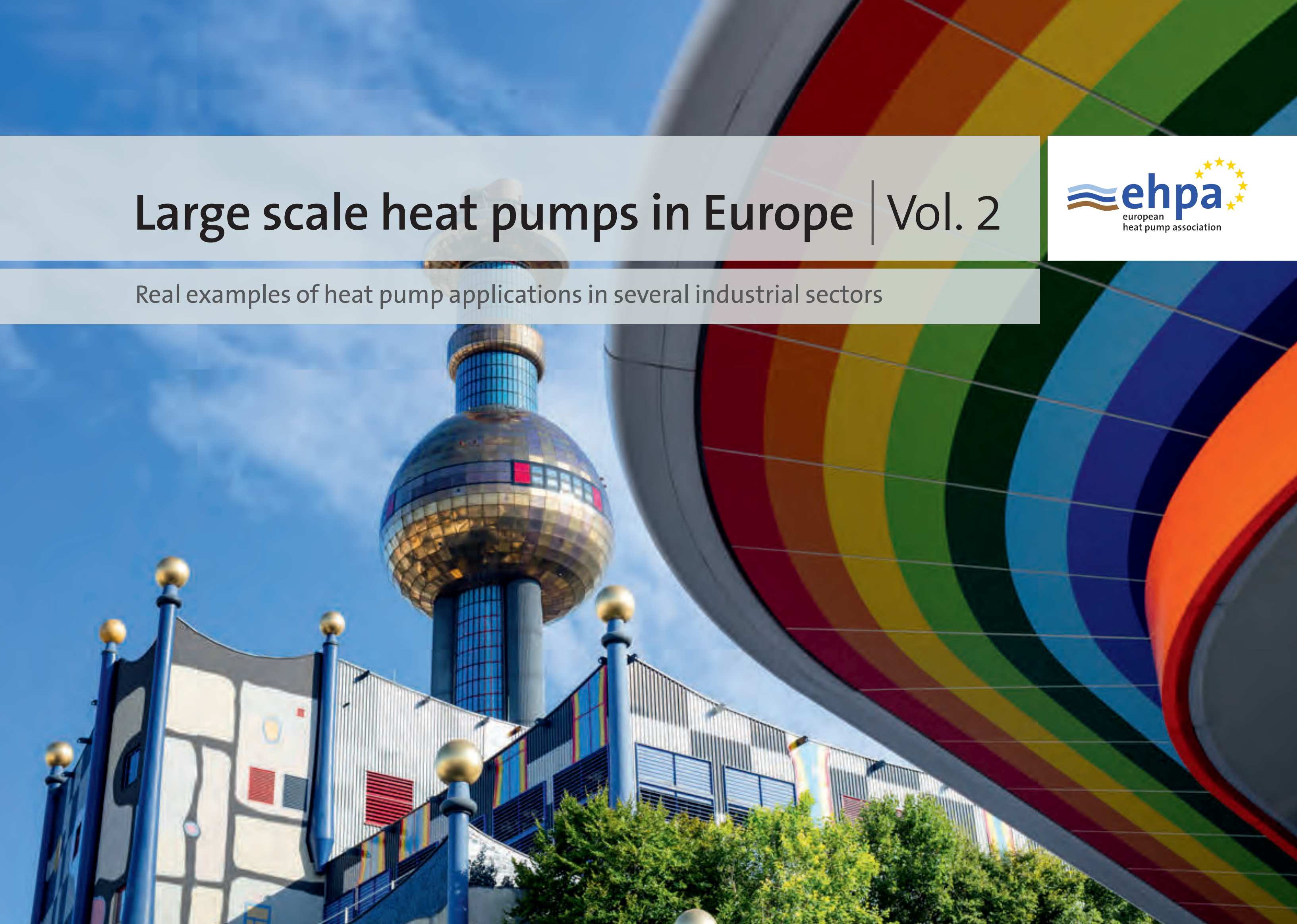

Large scale heat pumps in Europe | Vol. 2

Real examples of heat pump applications in several industrial sectors

ehpa
european
heat pump association

european
heat pump association

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.

EHPA represents and promotes awareness for all heat pump applications, in residential, commercial and industrial sectors.

Title: Source of picture – Ochsner: Vienna district heating using heat pumps

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Editorial

Dear readers,

the usage of the so-called cooling circuits has become such an integral part of our daily life that we hardly notice them anymore: Refrigerators and air-conditioners, nowadays even in cars, are so commonplace that we only notice them in case they do not work.

While the above-mentioned applications focus on the cold side, this very same technology also has a hot side, which can be used for heating purposes and is then referred to as a heat pump. Although being around for at least 150 years, the heat pump technology took much longer to enter our daily life, which is mainly due to the availability of cheap oil and gas. Except for a short heyday during the two oil-crisis' in the 70s of the last century, the same technology stayed a niche-product for many, many years and some manufacturers even stopped production at all.

All that changed rather recently, after the public and regulators started to recognize that there are limitations to the availability of fossil fuels and, of course, the negative impact of burning these fuels to our climate. The trend towards heat pumps for heating purposes was further fostered by the fact that the technology has matured since the 80s and has become much more reliable, cost-efficient and flexible in its applications. At the same time, the heat pump technology has successfully been fighting its own "demons", using today exclusively ozone-layer neutral and increasingly low-GWP refrigerants. The final breakthrough for this technology in residential heating was the ability to use ambient air as a cheap, clean and efficient heat source.

Today, there is no doubt that the heat pump technology will be the dominating method for residential heating in the years to come, being even CO_2-neutral when powered with electricity from renewable sources. Alone in Germany, there have been 99 000 new installations within 2018, marking a sharp rise compared to previous years.

