COOL DH
COOL DISTRICT HEATING

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.

Deliverable no.: **D4.1**

Name of deliverable: **Demonstration of new type of substation**

Revision no.: **1.0**

Due date of deliverable:	M24
Actual submission date:	M24-30
Start date of project:	1st October 2017
Duration:	48 months

Organisation name of lead contractor for this deliverable:	Høje Taastrup Fjernvarme a.m.b.a. (UTIL-DK)
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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 767799		
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Scope of deliverable

The scope of this deliverable is to show the installation of DH units to produce domestic hot water and space heating in each dwelling of the demonstration site in Østerby district.

Context of deliverable

In the new generation of district heating networks, the lower supply temperature leads to the reduction of the heat losses in the distribution network, reaching a higher efficiency of the system. However, the reduced temperature increases the risk of Legionella contamination in domestic hot water system if the safe temperature limit is not reached. Based on these considerations this deliverable aims to show the installation of the district heating units in the Danish demonstration site, where an existing district heating network is upgraded and converted to low-temperature supply. Part of the heat supply will be supplied by the surplus heat coming from a shopping mall located in the same area.

Perspective of deliverable

The deliverable provides information about the installation of the district heating unit in the demonstration site in Østerby district. It can provide an example of the results obtained with the renovation of a district heating network, where single-family units are installed to provide the heating in the buildings. The domestic hot water (DHW) temperature can now be supplied at 50°C, and the DHW water volume in the consumer installation incl. the micro heat exchanger is kept below 3 litres.

The diffusion of low-temperature district heating networks in the next future will consequently require a larger use of dedicated solutions that can fulfil the temperature and safety requirements, particularly in connection to the risk of Legionella contamination. The deliverable aim to show one of the available technologies installed in a real network.

Involved partners

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Summary

The transition to low-temperature supply in district heating networks requires new technical solutions to meet the heat requirements of the consumers and guarantee their safety, mainly in connection to the possibility of Legionella contamination through the domestic hot water system. At the same time, the efficiency of the district heating system must be ensured.

The purpose of the deliverable is to present the new heat distribution system applied to the demo case in Høje-Taastrup Municipality, where new single-family units (also called flat stations) were installed at each house to supply the heat for domestic hot water and space heating. The units are pre-assembled, which ensures an easy installation procedure. Furthermore, since they use an instant heat exchanger to produce the domestic hot water, which is characterised by a small water volume, the risk of Legionella contamination is reduced to the minimum. The district heating unit must work at the lowest possible temperature and ensure a good temperature difference (delta T), with low return temperature. For this purpose the heat exchanger must be suitable for LTDH i.e. thermally long and with efficient and rapid working control.

Contents

1 Introduction

The developments occurred in the district heating (DH) sector in the last two decades are leading the transition from the 3rd to the 4th Generation District Heating. New technologies, new insulation properties, attention to the buildings' features and the stricter requirements in terms of energy consumption and emissions have improved the efficiency of the entire sector, from the production to the consumption. In particular, the improvements achieved at in the building sector are leading to the reduction of the energy demand, which is also reflected on a lower supply temperature required. The standard district heating systems are going to be replaced by low-temperature district heating (LTDH) or ultra-low-temperature district heating (ULTDH) networks, where the supply temperature will be respectively between 50-60°C in LTDH and below 50°C in ULTDH [1].

The European Union (EU) will play a primary role in the transition towards a more efficient DH sector, financings development and research project. As part of the biggest EU research and innovation programme Horizon 2020, COOL DH project will investigate new technical solutions that can be applied in LTDH networks to ensure the comfort of the occupants and increase the share of renewable energy. The acronym COOL DH stands for "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".

As result of COOL DH project, two real-scale demo sites will be implemented to show and test the innovative solutions developed throughout the project. The first demonstration site is located in Denmark in the city of Høje-Taastrup, where the old DH network that was suppling Østerby district was upgraded to a new LTDH network, which will take advantage of the surplus heat coming from a shopping mall located in the area. The second demonstration site is in Sweden in the city of Lund. A new district in Brunnshög area is under development, where research facilities, office buildings and residential buildings will be built. The area will be supplied by a new LTDH network, which will use the surplus heat produced by the world's strongest synchrotron microscope (MAX IV) as heat source.

