supplied by Johnson Controls.

The initial total power of these heat pumps was 3,9 MW, but at a later stage another heat pump supplied by the same manufacturer was added, increasing the total capacity to 5,2 MW. Together with direct surplus heat distribution, the plant achieves a total heat capacity of 8 MW, and a plant COP between 6,5 and 7. The heat pumps use the waste heat at a temperature between 28–33°C, and condensate at 70°C. The district heating grid covers 60% of the city of Skjern.

The total heat sold in 2015 was approximately 40 GWh. This corresponds to an annual saving of 8 200 tons of CO₂. According to the management of the factory, the heat sales will increase to 45 GWh.



Left: The 1,3 MW heat pump
Right: The 3,9 MW heat pumps
Source: Skjern Paper factory

Technical details of the application
Heating capacity: 5.3 MW
COP: 6,7
Refrigerant: R717
Heating source: Humid air 55°C → 30°C
Supplied temperature: (Sink) Hot water 40°C, return at 70°C

By  Johnson Controls



Vienna district heating

A high-temperature heat pump is used to boost the capacity of the city's district heating system

Vienna is the capital and largest city of Austria with a population of about 1.8 million people. One third of all residences in Vienna are supplied by district heating. By using a 255 kW high-temperature heat pump supplied by Ochsner, the capacity and efficiency of the Vienna district heating system is increased, without enlarging the capacity of the power plant, respectively of the boiler. Therefore, in this example, the return line of the district heating system, with a temperature level of about 45°C is used as heat source for the heat pump. The heating capacity of the heat pump is used as a supply line for a secondary system, with a temperature that ranges between 70 and 85°C, but the same device can also supply flow temperatures of up to 98°C. The heat pump achieves an annual COP of 5,3, and uses the non-flammable and non-poisonous refrigerant ÖKO 1.



Left: The district heating plant
Right: The heat pump room
Source: Ochsner

Technical details of the application

Heating capacity: 255 kW

COP: 5,3

Refrigerant: ÖKO1

Heating source: Water

Supplied temperature: 70 – 85°C

By **OCHSNER**
HEAT PUMPS



Mäntsälä combined data and heat

Waste heat from a data centre is transformed by heat pumps to supply heat in the local district heating network



The city of Mäntsälä is located in the south of Finland and has a population of over 20 000 inhabitants. It represents a good practice example, where the municipality buys waste heat from a local data centre to supply heat in the city. No less than 1500 houses in the city are currently supplied using district heating,



Technical details of the application

Heating capacity: 3 600 kW

COP: 3,4

Refrigerant: R134a

Heating source:
Data center exhaust air to water

Supplied temperature:

By  **CALEFA**

Top: The district heating plant. Bottom left: DH scheme. Source: Calefa

but in the future, approximately 4000 houses will be connected to the network.

In the first phase, the heat in the data centre is collected using heat exchangers, transforming the warm air into liquid. Then, in the second phase, the 4 MW heat pumps in the district heating plant rise the temperature of

the water from 40 to 85°C. The heat pumps are optimised to achieve high temperature and high COP, over 4.

It is estimated that the heat provided in the first phase is enough to provide the base load in the summer, thus approximately 75% of the heat in the city comes from clean energy

sources. Therefore, the need for fossil fuels is reduced dramatically, and at the completion of the project, the CO₂ emissions are expected to be reduced by 22 000 t/year.



Technical details of the application

Heating capacity: 4,5 MW

COP: 4,8

Refrigerant: NH₃

Heating source: Water

Supplied temperature: 65°C

By **SULZER**



The Lausanne heat pump plant

A heat pump built in 1985 is delivering low temperature heat to the school and university in Lausanne

The two 4,5 MW heat pumps are using the water of lake Lemman as a heat source. Extracting the water at a flow of approximately 260 l/second, with a constant temperature of 6–7°C, the heat pumps are able to supply heat in two district heating networks and a storage tank.

The heat pumps work at full capacity even when there is lower demand from the district heating systems, by filling the storage tank. The storage option has the role of limiting the

start-ups of the heat pumps, thus limiting their mechanical wear. The heat pumps work only when the temperature is below 16°C, by supplying 28 to 65°C in the average temperature network and 26 to 50°C in the low temperature network. However, for the peak loads, when outside temperatures are very low, the heat pumps are supported by two gas turbines. Cooling capacities, for the laboratories and ventilation, are ensured by the same heat pumps. The refrigerant used is NH₃ and the COP achieved is 4,8.



