



LIFE4HeatRecovery newsletter #1

Welcome to the first newsletter of LIFE4HeatRecovery.

LIFE4HeatRecovery is a LIFE Programme European Project coordinated by EURAC, a scientific research centre based in Bolzano-Bozen (Italy).

The project has started in June 2018 and will end in June 2022: this is the first newsletter and there will be one for every year of the project.

Nine other partners join EURAC on the project: the utilities Alperia, Cogeme, LGH from Italy, Mijnwater B.V. and Warmtebedrijf Rotterdam based in the Netherlands; Enisyst (Germany), a company specialized in control and monitoring design; the KWA Contracting AG company (Germany); Uhrig Group, a German specialist for wastewater and rain water systems and the Municipality of Wüstenrot, a town in the German state of Baden-Württemberg.

We would like to describe the project and focus on the pilot systems that LIFE4HeatRecovery will implement during its development.

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The project

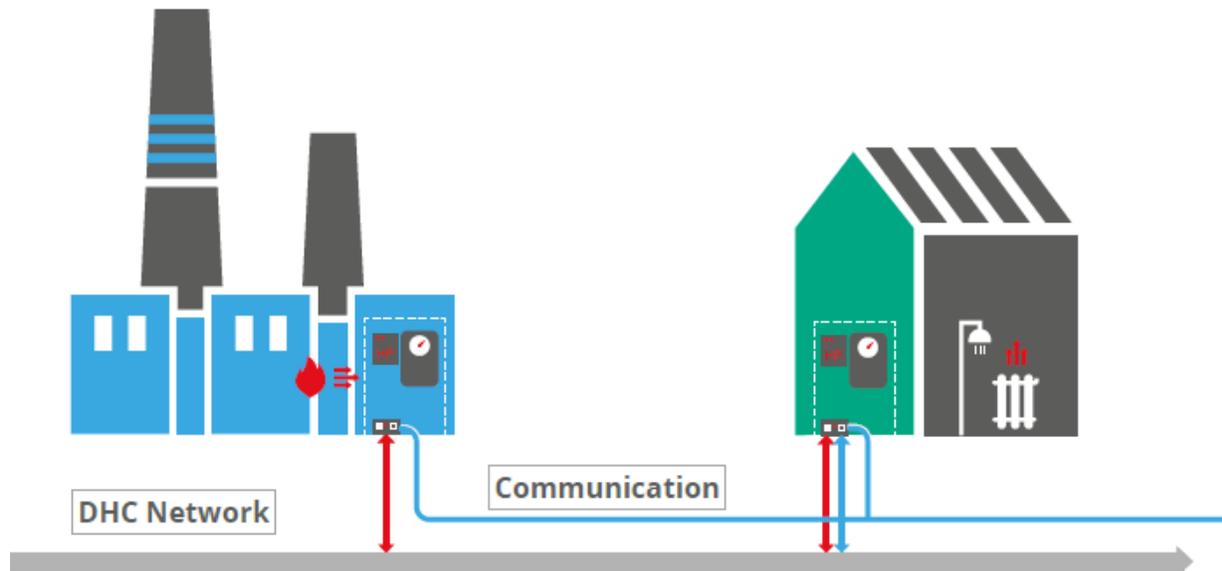
Traditional 3rd generation District Heating networks distribute energy from a centralized generation plant to a number of remote customers. Fourth generation networks advance on this basis by lowering the network temperature, but still mainly aiming at high-temperature energy sources, including industrial waste heat.

Recovering such energy requires complex interventions in the process plants of industries, which is rarely allowed by the company owners. Therefore, the range of attractive cases is limited.

Since the largest amount of **waste heat available in the urban environment is rejected by low temperature sources** and service facilities, the solution proposed is to recover such low temperature energy into DH networks by means of heat pumps.

The idea is based on the water-loop concept used in commercial buildings and here extended to the district and city level: the **district heating and cooling network can be fed by multiple waste heat sources**, which contribute to balance out the energy drawings by heat users.

