Pilot Testing Measures

LowTEMP

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LowTEMP training package - OVERVIEW

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Introduction

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- Intro Energy Supply Systems and LTDH
- Energy Supply Systems in Baltic Sea Region

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- Methodology of Development of Energy Strategies
- Pilot Energy Strategies – Aims and Conditions
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- Life cycle costs of LTDH projects
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Introduction

- **Implementation** of pilot activities in Municipalities to test and/or start the implementation of LTDH in their DH infrastructure (one or two pilots for each Municipalities)

- **Exploring different characteristics** (i.e. current type of the DH supply infrastructure, connected types of buildings, existing problems and potential for improvements)

- Checking the **possibility to apply the low temperature DH supply** in existing buildings and housing areas to be found in the BSR region

- **Modern monitoring equipments testing** potential LTDH connection to standard old type housing area after retrofit

Figure 1a: Scheme of existing DH system of Beļava village [1]

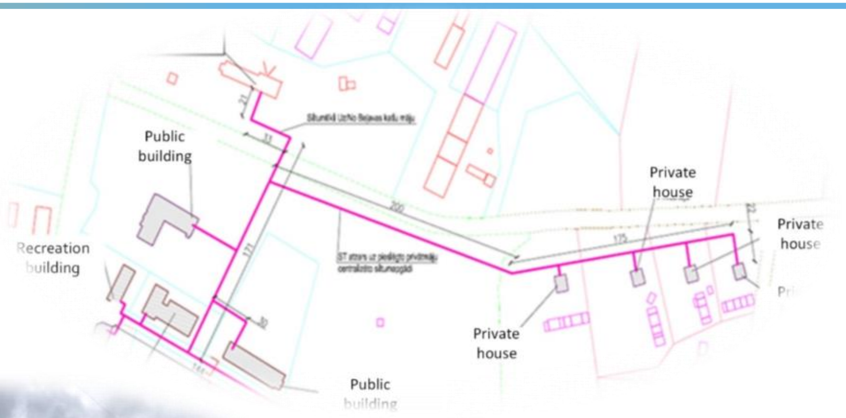

Figure 1b: Transformation of DH system of Beļava village. Author: Gulbene municipality

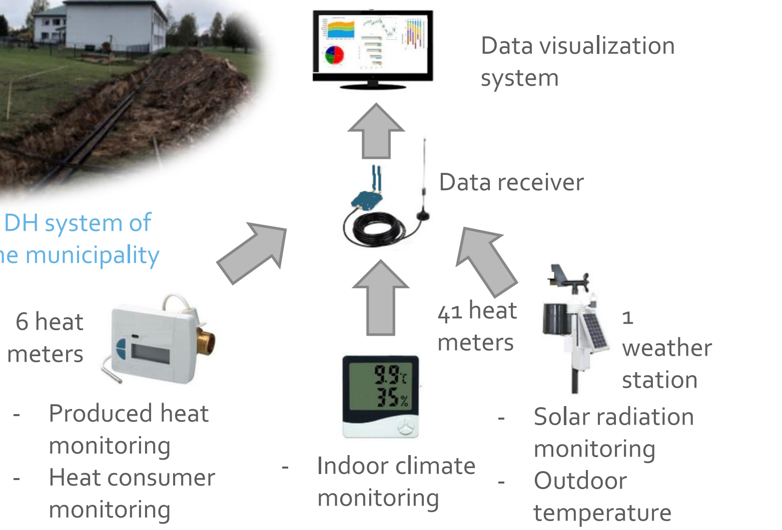

Figure 1c: Monitoring system of DH system of Beļava village. author: V. Kirsanovs (Riga Technical University)

Introduction

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In this presentation:

- Low-temperature district heating grid in a completely new residential area in Halmstad, Sweden
- Low temperature centralized heat supply system of Beļava village in Gulbene Municipality, Latvia

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Introduction

Further material:

- Modernization of a gas boiler room with the use of an absorption heat pump for heating the building of the Local Government Nursery in Rumia, Poland
- Lowering the operating parameters of the installation in existing oversized buildings in Wejherowo, Poland
- Waste Heat Potential Study of Cooling Water Towers in Koskenkorva, Ilmajoki, Finland
- Examination of 145 social / public objects aimed at collection and analysis of data on heat supply, heat losses and heat consumption, Petrozavodsk (Russia),
- Design for reconstruction and/or modernisation of heat substations and other relevant energy saving measures in selected objects, Petrozavodsk (Russia)

Pilot Testing Measure

Low-temperature district heating grid in a completely new residential area in Halmstad

Background

- Ranagård in Halmstad: new residential area with low temperature district heating (LTDH)
- Ranagård maximum heat demand: 3 MW.
- Ranagård: 3 main areas of which 1 will be supplied with 4^{th} generation district heating with a 3 pipes system (4GDH-3P), and area 2 and 3 will be supplied with conventional LTDH

Figure 2 – Location of the pilot testing measure in Ranagård, Halmstad [2]

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Background (II)

- 4GDH-3P
  - It is a 4th generation District Hearing in low temperature regime with a 3-pipe system
  - Third pipe: circulation of the supply water when the heating demand is low, replacing the circulation in buildings. The circulation in the third pipe enables lower return temperatures

- Technical solution for distribution networks in Ranagård
  - Connection to the conventional district heating network in Halmstad by two technical buildings where the supply temperature of the conventional network is lowered to the supply temperature in the LTDH and 4GDH-3P.
  - The temperature is lowered by mixing the primary supply with the return of the LTDH and 4GDH-3P

Figure 3 –.Ranagård - Halmstad is Growing - Halmstad Municipality
Source: www.halmstad.se [3]

Background (III)

- About 50 % of the return water is mixed with the supply water to obtain the desired temperature by a valve that is controlled by the supply temperature of the 4GDH-3P, after the distribution pumps
- The rest of the return water goes back to the return water of the conventional district heating network
- The supply temperature is 65 °C for the LTDH and 4GDH-3P
- The return temperature is expected to be 32°C for the LTDH and 28°C for the 4GDH-3P.