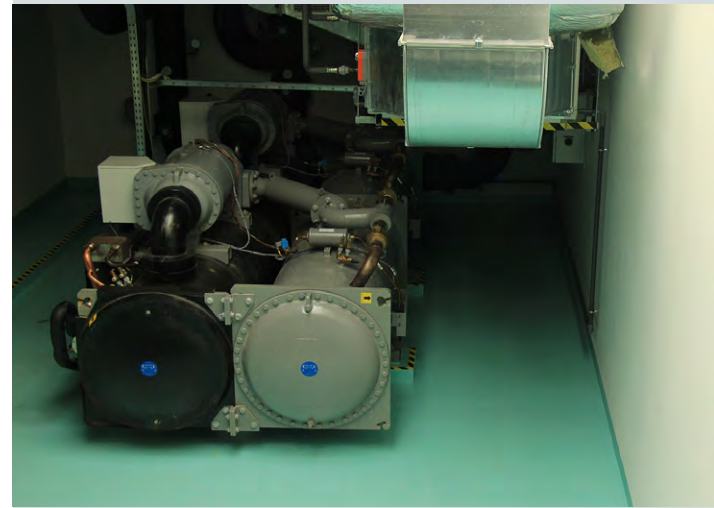
The district heating plant room
Source: Patrick Lugon EPFL

Budapest military hospital

The waste water in the sewage system is used to heat up and cool down a hospital

Sewage water is a heat source which provides a stable temperature of 10–20°C throughout the year. By exploiting this favourable condition, the Hungarian company Thermowatt developed a heat pump system which can make use of this alternative heat source. Therefore, since July 2014, such a system provides heating and cooling for a 40 000 m² building complex that is part of the large NATO Military Hospital in Budapest. The system provides 3,8 MW of heating and 3,3 MW of cooling using two approximately equal-sized Carrier water-water heat pumps, out of

which one is an inverter, thus providing better system work and higher efficiency. The entire system, including the filtration unit, is housed in a concrete underground structure located below a car park and occupies about 210 m². Both heating and cooling are delivered through air handling units comprising large heat exchangers and operating at just 32°C, thus contributing to the high system COP of 6,5–7,1. The system is fed from a collector by using gravity, and its size was determined by the amount of wastewater available – 11 000 m³/day.



Top left: Waste water heat exchanger
Bottom left: Underground engine house
Right: Carrier 30XWHP-1612 water-water heat pump
Source: Thermowatt



