Cool ways of using low grade Heat Sources from Cooling and Surplus Heat for heating of Energy Efficient Buildings with new Low Temperature District Heating (LTDH) Solutions.

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Authors: Ali Moallemi, Henrik Gadd

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Dissemination level		
PU	Public	X
PP	Restricted to other programme participants (including the Commission Services)	
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CO	Confidential, only for members of the consortium (including the Commission Services)	

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Scope of deliverable

The aim of this deliverable is to show the results of monitoring of external access to a substation.

Context of deliverable

This report shows the results of monitoring of heat consumption in a substation. This substation is controlled by an external access and new digital connectivity interface to optimize heat consumption.

Perspective of deliverable

This working report is to be used for analyzing results of heat usage optimization using smart meters called Optimizer in a building block in Kämnärsrätten area of Lund. Using a smart control system can help to optimize the heat usage to reduce return temperature, emissions, and primary energy use and of course, bill payments.

Involved partners

Lund University (UNI-SE) as lead was responsible for compiling the working report. In the process for developing this report, representatives from UNI-SE (lead), Kraftringen AB (UTIL-SE), Cetetherm AB (IND-SE2) and COWI A/S (COWI-DK) have been involved.

Summary

In this project, a building block was selected for heat optimization. A new control system called Optimizer using smart meters was designed by IND-SE to optimize heat use in this building. Data of this Optimizer is under monitoring regularly. Finally, evaluation of this smart control system can be done by comparison of energy signature before and after operation of this system. This comparison is made by gathering historical data and operational data of the building block.

Abbreviations

DH	District Heating
EU	European Union
IND-SE	Cetetherm
LTDH	Low-Temperature District Heating
NOP	Not in Optimization
OPT	Optimization
SH	Space Heating
UNI-SE	Lund University
UTIL-SE	Kraftringen AB

COOL DH
COOL DISTRICT HEATING

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1 Introduction

This project deals with how upgrading a district heating substation with a new digital system can reduce heat usage in a residential building. Cetetherm (IND-SE) together with Kraftringen (UTIL-SE) have already installed a new digital demo in the DH network of Lund. The digital system the optimizer has been developed by IND-SE and the system is up and running in a DH substation covering 99 apartments since Nov. 2021. The initial plan was to install it in a building in Brunnshög. However, since the construction of buildings has been delayed, it was decided to find another suitable site. The choice fell upon the student housing area of Kämnärsrätten.

Kämnärsrätten is located just a few hundred meters west of Brunnshög and it is an area built in 1969 with five similar blocks, the demo site, is one of these. The housing area is about 6100 m^2 in three-level residential building plus a basement (2500 m^2) with shared spaces. The building block and substation are owned and managed by AF Bostäder, a local student housing organisation.

The substation services the apartments with heating and hot water. The optimizer enables monitoring and energy optimization of district heating use in the buildings. It can help reduce energy use and cost, compared with normal non-upgraded substation installations.

Initial studies and projections showed that by upgrading the substation with a smarter and cloud connected digital system the overall energy use and costs could be reduced by 8-12% depending on the energy cost level to justify the investment. The payback period was estimated to be about 4 years. A major part of the cost is related to each installation in the substation.

The installation of the new digital solution was made by replacing the existing control system in the substation with the new one. Existing sensors and valve together with pumps are still in use and now also connected to the new control system. Indoor sensors in 5 apartments were installed. Alarms from expansion vessel were also connected to the new control system. A new router operating on the 4G net was installed to provide cloud communication.

The current substation was installed in 2008. The new control system was installed in June 2021 and the new AI control concept was activated November 2021. The building block, served by one substation has an annual DH consumption of about 1 GWh/year before the installation of optimizer and substation upgrade. The layout and a photo of the building block is shown in Figure 1. The location of the substation is highlighted in green.

Figure 1: Demo Site in Kämnärsrätten

1.1 System Interface

The interface of the newly developed digital control system optimizer by Cetetherm (IND-SE) is shown in Figure 2.

