



# HighLift by Olvondo

steam generating heat pump

Lower your carbon footprint,  
increase your profit

May 2023





# Olvondo Technology at a glance



## Olvondo Technology AS

- Norwegian technology company owned and supported by two Norwegian industry groups.
- Develops and manufactures High Temperature Heat Pumps, HTHP for industrial use.
- Company set-up:
  - Holmestrand – Commercial office, headquarters, engineering and R&D
  - Bømlo – Service & maintenance, manufacturing and facility office

## HighLift by Olvondo ©

- Since the concept studies in 2004 the HighLift technology has matured till TRL9 .
- HighLift technology is currently in operations at pilot customers in the Nordic countries with more than 90.000 operational hours.
- The HighLift heat pump is now commercially available
  - Installation of steam producing heat pump in The Netherlands
  - Pre-studies ongoing within several European countries







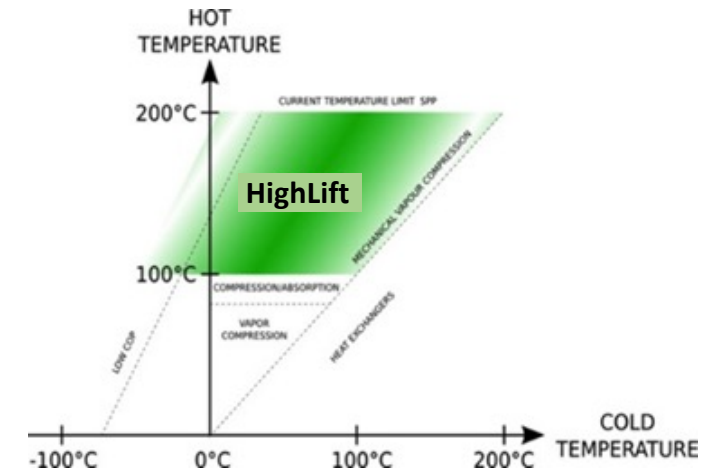
Receive heat from a waste stream



Extract and increase the heat from waste source

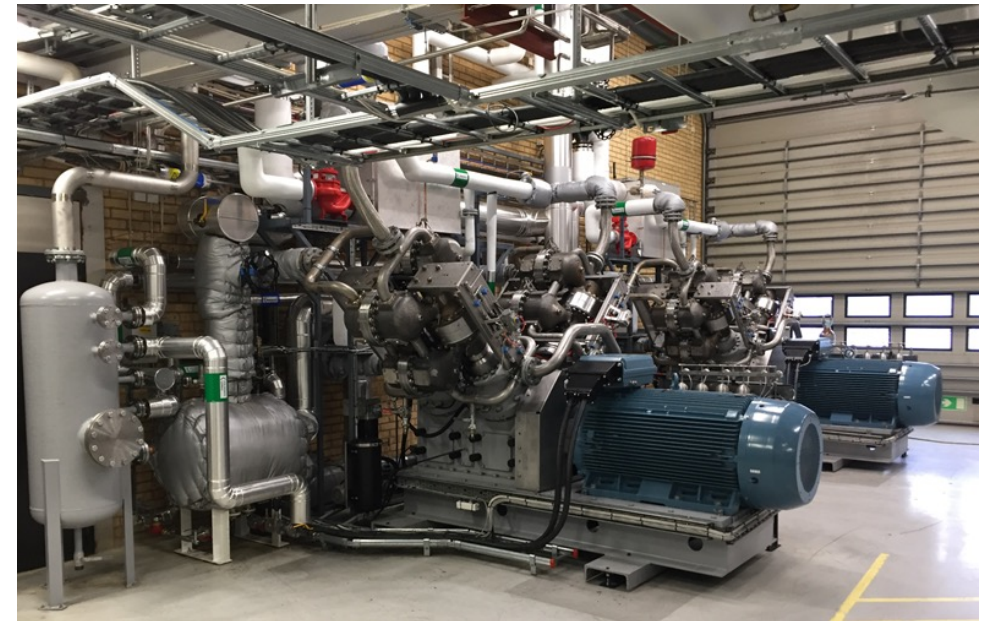


Deliver useful heat

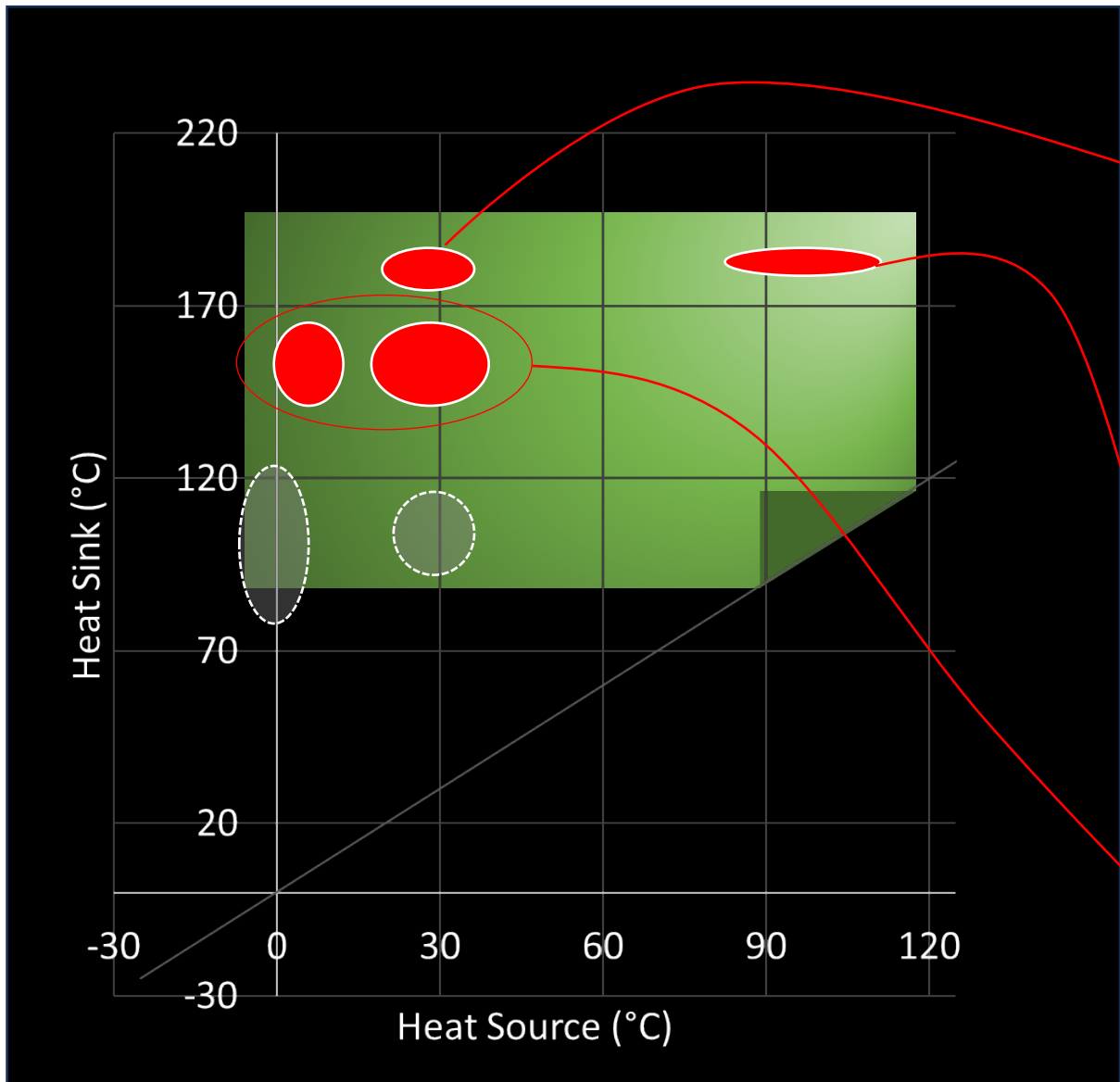


## The HighLift high temperature heatpumps:

- recycle low temperature, low value waste heat to high temperature, high value process heat
- produce steam and cooling in one process
- use helium as working media
- enable high temperature lifts, delivering very high sink temperatures
- based on a reverse Stirling engine process

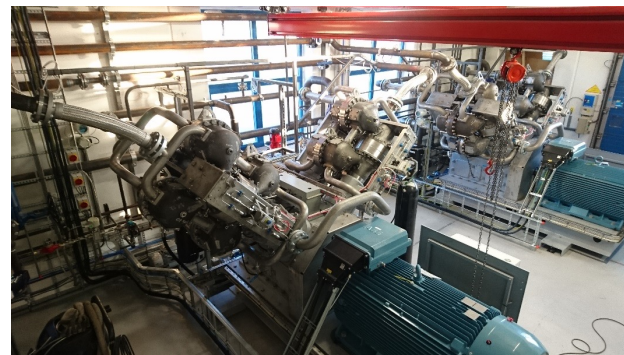


# Heat pump installation examples



Hot side: 180°C (10 bar)  
Cold side: 40°C

Heating: ~450-500 kW<sub>th</sub>



Hot side: 180°C (10 bar)  
Cold side: 100°C (DH)