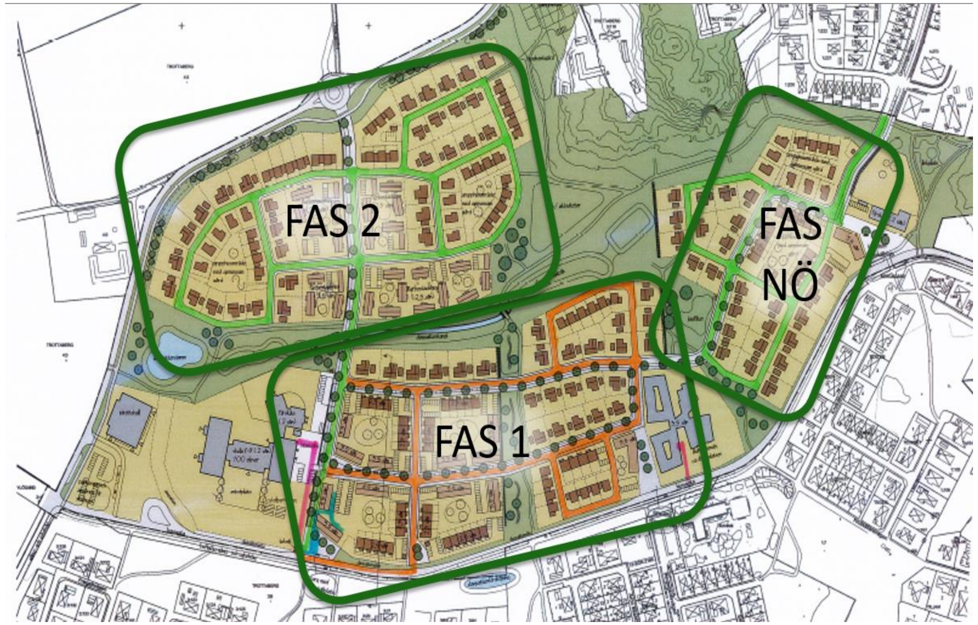

Figure 4 – DH-areas in Ranagård. Source: Halmstads Energi och Miljö AB [4].

Main problem

- Due to the difference in construction design between the 3rd generation district heating and 4th generation, a practical field test was conducted to determine the minimum amount of space needed between the pipes outer casing to be able to build a tree pip district heating grid.

- HEM has also performed calculations tests to get the right dimensioning for sufficient flow with minimal energy losses.

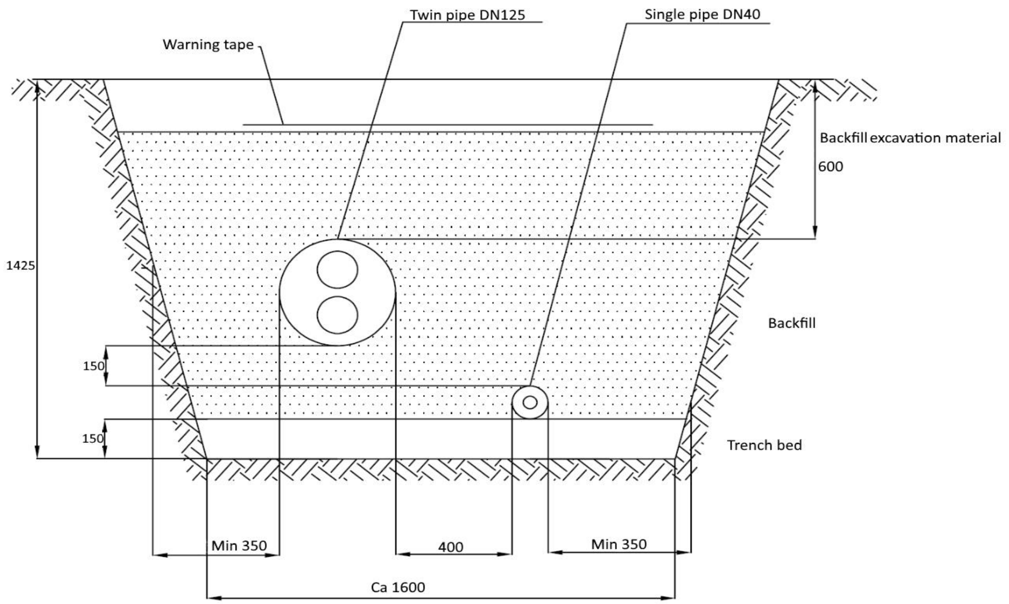

Figure 4 – Cross section of piping. Source: Halmstads Energi och Miljö AB [4].

Figure 5 – Figure 6 – Welding tests. Source: Halmstads Energi och Miljö AB [4].

Main problem (II)

- A "standard section" was formed with the measurements in the field test
- This section shows the placement of a DN125 pipe and a single pipe DN40
- The fitting of casing joints and an easy assembling of the pipes is guaranteed
- Time and effort savings for the construction phase and will also reduce the amount of readjustments of the trench to be able to lay down the pipes correctly

Figure 6 – Welding tests.
Source: Halmstads Energi och Miljö AB [4].

Figure 6 – Welding tests.
Source: Halmstads Energi och Miljö AB [4].

The pipes were placed according to a theoretical pipe segment. The pipes were later adjusted to find the optimum height to width ratio to be able to assemble pipes and joints

Aim and scope of the pilot measure

MAIN AIM AND SCOPE: build a low-temperature DH grid in a new residential area in Halmstad

SPECIFIC AIMS AND SCOPES:

- Test and compare advantages / disadvantages with the three-pipe system in terms of energy efficiency, construction, etc. 4GDH-3P is a 3-pipe system that is energy efficient and allows lower water temperatures

- Handle the challenge of designing and dimensioning of the grid for the three-pipe system dealing with the difference in construction design between the 3rd generation district heating and 4th generation (i.e. need to know the minimum amount of space needed between the pipes outer casing to be able to build a tree pipe district heating grid)

Aim and scope of the pilot measure (II)

- Design and dimension the downshift stations needed to build a low-temperature district heating grid in a high-temperature and existing grid
- In the Ranagård area, three sub-areas are being built to compare the different systems (i.e. one 4GDH-3P with 3 pipes and two LTDH networks with two-pipe systems with low temperature water)
- Technically and financially guarantee that the downshift stations and the customer's district heating exchangers operate in a low-temperature system and that there are no additional requirements for the customer's property

Figure 8 – Welding tests. Source: Halmstads Energi och Miljö AB [4].