As it can be seen, different data can be obtained from this interface such as heat usage, power, supply and return temperatures, outdoor temperature, flow and volume on the primary side, but also temperatures from the radiator system and domestic hot water circuit. Besides online monitoring data, historical data of each parameter is also provided in this system.

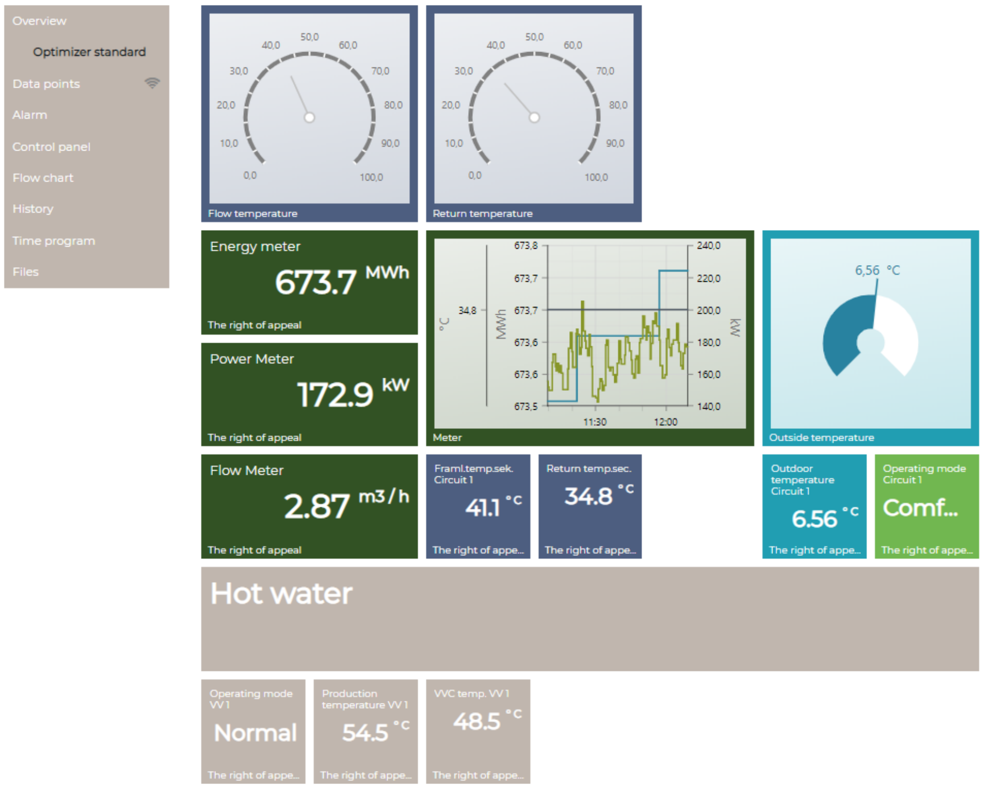

Figure 2: New AI concept and system interface cockpit for substations

1.2 Objectives

Heat use usage with the new control system compared to historical data before the installation are presented in this report. The performance of the system will be evaluated in relation to heat usage and demand profile operations in a building block in Kämnärsrätten area of Lund City.

2 Data Analysing

This report monitors heat use in the building after installing new smart control system. The heat demand profile and energy signature can be obtained by gathering regular daily heat usage data of the building. Then, these data can be compared with historical data in previous years from 2019 to 2021. Heat demand in different years can be seen in Figure 3.