Heating: ~450-500 kW<sub>th</sub>

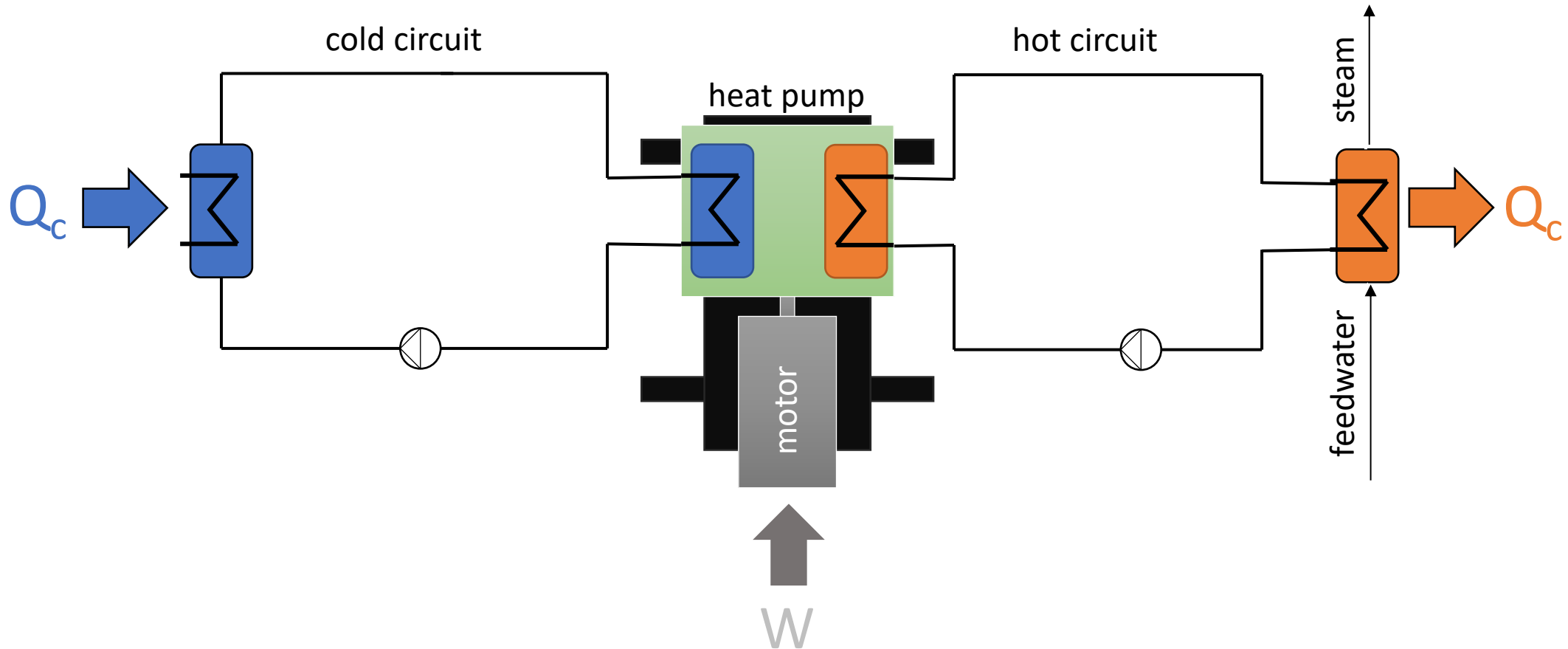


Hot side: 170°C (6-7 bar)  
Cold side: 10°C, 40°C

Heating: ~450-500 kW<sub>th</sub>



