Global corporates line up for heat pump CO2 savings

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"Although these companies are very careful with operational and investment costs, they are also willing to invest in new technologies to bring them closer to their goals. Shareholders, boards, employees and customers are forcing them to go zero carbon," Geelen said.

"*They cannot get there by small incremental steps of improved energy efficiency, so they have to redesign some process steps from scratch. Electric drying with heat pumps allows them to first improve energy efficiency by as much as 75% and then to apply renewable energy in the form of electricity, eliminating CO2 emissions completely from the drying process. In the food industry, the dryer is often the biggest single energy consumer in the plant, so the impact of electrification on the total emissions is very significant,"* he said.

Efficiency comes from recovered exhaust air energy

The big efficiency improvement is the result of recovery of energy from the dryer's exhaust air, for which the heat pump's 'cold side' provides the cold water to trigger condensation. This warm and wet exhaust air is traditionally blown off into atmosphere, wasting the heat, hence the vapour clouds coming from chimneys. Recovering the energy

from the air, is obviously the right thing to do first. The heat pump then uses this recovered energy and boosts its temperature back up to a level that is sufficient for the drying process. The gas burner is then no longer needed. "*Some big companies are prepared to invest in such technology not only because of their zero carbon targets. They also know that the Total Cost of Ownership (TCO) of such dryers is lower in most countries, and with carbon pricing becoming more and more prevalent, the TCO savings will add up over the 25-year lifetime of the dryer*, he explained.

Industry's energy footprint

According to the International Energy Agency, industry emits 23 per cent of total global energy-related CO2 emissions. During the project's final workshops, DryFiciency Coordinator and Senior Research Engineer Energy at the Austrian Institute of Technology (AIT), **Veronika Wilk,** brought us closer to understanding the potential impact on the reduction of CO2 emissions should heat pump technology be implemented on a larger scale across Europe. "*If we equip 50% of all industrial dryers in Europe with a DryFiciency heat pump, we can reduce energy consumption by 107 – 268 terra-watt hours. This is 7-18% of the energy consumption reduction that we still have to achieve to comply with the 2030 targets of the EU. The heat pumps for drying would also reduce CO2 emissions by 27-66 million t/a, contributing to 3-7% of the emission reduction necessary until 2030*," Wilk said.

DryFiciency heat pump demonstrations

In the DryFiciency project, high temperature closed loop heat pump demonstrations were undertaken to assess whether they could sustain temperatures of up to 160 degrees Celsius when docked onto industrial drying processes. Additionally, an open loop heat pump demonstration was successfully installed. Milestones were achieved at three separate demonstration installations in the drying of starch, bricks and waste, including the achievement of the global high temperature closed loop heat pump record of 160°C at the factories operated by Austria's **Wienerberger** and **Agrana**. Norbert Harringer, Chief Technology Officer and Member of the Board, Agrana Group, commented on the potential, significant CO2 savings that could be achieved. *"A recovered energy potential of such heat pumps of about 20 megawatts could be realised similar to our demonstrator in Pischelsdorf (referring to the DryFiciency demonstrator). In our Austrian plants this could save about 160,000 megawatt hours per year of primary energy, and of around 31,700 tonnes of CO2 emissions per year,"* he said. Meanwhile, also at the Conference, Johannes Rath, Chief Technology Officer Wienerberger Building Solutions, also hinted at the company's future plans. "*DryFiciency is very important to us. Wienerberger is operating more than 150 brick plants. In every one of these there is a brick dryer consuming a major amount of energy. The implementation of heat pump technology is a chance for us to improve our carbon footprint and at the same time also the production costs. Therefore, heat pump technology is key to achieving our sustainability targets*," he said.

Scanship DryFiciency partner successfully demonstrated an open heat loop pump by drying organic waste for a town council in Drammen, Norway. A detailed read is available HERE.

How can this technology be taken up quickly?

There are many factors that speak in favour of rolling out this technology globally. The EU's recent legislative "Fit for 55" package, released in July 2021, aims for a 55 per cent net reduction in greenhouse gas emissions by 2030. According to the EU "Fit for 55" **press release**, the proposal aims for an "increased use of renewable energy; greater energy efficiency; a faster roll-out of low emission transport modes and the infrastructure of fuels to support them" in line with the Green Deal objectives. The package brought in 13 new proposals to effectively incorporate a wider range of sectors to comply with **European Climate law.** Eight revisions to existing laws and five new proposals covering climate, land use, energy, transport and taxation will bring policies in line with set CO2 achievement targets for the Green Deal. Effectively, they will amount to a tightening of what will become a new Emissions Trading System (ETS). The new ETS mirrors the landmark 2005 Emissions Trading System which forced big polluters to achieve better carbon footprints using the cap-and-trade system. Since 2005, the ETS "*has successfully brought down emissions from power generation and energy-intensive industries by 42.8 per cent in the past 16 years,*" the press released stated. Clearly the EU is determined to pave the way to meet climate targets by making it harder and more expensive to pollute. These measures have encouraged corporates to re-think their sustainability strategies, ideally beyond the **cap-and-trade system**. As Geelen said, they know that they have more to lose by not engaging. Some companies would even like to be seen as sustainability leaders with corporate strategy driving the decision at a faster pace.