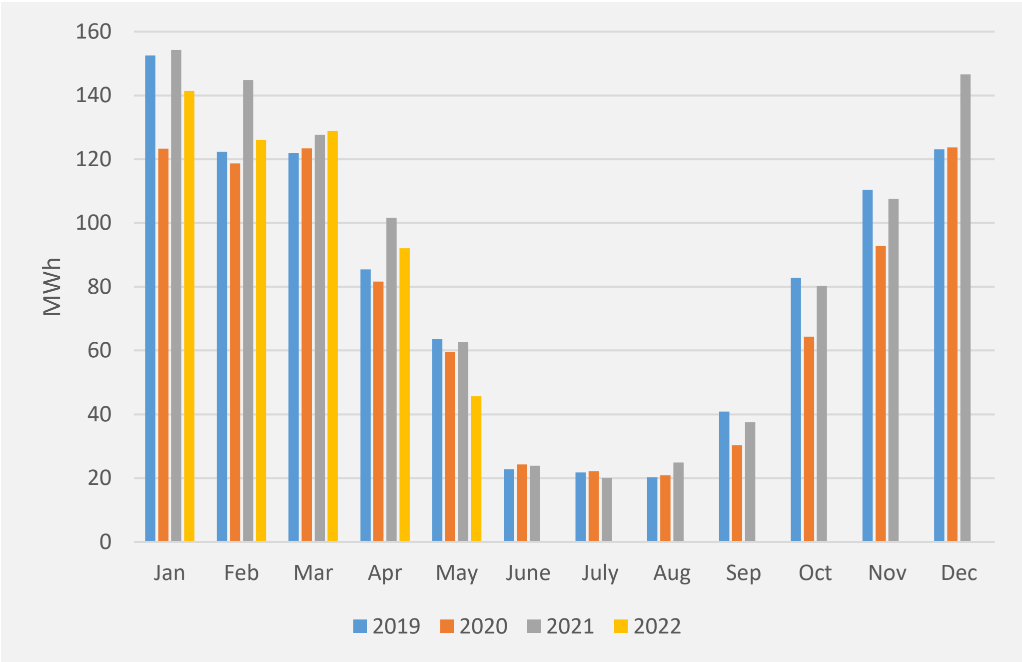

Figure 3: Heat demand profile in recent years

Figure 3 only shows actual heat demands and it is not a fair comparison between yearly data. For this reason, a normalized profile using historical degree-days is illustrated in Figure 4.