Having brought the heat pump technology on its way, is it now time to sit back and enjoy this success?
Clearly no! Besides of the residential heating market, there is another, still mostly

untapped market for heating and cooling, in energy-wise similar to the total residential heating market: commerce and industry as well as regional and municipal energy distribution.

Mostly unnoticed by public and industry, the heat pump technology has not only matured towards an ecologically and economically alternative to traditional residential heating technologies. It has also much developed in terms of available power-output, served temperature levels and flexibility of use for very different applications. Applications from hundreds kW to even multiple MW in power output and heating temperatures approaching or even exceeding boiling temperature of water and being able to serve multiple sources and users simultaneously, are today not only available but state-of-the-art, proven technology.

The significantly raised temperature levels on the source- and the sink-side in combination with the technology’s intrinsic ability to cool and heat simultaneously, opens new applications and even new business models. Among others, most noteworthy are the ability to efficiently recover waste-heat for industrial processes or for energy distribution and to directly combine cooling- and heating-demands, thereby contributing significantly to reducing energy costs and CO_2 footprint for a healthy climate – by earning additional money.

With this brochure of real-life examples, already the second one issued by the EHPA and its members, we want to provide food for thought about how flexible this technology is and in how many different and useful ways it can be applied. We are sure that you will enjoy these examples and will quickly come up with your own, innovative ideas, starting your own heat pump journey.

Dr. Stefan Irmisch
Managing Director Combined Heat & Power /
Commercial Heat Pumps
Viessmann Kraft-Wärme-Kopplung GmbH

An intelligent hybrid system saves energy and improves production

In 2018, Kiilto took a large step forwards in environmental issues when it started to utilize the waste heat generated by glue production at the Lempäälä plant. The globally unique hybrid system utilizes heat pump technology and geothermal heating and cooling.

The Finnish company Kiilto Oy manufactures chemicals for construction and industrial purposes at its Lempäälä plant. The polymerization process is one of the stages of manufacturing adhesives which releases a lot of thermal energy. During the process, the reactor must be cooled mechanically. For cooling, industrial heat pumps are used to recover waste heat for heating the plant and its water. More cooling power is drawn from the ground.
The hybrid system, which replaces natural gas, utilizes geothermal heating and cooling in addition to the heat pump system in its heating and cooling processes. The bedrock acts as a heat storage excess waste heat for later reuse.

- Heat is generated from the geothermal heating system to heat the property during the winter when the earth cools around the wells. Geocooling stored in geothermal wells is used during production to provide further cooling for the process. At the same time, the ground is warming up for the next nocturnal heating season, says Kiilto's Technical Manager Vesa Juhannusvuori.
- Improved cooling has significantly increased the production capacity of the polymerization process. An even bigger benefit is that production plans no longer need to be changed according to the cooling capacity, Juhannusvuori says.
- Cooling water now remains at a constant temperature throughout the process, which increases the uniformity of production, says Juhannusvuori.

Kiilto heats hot water and 3.2 hectares of industrial properties with waste heat. With energy reuse Kiilto saves every year over 1800 MWh of energy, which translates into an annual energy bill reduction of 88 000 euros. With the hybrid system, CO_2 emissions have dropped over 350 000 kg per year.

> “Our expectations were certainly met and even exceeded towards the system functionality based on heat pumps. The system has been working uninterrupted since the beginning and has reduced our total energy consumption by 14%. We re-use our wasteheat to heat our production plant in Lempäälä and its operating waters.”

Mikko Viljanmaa,
Deputy Managing Director,
Kiilto Oy

Technical details of the application

Heating capacity: Process HP 650kW, Geothermal HP 130kW

COP: 3,2 – 4,5

Refrigerant: Process HP R134a, Geothermal HP R410A

Heating source: Waste heat is recovered from polymerization process and geothermal heat. The heat is used to hot tap water and facility heating (area about 32 000 m²)

Supplied temperature: 55 – 75°C

By CALEFA

Left: The system can be controlled and optimized locally or remotely. Petri Vuori, CEO of Calefa, is presenting the system's operation to Kiilto Technical Manager Vesa Juhannusvuori.

Right: Kiilto plant buildings

Source: Calefa

Photo source: GEA

Technical details of the application

Heating capacity: 1400 kW

COP: 5,9 (yearly average)

Refrigerant: Ammonia

Heating source:
Ammonia refrigeration plant

Supplied temperature: 63 °C

By GEA

Sustainable circular energy as a core value in chocolate bar processing

GEA Heat Pump Solution Reduces MARS' Energy Consumption by 6 %

MARS Nederland in Veghel, The Netherlands, operates the largest chocolate factory in the world. GEA heat pump technology installed at the facility allows waste heat from the refrigeration plant to be upcycled and reused, which has reduced total energy consumption across the site by 6 %, equivalent to the combined annual energy consumption of about 625 households.

Heat recycling is a key contributor to MARS' drive to become fully energy neutral by 2040. This includes focusing on zero fossil fuels, recycling all waste, and discharging only completely cleaned process water. Each Mars factory aims to reduce energy consumption, carbon dioxide emissions, waste production and water consumption by 3 % each year.

The customized GEA heat pump solution makes it possible to boost heat waste from the refrigeration units (ambient temperature) to a desirable hot temperature level, which is then used to heat water. Heat taken from the refrigeration units is upgraded by the heat pump to heat water up to 63°C. This water is then channeled through the factory's specially installed warm water piping network, from where it can be sent to various processes and users within the plant, for example, chocolate and syrup storage, and air-handling units.