If a high temperature network is concerned, a heat pump is needed to rise waste heat temperature to the network's level. On the contrary, if a low temperature network is considered, heat recovery can be performed directly (without heat pumps), but heat pumps is needed at consumers' side to rise the temperature of the energy distributed to the useful levels (35°C to 55°C depending on the uses).



Representation of interchange of energy between the network and the buildings

LIFE4HeatRecovery steps further beyond by developing and demonstrating a new generation of smart district heating and cooling networks, where low-temperature waste heat sources can be as distributed as consumers are.

LIFE4HeatRecovery solutions will integrate effectively multiple waste heat sources from urban wastewater and service buildings, where they are available along the DHC network, by managing energy at different temperature levels. This will guarantee **flexibility and scalability** to the network design, and **reliable, secure and clean thermal energy to the consumers**.

Together with storages, control strategies optimising harvest and re-use of waste heat are key from the technical and economic perspectives. On the one hand, strategies will be assessed that assure a thermal balance among diffused energy integration, storage and utilization. On the other, energy trading strategies will be elaborated allowing to manage thermal energy purchasing from different sources, and electricity use when it is more convenient for customers and energy utility companies.

As **infrastructural costs** are a barrier hindering public investments in the DHC segment, LIFE4HeatRecovery will also elaborate innovative financing mechanisms based on Public Private Partnerships and active participation models. This strategy moves towards leveraging large private capitals, incorporating, in a unique action, customers, network owners and European interests - pursued through sustainability and recovery plans-, and investors profits.

As such, **LIFE4HeatRecovery has a social dimension**, creating new business opportunities and new participation, the energy users assuming a focal position and becoming protagonists in the heating and cooling market.

Pilot systems and skids

In order to achieve the objectives mentioned above, **four real networks in Italy, the Netherlands and Germany will be developed**, with the purpose to recover:

1. Direct waste heat in low temperature DH networks
2. Waste heat in high temperature DH networks by means of heat pumps

For each of the demonstration sites, **prefabricated skids will be designed and manufactured**, including all necessary hydraulics, electric and electronic components. The skids, designed to connect the waste heat source to the network, will be manufactured in selected factories before transportation on site and installation, in order to demonstrate the replicability and the sustainability of the technologies implemented.

Prefabrication, standardisation and modularity will be distinctive, innovative design drivers guiding the developments. Thanks to this strategy, design and installation time and errors are minimised. Moreover, manufacturing costs reduction is pursued.

LIFE4HeatRecovery solutions reduce GHG emissions and Primary Energy consumption by 60% to 70%, compared to fossil fuels technologies.



Ospitaletto

District Heating Network

The demonstration network in Ospitaletto, in the Italian province of Brescia, is a **cold district heating and cooling network**, that, thanks to the low temperature, can deliver both heating and cooling services on the same pipelines.

The main thermal energy source is geothermal, provided by means of the waste heat from a steel factory near the centre of town and two water wells. Customers are both public buildings (schools and gyms) and private owned multifamily houses.

The demonstrator is a double pipe network that develops over **a length of 2.3 km, with a total capacity installed of about 2.5 MW.**

Waste heat source

The waste heat source is a **steel manufacturing company** fully integrated in the urban perimeter.

The total thermal energy, that can be recovered from the production plant cooling towers, is more than the Ospitaletto network could now deliver to its customers, therefore part of the thermal energy recovered will be used directly for the factory's needs.