Welding the pipes together and assembling the casing joints

Figure 9 – Welding tests. Source: Halmstads Energi och Miljö AB

Aim and scope of the pilot measure (III)

- Further develop the risk analyzes and propose how the risks should be analyzed
- Initiate a dialogue with house manufacturers about not including heat pumps as standard in the house delivery, and that it can be replaced with a district heating exchanger
- Develop a technical as well as an business solution on how low-quality energy sources can be connected to the grid and how the product should be communicated both externally and internally
- Develop a technical and business solution on how customers should connect to 4GDH-3P systems
- Develop proposals for appropriate incentives for the product to be of interest to the customer
- Develop a communication plan for the introduction of 4th generation district heating at Ranagård
- Develop a sales plan for Ranagård

Description of the implemented technology

- Example of a downshift station for a LTDH subnetwork is being built in the middle of a HTDH network
  - Beginning of construction in mid 2020 and the first houses planned to be built in mid 2022
- Ranagård in Halmstad will provide with low temperature district heating for approximately 500 houses and apartments
- Ranagård has a total maximum heat demand of about 3 MW

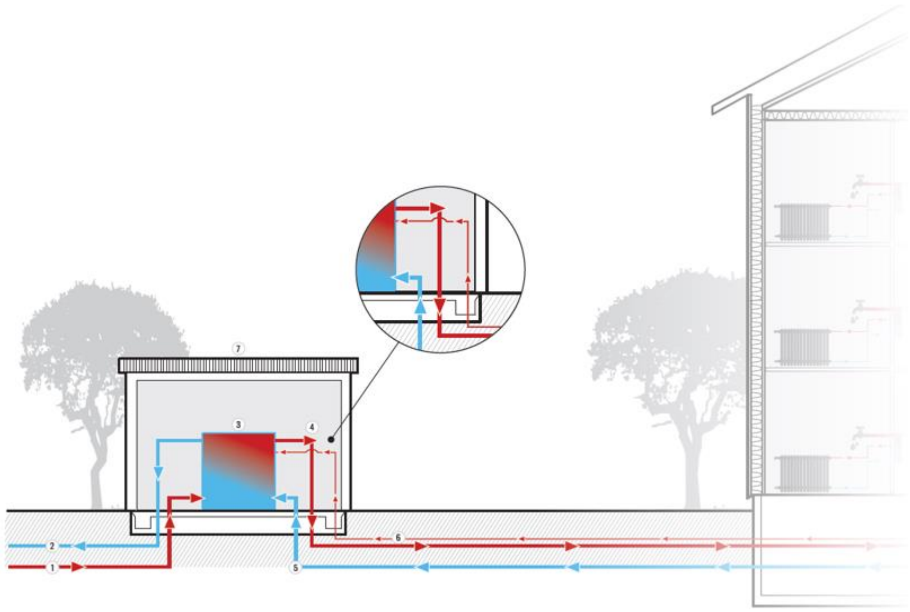

Figure 10 – Rough technical scheme of a 4GDH-3P downshift station.
Source: Varberg Energi [5].

Description of the implemented technology (II)

- Ranagård is divided in three areas:
  - area 1 is LTDH with 3 pipes
  - area 2 is LTDH with 2 pipes
  - area 3 is LTDH with 2 pipes
- There are 2 downshift stations:
  - first downshift station used for areas 1 and 2
  - second downshift station used for area 3