The next step will be to configure heat pump technology that can achieve 90 °C water heating using recycled waste heat, and also heat fresh water. The final stage will be to develop a solution that can provide steam from recycled heat for relevant processes. This will be a challenge, but there has already been promising progress in new developments.

Heat from waste heat in machinery production

Heat pump systems used in production facilities to re-use heat and provide heating in office complex

The list of machines used at Vorbach for the production of tools and moulds is impressive. More than 2900 moulds have been manufactured since the company was founded in 1953. Many of Vorbach's customers supply major automotive concerns, where the templates, which are manufactured to the nearest hundredth of a millimetre, are used to produce millions of parts.
With the construction of a new production facility for plastic parts, Vorbach also looked to invest in a new energy system. A Viessmann heat pump, which uses waste heat from production machinery as its primary heat source, was the obvious choice. This heat, which is available virtually free of charge, heats the office complex.

In addition, an external heat exchanger was installed, which acts as a heat source during spring and autumn. It is also used to dissipate surplus heat in summer.

Picture 1 (right): The waste heat from tool and mould-making machines is used for heating.

Picture 2 (left above): The office building is heated by the Vitocal heat pump, which has an output of 107 kW and a cooling capacity of 84 kW.

Picture 3 (left below): Vorbach specialises in the production of tools and plastic parts.

“When planning our new building development, our commitment to environmental protection and to cost savings led us to consider how we could achieve both goals. We carried out detailed consultation and planning in order to increase energy efficiency and invest in a modern concept, and decided to invest in a large heat pump from Viessmann. It produces the cooling energy for our plant. Using the accumulated process heat as well as our air compressors for heating, we meet 55 percent of our energy needs, which we would otherwise have to pay for.”

Christian Vorbach
(Dipl.-Engineering),
Managing Director, Vorbach GmbH & Co. KG

Technical details of the application

Heating capacity: 107 kW

COP: 4,7 (B20/W50)

Refrigerant: R134a

Heating source: Waste heat

Supplied temperature: max. 70°C

By

VIESSMANN
climate of innovation

Internal integration of combined heating & cooling in Colruyt meat processing plant

Colruyt Group is a leading Belgian retail group that bares great emphasis on sustainability.

It's large tech department has a reputation for developing and pioneering company specific applications, and for being an early adopter in committing to sustainable energy initiatives.

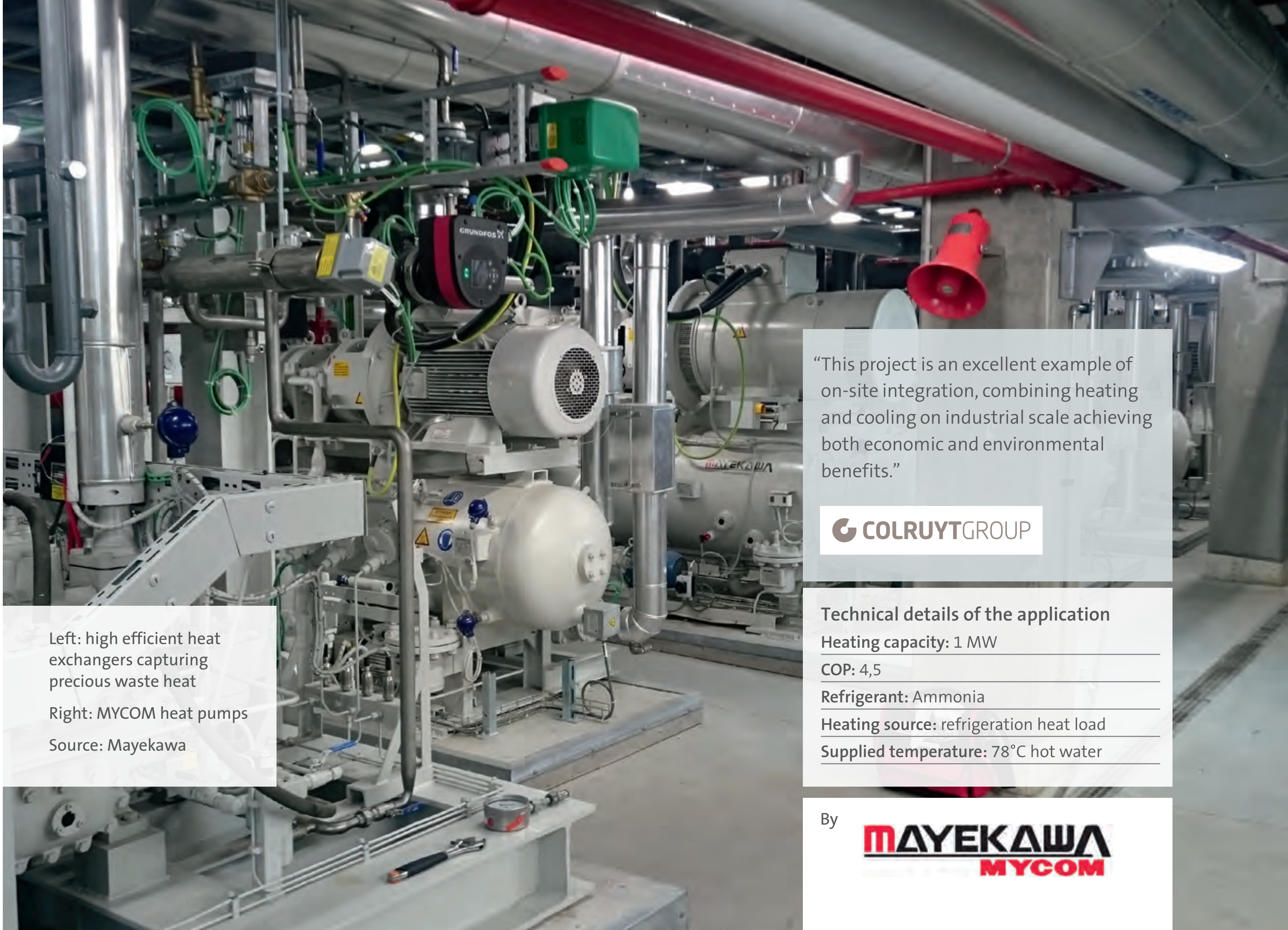
The efficiency of the cold chain is essential for the quality and safety of fresh food. Sourcing, processing, storage and distribution activities of fresh products are strongly integrated across Colruyt Group. In this way they have been able to perform a holistic approach towards integrated thermal energy consumption and production.