This report will present the installation of the new heat distribution system implemented to the demo case in Høje-Taastrup Municipality, where new single-family units (also called flat stations or district heating units) were installed at each house to supply the heat for domestic hot water and space heating.

1.1 Nomenclature

DH	District Heating
LTDH	Low-Temperature District Heating
ULTDH	Ultra-Low-Temperature District Heating
EU	European Union
DHW	Domestic Hot Water
SH	Space Heating
DHWC	Domestic Hot Water Circulation

2 Background

2.1 European Union's strategy

The building sector is responsible for approximately 40% of the energy consumption and 36% of the CO_2 emission in the EU [2]. In EU households, heating and hot water alone account for 79% of the total final energy use, while cooling is a small share, even though this demand has a rising trend during summer months [3]. In relation to the building stock, about 35% of the EU's buildings are over 50 years and almost 75% are considered as energy inefficient. Among these, only 0.4-1.2% of the buildings are renovated each year. Therefore, a remarkable potential in terms of energy savings and CO_2 emission reduction is identified in the existing buildings. In particular, the energy consumption can be potentially reduced by 5-6%, while the CO_2 emissions can be lowered about 5% [2]. Regarding the energy production, the 84% of the heating and cooling demand is still generated from fossil fuel, while only 16% is generated from renewables. Therefore, to reach the EU's climate and energy goals, the heating and cooling sector must considerably reduce its energy consumption as well as cut the use of fossil fuels [3].

The EU's strategy to the reduce the energy consumption and CO_2 emissions is defined by a plan that establish the terms of reduction and the actions that can be undertaken. It is a long-term plan with intermediates steps in 2020, 2030 and 2050. The aims for 2020 is a 20% cut in greenhouse gasses emissions (from 1990 levels), 20% of the energy in EU should be from renewables and a 20% improvement in energy efficiency must be reached [4]. In 2030, the aims are to cut at least 40% of greenhouse gas emissions, increase the share of renewable energy at least of 27% and improve the energy efficiency at least of 27% [5]. In 2050, the cut in greenhouse gas emissions should reach at least 80%. The action plan will involve all the sectors [6].

3 Purpose

The transition to low-temperature supply from the DH network highlights new challenges to fulfil the consumers' requirements and at the same time guarantee a high efficiency of the DH system. Therefore, new technical solutions must be investigated in order to achieve the aim of decreasing the supply (and return) temperature.

Among the possible solutions, the single-family units (also called flat stations or district heating units) represents a valid technology to solve the problem. It can be placed in every flat (or single-family dwelling) and it can be implemented with or without a central substation. The flat stations can be implemented in multifamily houses as alternative to water tanks, even though is some areas the use of heat tanks persists.

Following the inputs provided by the investigation presented in the deliverable "D2.3 Substation solution for single family units", where the district heating unit was selected, the purpose of this deliverable is to show the new heat distribution system applied to the demo case in Høje-Taastrup Municipality, where new units were installed at each house to supply the heat for domestic hot water and space heating.

4 DH-unit/Flat stations concept

The flat station is a technology that implements a decentralized heating system, where heat exchangers are used for the instantaneous production of DHW and optionally SH. The units are normally installed in each flat and then connected to the heating water source through a piping system. The water coming from the heat source passes through the heat exchanger and heats up the water on the cold side, which is then delivered to the consumer's tap. The DHW capacity in the flat station is normally controlled by a self-acting control valve, which regulated the flow on the two sides of the heat exchanger.

The implementation of a flat station ensures a low risk of Legionella contamination since there is no stagnant water in the system. It also allows the use of lower supply temperatures, which can be in the range 50-55°C. In terms of installations requirements, the flat station is usually preassembled, and it requires little space.

Figure 1**Error! Reference source not found.** shows a simplified diagram of the type of flat station implemented in Østerby district, where the domestic hot water and the space heating are supplied to the final user through two dedicated heat exchangers.