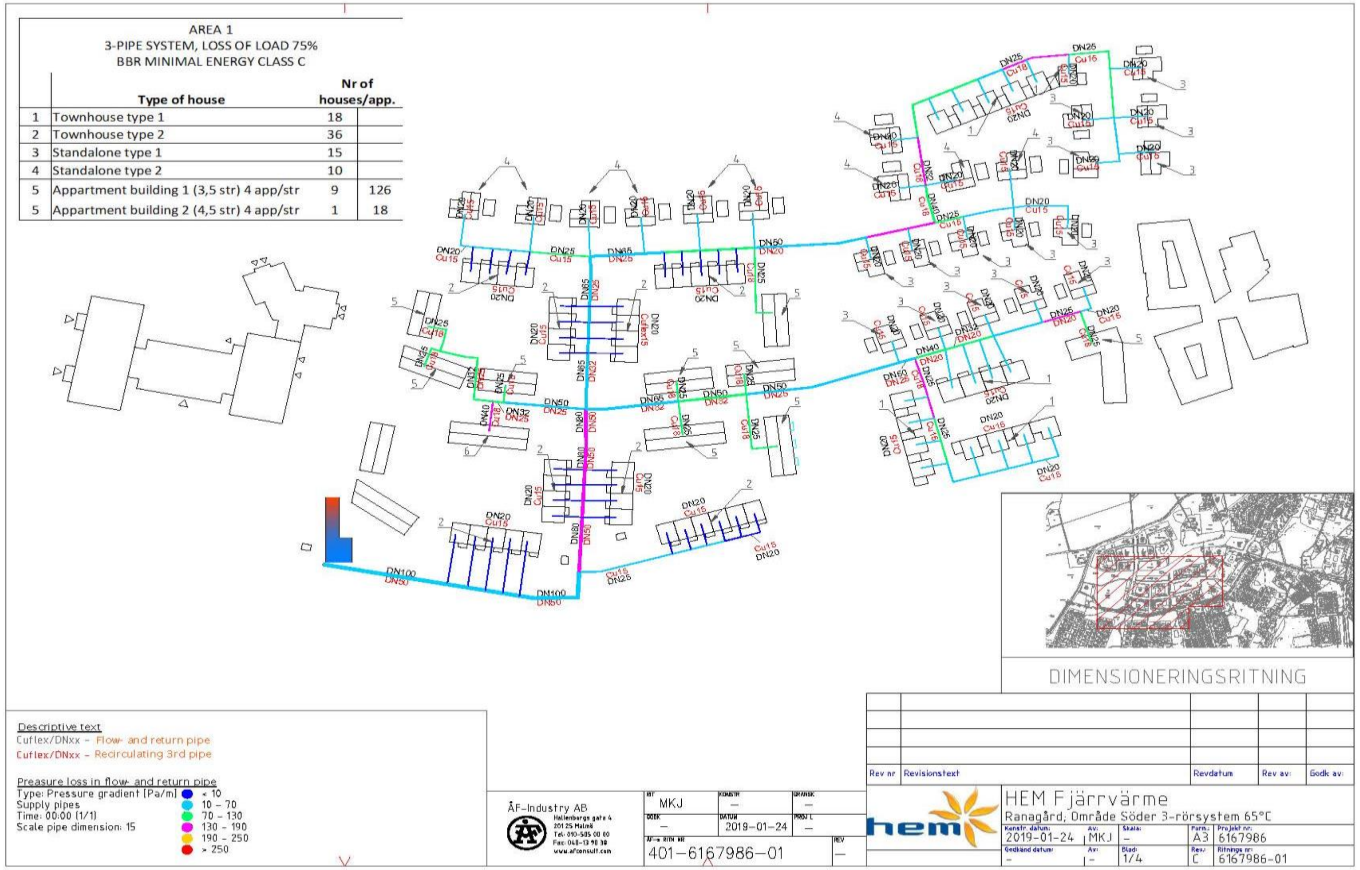

Figure 11 – Grid Dimensionening. Source: Halmstads Energi och Miljö AB [4].

Description of the implemented technology (III)

The main components in the **downshift station** are:

- 2 distributions pumps for each network: each pump is dimensioned to handle the total flow and operates one at a time
- The control valves control the amount of return water that is mixed with the supply water to obtain the desired supply temperature in the networks.
- Possible provision to Ranagård district with the same temperature as for the conventional district heating network by opening bypass valves in the technical house
- Monitoring, control and regulation technology

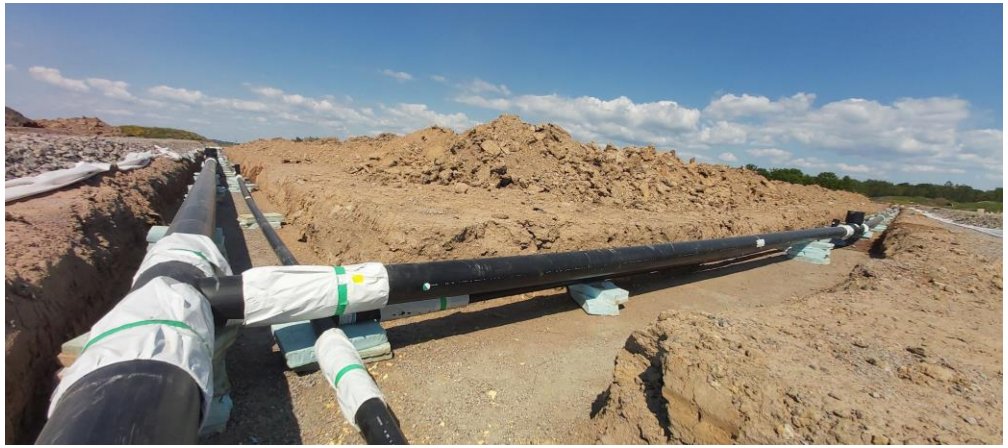

Figure 12 – 3-pipe solution at site. Source: Halmstads Energi och Miljö AB [4].

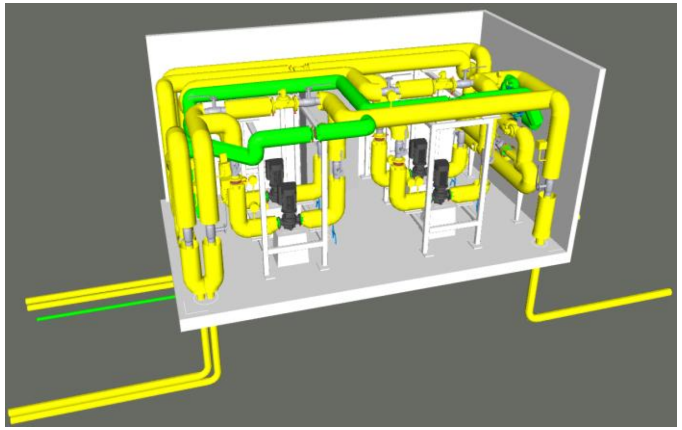

Figure 13 – Downshift station. Source: Halmstads Energi och Miljö AB [4].

Benefits

- A network that allows energy to flow in and out depending on needs and that is designed so that the losses are as small as possible
- With three pipe systems, energy losses are reduced
- With low-temperature water, the network can both deliver and more easily receive surplus heat
- The return temperature can be lowered, which makes the incineration plants more efficient. A more efficient incineration plant saves energy and reduces emissions
- Better environmental performances and more flexible business models

Figure 14 – 3-pipe solution at site.
Source: Halmstads Energi och Miljö AB [4].

Beneficiaries

- Halmstad Municipality: technical knowledge exchange during the design phase technical drawings based of engineering calculations
- Other municipalities: the technical solution proposed can be exploited in other DH systems both in Europe or worldwide
- Triple Helix approach: Halmstad University, HFAB (Halmstad Real Estate AB) and Halmstad Municipality
- Interest from other municipalities, real estate companies, heating companies and citizines

Identified obstacle and barriers

- Finding the right business model for the construction of DH-grids, that benefits from reduced electricity use, the use of green electricity and giving customers the experience of doing right
- Finding the value chain and building the business model on the value of circularity rather than in a linear idea
- Environmental-, energy- and business policy and parameters control
- Choice between district heating and individual heating with heat pumps
- Difference between private and public energy companies, level of profit, time for ROI, social responsibility, residual heat management, energy utilization from waste and the correct price level of energy to actively contribute to reduced energy use

Next step

- Infrastructure building clearly in the area with roads, water, sewage, fiber and district heating pipes
- Single-family houses and multi-family houses building in the area

Figure 15 – Overview of field before commencing. Source: Halmstads Energi och Miljö AB [4].