It's an endeavor towards full integration of heating, cooling and storage concepts committed to the use of natural refrigerants and powered by the best possible primary energy source.

Their central meat processing plant Fine Food Meat is the largest of its kind. On the site they have a wind turbine supplying the power needs.

Meat processing activities require hot water for production and cleaning. A large heat pump unit was designed to take full advantage of the heat load from the existing industrial refrigeration machine room capacity of several mega-watts.

The 1 MW Mayekawa ammonia heat pump unit consists of 3 Mycom piston compressors combined with highly efficient heat exchangers producing hot water with temperatures up to 78 °C achieving high COP's.



Left: high efficient heat exchangers capturing precious waste heat

Right: MYCOM heat pumps

Source: Mayekawa

> “This project is an excellent example of on-site integration, combining heating and cooling on industrial scale achieving both economic and environmental benefits.”

COLRUYTGROUP

Technical details of the application

Heating capacity: 1 MW

COP: 4,5

Refrigerant: Ammonia

Heating source: refrigeration heat load

Supplied temperature: 78°C hot water

By

MAYEKAWA
MYCOM

“The OCHSNER engineering support during the design phase allowed us to create a system that is perfectly suited to the continuous variations in the quantity of the available ground water. The precise commissioning of the heat pumps performed by OCHSNER provided a perfectly working system to us.”

EVOLVE

Technical details of the application

Heating capacity: 2 x 850 kW

COP: 4,6 (W15/W50)

Refrigerant: R134a

Heating source: Groundwater

Supplied temperature: 50–75 °C

By OCHSNER HEAT PUMPS

Picture 1: Machine room with two heat pumps

Picture 2: New building for the geothermal plant

Picture 3: OCHSNER Heat Pump before delivery

Source : Ochsner

Environment-friendly district heating network in Milan

OCHSNER industrial heat pumps reduce the excessively high groundwater level as a side effect.

The Forlanini district in Milan, with about 2000 apartments, is supplied by a district heating network which is powered by natural gas boilers and a combined heat and power plant (CHP). While elsewhere groundwater levels continue to fall, Italy's fashion capital seems to be in the opposite position.

The plant is located in a basement 8 m below ground level and due to the rising of the underground water level it has been subject to flooding several times, which had caused serious damages. This was a critical situation, considering that a CHP with a capacity of 2,4 MW electrical and 2,5 MW heat capacity is installed in the building. In order to prevent these threats, between 50 and 250 m^3 /h of groundwater were pumped away into a nearby river, all over the year, with large power consumption.

Groundwater represents an ideal heat source for heat pumps. Therefore, OCHSNER and its Italian partners developed an innovative approach to efficiently use this energy source. Wells were built for capturing water to be used in a geothermal plant, consisting of 2 heat pumps which are allocated in a new building. The available amount of groundwater and the heat demand are compared by a sophisticated control. According to the calculated value, one or both water-to-water heat pumps are activated. Each heat pump has a heating capacity of more than 800 kW at W10 / W35. A maximum flow temperature of 75°C provides reserves to guarantee a reliable heat supply, even at cold winter days.

The electric power for the screw compressors of the two heat pumps is produced by the CHP unit, which contributes to a short payback period. This project is an innovative approach to an environment-friendly heat supply in Milan.

Process heat in metalworking

The use of heat pumps feed by process heat resulting from coolant in metal casting.

Fertigungstechnik NORD, Gadebusch Nord Drivesystems is one of the world's leading manufacturers of custom gear units, motors and frequency converters/inverters. Process heat is continuously available from the machinery used for metal-working. It is derived mainly from the coolant, which is heated up in the course of machining processes such as turning, drilling and milling. This is why almost all the machines have heat exchangers that cool the mixture of water and oil to 23 °C in a single cycle. The heat extracted is compressed to a flow temperature of 55 °C by two large Vitocal 350-G Pro heat pumps, each with 300 kW heating output. In addition, heat is drawn from the ambient air, which enables an energy saving heating supply at outside temperatures of down to –2 °C. This economical and efficient form of heat generation covers 90 % of the annual heating energy. On especially cold winter days, the peak load is generated by two Vitoplex 200 low temperature boilers, type SX2, with rated heating outputs of 440 kW and 350 kW.

Picture 1 (upper left): The waste heat from production is used for heating by two Vitocal 350-G Pro heat pumps – the heat exchangers can be seen above on the right.

Picture 2 (left): Heat exchangers extract energy from the coolant, which is heated up in the course of various processes – for example, when machining castings.

Picture 3 (right): Two large Vitocal 350-G Pro heat pumps, each with a heating output of 300 kW

> "Investing in the heat pump system contributed to considerable savings in energy costs. It's total energy consumption was only one third of the old system's, enabling the new energy system to virtually pay for itself. The required energy continually accumulates as process heat during production. In turn, the temperature of the heated cooling fluid that is removed is reduced by three to five degrees Celsius. This economical and efficient heat generation meets up to 90 percent of our annual heating energy needs. The part of the system that uses electricity reduces the savings to 48 percent of total demand for power and gas, heating five halls with an area of 13 700 m^2."