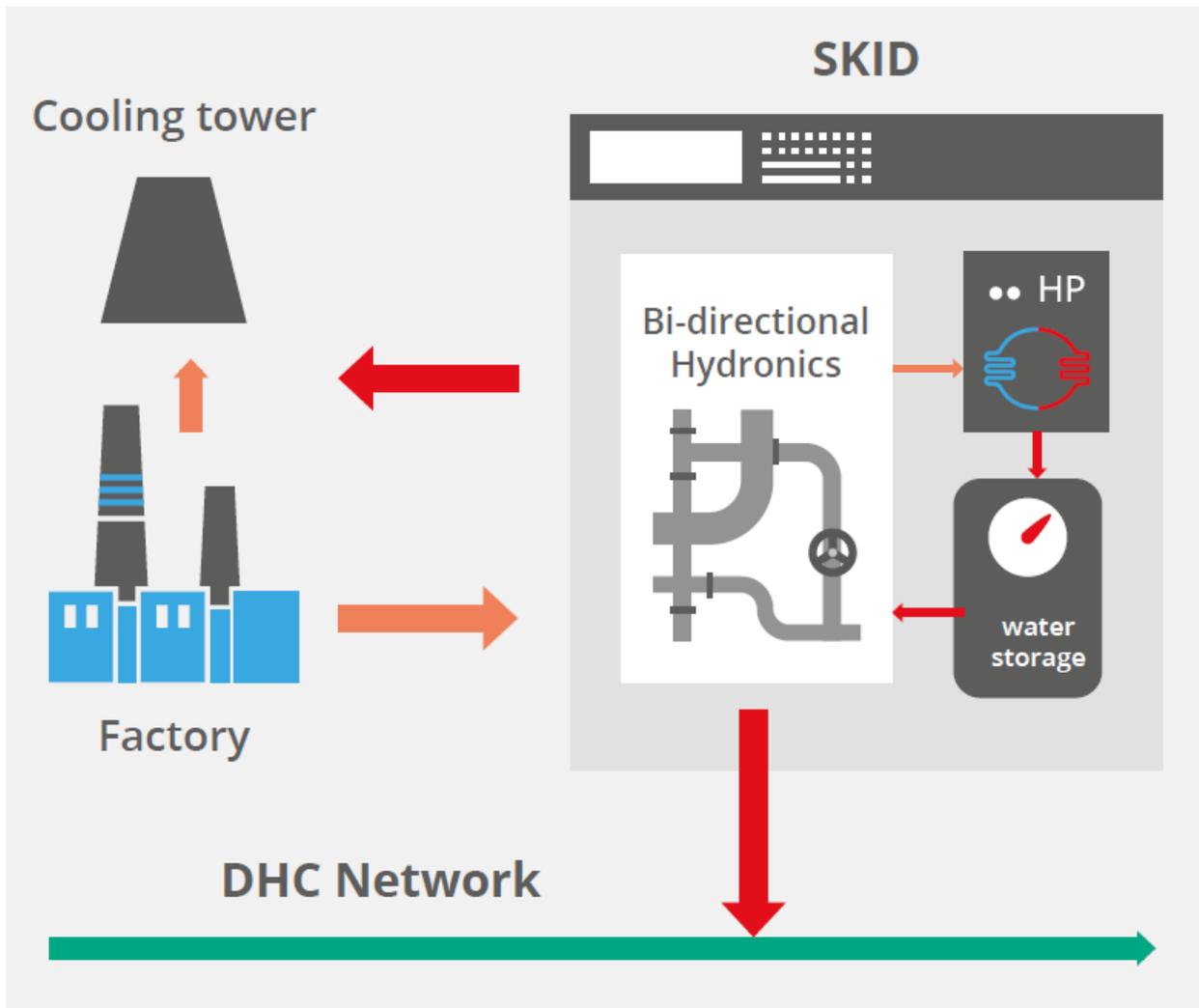
Waste heat recovery measures implemented

The total capacity will be 150 kW for the demonstration kit and 50 kW for the industrialized kit.

This action will also demonstrate the extreme **simplification** in manufacturing and installation related to modular and plug&play solutions: local energy consultants and installation companies can implement the waste heat integration without specialist skills on complex energy distribution systems.

With this skid configuration, the steel company plays the double role of energy provider and consumer, which is particularly interesting for the project, both from the technical and contractual perspectives.

The **waste heat recovered will be about 232 MWh/y**, corresponding to 325 MWh/y of useful energy self-consumed or made available to final customers by heat pumps at their premises. This data refers only to hot sanitary water; space heating values are currently under evaluation.