Contact information

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  - Contact person Rolf Strandell tel. +46 (0)35 / 190 613 , rolf.strandell@hem.se

Pilot Testing Measure

Low temperature centralized heat supply system of Beļava village in Gulbene Municipality, Latvia

General information about Belava

Gulbene municipality

- Territory: 1872 km²
- Population: 22 066 people
- 13 parishes – Gulbene municipality

Belava parish:

- 169 km²
- 5 villages
- Population - 1546 people

Figure 16 – Location of the pilot testing measure in Belava parish, Gulebene (Latvia) [2]

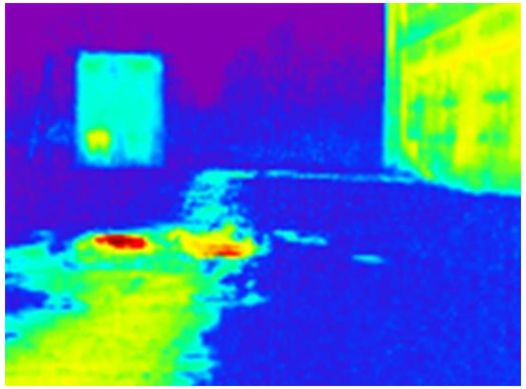
Background

- The former District heating (DH) system at Beļava consisted of a wood boiler house and 9 buildings
- DH includes different groups of consumers: public buildings (i.e. local authority, kindergarten, mail), 1 cultural centre, 1 recreation building, 1 shop, 1 multifamily residential building and 4 private houses
- Public building, cultural house and shop are renovated
- Multifamily residential building is not insulated and have high heat consumption around 190 kWh/m_2 per year
- Existing boiler house: 1 MW fire wood boiler.

Main problem

<u>Existing DH system was old and not effective</u>

- **Heat transportation**
  - disproportionate DH grid
  - old pipes with bad quality insulation
  - heat loss in the grid ~40 %



Picture 17: Thermography images of DH system of Beļava village. Author: V. Kirsanovs (Riga Technical University)

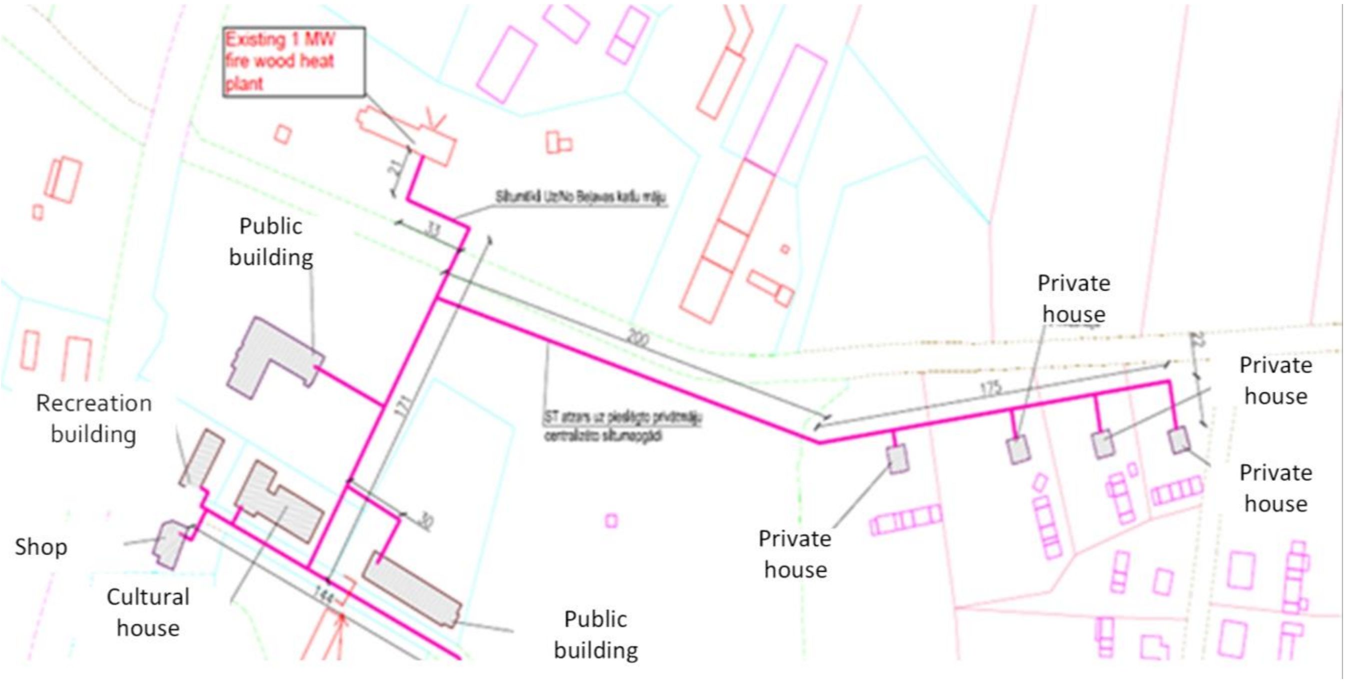


Figure 18: Scheme of existing DH system of Beļava village [1].

Main problem (II)

- **Heat production**
  - low boiler efficiency (50 – 60 %)
  - 3 workers for wood log preparing and manual loading into boiler
- **Heat consumers**
  - no heat meter for each consumer

Figure 19: Wood boiler at Belava village. Author: Gulbene municipality [6].

Figure 20: Existing boiler house at Belava village. Author: Gulbene municipality [6].