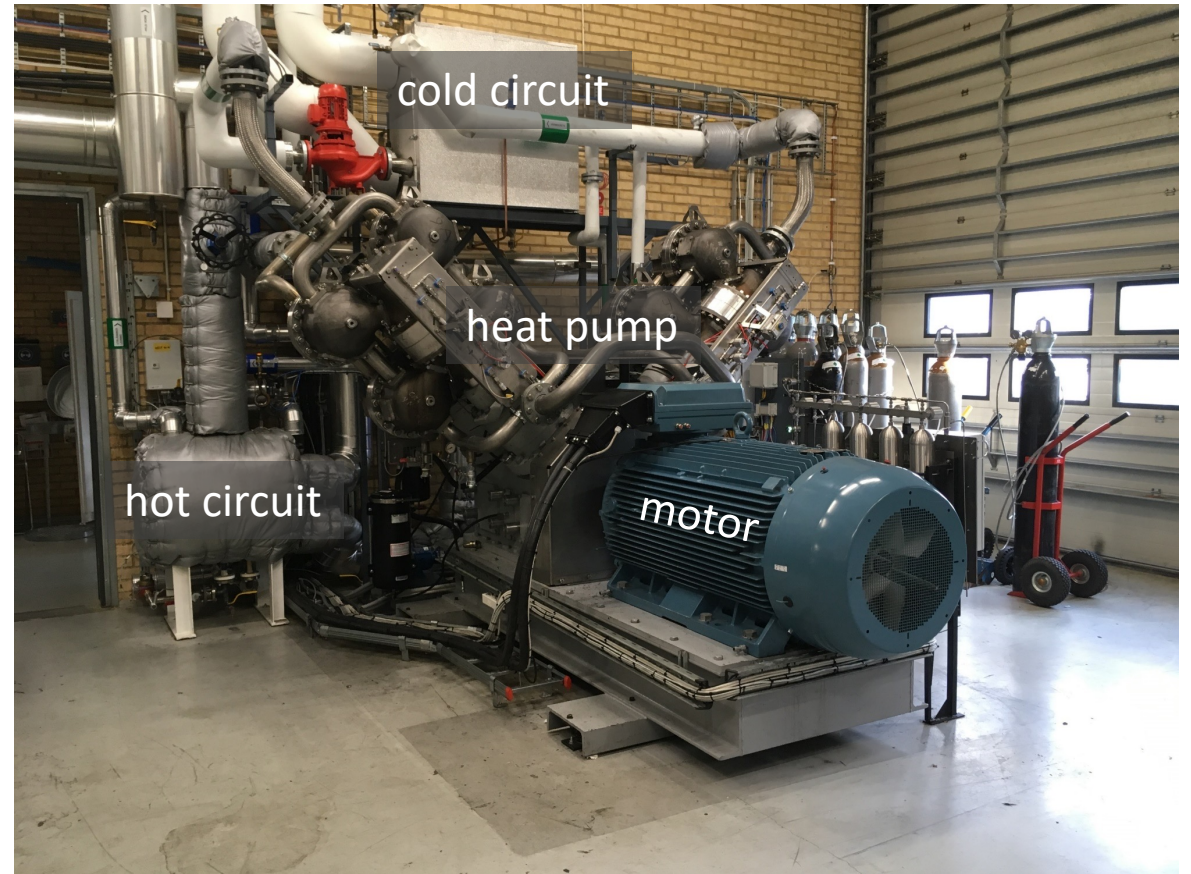
# Typical installation flow sheet



# Example of an installation

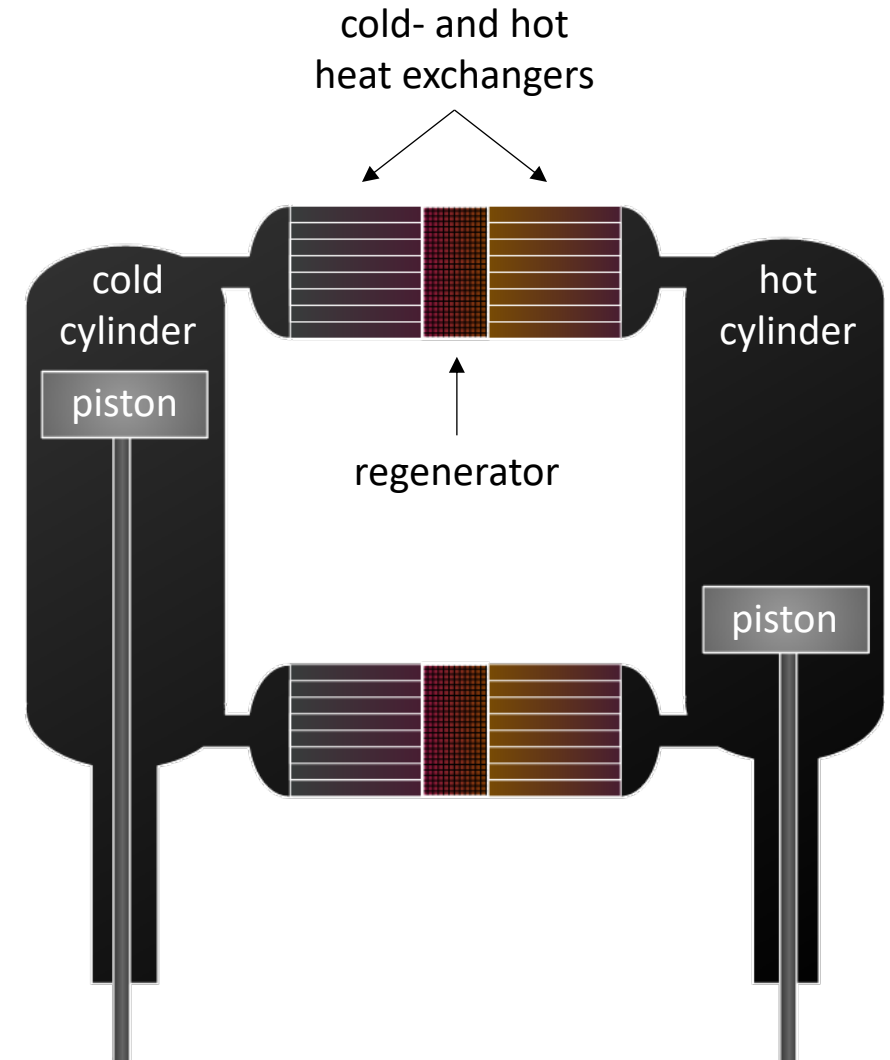
## Main components:

- heat pump
- steam generator
- plate heat exchanger
- auxiliary circuits
- working-medium system



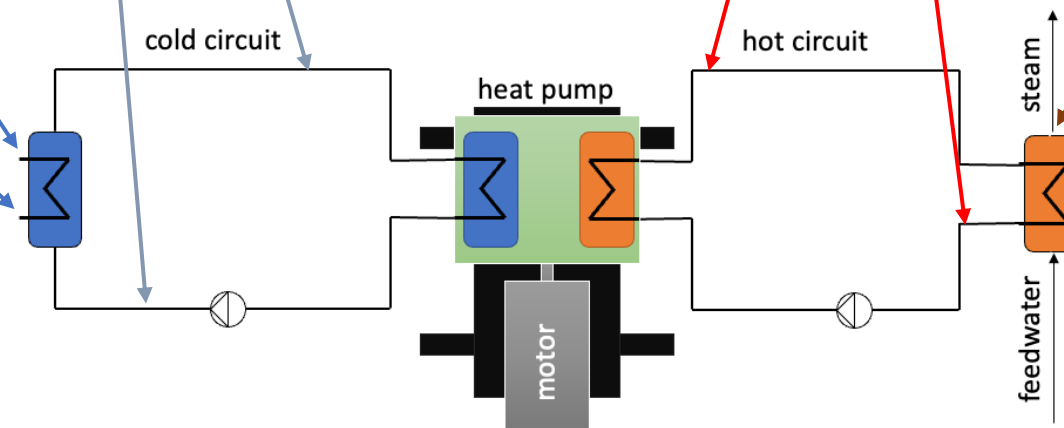
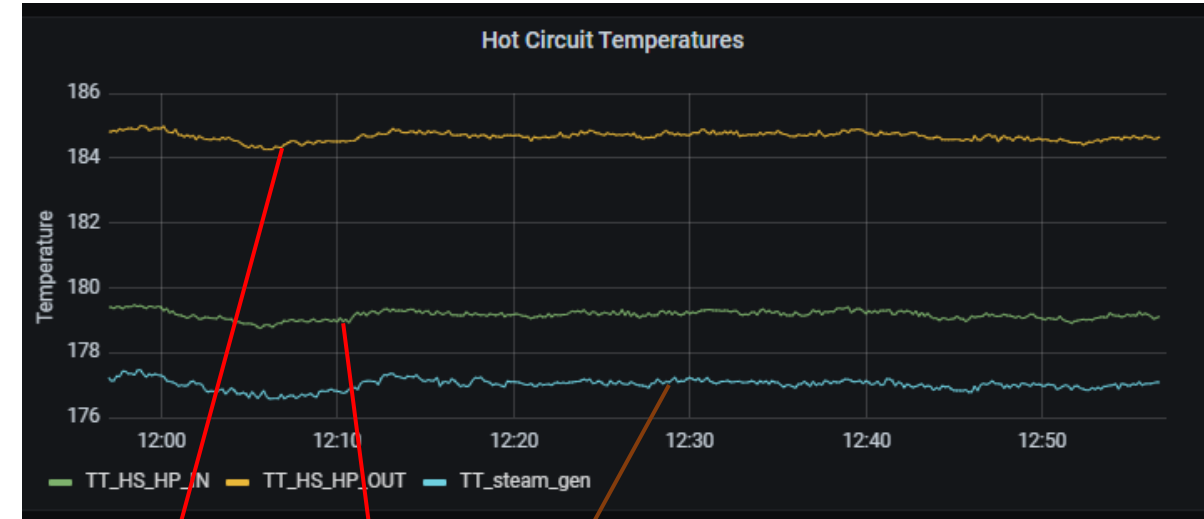
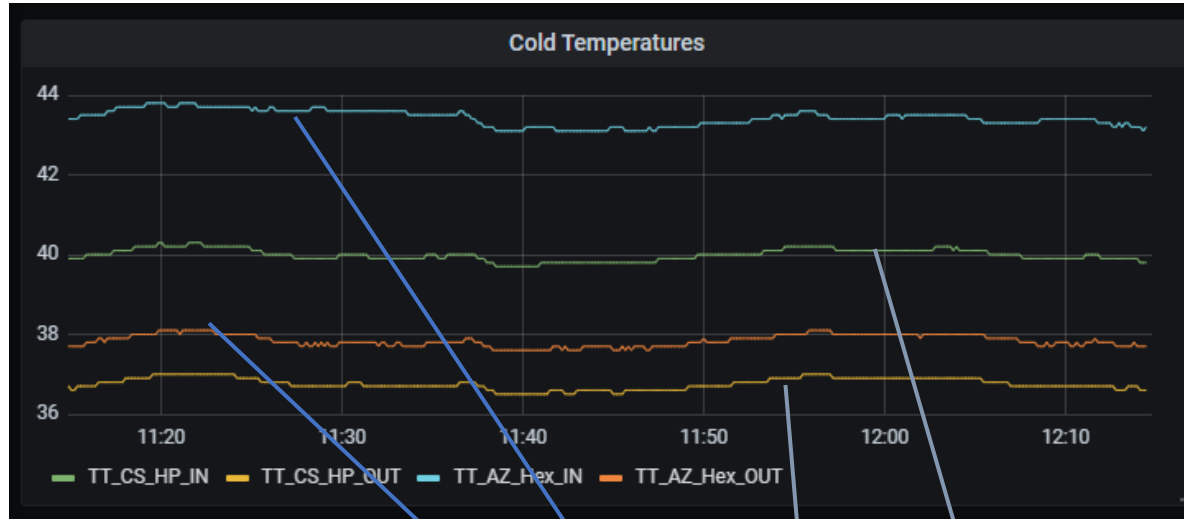
# Process description

- Mechanical layout comparable to a 4-cylinder piston compressor.
- Working-medium a gas (He, R704).
- Heat transfer through water (from the working-medium).
- Self-adaptive to very large variation in temperatures.