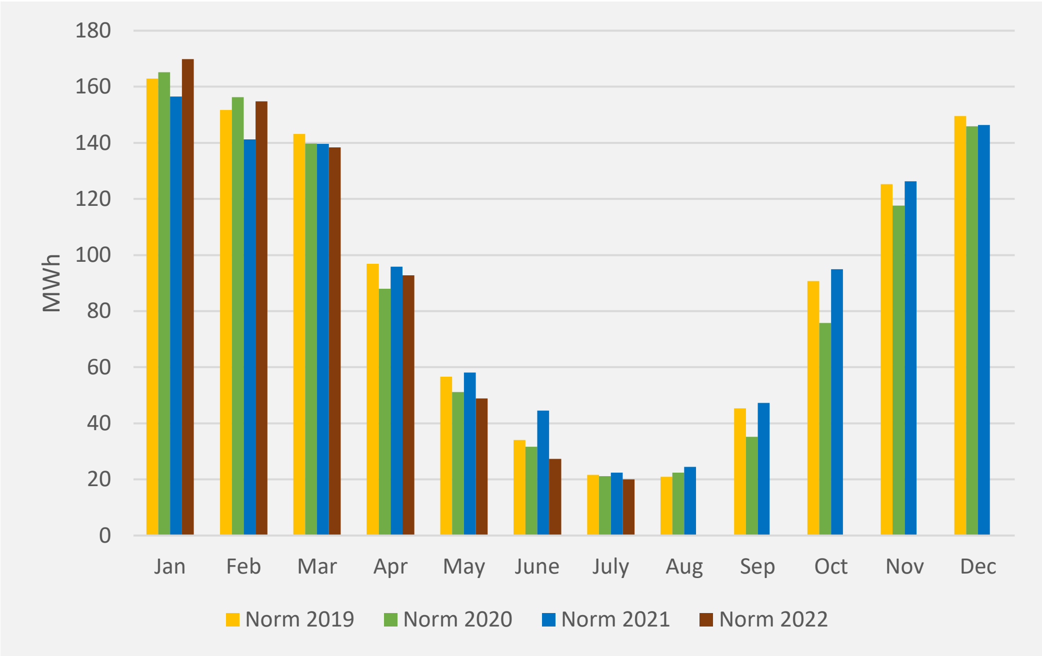

Figure 4: Normalized heat demand in recent years

The optimizer system was activated in November 2021. Therefore, it is possible to compare it performance with historical data in 9 months from Nov. 2021 to July 2022. According to Figure 4, the normalized heat demand during the optimizer operation is slightly lower than similar months in previous years, especially in non-cold months. Inversely in cold months, the normalized heat demand during the optimizer operation is higher than historical data.

In the heat energy signature, daily average heat power in kWh/h, daily heat demand divided by 24, is plotted against outdoor temperature as shown in Figure . In this Figure , energy signatures are compared over recent years before and after activating of the optimizer system.

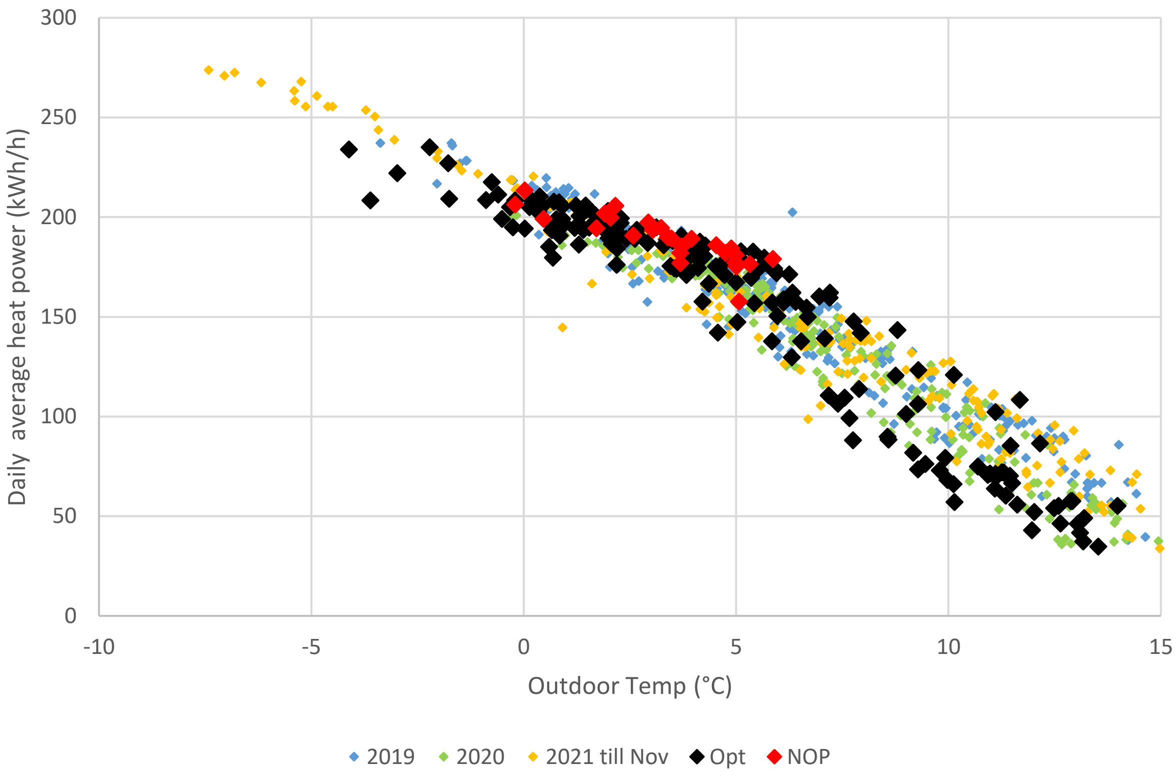

Figure 5: Heat signatures over recent years

Blue, green and yellow points show historical data of 2019, 2020 and 2021 respectively before operation of new control system. Black and red points show values after installation of optimizer in November 2021 up to and including July 2022. There are some time periods after the initial installation of new control system that the optimizer has not been in operation. Therefore, black points show operational data and red ones show non-operational data of the optimizer, i.e. non-operational data means without the optimization system as before installing the optimizer. In the same way, the regression lines of the heat signatures are compared in Figure 6.