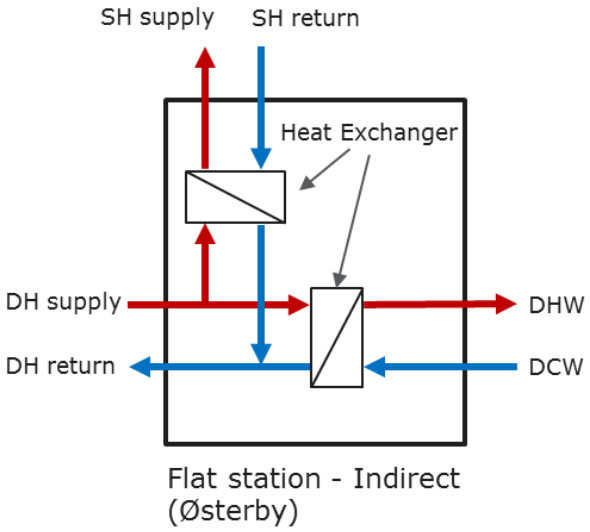

Figure 1. Simplified representation of the flat station technology implemented in Østerby district

5 Østerby district

As it was already mentioned, a real-scale demonstration site of a LTDH network will be implemented in Denmark in the city of Høje Taastrup. The old DH network of Østerby district was replaced with a new network, which supplies the heat to an area with 159 users for a total area of 12,692 m². The LTDH will take advantage of the surplus heat from the cooling system that operates in the nearby shopping mall called "CITY2", which runs thanks to a 16,300 m² PV plant. The network will be designed to ensure a temperature of 55°C on the supply side and 30°C on the return side. In Østerby network, it is expected that the furthest user will be supplied with 53°C and a flow of 1000 l/h. Figure 2 gives an overview of the Østerby district as well as the shopping center CITY2. The red highlighted area represents the part of the district that will be supplied by the new low-temperature district heating network.

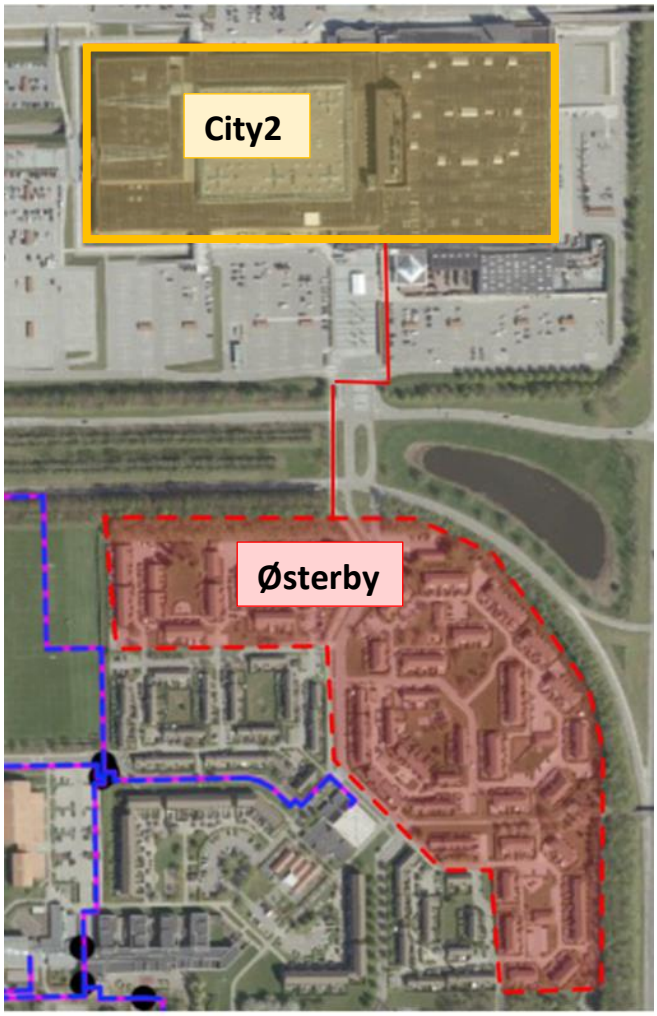

Figure 2. Østerby district and City2 shopping mall

The DH-unit specified will be a Gemina Termix VVX 3-2, which is specifically developed for low temperature district heating installations. Table 1 shows the main features of the DH-unit solutions implemented in the demo site located in Høje-Taastrup Municipality.