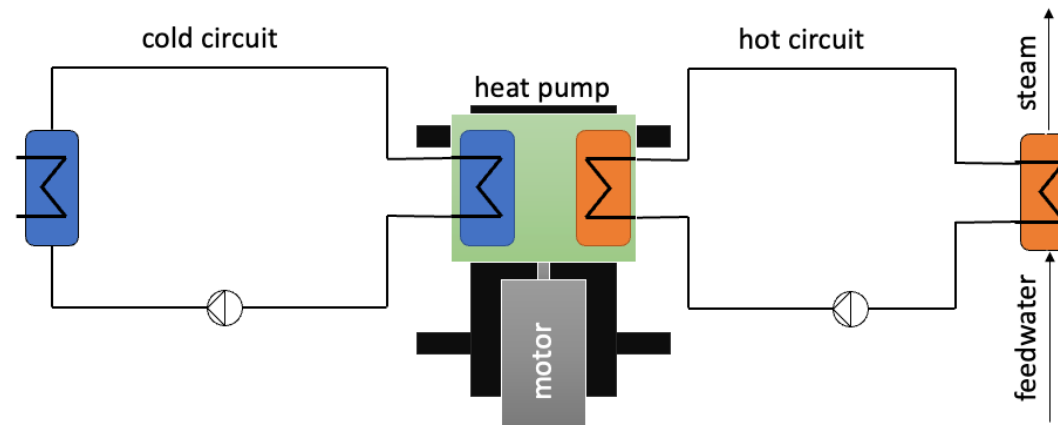
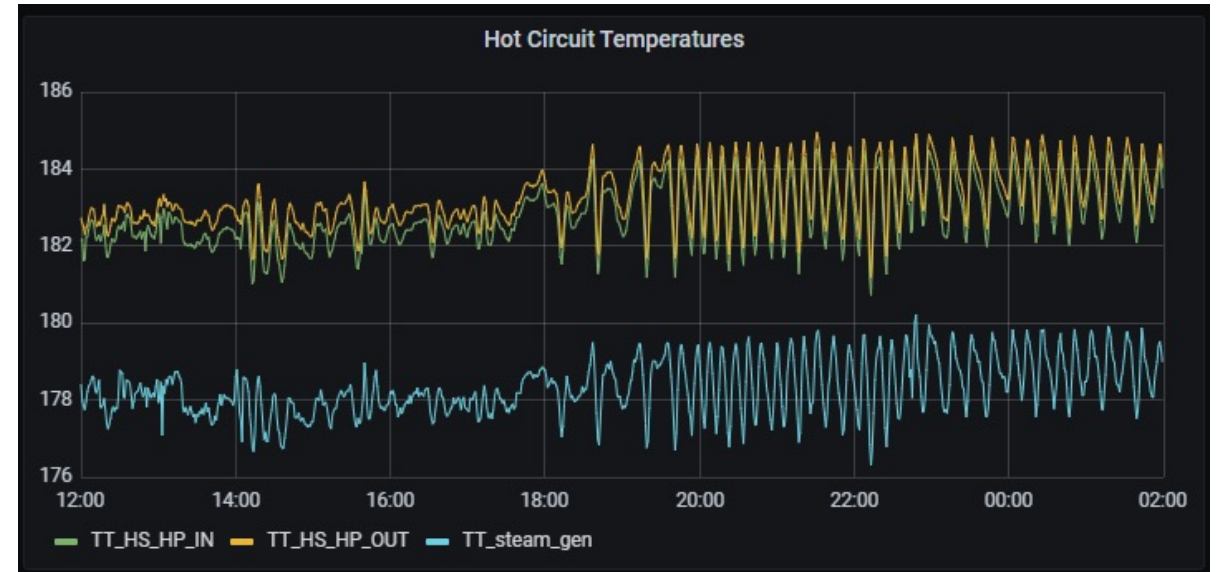
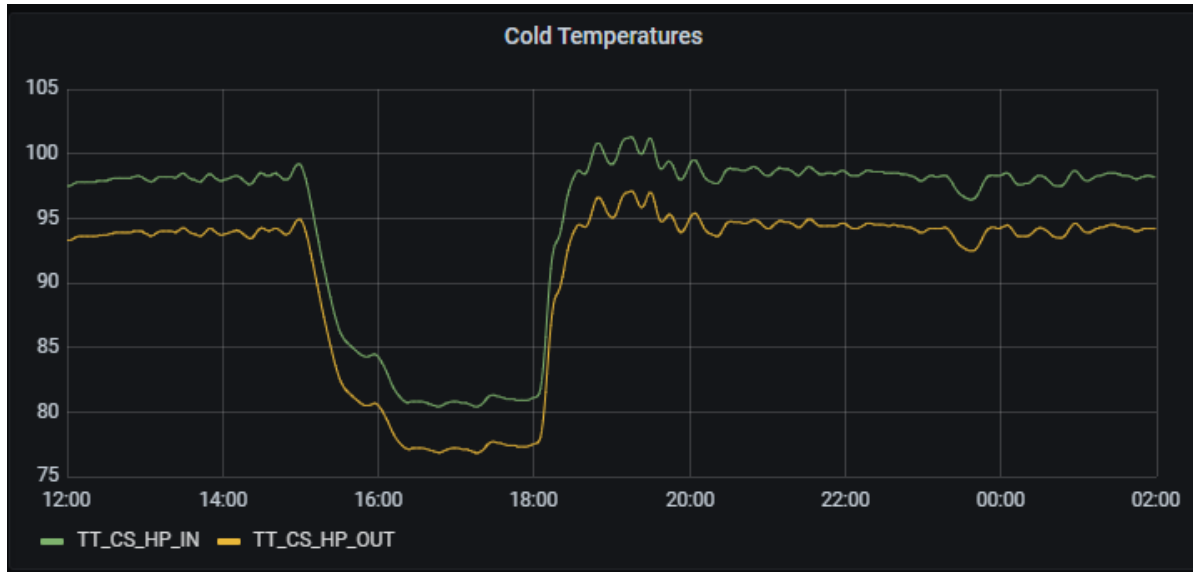