Steffen Timm
(Dipl.-Engineering), Operations Manager,
Manufacturing Technology Nord

Technical details of the application

Heating capacity: 2 x 300 kW

COP: 4,3 (B0/W35)

Refrigerant: R134a

Heating source: Process heat

Supplied temperature: max. 65°C

By

VIESSMANN
climate of innovation

> “I would recommend a similar system for production plants where the amount of exhaust air is relatively high and the processes require a lot of heating.”

MSK Plast

Teemu Ritala,
Production Manager,
MSK Plast Oy

Technical details of the application

Heating capacity: Process heat pump 600kW

COP: 4,3

Refrigerant: R134a

Heating source: Waste heat is recovered from painting chambers and ovens. The heat is used to process water, facility heating, hot tap water and wash water heating

Supplied temperature: +65°C

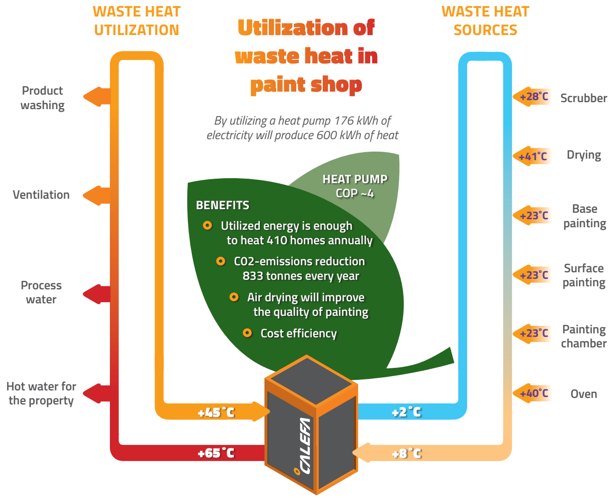
By CALEFA

When the process heat is recovered, the production hall serves as an ideal and comfortable working environment.

Source: Calefa

Reusing waste heat has paid off: Ongoing energy savings and a substantially smaller carbon footprint

MSK Plast Oy harnessed the waste heat from its painting department for reuse. The result is improved production, 833 000 kilos less CO_2 emissions, and a significant reduction in energy use every single year.


Utilization of waste heat in paint shop

By utilizing a heat pump 176 kWh of electricity will produce 600 kWh of heat

BENEFITS

- Utilized energy is enough to heat 410 homes annually
- C02-emissions reduction 833 tonnes every year
- Air drying will improve the quality of painting
- Cost efficiency

Plastic parts for Volvo and other well-known manufacturers are made in Kauhava in Finland. Enhanced customer awareness and an expansion of operations have encouraged MSK Plast to develop the highest ecological standards. The painting department is currently one the most environmentally friendly in the Nordic countries.

The company's most significant single act has been to reuse waste heat from the painting department, which saves 3800 MWh of energy per year, which would heat around 410 detached houses. CO_2 emissions will drop by 833 tonnes per year.

The system collects waste heat from the painting department's many exhaust air ducts. When the heat from the processes is recovered, the production space remains optimal and comfortable to work in.

The recovered waste heat is utilized to heat process water, the painting lines' washing water, and the building's supply air and water.

Calefa Ltd, which supplied the waste heat reuse system, improves its industrial customers' productivity as well as the reuse of energy.

MSK Plast previously experienced wastage and a slowdown in turn-around times during the most humid seasons when the air humidity in the painting process would rise too high. Calefa's heat pump technology solution is also utilized to dehumidify the air in the painting department.

"This is of great importance for product turnaround times. When the product is ready in one go, more parts get completed", says MSK Plast quality engineer Suvi Paavola.

Dehumidification of the paint shop is an added value that comes with the waste heat reuse system. By reducing wastage, it brings additional savings to the environment and the factory's costs.

Technical details of the application

Heating capacity: 2 × 4510 kW

COP: 4,7

Refrigerant: Ammonia

Heating source: Ethylenglykol 34%

Supplied temperature: 83°C

By GEA

Left: Chipboards

Right: Machine room with two GEA heat pumps

Source: GEA

Heat pumps boost the energy efficiency of a Swiss Krono chipboard factory

Hot water and energy equivalent of 10 MW produced by heat pump technology

Located in the northeast of Germany, the Swiss company 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 Grasso 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 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 2 heat pumps in 2016, an energy equivalent reduction of approximately 32 GWh and a CO_2 equivalent reduction of 6 700 tons have been achieved.

District heating plugged into precious industrial waste heat source

CP Kelco in Lille-Skensved Denmark is a Huber Group company, manufacturing food industry ingredients. An element in their process is distillation of alcohol Final condensation typically used to release large quantities of waste heat via cooling towers.

In 2016 CP Kelco, entered a cooperation with VEKS. (a west-Copenhagen district heating network). The aim was to obtain an efficient and flexible heat reclaim system without limiting production operations nor increase operational costs for CP Kelco, together with a cost-effective and stable supply of Green energy to the local district heating network of VEKS and its customers.

Consultants Viegand&Maagøe, specialists in energy efficiency projects, explored, analyzed, shaped and managed the project from start to finish.

The project was rated to achieve a payback period of around 4 years.

The system is a combination of direct heat transfer through highly efficient heat exchangers and the incorporation of two 1,5 MW ammonia heat pump units from Mayekawa with Mycom piston compressors. It produces district heating water with temperatures up to 85 °C achieving extreme high overall system COP values exceeding 40.