The concept of the skid

| | |
|---|-----------------------------|
| Pilot Plant | Ospitaletto |
| Country | Italy |
| Length of network | 2.3 km |
| Installed capacity | 2.5 MW |
| Waste heat source | Steel manufacturing company |
| Skid capacity | 150 kW |
| Waste heat recovered (only for hot sanitary water) | 232 MWh/y |

Rotterdam

The City of Rotterdam has translated the goals of the Paris Climate Agreement and the Dutch National Climate Agreement into the following ambitions for the it:

- By 2022, development of annual CO₂ emissions will have been redirected into a downward trend;
- By 2030, CO₂ emissions will have been reduced by 49% as compared to 1990;
- By 2050 the City of Rotterdam will be climate neutral.

One of the proposed measures is to use local district heating networks for heating of houses and other buildings in the City.

District Heating Network

The district heating network of Rotterdam is fed by waste heat sources in the industrial area nearby the city. The system that connects the industrial area with the local district heating system has been operational since October 2013: **a 26 km transport infrastructure system** was built, running from the waste incineration plant to the southern and northern parts of the city, with a **total thermal capacity of 100 MW**.

The supply temperature of the transport network is 98-120 °C and the return temperature is 50-70 °C. The district heating network in the southern part of the city supplies heat of 70 °C to houses and other buildings, with a return temperature of approximately 40 °C.

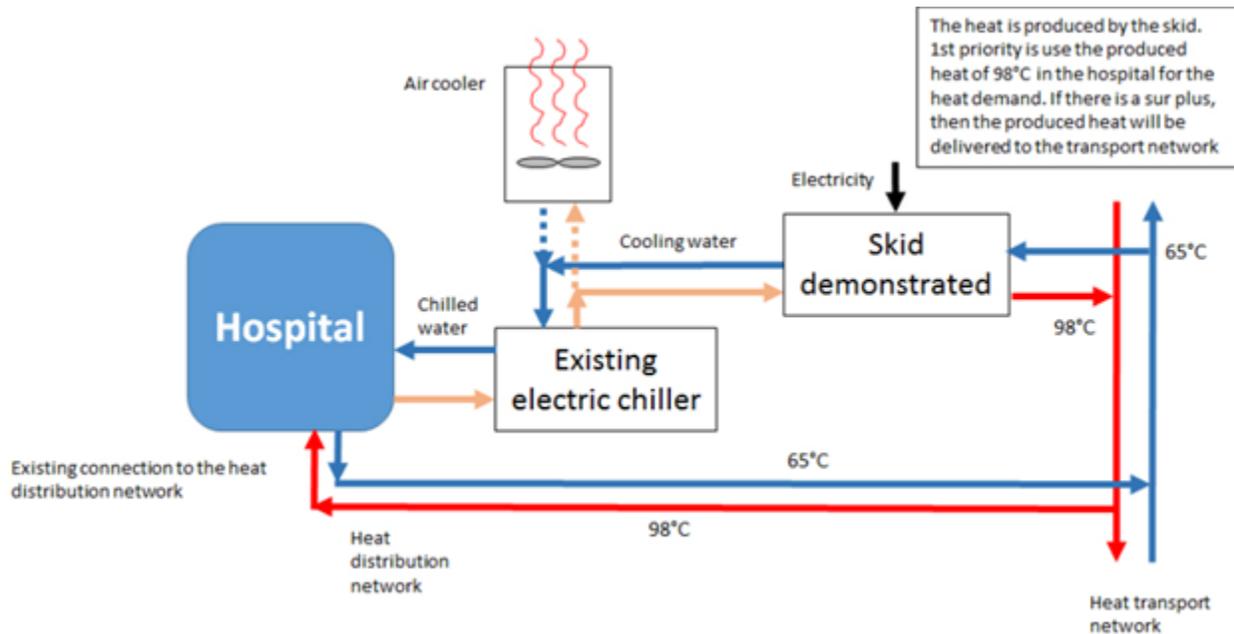
Waste heat source

The **hospital** Maastrad Ziekenhuis is already connected to the network to cover its space heating and sanitary hot water demand: the waste heat recovery measure foreseen involves installing a heat exchanger between chillers and cooling towers to recover heat at around 30 °C (the 'skid').