# Operation metrics from an installation

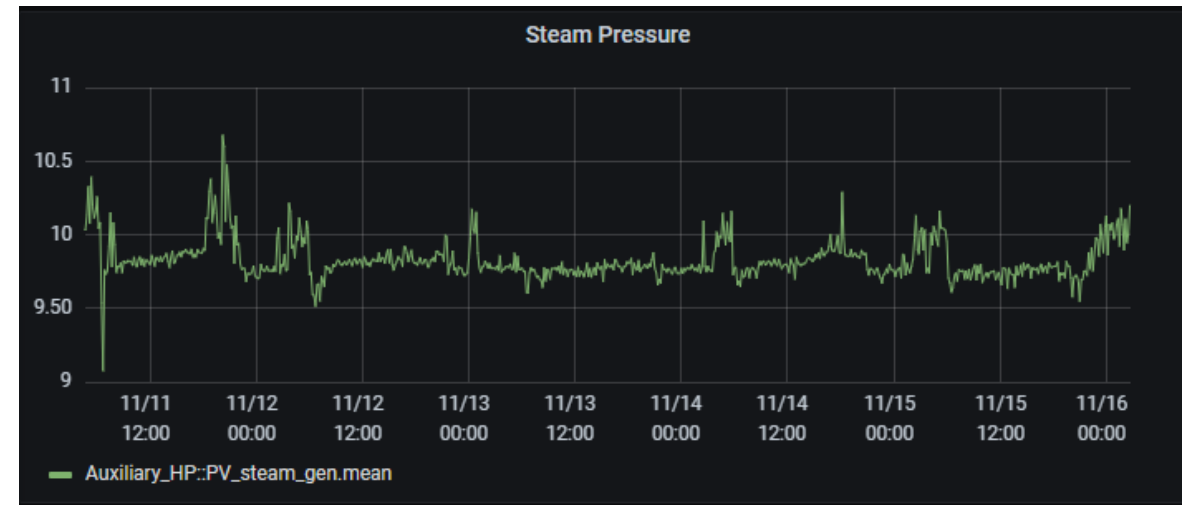
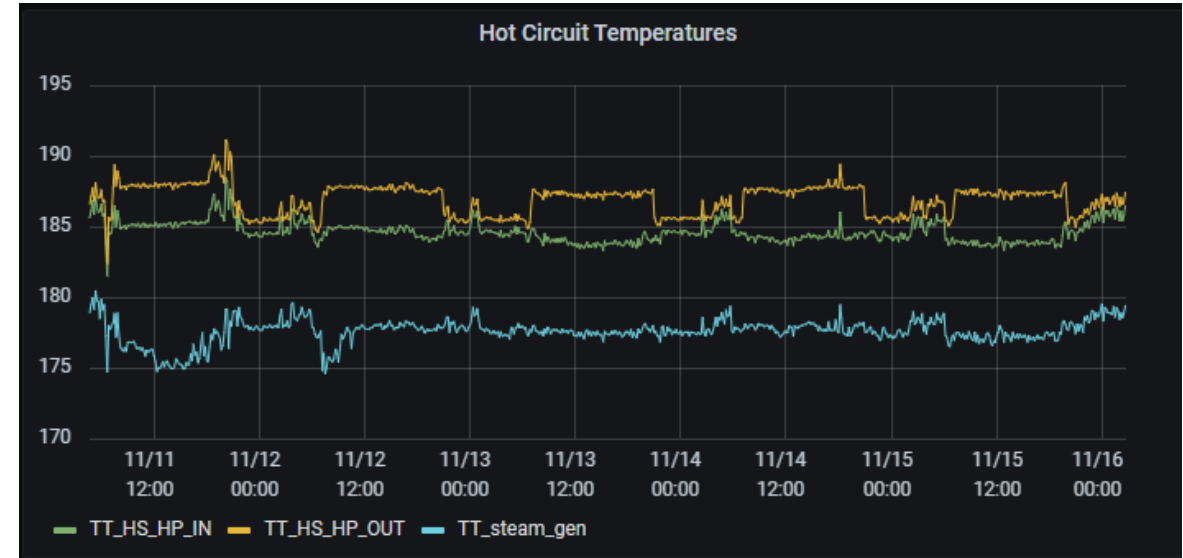
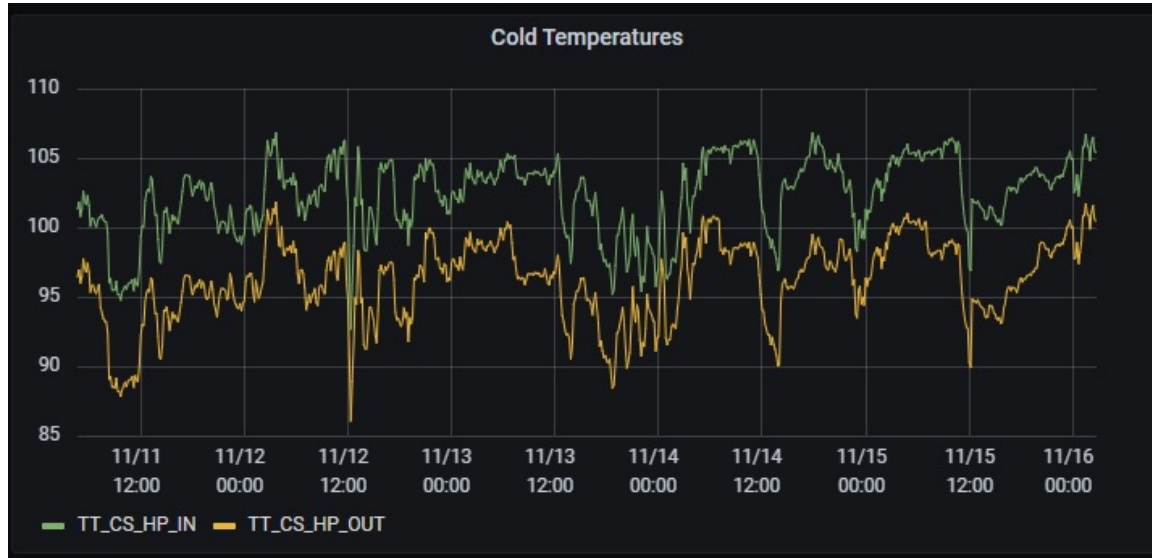