Technical details of the application

Heating capacity: 3 800 kW

COP: 6,8

Refrigerant: R134a

Heating source: Water

Supplied temperature: 33°C

Cooling capacity: 3 800 kW

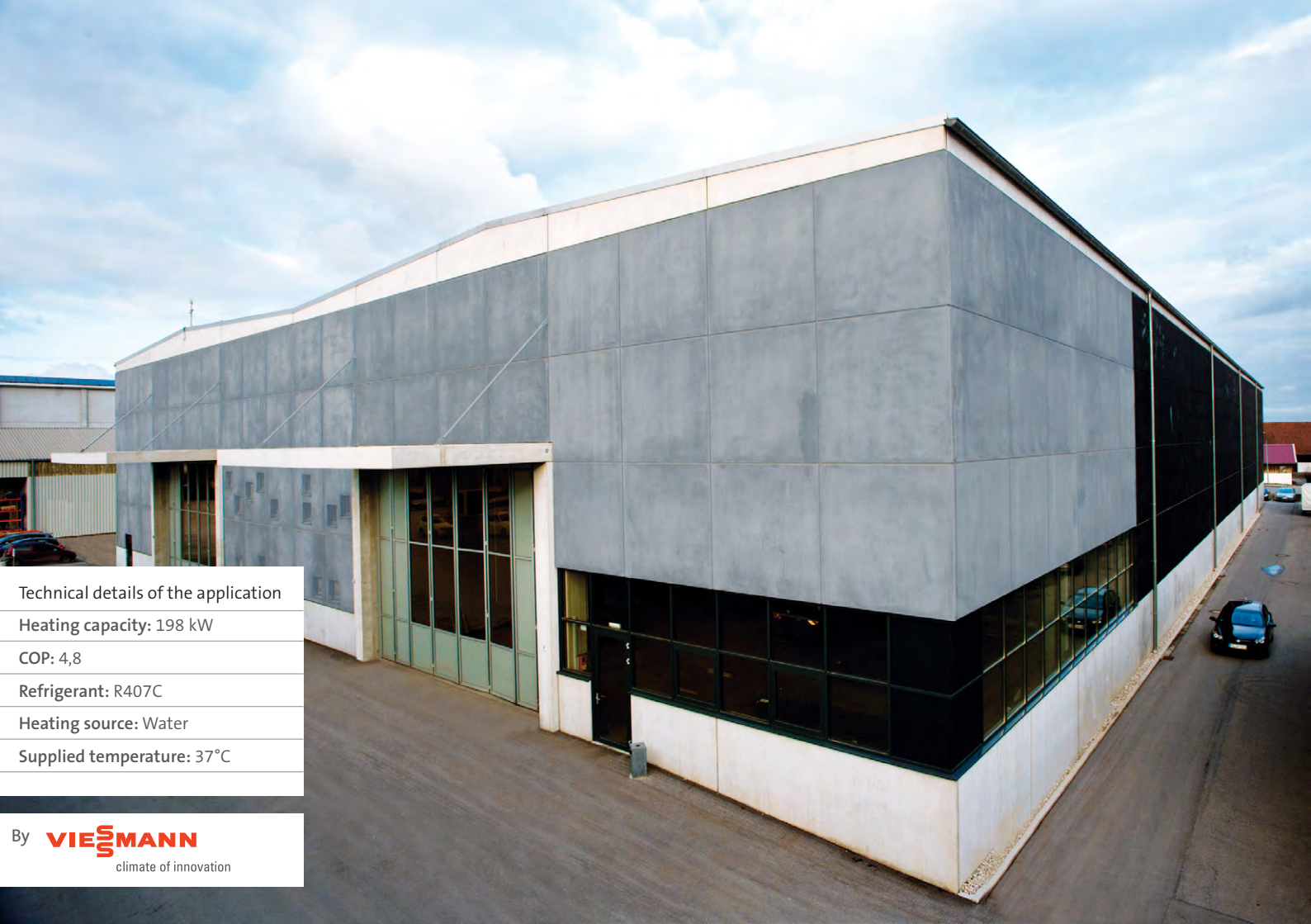
EER: 7,3

Refrigerant: R134a

Heating source: Water

Supplied cooling temperature: 6°C

By  THERMOWATT



Technical details of the application
Heating capacity: 198 kW
COP: 4,8
Refrigerant: R407C
Heating source: Water
Supplied temperature: 37°C

By **VIESSMANN**
climate of innovation

Energy from concrete walls

The outer-walls of a fabrication plant are used as a source for a heat pump



Left: The fabrication hall. Right: The heat pump
Source: Viessmann

The Laumer Bautechnik, located in Bavaria, Germany, was looking for an innovative and cost-efficient heating solution for its pre-fabricated concrete sections fabrication building. By having the University of Munich and the German Ministry of Environment as partners, they developed a heating solution using pre-fabricated concrete elements as energy collectors in combination with a ground heat storage and a heat pump. In this solution, the outer-walls of the fabrication hall, painted black for increased heat absorption and with cast-in piping for energy transportation, serve as heat collectors, while at the same time forming a weather protection. The structural integrity is provided by the inner walls separated from the outer ones by

an insulation layer. According to the planning office Kaufmann in Mülheim/Inn, the collector has a surface of 14 000 m² and the ground storage a volume of 5 000 m³. The collected heat is transported into a underground heat storage where it is collected for the winter heating period. At the core of the system is a large water-water heat pump from Viessmann, using ground heat storage and alternatively a ground source as the heat source, and providing an industrial size panel heating system with the required heating temperature of 37°C, also covering peak demands.

The heat pump has a heating power of 198 kW with a COP of 4,8, and the system is in operation since 2014.