  - DH grid and building heating system are not separated with heat exchanger
  - payment based on EUR/m² and not depending on consumers heat consumption
  - consumers are not motivated to save heat energy
  - high heat supply tariff – 87.50 EUR/MWh

Aim and scope of the pilot measure

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The implementation of a modern DH and smart metering system within existing buildings:

- Transformation of existing DH to LTDH to **develop demonstrative pilot example**
- **Provide LTDH** for two insulated buildings to three different consumer groups in Beļava Parish: culture center, local government and kindergarten
- **Develop a smart metering system** for LTDH monitoring as base for a future integrated energy management system
- **Testing of LTDH implementation strategy**, weak point recognition and suggestion determination for strategies improvement
- **Change of reluctant attitude** towards LTDH implementation by presentation of achieved benefits
- **Reduce CO_2-emissions** from DH system

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Pilot measure timeline

Existing DH system analysis
LTDH implementation strategy development

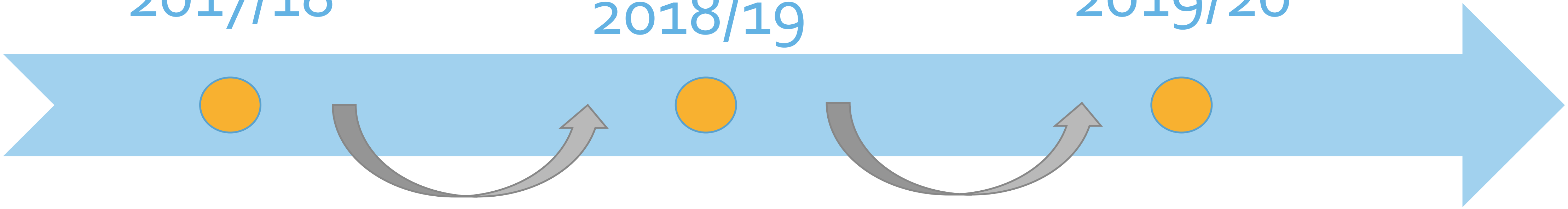
2017/18

Implementation of measures

2018/19

Conclusions and recommendations for LTDH implementation at other parishes

2019/20



DH grid reconstruction and heat supply transformation

DH system optimization

Description of the implemented technology

Complex DH modernisation and transformation was done.

- **Heat production** – actual heat load calculation and installation of the container type house with automatically operated 200 kW pellet boiler selection with high heat production efficiency

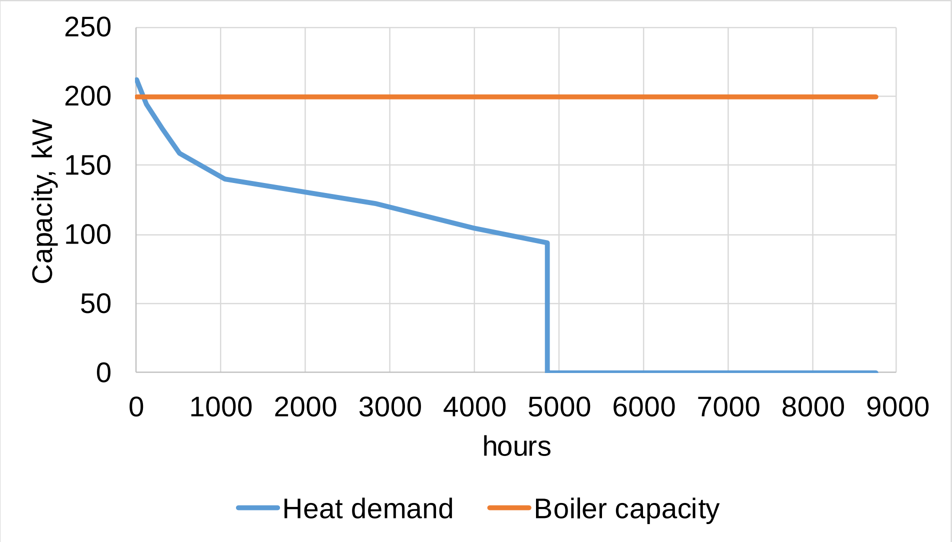


Figure 21 : New boiler house at Belava village. Author: Gulbene municipality [6].

Figure 22: Pellet boiler at Belava village. Author: Gulbene municipality [6].

Description of the implemented technology (II)

- **Heat transportation** –
  - DH grid length decrease (disconnection of 4 private houses and boiler house placement closer to main heat consumers)
  - replace of old pipes to new industrially isolated pipelines
  - decrease the temperature in grid - 65°/35° for renovated buildings and 80°/60° not insulated buildings (two separate circulation loops)

Figure 23: Transformation of DH system of Beļava village. Author: Gulbene municipality [2]

Figure 24: Scheme of new DH system of Beļava village. Readapted from a courtesy of Gulbene Municipality [6].

Description of the implemented technology (III)

- **Heat consumers**
  - substations and heat distribution system for each consumer
  - heat meter installation for consumers and ensure payment based on a heat meter readings

Figure 23: Substations and heat distribution system of public building. Author: Gulbene municipality [6].

Monitoring and optimization

- LTDH system monitoring was organized by installation of smart metering system installation for:
  - Produced heat monitoring
  - Heat consumption monitoring
  - Indoor climate monitoring for each building
  - Outdoor temperature and solar radiation monitoring