# Operation metrics from an installation

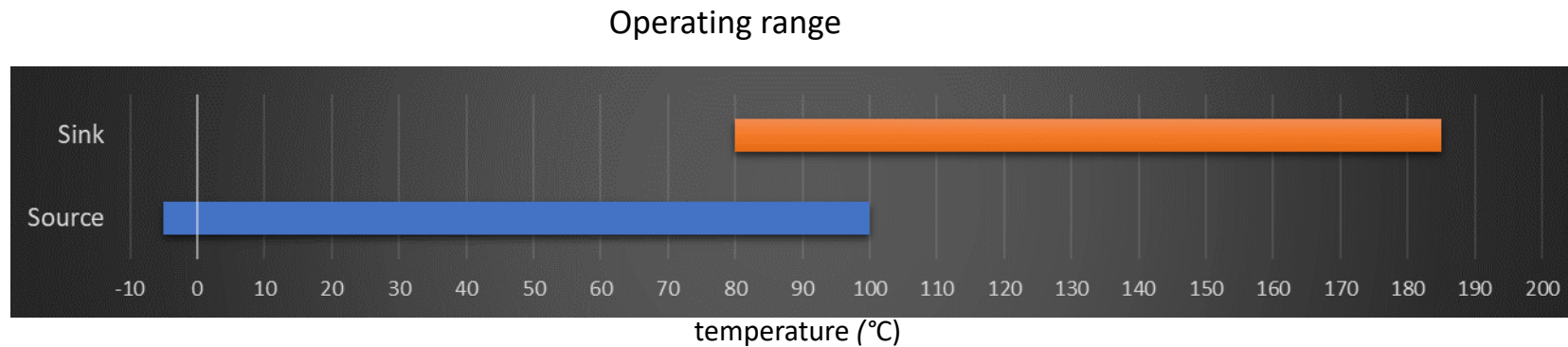


# Operation metrics from an installation





## HighLift by Olvondo – Commercial available steam generating heat pump



- Combined heating and cooling applications
- Suitable for steam generation 1 to 10 bar<sub>g</sub>
- Efficiency 45-55%
- Thermal output: 450-750 kW<sub>th</sub>

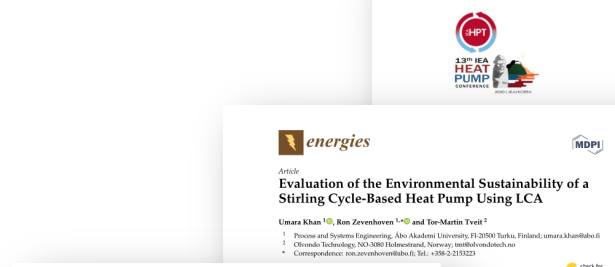
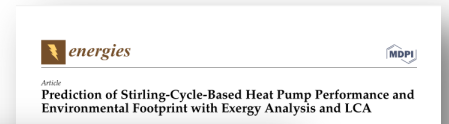
# Further material



Publications in scientific journals (open access) and scientific conferences.

Links on the HighLift-webpage:

<https://highlift.olvondotech.no>



**1042** PROCEEDINGS OF ECOS 2020 - THE 12<sup>TH</sup> INTERNATIONAL CONFERENCE ON EFFICIENCY, COST, OPTIMIZATION, SIMULATION AND ENVIRONMENTAL IMPACT OF ENERGY SYSTEMS, 2020, 29-JULY 3, 2020, OSAKA, JAPAN

### Performance improvement of an industrial Stirling engine heat pump

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**Abstract:** After widespread use for refrigeration and cooling, heat pumps (HPs) are also becoming mainstream for private and public building heating. Driving forces are the need to reduce greenhouse gas emissions and the increased availability of renewable electricity. Nowadays, HPs find use in industry, choosing for low temperature (waste) heat and cheap (renewable) electricity rather than a combustion system for the production of process heat. However, temperatures above 150°C still present challenges for HP systems based on a vapor-compression process, being limited by compressor technology and availability of suitable refrigerants. So-called very high temperature heat pumps (VHTHPs) based on alternative processes using renewable electricity are an attractive "green" route to producing ~200 °C steam. This paper describes work aiming at improving the performance, reliability and efficiency of an industrial Stirling engine-based heat pump system in operation at a pharmaceutical research facility. It is funded by the EU Horizon 2020 FTI programme, targeting reduced greenhouse gas emissions, efficient use of energy and increased use of renewable energy resources. In short, heat output shall increase from 500 kW to 750 kW closer to 200°C rather than 180°C with input heat of ~30°C while efficiency expressed as coefficient of performance (COP<sub>h</sub>) increases from 1.4 – 1.5 to 1.8 – 1.9. The approach is to increase the pressure of the helium medium, while changes to the hardware would involve new designs for the internal heat exchanger, regenerator, piston rod seal, piston rings and other seals. CFD and structural mechanics models were used to simulate existing and future designs for heat exchangers, regenerator and seals while process dynamics simulations showed the responses to, for example, small leaks and the effect of diastolic temperature gradients in the heat exchangers or regenerator porosity. The results show how the existing system could be improved to obtain the enhanced performance aimed at.

**Keywords:** Heat pump system, Stirling engine, increased output, efficiency, system dynamics

### 1. Introduction

The first decades of the 21st century have shown transitions and changes towards energy systems that have a higher efficiency, lower or zero emissions of greenhouse gases and a smaller environmental footprint in general. In today's world, the increased availability of electricity from renewable sources may on one hand be interesting but on the other hand is more predictable than the pricing levels for natural gas. Heat pumps (HPs) have a long history with common products for refrigeration and air conditioning and can in principle use a cheap renewable source for both input heat and electricity. System purchases by users are nonetheless often motivated by an attractive coefficient of performance (COP). Industry is increasingly implementing HP technology that circumvents the formation of CO<sub>2</sub> when producing heat, although reaching sufficiently high temperatures > 150°C may be challenging (being limited by compressor technology and availability of suitable refrigerants). So-called very high temperature heat pumps (VHTHPs) [1] based on alternative processes using renewable electricity are an attractive "green" route to ~200 °C steam.

A Stirling engine-based heat pump is one approach towards higher output temperatures. The so-called HighLift concept based on this [2] is applied in the milk and dairy products industry and, for the work

Simulation of pressure imbalance phenomena in a double-acting alpha-cycle

13th IEA Heat Pump Conference  
May 11-14, 2020 Jyväskylä, Finland

Using VHTHPs facility  
Ron Zevenhoven<sup>1</sup>

Heat Pump Conference 2020

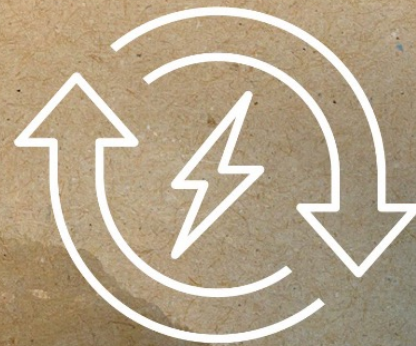
industry is a global industry for global. Being global in the environmental protection and energy. The greenhouse gas part of lowering CO<sub>2</sub> emissions industry means in steam is usually produced with steam plant. Electric with a switch from oil to natural gas to biogas, to produce steam production using high CO<sub>2</sub> even more sustainable.