Nagold innovative heating and cooling system

Sun and air are providing the free of cost, all-year round, comfortable room temperatures



Underneath the parking lot of a new office building in Nagold, Germany, a large, 300 m³ ice-storage tank can be found. It is part of an innovative energy concept, where 100% of the building's heating and cooling demands are provided by regenerative energy sources. The whole building is heated and cooled via water pipes embedded into the concrete ceilings, always keeping the surface temperature close to the air temperature in the office space, thus providing a comfortable environment, despite the large glass surfaces around the building. The heating and cooling system consists of an ice-storage tank, a large heat pump, and a solar/air absorber mounted on the roof, along with a photo-voltaic installation providing the electricity to power the heat pump. The main heat sources are the 42 roof-mounted solar/air absorbers operating

at low temperatures, which produce more energy than classical solar installations, as heat can be collected even on cloudy days.

The system is independent from seasonal variation, as surplus energy is stored in ice-storage tank for later use. At the heart of the system is a heat pump, using the ice-storage tank as heat source, providing energy for both heating and hot tap water. Energy provided from the roof absorbers and the surrounding melts the ice again, creating an infinite heat source for the heat pump. Such phase changes in the water allow to store or release large quantities of energy while keeping the size of the storage moderate. The heating and cooling power of the system is 73 and 100,8 kW, with a COP of up to 4,9 and a maximum heating temperature of 60°C.





Left: Office building; Ice-storage tank; Solar/air absorbers + PV panels
Right: Vitocal 300 G-Pro heat-pump system
Source: Viessmann

Technical details of the application

Heating capacity: 73 kW

Cooling capacity: 100 kW

COP: 4,9

Refrigerant: R410A

Heating source: Water

Supplied temperature: 60°C

By **VIESSMANN**
climate of innovation



Technical details of the application

Heating capacity: 2 x 360 kW
COP: 5,0
Refrigerant: R134a
Heating source: Water
Supplied temperature: 35 – 45°C

By **OCHSNER**
HEAT PUMPS

Hamburg's energy efficient office building

Waste heat from the computing centre is transferred to heat up a 13-floor building

In Hamburg, two modern heat pumps were installed and put into operation in the head office of Vattenfall Europe AG. The system uses waste heat of the in-house IT server rooms and computer centres. Heat transfer can cover 50% of the total basic thermal load of the 13-floor building of 50 000 m².

This project reduces the negative impact on the environment by saving more than 600 tons of CO₂ per year. The temperature of waste heat is risen up to 45°C. It is then fed into the heating system by two highly efficient water-water heat pumps supplied by Ochsner. Each heat pump has a heating capacity of 360 kW. Turbo compressors

with magnetic bearings minimize friction loss and thus oil lubrication is no longer necessary. An intelligent control technology continuously adapts the performance of the machines on the cold and the warm side to the respective demand. Approximately 8 kWh of thermal energy (heat and cold) are produced for each electrical kWh. This corresponds to a coefficient of performance (energy multiplier) of 8.

The installation into the existing application was carried out during the regular business. Finally the sound insulation had to meet high requirements because the offices are located directly above the system.



Left: Heat pump – EHA Energie Handels Gesellschaft
Right: Administration Building – Vattenfall
Source: Ochsner

Sea water heat pump for district heating in Fornebu/Rolfsbukta

In 2012, Oslofjord Varmer AS set a milestone with Europe's first district heating project based on two UNITOP® 43/28 water/water heat pumps using the low Global Warming Potential (GWP) refrigerant HFO-1234ze, a HydroFluoroOlefin (HFO) with a GWP lower than 1 from Honeywell. The heat pump supplier was Friotherm AG, Switzerland.