The entire heat pump system was designed, installed and commissioned in December 2017 by Svedan Industri Køleanlæg.

This project at CP Kelco is an excellent example of cooperation between production industry and energy supply companies achieving both economic and environmental benefits.

High efficient heat exchangers capturing precious waste heat (Source Mayekawa)

> “This project at CP Kelco is an excellent example of cooperation between production industry and energy supply companies achieving both economic and environmental benefits.”

CPKelco
A HUBER COMPANY

Technical details of the application

Heating capacity: 7~4 MW (winter/summer)

COP: 10

Refrigerant: Ammonia

Heating source: high temperature alcohol condensing heat exchangers (75 °C water)

Supplied temperature: 85 °C hot water returned at 55 °C

By MAYEKAWA MYCOM

Energy from Sewage

Sewage heat-fed heat pumps provide district heating to Újpest, a northeastern district of Budapest with over 100,000 habitants

Below the principal square of Újpest is a large sewage main collector with an average hourly flow of over 800 cubic meters. Part of this flow is redirected to an engine house built under the square below a parking lot. It is filtered by a specifically designed screening unit and led to purpose-built, self-cleaning heat exchangers to recover its thermal energy. The used sewage is directed back to the main collector while the recovered thermal energy is passed onto two large industrial heat pumps. These heat pumps heat and cool the area's brand-new market hall, a municipal office building and the over 100-year old city hall of the district.

The combined served floor space is 12 500 m^2 and the system has been in operations since 2017.

The system supplies 100 % of the heating and cooling needs of the buildings. The heat pumps provide a forward temperature of 60°C during the winter season and 7°C during the summer months. COP/EER figures reach up to 3,9/5,8, respectively due to the relatively constant 17°C temperature of the sewage all year round. The currently installed heat pump capacity is 1.7 MW and the system is designed to be able to provide heating and cooling energy simultaneously depending on needs. Operation is remotely controlled by a unique software designed for this purpose.

The configuration of the system allows for the capacity scale-up. Additional heat pumps along with a newly designed self-cleaning screening unit and fine-tuned heat exchangers are planned to be installed to serve new buildings now under development in the area. Most pipe works have been already laid for the planned expansion. The 500 cubic meters per hour minimum sewage flow in the main collector allows for the doubling of the current heating and cooling capacity.

Pictures in the clockwise direction:

Picture 1: Heat pump

Picture 2:Mayor's office

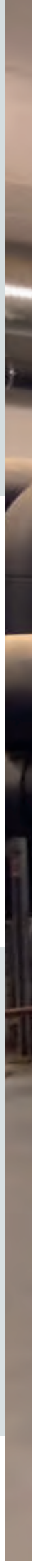
Picture 3: Market hall

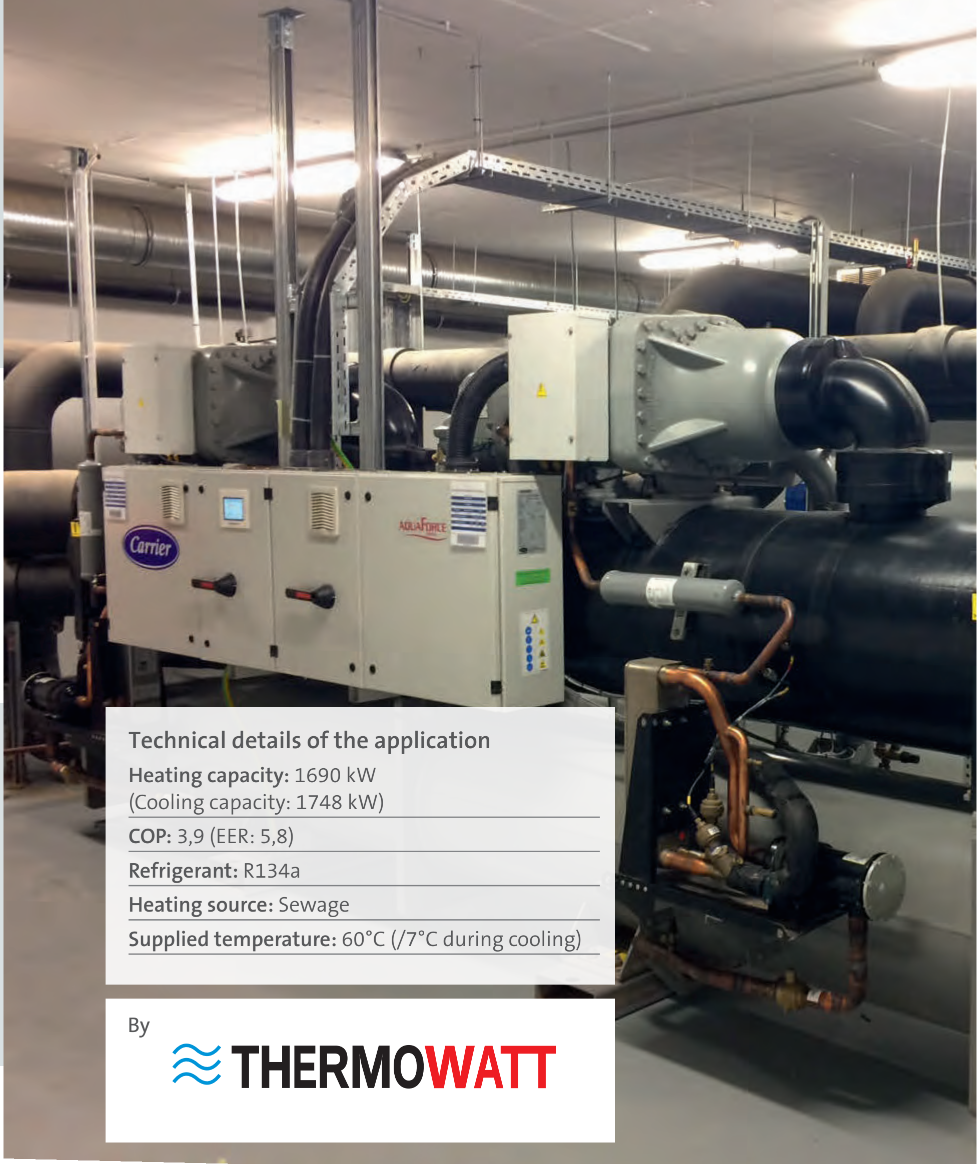
Picture 4: Custom-made heat exchangers

Source: Thermowatt

> "With heat pumps, we could significantly reduce our carbon footprint and tap a resource that would be otherwise wasted, literally."

Újpest
Önkormányzata





Technical details of the application

Heating capacity: 1690 kW
(Cooling capacity: 1748 kW)

COP: 3,9 (EER: 5,8)

Refrigerant: R134a

Heating source: Sewage

Supplied temperature: 60°C (/7°C during cooling)

By THERMOWATT

Photo credit: APA-PictureDesk/Agrana/Schedl

> “Heat pump technology shows potential to reach energy savings impossible to be reached by other technologies. It is considered to open doors for heat pump technology in Agrana’s production plants in the future.”

AGRANA STÄRKE

Emmerich Haimer,
responsible Technician
at Agrana Stärke GmbH

Technical details of the application

Heating capacity: 400 kW

Refrigerant: OpteonMZ

Heating source: Waste heat (water)

Supplied temperature: 110–160°C

By

DryF

Use of Waste Heat for Starch Drying at Agrana

Agrana Stärke GmbH is a leading specialist in processing and adding value to high quality agricultural commodities such as corn, potatoes and wheat, and is part of the Agrana group.

In the context of the European co-founded H2020 project Dryficiency, which is coordinated by AIT Austrian Institute of Technology GmbH (www.ait.ac.at), Agrana integrates a closed loop high temperature heat pump in its continuous starch drying process at the company's production plant in Pischelsdorf, Lower Austria.

The DryFiciency heat pump demonstrator consists of innovative heat pump components which were developed within the DryFiciency project: a modified semi-hermetic screw compressor by Bitzer (www.bitzer.de) and a novel lubricant developed by FUCHS Schmierstoffe GmbH (www.fuchs.com). OpteonMZ is used as working fluid. It is an environmentally friendly synthetic refrigerant for high temperature applications supplied by Chemours group (www.chemours.com)

The heat pump will be integrated in the starch drying process, that requires hot air at about 160°C. It recovers waste heat from other drying processes and reduces the steam consumption of the dryer, which is provided by a natural gas fired power plant.

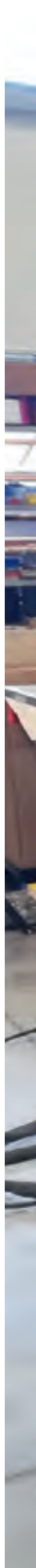
The heat pump demonstrator has a heating capacity of approx. 400 kW, which is about 10% of the starch dryer's heat demand. The heat supply temperatures range from 110 to 160 °C. The heat pump demonstrator plant shall decrease the yearly end energy consumption by 2 200 MWh and contribute to save CO_2 emissions of about 500 t.

For more information, please visit our website **www.dryficiency.eu** and sign up our newsletter or our social media channels.

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

Heat Pumps for Brick Drying at Wienerberger

Wienerberger group is the world's largest producer of clay blocks and facing bricks, leading in the clay roof tile and concrete pavements market in Europe, and one of the strongest market players in concrete and plastic pipes (www.wienerberger.com).



Left: Bricks

Right: DryFiciency heat pump

Source: Wienerberger © Johannes Zinner

Heat pump drying shall replace the actual fossil-based combustion-driven drying technique in the future. Therefore, Wienerberger will integrate a closed loop high temperature heat pump demonstrator in a brick dryer at their production site in Uttendorf, Upper Austria, as part of the European co-founded H2020 project DryFiciency, which is coordinated by AIT Austrian Institute of Technology GmbH (www.ait.ac.at).

Bricks are dried in a continuous tunnel dryer, where the moisture content of the bricks is reduced from around 30% to 2 – 4%. The heat pump uses waste heat to provide hot air for the dryer. It includes piston compressors from Viking Heat Engines A/S (www.vikingheatengines.com), which are based on a proven, heavy-duty design developed in collaboration with the world's largest engine design company, AVL.

The compressors are compatible with all common refrigerants of the 3rd and 4th generations e.g. HFOs like OpteonMZ from Chemours group (www.chemours.com), which is used in the demonstrator. For its lubrication a novel lubricant is supplied by FUCHS Schmierstoffe GmbH (www.fuchs.com).

The heating capacity of the heat pump demonstrator is 400 kW, the heat supply temperatures range from 110 to 160°C. The heat pump replaces a natural gas burner and shall lead to end energy savings of up to 84% and reductions in CO_2 emissions of about 80%.

For more information, please visit our website **www.dryficiency.eu** and sign up to our newsletter or our social media channels.

> “DryFiciency fills the current gap in heat pump technologies necessary to fully operate our brick dryers on heat pumps recovering latent energy from moist air and providing high temperatures for drying.”

Stefan Puskas,
responsible
Project Manager
Engineering at
Wienerberger AG

Technical details of the application

Heating capacity: 400 kW

Refrigerant: OpteonMZ

Heating source: Waste heat (water)

Supplied temperature: 110 – 160°C

By

DryF

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 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.

