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How industrial waste heat can keep cities warm and decarbonize production

Turboden's large heat pumps are helping industry customers boost efficiency and sustainability by reusing their waste heat in other processes or exporting it to public utilities. Here, the company's Andrea Magalini and Nicola Rossetti explain why this green heat source has a bright future.



Nicola Rossetti: 'We utilise the waste heat of the iron and steel factory. We developed a large heat pump system, a 6-MegaWatt thermal (MWth) heat pump which extracts the heat from the processor, and increases the temperature to 120 degrees in order to supply it to the district heating of the city.'

Brescia, an ancient city of 200,000 people, sits at the foot of the Italian Alps, between Lake Garda and Lake Iseo. As well as a long history, it has a strong industrial heritage, as evidenced by the electric furnace steel mill located in the north of the city. Steel production requires very high temperatures, making it particularly hard to decarbonise – but now that heat itself is being utilised in a project that will help to reduce the plant's carbon footprint.

Also based in Brescia, Turboden (a part of Mitsubishi Heavy Industries Group) is an Italian company and a global leader in the design, manufacture, and maintenance of customized decarbonization solutions. Its products include large heat pumps – utility-scale heating plants that can transfer large quantities of waste heat from industrial processes to district heating networks, which heat homes, businesses, and public buildings. This is the solution currently being implemented in Brescia, at the ORI Martin plant.

“This is a steel mill in the middle of the city, so they are constantly looking at ways to be more and more sustainable,” says Andrea Magalini, sales director at Turboden. “It's important for them to give back to the community in a way that is good for the environment – and exporting waste heat to the district heating network is something that has great mutual benefit.”

Nicola Rossetti, Turboden's business development manager, explains how it works. “We utilise the waste heat of the iron and steel factory, which is available at low temperature and under normal circumstances is not only wasted – it actually increases energy consumption because it requires cooling. We developed a large heat pump system, a 6-MegaWatt thermal (MWth) heat pump which extracts the heat from the processor, and increases the temperature to 120 degrees in order to supply it to the district heating of the city.”

Creating valuable efficiencies

It's a virtuous circle, where everyone benefits: pollution is reduced; the city gets a cost-competitive form of decarbonised heating; and the steel plant gets to improve its sustainability credentials while contributing to energy security. The heat can also be channelled back into production processes, creating valuable efficiencies for manufacturers.

“In most industrial processes, there is a certain level of inefficiency that is inherent in the process,” says Magalini. “You have fumes that go out into the atmosphere, or you have cooling towers, so you spend energy to cool down heat that is not exploited to produce anything. And if you look at the overall industrial footprint in the world, that is a huge amount of heat that is not being used.

“[But] with our systems, you can exploit this heat in order to produce electricity or heat, which can be used for self-consumption in some cases – for example, steam generation for the industrial process itself – thus increasing the efficiency and the sustainability of the overall process. Or it can be exported to the grid, or to a district heating network to heat cities and houses and commercial spaces. So, it's a big opportunity.”

For Turboden, large heat pumps are at the forefront of the drive to electrify heat supply in an increasingly decarbonised power grid. The company foresees using the technology to play a broader role in the decarbonisation of district heating and of some energy-intensive industrial processes.

“You know, almost one third of overall CO₂ emissions are related to power and heat production,” says Magalini. “But when speaking about the energy transition, people tend to refer to electricity production: wind energy, photovoltaics [PV] and so forth. But when you switch to heat, the situation is different: there is no equivalent to PV for heat production. You can use some power to heat up water, but it's not always convenient to do that on an industrial scale. So, heat pumps are the key means to connect green electricity production with green heat production in an efficient and competitive way.”

Large heat pumps and low-emissions electricity

Central to this is the way in which large heat pumps transfer heat from the source to the user, and that it can do so using low-emissions electricity. “Indeed, the heat must exploit green or low-emission electricity in order to transfer heat from a low-grade source to a high-temperature user,” says Magalini. “It's very suitable specifically for industrial application.”

While these technologies are especially pertinent to the green energy transition of today, Turboden has in fact been working on systems like this for more than four decades.

“We have 40 years of history, turning 43 actually this year,” says Magalini. “We have the fully-fledged capabilities to take care of the engineering and design of all the systems.

“Specifically, we are experts in closed-loop thermodynamic cycles, which is the core of our flagship product, the Organic Rankine Cycle (ORC) but also of the heat pumps, and [in the] design of turbomachinery, which is also the core of ORC and heat pumps – you have turbines in the ORCs, and compressors in heat pumps. So, building upon this core capabilities, we can shape solutions that are suitable for our specific customers' needs.”

In 2013, Turboden became part of Mitsubishi Heavy Industries (MHI) Group. As Magalini says, this means it has “broad shoulders”, but can also maintain the personal touch you might expect from a mid-sized Italian company.

“We have tailor-made solutions for the needs of the customer, which can give us an advantage over some alternatives that tend to provide standardised solutions, which might not be the best [option] for the [specific] case of the customers.”



It's a fast-growing market, which is serving to bring costs down, says Rossetti, pointing to a recent report from the International Energy Agency. "Heat pumps already have the lowest levelised cost of heat among the possible technologies to produce decarbonised heat," he says. "And this is important because, at the end of the day, there's a question of money, and with heat pumps, you can have decarbonised heat at a lower cost. This is important for the sustainability of the technology itself in the market."

Another point Rossetti is keen to get across is the versatility of the technology, which many people may associate with small-scale heat pumps for domestic use. But the temperature ranges possible are much wider than you might expect, he says, meaning it also has potential for large-scale industrial applications, which typically require much higher temperatures, higher than can often be achieved through renewable sources. Turboden is a forerunner in this kind of application.

A key technology to meet heating demand

"Our focus in this market is related to high-temperature and large-size heat pumps or to customized solutions based on our technology or even on a combination of technologies," he says. And this is something that when you speak about heat pumps, not [every] stakeholder knows, but actually you can provide heat at temperatures of up to 200 degrees Celsius. There are plans for heat pumps of over 100MWth. This is for sure one of the key technologies to almost completely cover all of the heating demand that needs to be decarbonised."

One way in which the technology could be developed further is through combining it with other technologies in order to cover an even wider range of heating demand, says Rosetti. "This is important, because there is also a huge portion of heat demand that is from 200°C up to 500°C, and that part shall [have to] be decarbonised, because it's almost 100% produced via fossil fuel nowadays."

This is likely to be a focus as the industry develops. With the technology in operation, and costs low enough to justify a much wider rollout, market prospects are very bright, says Magalini: "We think that we already have the solution; now we are looking for projects and implementing projects to grow the market."

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Turboden Large Heat Pumps – Our Experience. Your Power

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