Waste heat recovery measures implemented

The **skid total capacity will be about 60-140 kW**: the primary user of the skid will be the hospital itself, as this allows for minimisation heat losses along the distribution system. For the waste heat that is not used by the hospital, the possibility to feed into the network will be considered, although the high temperature of the network might hinder this solution.

On the other hand, both sanitary hot water and space heating demand of the hospital will be involved, where, due to the size of the hospital, space heating requires a distribution subnetwork of significant length. In this way, it will be possible to demonstrate a skid for multi-directional energy flows: waste heat recovery from chillers, self-consumption for sanitary hot water or connection to the space heating subnetwork.



The Rotterdam network. This sketch refers to the possible integration with high-temperature district heating. An alternative option could be restricted to self-consumption only, but with both sanitary hot water and space heating, involving the hospital distribution network.

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|-----------------------------|-------------------|
| Pilot Plant | Rotterdam |
| Country | The Netherlands |
| Installed capacity | 6,6 MW |
| Waste heat source | hospital chillers |
| Skid capacity | 60-140 kW |
| Waste heat recovered | 480 MWh/y |

Heerlen

The city of Heerlen is located in the province of Limburg, in the Netherlands.

District Heating and Cooling Network

The peculiarity of the Heerlen's network is that it is based on a abandoned **coalmine**, now flooded as water reservoir. The system was built in several stages. In the period 2004 – 2008 the system (Minewater 1.0) was designed as a traditional unilateral network for heat and cold supply, and the underground mine water reservoir was used purely as a geothermal source. The mine water system was transformed in the period 2012 – 2013 into a thermal smart grid (Minewater 2.0), suited for the implementation of multiple energy sources and the mine water reservoir evolved into an energy buffer. The Mijwater system is now moving towards a 'demand and supply controlled system' (Mijwater 3.0), based on smart storage and an intelligent high-level control.

The thermal smart grid consists of a 2-pipe system with a hot and cold pipe for distribution, exchange and storage of energy. The network includes a main "backbone" connected to local (hydraulically separated) "clusters", through properly designed compact stations. These stations are well integrated in the urban environment thanks to underground chambers hosting the corresponding equipment, typically delivered with a single skid. The temperature level in the hot and cold pipes lies between 28 °C and 16 °C. With decentralize heat pumps in the buildings, the source temperature is lifted or reduced to the required levels.

Waste heat source

Mijwater is utilizing several heat sources already, including the reverse cooling needs from connected buildings. Due to Dutch climate and insulation grade of existing building stock, still a net large heat demand is needed over the year. To comply with this demand Mijwater is addressing new sources like LT waste heat and heat from sewage. In the new developed cluster D many industrial companies are located and may offer their waste heat to the Mijwater grid. One of those companies is implied in the project, serving as example for further deployment. The bleu print for energy plant design, business case and contractual forms are to be used for a series of followers within the cluster. The waste energy will be used directly within the cluster or transferred through the backbone connection to the larger network in the city.

The Mijwater 5GDHC grid in Heerlen currently serves 250.000 m² of floor space in large office buildings, shops, supermarkets, educational institutions, and homes. Total trench length amounts to 40 km, half for the backbone, and half for the 4 cluster grids. In 2017/18, the grid delivered 5.1 GWh/a of heating, and 5.2 GWh/a of cooling. Our electricity bill was 2.3 GWh/a. Peak heat demand is about 10 MWth