Table 1. Indirect DH-unit solutions for low-temperature district heating networks

Solution	Technical data	Main features
Gemina Termix ***Termix VVX***  Size with the cover: width 540 mm depth 430 mm height 800 mm weight 29 kg	• Nominal pressure = 16 bar (primary) • Nominal pressure = 10 bar DHW (secondary) <u>DHW</u> • ΔP_{DHW} = 0.25-0.35 bar • T_{Prim_DHW} = 55°C/15.9-17.2°C • T_{Sec_DHW} = 10°C/45°C • $Capacity_{DHW}$ = 32.3-41 kW • Supply flow DH ≈ 740-920 l/h (calculated) <u>SH</u> • ΔP_{SH} = 0.35 bar • T_{Prim_SH} = 60°C/30°C • T_{Sec_SH} = 25°C/55°C • $Capacity_{SH}$ = 4-22 kW • Supply flow DH ≈ 120-640 l/h (calculated)	• High efficiency heat exchangers • Pressure difference control • EPP insulation cover (Follows the requirements of the DS452) • Idle load function (bypass) • Check of the user consumption pattern • Meter connections • Automatic control of the heating with outdoor and indoor sensors (weather compensation) • Expansion vessel • High efficiency pump • DHW thermostatic regulator • DHW circulation (optional) • Serves 1-2 apartments • Price per unit approx. 1700 € (excl. VAT) [7]

As it was already mentioned, the solutions presented are used for the indirect connection of the SH system with the DH network. These solutions are used when the pressure of the network is too high for the system installed in the building and, it is necessary to decouple the SH system from the DH network. In Table 1, the supply temperature of the SH system is higher than the DHW system, since it refers to the DH supply temperature used during the heating season.

6 Installation

As it was mentioned, 159 units were installed at the final customers to supply the heating. The installation was performed during the period between the autumn 2019 and the spring 2020. As it is shown in Figure 3, The challenging part of the installation of the new DH network was partly represented by the digging work (Figure 3) that was performed in the final users' garden, since one of the aim of the installation was to reduce the length of the service pipes and consequently reduce the heat losses in the network. As it is possible to see from the picture, the service pipes were buried only around one meter far from the external wall of the buildings.

Figure 3. Installation of the service pipes in Østerby district

The service pipes were then connected to the buildings, as it is shown in Figure 4. In details, it is possible to see that the service pipe showed in the picture supplies two dwellings.

Figure 4. Connection of two dwellings to the service pipe of the district heating network in Østerby district

Figure 5 shows the installation of a Gemina Termix unit in a dwelling in Østerby district. The unit is installed in a dedicated space of the building (underneath a staircase), where the heating system pipes of the building are located. The connection of the unit to the district heating pipes was optimised, keeping the pipes as short as possible to reduce the heat losses. To limit the at losses from the unit, the insulation cover is mounted around the unit. From the Figure 5, it is possible to see that an energy meter is installed above the control panel of the unit, so that it is possible to measure the heat consumption individually. Furthermore, on the right of the energy meter, the antenna for the remote reading of the meter is installed. From the previous picture (Figure 4), it is possible to notice the cables connected to the antennas on the roof.

Figure 5. Final installation of a district heating unit (flat station) at a customer's dwelling in Østerby district

The installation cost of the new heating system is going to be managed by the district heating company that supplies the area (Høje Taastrup District Heating a.m.b.a.), which will also own the units. Business model: The costs of the new distribution system will be payed by the users in their subscription for DH supply. It considers the payment of the units over a 20 years period, which will also include the operation and maintenance costs. Savings in heat loss and maintenance from the earlier grid owned by the tenants will pay the increased subscription cost for the new substation solution.

7 References

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