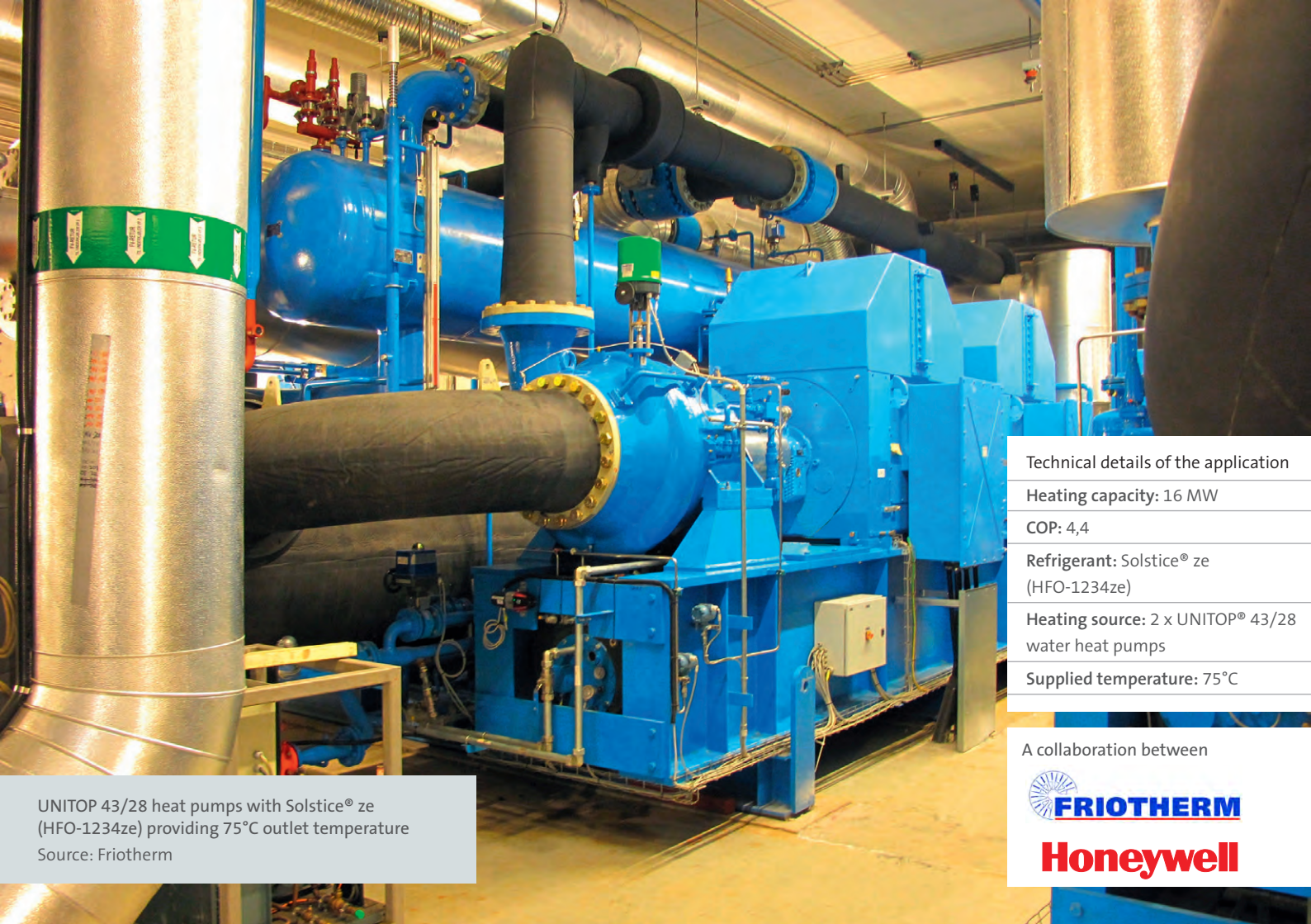
The 340-hectare site of Fornebu is situated 10 kilometers from downtown Oslo with its strong commercial and financial community. The development plan for the area includes housing for a population of 11 000 and 15 000 work places on an area of 1 350 000 m². The Fornebu development site is equipped with a district heating/cooling system which has a future estimated maximum heating power demand of 60–70 MW, and a heat production of 100–125 GWh/year. In the energy concept it has been decided that the main heat load will be covered with high capacity heat pumps and the peak load during the coldest period with bio-oil boilers. Further increase of heating and cooling demand of the Fornebu development site resulted in the construction of the Rolfsbukta heat pump plant, which is operating in the basement of a hotel since 2012.

As a response to the increasingly restrictive environmental regulations of refrigerants, the use of the new working fluid HFO-1234ze was decided. The classification society Norske Veritas was engaged by the Oslofjord Varmer to perform a risk analysis for the heat pump plant using this new slightly flammable

working fluid with a global warming potential below 1. The results showed that compared to the refrigerants from safety class A1 some additional safety precautions had to be taken. The emergency ventilation of the machinery room had to conform to ATEX 94/9/CE and an automatic power cut-off switch for the case of a refrigerant leakage was installed.

The total heating capacity of both heat pumps in Winter Mode is 16MW. The two heat pumps simultaneously produce chilled water at 2.5°C for district cooling, with heat recovery at 75°C for district heating. If the cooling demand is too low, the additionally required low temperature heat is extracted from sea water by the means of intermediate heat exchangers.