Waste heat recovery measures implemented

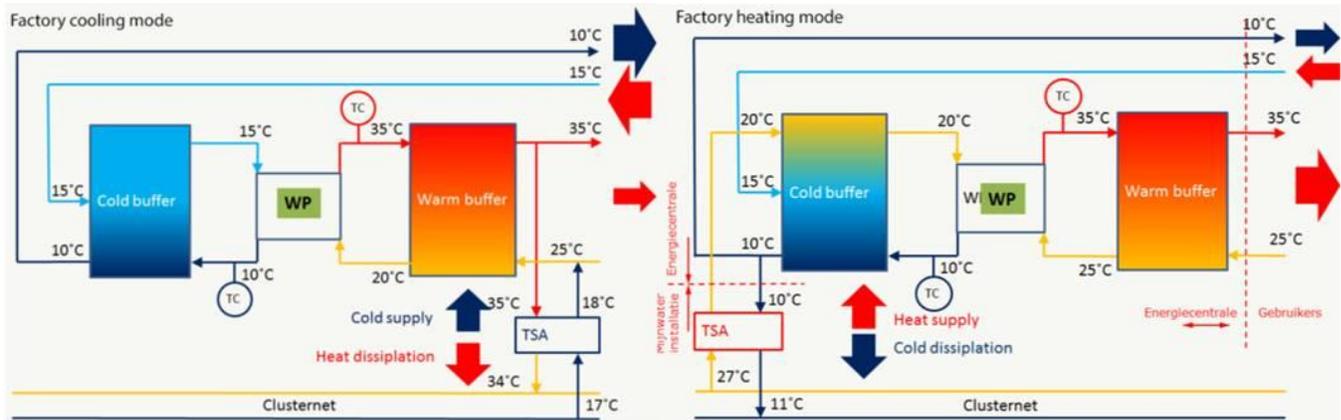
The recovery measure involves low-temperature waste heat from cooling processes. Recovered heat will be delivered to a "cold" buffer. A conventional compression heat pump will then transfer the heat to a "warm" buffer, in turn connected to the heating. The network will be connected through heat exchangers on both the cold and warm sides of this system, thereby providing heating or cooling depending on the

need. The buffers will be stratified and with multiple temperature levels to optimize the exploitation of the different temperatures.

All the needed equipment (heat pump, heat exchangers, etc.) will be arranged in a compact skid solution, with a **thermal capacity of about 700 kW**.

Once more, the primary user of the skid will be the factory itself.

The estimated amount of **heat recovered is about 1140 MWh/y**.



Factory heating and cooling mode of the network

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|-----------------------------|--------------------|
| Pilot Plant | Heerlen |
| Country | The Netherlands |
| Length of network | 40 km |
| Installed capacity | 10 MW |
| Waste heat source | Detergents factory |
| Skid capacity | 700 kW |
| Waste heat recovered | 1140 MWh/y |

Wüstenrot

The German demonstration site is an existing innovative plus energy district, located in Wüstenrot. This district comprises actually 16 newly built highly energy efficient residential detached or standalone buildings. The net zero energy supply concept combines a low depth geothermal system, heat-pumps and large photovoltaic systems. The low temperature energy source of the heat pumps is the central cold water heating network, which is connected to a large surface-near an **agrothermal system** with a size of 4400 m². Each building is equipped with a controllable heat pump and a thermal storage. The plus-energy district is going to be extended within the next 5 to 10 years by 10 to 15 buildings, including also refurbished ones.

District Heating Network

The demonstration network in Wüstenrot is a double pipe, cold district heating and cooling network operated at temperatures between 10 °C and 20 °C, enabling free cooling to be delivered to the buildings during summertime. **The total capacity installed so far is about 2.5 MW and about 260 MWh/y are distributed.**

Waste heat source

South of the plus energy district, the main sewer pipe of Wüstenrot with a diameter of 1000 mm leads wastewater to the treatment plant, located 3 km east of the district. The waste water flow rate varies between 8 and 30 l/s. The main challenge to be addressed is the development of economic viable solutions for the application of wastewater heat recovery systems in rural areas with low building density.