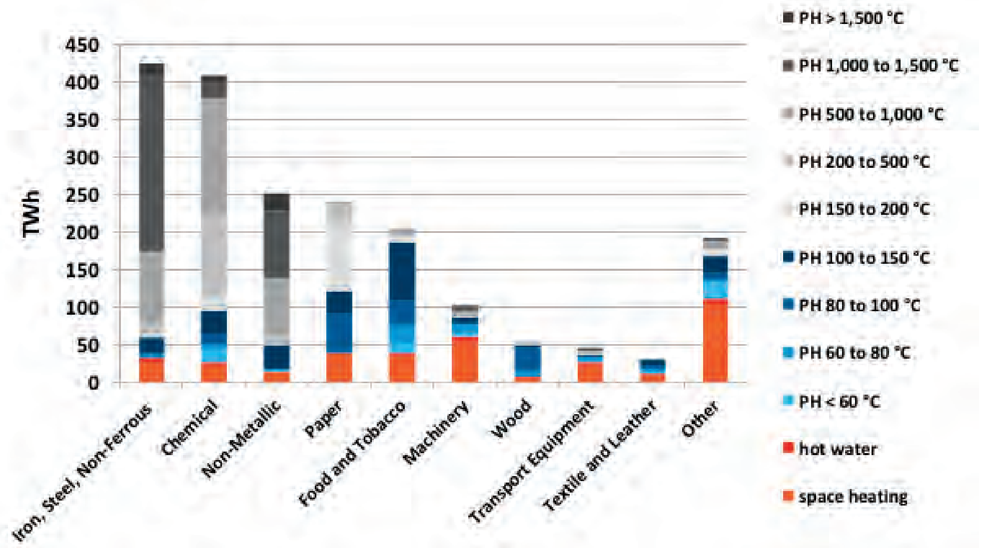


Figure 1: Distinction of heat demand in industry by sector and temperature range. [1]

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 figure 2). Adding the sectors of hot water and space heating reveals an additional 74 TWh (see orange shaded bars in figure 2). With technical progress, an additional potential of 32 TWh in the temperature range from 100 to 150 °C can be made accessible (see darkest blue bar in figure 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]

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 CO_2 emissions, extending the economic potential of demand reduction will also reduce CO_2 emissions from the industrial sector. The study concludes a total CO_2 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 CO_2 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

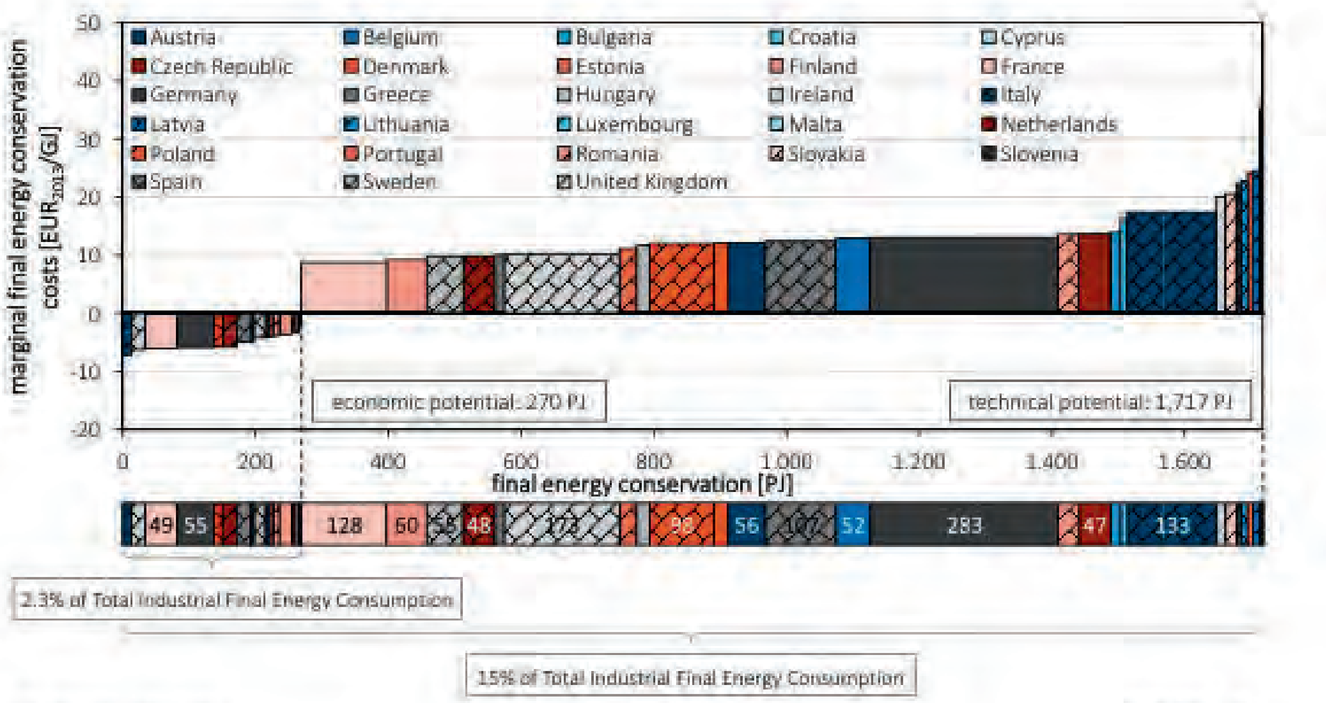


Figure 2: Industrial heat pump potential in EU-28 [2]

Rotterdam. Source: Municipality of Rotterdam

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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