In Summer Mode the two compressors of each heat pump are working in parallel. With reduced isentropic lift and indirectly cooling by sea water as heat sink, both units are producing up to 20 000kW of cooling capacity with chilled water at 2.5°C. The Rolfsbukta plant is the first and largest heat pump plant worldwide, using HFO-1234ze and is an important development in the use of new ultra-low GWP working fluids.



UNITOP 43/28 heat pumps with Solstice[®] ze (HFO-1234ze) providing 75°C outlet temperature
Source: Friothersm

Technical details of the application

Heating capacity: 16 MW

COP: 4,4

Refrigerant: Solstice[®] ze (HFO-1234ze)

Heating source: 2 x UNITOP[®] 43/28 water heat pumps

Supplied temperature: 75°C

A collaboration between



Honeywell



Energy efficient food processing

Nutrex is a food producer specialized on vinegar and part of the swiss holding COOP. In 2008 COOP took the decision to achieve CO₂ neutrality within 15 years. Nutrex managed to achieve this goal already in 2009 by applying modern heat pump technology in its production site.

For the quality production of vinegar two processes are used: fermentation and pasteurization. These two processes fit perfectly for the application of a heat pump and serve as its source and sink.

Vinegar fermentation occurs as the alcohol is being converted into acid by bacteria. It is an exothermic reaction and stops working when the mixture is getting too warm. To stabilize the process over 10 days at 30°C, the large tanks need to be cooled. On the other side, vinegar pasteurization takes place above 70°C to obtain a non-perishable food. At Nutrex a heat pump was installed with a cooling capacity of 136 kW and a heating capacity of 194 kW. This runs with a COP of 3,4. Beside of the pasteurization, the produced heat is used for heating of the laboratory and of the building.

Since the replacement of conventional oil heating in 2009, Nutrex has achieved a CO₂-free production. The use of the heat pumps has reduced the CO₂ emissions by approximately 310 000 kg/year and saves up to 65 000 liter of fuel/year.



Left: Production of the vinegar/fermentation
Right: Heat pump in machine room
Source: Viessmann/Nutrex

Technical details of the application

Heating capacity: 194 kW

COP: 3,4

Refrigerant: R134a

Heating source: Water

Supplied temperature: > 70°C

By **VISSMANN**
climate of innovation



Technical details of the application

Heating capacity: 158 kW

COP: 2,0 (at highest flow temp.)

Refrigerant: ÖKO1

Heating source: Water

Supplied temperature: 70 – 120°C

By **OCHSNER**
HEAT PUMPS

The district heating plant room
Source: Ochsner

Mänttä-Vilppula district heating

A steam-temperature heat pump supplies flow temperatures of up to 120°C

Mänttä-Vilppula is a town and municipality of Finland located in the Pirkanmaa region. The town has a population of 10 564 and covers an area of 535 km² of which 122.61 km² is water.

By using a 158 kW steam-temperature heat pump supplied by Ochsner, the capacity and the efficiency of the district heating system in Mänttä-Vilppula is increased, without enlarging the capacity of the power plant, respectively of the boiler. Therefore, in this application, the return line of the district heating system, with a temperature level of 45°C to 55°C is used as heat source for the heat pump. The heating capacity of the heat pump is used as a supply line for a local district heating system.

Depending on the outside temperature the heat pump delivers hot water with a temperature between 70°C and 120°C, but the same device could also supply flow temperatures of up to 130°C. The heat pump was commissioned in 2017, achieves an annual COP of over 2,0 at highest flow temperature and uses the non-flammable and non-poisonous refrigerant ÖKO 1.

Waste heat in University of Burgundy

The French university recovers the waste heat of its datacentre

The University of Burgundy is located in Dijon, between Paris and Lyon, and enrolls 27 000 students every year. To heat the buildings on the 115-hectare campus the university opted for a highly ecological solution by reusing the otherwise dumped energy of the new datacentre cooling system.

As the heating and cooling load is used at the same time, a high-temperature heat pump supplied by Ochsner fulfils both functions (heating and cooling) simultaneously: Cooling of the datacentre, heating of the buildings in winter and in summer the heat is used to produce hot water for the kitchens of the university restaurant among others.