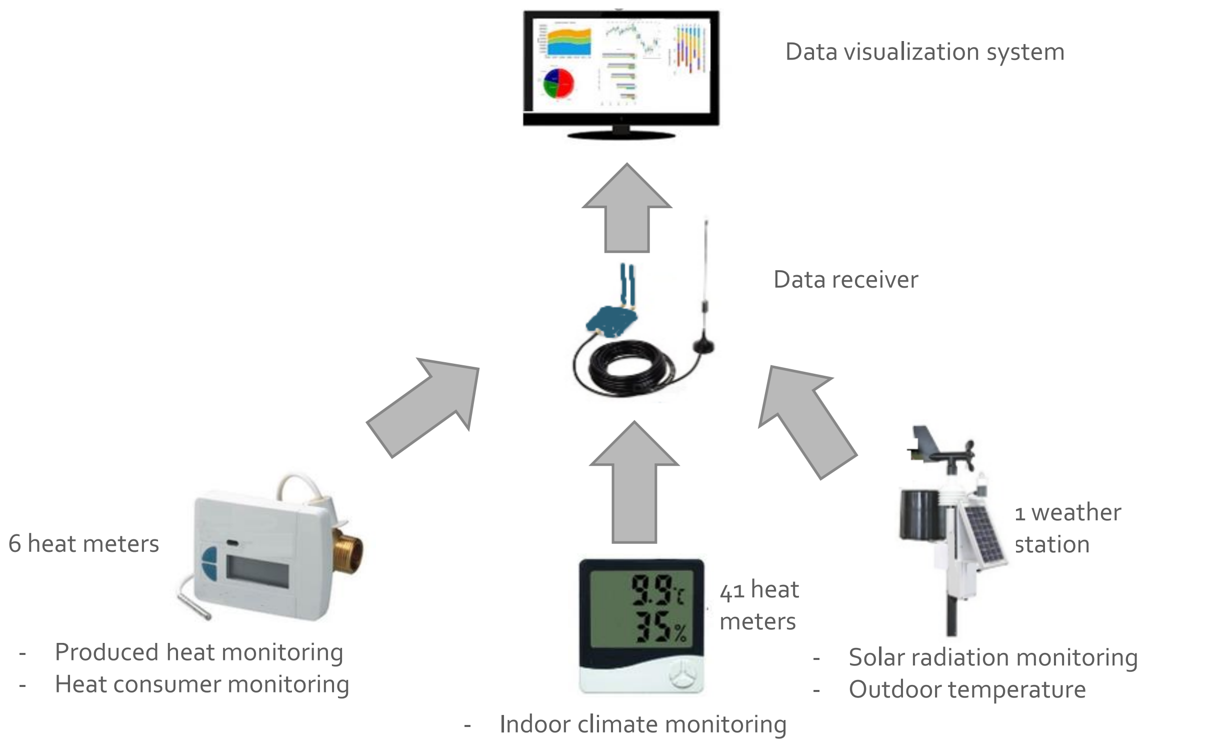


Figure 24: Monitoring system of DH system of Beļava village. Author: V. Kirsanovs (Riga Technical University)

Costs of the pilot measure

Financed by LowTEMP project:

- Smart metering system – 21 657,79 €
- Mobile indoor climate data centers – 16 873,07 €

Financed by Gulbene municipality:

- Designing and coordination– 4 961,00 €
- Construction – 194 005,36 € (of which 10941,00 € financed by LowTEMP)
- Strategy development for LTDH implementation in other regions of Municipality– 19 807,70 € (partially financed by LowTEMP)

Benefits

LowTEMP

	2017/18	2018/19	2019/20
Boiler house efficiency [%]	~ 55	83,7	90,3
Heat loss at DH grid [%]	~40	4,6	3,8
Fuel consumption [MWh/year]	1 179	470	459
Electricity consumption, [kWh/MWh]	~20-25	10,9	10,1
Heat supply tariff [€/MWh]	87,50	69,07	69,07

- Cost savings per year average: 16 900 €
- Investment payback period: 11 years

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Benefits (II)

- Heat loss decreased at DH grid and used fuel energy reduction allows to reduce CO_2 and other air pollution emissions, which is important both for the municipality and the residents
- Due to the innovative approach the implementation of this Pilot Project has attracted great interest among specialists in the field of heating, design and construction, as well as representatives of the state and municipalities

Beneficiaries

- **House owners, apartment owners and apartment building managers**:
  - Reduced heating costs
  - Improved indoor climate conditions
- **Heat suppliers**:
  - Improved heat production efficiency
  - Reduce heat transfer losses
  - Possible integration of waste heat sources
- **Municipality**:
  - Improved DH energy management from installation of stationary and mobile smart metering systems
  - Knowledge about 4^{th} generation DH and implementation in new projects
- **Other municipalities**:
  - Good practice example and action plan for LTDH implementation

Identified obstacle and barriers

- Low correlation between outside temperature and supply temperature from boiler house was identified
- The adjustment of the boiler house automation to increase the higher DH system efficiency