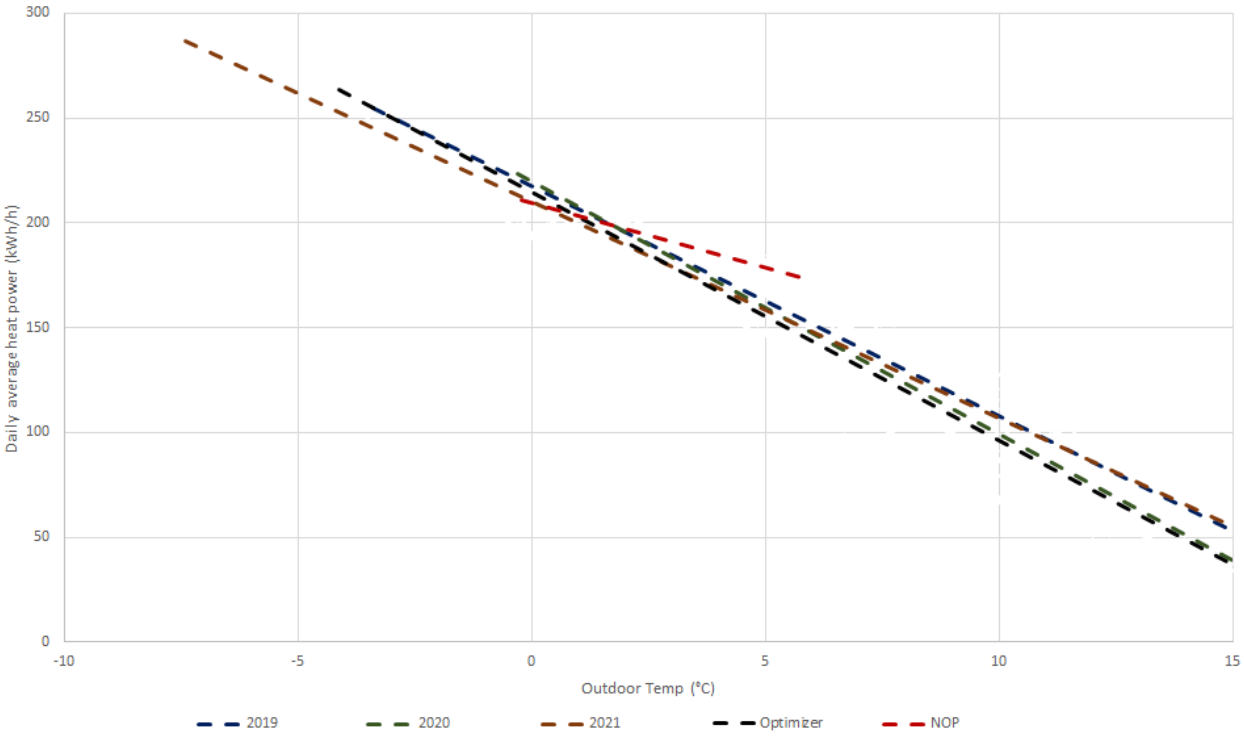

Figure 6: Regression lines of heat signatures

In Figure supply and return temperatures in the building are compared over recent years before and after activation of the optimizer. This is done to analyse if the optimizer affects the return temperature or if there has been a change in the supply temperature which could affect the outcome of the evaluation.