With a heating capacity of 420 kW and a cooling capacity of 255 kW the heat pump contributes to save 117 tons of CO₂ each year. With a flow temperature of 90°C and by using the cooling and the heating function simultaneously, a COP integrated (total) of 4,2 is obtained.



Left: University of Burgundy.
Source: University of Burgundy
Right: The heat pump. Source: Tenova



Technical details of the application
Heating capacity: 420 kW
COP: 2,6
Refrigerant: R134a + ÖKO1
Heating source: Water
Supplied temperature: 90°C

By **OCHSNER**
HEAT PUMPS



Technical details of the application

Heating capacity: 2 x 5 000 kW

COP: 4,5

Refrigerant: Ammonia

Heating source: Ethylene glycol 34%

Supplied temperature: 78°C

By **GEA** engineering for a better world

Machine room with two GEA heat pumps
Source: GEA

Heat pumps boosting the energy efficiency of Swiss Krono's chipboard factory

Located in the northeast of Germany, the German subsidiary of Swiss Krono produces chipboards primarily based on wood from surrounding areas.

This production process heavily consumes electrical and thermal power sources owing to several energy-intensive manufacturing steps. (> 200 GWh electrical and > 1300 GWh thermal). These processes especially include slicing of tree trunks, drying of woodchips, and compacting them to form chipboard. To minimize energy consumption for the chipboard products, Swiss Krono has implemented a large number of energy-reducing measures. One of the primary measures is two GEA heat pumps to provide hot water with an energy equivalent of 10 MW and at a hot water temperature of 80°C. Mixed with the 2 MW waste heat

from a cogeneration unit, the total of 12 MW for hot water is used to pre-dry the entire amount of wood chips. The energy efficiency of the heat pump solution here becomes more apparent if we consider the energy source for the heat pumps. A company-owned biomass-power plant provides electrical power of 20 MW. The exhaust vapors of the power plant are condensed by two air-cooled condensers. This energy source was previously ignored. Now, however, the condensate (at 39°C) is used as the energy source for the two heat pumps. As part of a closed water loop within the biomass-power plant, Swiss Krono installed two heat

exchangers to separate the water circuit of the power plant from the water circuit of the heat pump, and to transfer the heat to the source side of the heat pump. Under current conditions, the COP (Coefficient of Performance) of the heat pumps is 4,5. Pre-drying reduces the moisture content of the wooden chips and saves energy used for the final drying in two rotary dryers.

Based on 6 500 operating hours of each of the two heat pumps in 2016, an energy equivalent reduction of approximately 32 GWh and a CO₂ equivalent reduction of 6 700 tons have been achieved.

DryFiciency project

Horizon2020 innovation project for waste heat recovery in industrial drying processes

12–25% of energy in industrial processes is used for drying. Inefficiency is leading to 11.3 exajoule of energy loss in the EU and associated high CO₂ emissions.

DryFiciency is a Horizon 2020 funded project, developing and demonstrating two high-temperature industrial heat pump systems for waste heat recovery expected to save up to 80% of energy in industrial drying processes.

DryFiciency consortium's work will focus on increasing energy efficiency and reducing CO₂ emissions by:

1. demonstrating and evaluating two DryFiciency heat pump technologies in three industrial plants,
2. using a generic design approach to replicate the technology in a range of industries in both newly constructed and existing plants,
3. offering a certified training program to make engineering know how available and promote industry uptake.

Find out more: www.dryficiency.eu.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the grant agreement No. 695945.



Reducing energy consumption by 60-80 % for air or steam drying

Combining patented technologies to construct industrial scale heat pumps for up to 160°C

Open and closed loop applications demonstrated in three sectors

Above: Expected results Thermometer

Right: Agrana drying unit – one out of three demonstration sites.

Source: RTDS Group and Agrana Stärke GmbH







EHPA is a Brussels based industry association which aims at promoting awareness and proper deployment of heat pump technology in the European market place for residential, commercial and industrial applications. EHPA provides technical and economic input to European, national and local authorities in legislative, regulatory and energy efficiency matters.

EHPA has formed and operates a working group on industrial and commercial heat pumps (ICHP) to increase recognition for this area of application and its contribution potential to the EU's climate and energy targets. The group is open to all manufacturers of components and equipment of this heat pump category as well as to research bodies and other organisations interested in developing the segment.

The group is chaired by Mr. Eric Delforge, Mayekawa.
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