Waste heat recovery measures implemented

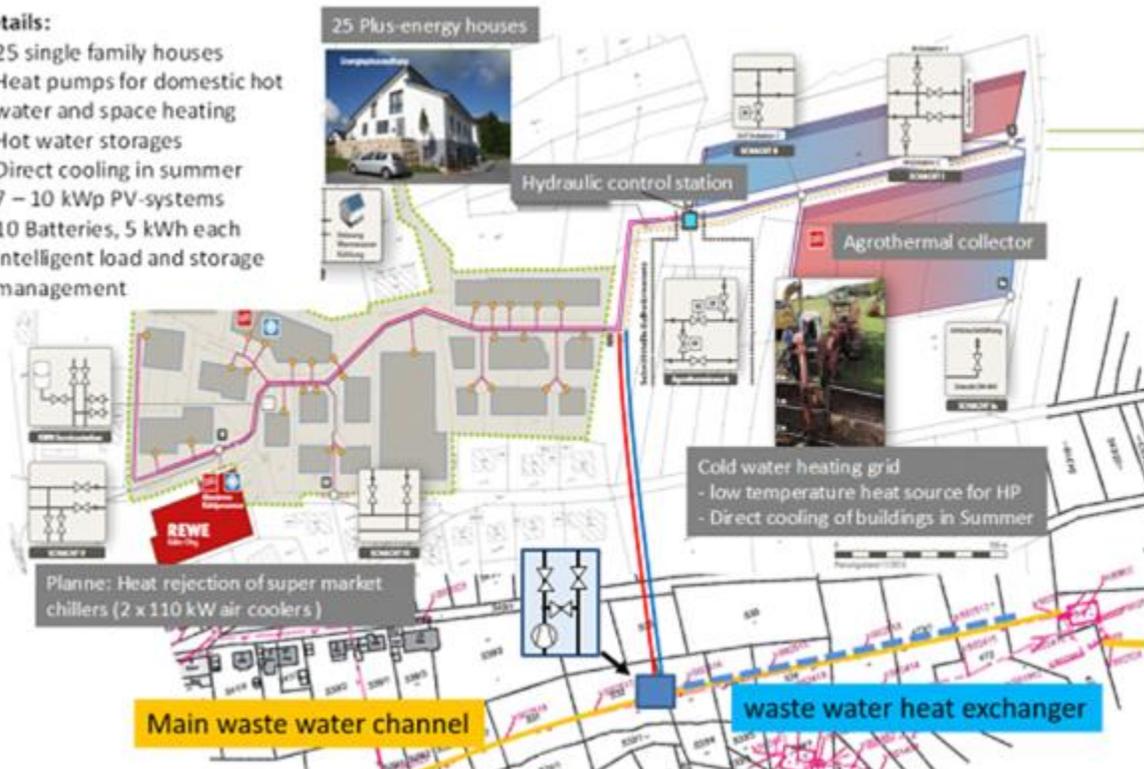
Within LIFE4HeatRecovery it is planned to **integrate heat exchangers with a surface of 120 m² in the wastewater pipe with a capacity of approximately 100 kW** and to integrate the waste heat recovery system into the low temperature district heating network of the plus energy district.

For easy, fast and reliable system integration a new pumping skid including valves, pumps and an intelligent control system will be developed. The skid will be mounted in a water tight concrete inspection chamber that will be transported on site and will lie in the ground next to the sewer channel.

A maximum energy recovery from wastewater of approximately **200 MWh/y** is to be expected with approximately 20 MWh/a electricity consumption for the pumps, sensors and controls included in the skid.

Details:

- 25 single family houses
- Heat pumps for domestic hot water and space heating
- Hot water storages
- Direct cooling in summer
- 7 – 10 kWp PV-systems
- 10 Batteries, 5 kWh each
- Intelligent load and storage management



The Wüstenrot prototype

| | |
|-----------------------------|-------------------|
| Pilot Plant | Wüstenrot |
| Country | Germany |
| Installed capacity | 2.5 MW |
| Waste heat source | Agrothermal field |
| Skid capacity | 100 kW |
| Waste heat recovered | 200 MWh/y |

The LIFE4HeatRecovery project (Contract Number: LIFE17 CCM/IT/000085) has received funding from the LIFE programme of the European Union