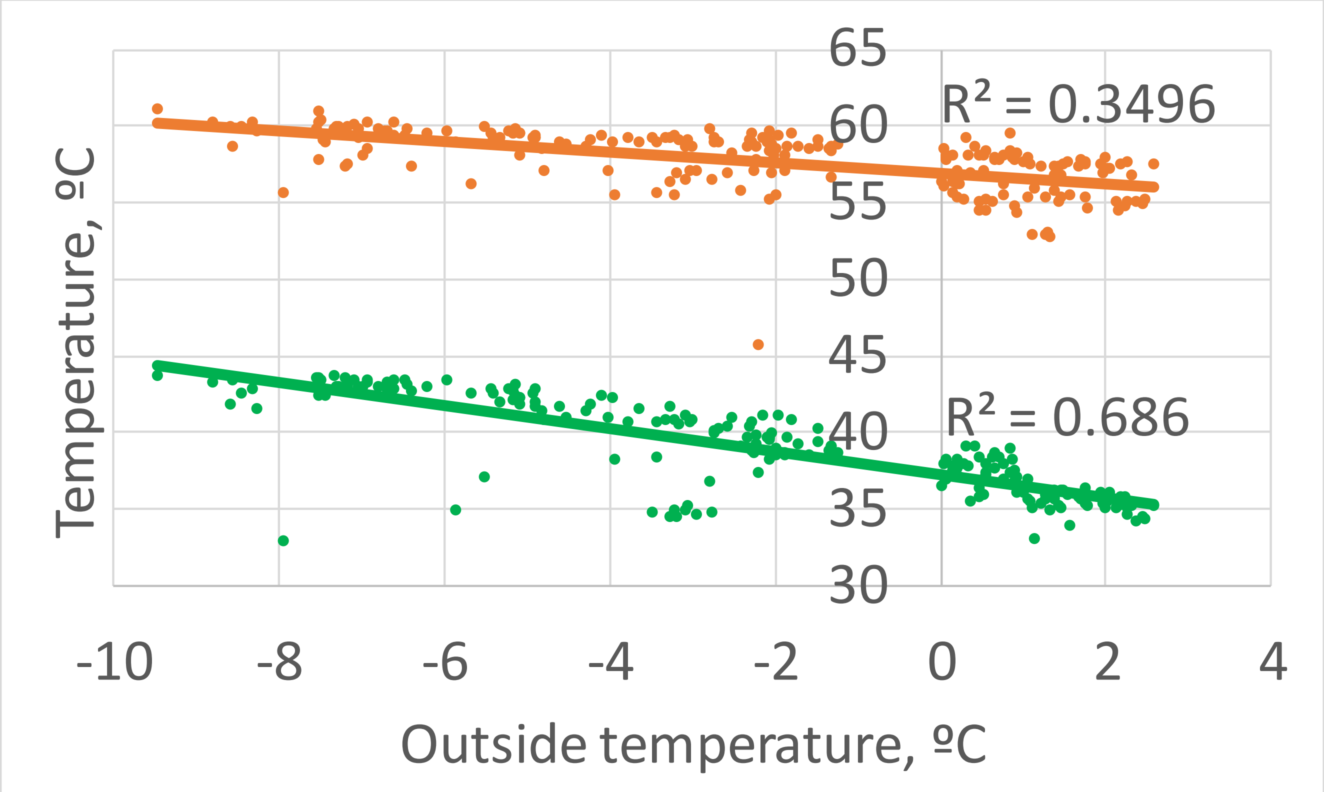

Figure 25: Correlation between outside temperature and supply temperature of new boiler at Belava village. Author: V. Kirsanovs (Riga Technical University)

Identified obstacle and barriers (II)

- Large differences between indoor temperatures at local authority building. The main reason of this are old and not effective heat distribution system at building.

- The possible solutions were selected:
  - Change of old and not effective radiators
  - Unlegal connected radiators identification and removal
  - Water circulation flowrate increase by heating system pipe rinsing or new circulation pump installation

Figure 26 – Indoor temperature distribution at public building. Author: V. Kirsanovs (Riga Technical University)

Identified obstacle and barriers (III)

- OBSTACLE: Resistance from the surrounding population was due to lack of knowledge
- SOLUTION: Information campaigns were organized to provide information to the population to solve this problem

- BARRIER: remote data collection system: interruptions in the data collection system
- SOLUTION: innovative data collection system installed and optimized

Figure 26 – Weather station . Author: Gulbene municipality [6].

Next step

- Experience acquired used in other parishes and municipalities for DH system modernisation and transformation to LTDH
- Information dissemination for different stakeholders:
  - heat suppliers
  - DH grid owners and providers
  - heat consumers and building owners
  - urban planners and DH engineers
  - municipalities and etc.

Conclusions

Cross evaluation and lesson learned

- There are many options for LTDH implementation at existing DH. Properly designed and implemented LTDH are economically reasonably and have environmental benefits
- To find optimal solution the deep analysis of existing heat supply system must be done. Lack of precious data about heat demand of prosumer can limited develop strategy for DH transformation. Data collection and database creation for future analysis must be done
- The development of long-term transformation path with goal and task identification is important. Also several alternative scenarios of LTDH implementation must be analyzed
- It is recommended look at the LTDH system not only as heat transportation in networks, but as a complex system, which also includes heat production and distribution on the consumer side

Cross evaluation and lesson learned (II)

- DH system can be transformed to LTDH gradually reducing temperature at grid at one area to another
- Low temperature of heat surplus heat source are one of the main limitation factor for surplus heat use at DH. Heat pump is effective technology for surplus heat use at DH, especially for LTDH
- Unbalanced system in the building causes incerased temperature in the rooms, uncontrolled heating demand and high heating bills.
- Upgrade of the heating substation system for indoor temperature regulation and temperature reduction outside working hours can be provided for heat demand heating bills reduction
- Installation of heating system automation with energy and indoor climate monitoring system, as well heating temperature reduction at building can be organized to achieve optimal heating system performance.
- It is important determine the appropriate heating curve for the operation of the building in order to optimize and reduce heat consumption in the facility after supply temperature reduction at building

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Recommendation

- Regarding to heat production it is recommended:
  1. to focus on modern technologies with high efficiency
  2. consider the use of renewable energy sources and surplus heat.
- Regarding to heat production it is recommended:
  1. decrease the temperature in grid;
  2. pipes with high quality isolation;
  3. use three pipe systems for energy losses reduction.
- Regarding to heat consumers it is recommended:
  - change old and not effective radiators
  - heat consumption and indoor microclimate monitoring

Conclusions

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- The pilot testing measures show the proof-of-concept for an action plan of DH system improvement, showing. The pilot project implementation offers the opportunity to identify main barriers and bottlenecks for a successful realization at a larger scale
- An in-depth analysis of the existing situation and the development of a clear and tailored action is necessary for new LTDH system construction or existing DH transformation to low temperature
- System monitoring and optimization is necessary to preclude the possibility of shortcomings and further achieve optimal working conditions of the system
- These pilot activities supplement the development of pilot energy strategies in municipalities and regions
- Existence of a reluctant attitude toward LTDH implementation does to the lack of knowledge. Informative campaigns are necessary to change people attitude and show positive experience of LTDH project realization

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References

[1] Maksims Feofilovs, Ieva Pakere, Francesco Romagnoli. Life Cycle Assessment of Different Low-Temperature District Heating Development Scenarios: A Case Study of Municipality in Latvia. Environmental and Climate Technologies, 2019, vol. 23, no. 2, pp. 272–290.

[2] Pilot Testing Measures [Online]. Available at http://www.lowtemp.eu/map/

[3] Courtesy from Halmstad Municipality, http:// www.halmstad.se

[4] Courtesy from Halmstads Energi och Miljö AB

[5] Courtesy from Varberg Energi

[6] Courtesy from Gulbene Municipality

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