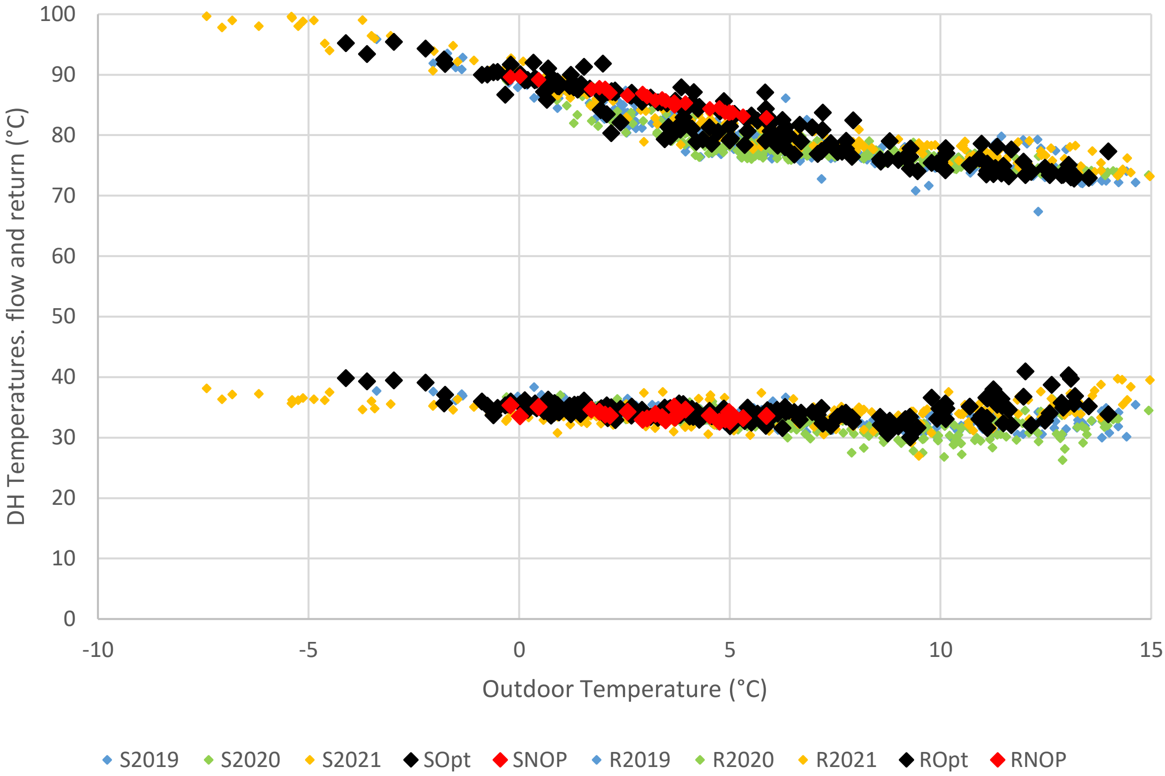

Figure 7: Temperature signatures over recent years

3 Conclusions

The following conclusions can be achieved according to Figure to Figure :

- There is no significant difference in heat signatures during recent years as it can be seen in Figure and Figure 6. However, the optimizer system shows a slightly better performance in temperatures above 7°C. As it was mentioned, the purpose of installing this optimizing system was to optimize and decrease heat usage of DH in this building. Despite this, the heat signature has not changed during the optimizer operation. One reason can be that the heating system in the selected building block seems to be working well with very low return temperatures from the beginning as Figure implies and, therefore, the scope of optimisation is limited.

- The optimizer system may reduce heat power at outdoor temperature below 0°C as shown in Figure . It can be a suitable solution for peak demands on building level and if it is synchronised in a larger group of buildings it could help energy suppliers to decrease peak loads. However, it is not clear that the related optimizer data below 0°C (black square points at top left of Figure) are outliers or not since there is not enough data in this regard.

- As it was expected and can be seen in Figure , the return temperature increased by reduction in flow temperature.

- As the optimizer has been working only for a short time (8.5 months until August 2022), it is hard to evaluate its performance. In addition, the optimizer has not been in operation in some periods during the operational phase since Nov. 2021. It caused even more lack in data evaluation.

- A future suggestion would be to have a longer period of evaluation preferably in several buildings in both traditional DH and LTDH systems.