Huge heat pump potential to reduce CO2 emissions

While heat pump technology holds enormous potential, current high temperature heat pump technology demonstrated in DryFiciency needs to be upscaled to larger working installations and still needs to be fully commercialized. The demonstrators have been in operation for more than 8,000 hours in total in the project, and scientific results indicate significant energy and CO2 emissions reductions of up to 80 per cent. Finding the right components to sustain the harsh operating environment for these demonstrators was essential. During these industrial drying processes some components were tested beyond their capability, while others found a reputation for themselves, like the DryFiciency partners **Bitzer** compressors, **Fuchs** lubricants and **Chemours** refrigerants.

Geelen Counterflow dryers sold in China, South Korea and Norway

When Geelen joined the DryFiciency External Advisory Board in 2017 he was impressed by the networking opportunities to help his company further improve the electric dryers they had been developing and pilot testing since 2014. Geelen Counterflow intensified the collaboration with DryFiciency partners which helped the company sell three fully electric dryers, one for petfood at Royal Canin (Mars Petcare) in South Korea (1.2 MWth), one for

petfood in China (2.4 MWth) and a third for aquafeed at Cargill-Ewos in Norway (3.4 MWth). An important key to convincing the customers was Geelen Counterflow's strategy to include gas burners as a back-up, so the customer can be confident the new technology cannot lead to unexpected down-time of the plant. The Geelen Counterflow hybrid electric dryers initially will be commissioned with gas burners. Later, when the dryers are running, the Counterflow Recovery Units (CRU) will be commissioned to start recovering energy through the condensation of warm, moist air coming out of the dryer. The warm air coming from the CRU will be boosted in temperature by high temperature industrial heat pumps which will supply 100 per cent of the heat for the dryer which means that the gas burners can be switched off or go into stand-by mode. The heat pump also supplies the cold water to trigger condensation of the water vapour in the exhaust air.

Hybrid dryers give price-switch flexibility, back-up options

This redundancy strategy with hybrid technology also enables plants to switch back to gas in case of excessively high variable electricity prices. This is not only economically attractive in exceptional cases, but also contributes to stabilizing the electric grid. *"I know that installing heat pumps as well as gas burners in these hybrid dryers seems a little counter-intuitive because it increases the price of installing thermal capacity, but to give these big companies the security of knowing that they have a back-up option in case something happens to the heat pump or heat exchangers, that is essential for them, that they know that they can flip a switch and revert to gas if necessary*," Geelen said. The net energy consumption of the dryer will then be up to 75 per cent lower and consist of electricity only. If the electricity is from renewable sources the direct and indirect CO2 emissions of the dryer can be eliminated. *"There are other big corporates actively inquiring about having the ability to operate the dryers on both gas and electricity, while reducing their carbon footprints. Currently, we have a client that is considering rolling out many dozens of these dryers across all continents between now and 2030*," Geelen added.

Energy prices will determine industry uptake

While the capital expenditure, or CAPEX investment of installing dryers with hybrid heat pump technology is high, due to the complicated nature of project engineering, the operational cost and CO2 footprint depend on the country of operation, the price of electricity and the availability of renewable sources of electricity. In this context, governments and industry need to provide sufficient sources of renewable electricity at affordable prices to wean big industry off fossil fuel power generation. Norway, for example, has an extremely advantageous operating environment for heat pump start-ups and technologies, detailed **HERE**.

The future

At the end of the DryFiciency project, many partners currently are working behind the scenes to take this technology to the next level including a number of demonstration projects. There is a lot of interest around the topic which has been helped by a series of

successful online **seminars** and ***Pump it up!* final conference** organized by RTDS-led communications, in association with the **European Heat Pump Association** which in total attracted around 1,000 participants. The final DryFiciency conference included a panel discussion by heat pump experts, including Geelen. Additionally, online training workshops on heat pump technology were held by the **AIT Austrian Institute of Technology**.

UNFCCC COP26

Geelen's next mission is to attend the United Nations Framework Convention on Climate Change (UNFCCC) **Council of the Parties (COP26)** meeting in Glasgow in November with the Secretary General of the European Heat Pump Association, **Thomas Nowak.** The COP26 meeting will bring together many governments, policy makers, business leaders and campaigners to increase the momentum and commitments of the Paris Agreement that was signed by 191 states, including the EU (figure as of July, 2021, **UNFCCC**). The Paris Agreement set a target of limiting global warming to under 2 degrees Celcius, but preferably to 1.5 degree Celsius, compared to pre-industrial levels. The UNFCCC has warned that without *"rapid, sustained and large-scale reductions, the goal of limiting global warming up to 1.5C compared to pre-industrial levels, as enshrined in the Paris Agreement, will be beyond reach"*. Geelen and Nowak plan to present heat pump-based solutions for industry and the built environment to policy makers in Glasgow during COP26. Heat pumps can provide the large emissions reductions that the world needs to address climate change. Nowak commented that the DryFiciency project influenced the way "*we see heat and the provision of heat in industrial processes tremendously"*. "*When we started this (DryFiciency), it was basically perceived that heat can only be provided by heat pumps at temperature levels of between 100 degrees Celsius, or maybe you could go to 110, 120 degrees Celsius, but not more. And now we have evidence, we have proof that this is not true, and I really applaud the European Commission for financing this project because it's so super useful and is very impactful*," he said. Geelen concluded that the message at COP26 is that "*technology to radically reduce CO2 emissions is already available for the built environment, and industrial heat applications up to 180C. Electrification is here to stay, and policy makers should plan accordingly".*

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