

## Kom på lösningar för Cytivas restvärme

Making use of industrial low temperature waste heat from the company Cytiva from an environmental aspect

*Emelie Heino, Filippa Beck-Norén, Johanna Ezra and Johanna Lundström*

The industry sector accounts for a vast amount of the world's total energy use, as much as 37% during 2018. Using energy in a sustainable way is necessary from both an environmental and an economical perspective, and it is therefore relevant to take measurements that result in a more efficient use of energy. One way for industries to become more energy efficient is to recover and then reuse the waste heat, which is energy that otherwise would go to waste.

This report aims to find a method to recover and reuse the low temperature waste heat available at the life science company Cytiva's production site in Uppsala, Sweden. The proposed solution will be to use the waste heat for heating a vertical greenhouse. The study will examine whether this is feasible, and also how installing photovoltaics affects the energy use. Furthermore, the environmental impact of operating the greenhouse with waste heat is also investigated, by calculating the CO<sub>2</sub> equivalent.

The low temperature waste heat that Cytiva provides relevant for this study is 6683 kW which will be used to heat up the greenhouse. Simulations in the software IDA ICE will be used to construct and simulate a model of the vertical greenhouse. Results from the simulations show that the chosen size, 25 × 50m × 35.5 meters, gives a good approximation according to the wanted temperature range, 18.3-32.2°C. Furthermore, the results imply that the total energy use, 790 652 kWh, and average power, 90.26 kW is less than the available waste heat and there is a large amount that still is unused. The CO<sub>2</sub> equivalent is calculated to 29 317 kg when the greenhouse is powered by electricity.

A sensitivity analysis is made to evaluate the window-to-wall ratio as well as the size of the entire greenhouse. It showed that both parameters are critical and makes a big difference in the simulations.