the environment the most [1]. A key challenge supporting energy and environmental conditions important to change practices and technologies. Acting factors for assessing the environmental effect is essential to follow the principles of sustainable better future, the negative impacts of energy use being the usage of renewable energy sources or by limited part of the global annual CO<sub>2</sub> emissions [2] measures of CO<sub>2</sub> from the energy sector which were in of Parties (COP21) in Paris from 30 November 2015. Initiatives have been taken to address these targets (to be below 2 °C, and preferably below 1.5°C) fuels, specifically coal, oil, and natural gas, to heating and air conditioning as they can use them taken freely from surroundings. Since heat

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In high-temperature applications and waste stream due to the promising role in producing analysis one such technology as developed by direct company. Advances in boilers, in the units of waste heat and electricity and generated use of a high-performance high-temperature normally viable and attractive, various analysis (LCA) can be combined. The total cumulative environmental energy losses caused throughout a study using SimaPro was conducted, which covered environmental footprint resulting from (years), and decommissioning phases of the heat source (oil-fuel oil boiler (OB), a bio-boiler (BB), and a boiler (BCB)).  
analysis, total cumulative energy loss (CECL),  
to has never been more important than to-ize patterns are unsustainable. The change-fully because of emissions of greenhouse gas (heat, fuel, and electricity) industry is-itions of GHGs, primarily CO<sub>2</sub> emissions, h-act not only on the environment, but also-duced in the energy market is able to-ive towards sustainable technologies that-creasing minimal environmental damage-ly, but this also needs to go even further and-ize parameters and system performance, like et al. find for studying design viable interactions and environmental impact and health [1]. Analyzing the full picture is the opposite goal, i.e. the pay-benefit (removal) cylinder wall, to design optimization [2]. It also includes gas flow past the piston in the resulting beta-type Stirling engine. Dai et al. [14] state the difference between the experiment and the critical on engine performance.  
to be used in the future. Other studies ing and better in working gases. Other studies ing with experimental solutions, such as de-riding a five-point Stirling engine design or higher-ity. Further (Daglar Stirling Engine, but more as-ported in the literature concerns laboratory scale-6. [14] performed experimental studies on re-temperatures et al. [15] studied the performance of



Thank you for your attention!



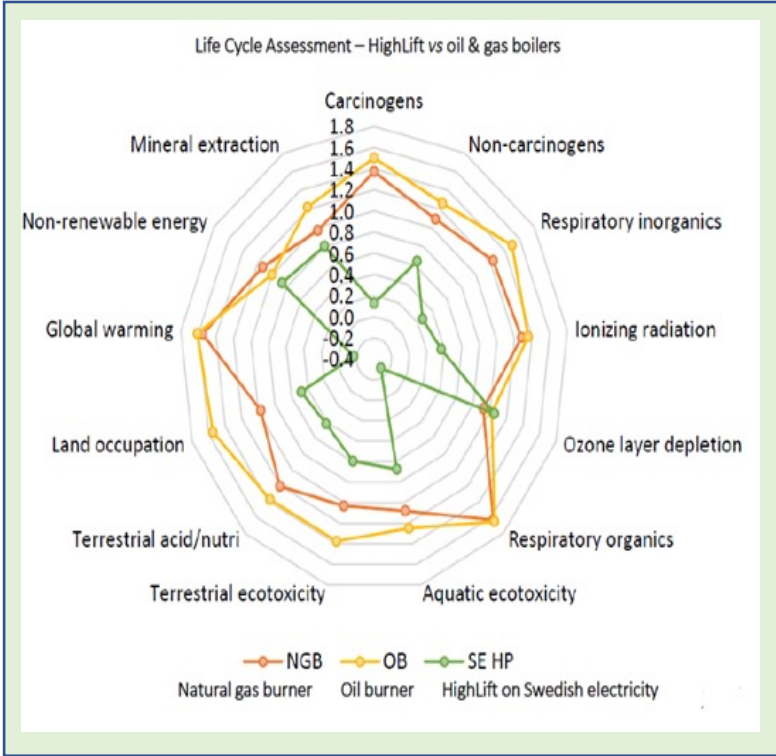
Energy  
Recovery

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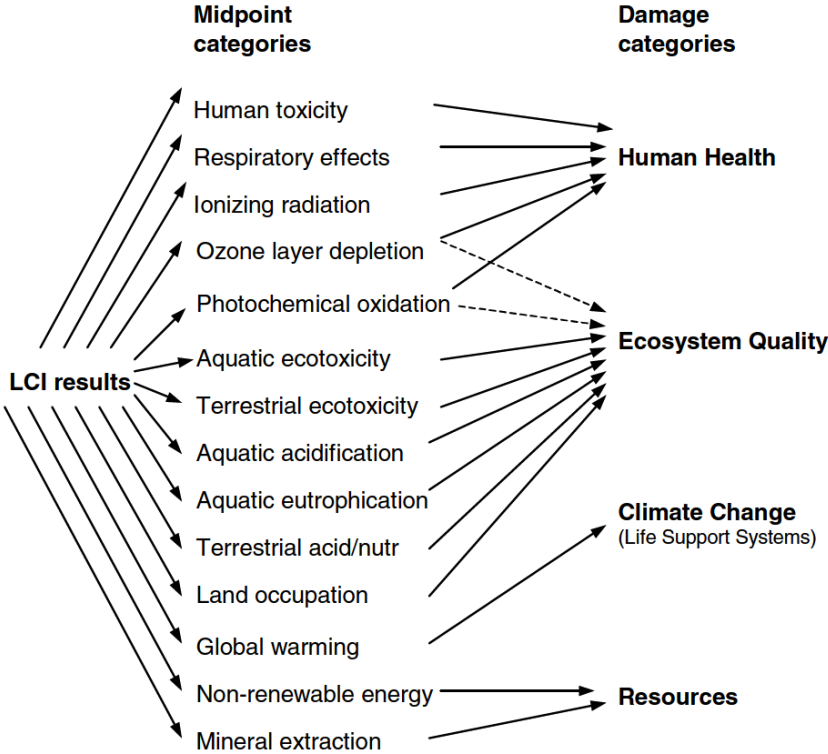
[www.olvondotech.no](http://www.olvondotech.no)



# HighLift has a significant environmental impact



HighLift Life Cycle Assessment



IMACT 2002+ method

## Spanish brewery example:

HighLift environmental impact reduction vs. natural gas boiler:

- 55%
- 1%
- 92%
- 95%

**Total environmental impact reduction (kPt): 92%**