# Solutions for low temperature heating of rooms and domestic hot water in existing buildings

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# Introduction

- **Implementation of 4th generation district heating systems must be based on lowering the operation temperature of room heating system and the domestic hot water system.**

- **Step 1: Lowering the return temperature**
- **Step 2: Lowering the supply temperature**

- **Solutions for existing buildings worked on in 4DH:**

**WP 1.1. Heating of existing buildings by low-temperature district heating. Dorte Skaarup Østergaard**
**WP 1.2. Supply of domestic hot water at comfort temperatures without Legionella. Xiaochen Yang**

# Solutions for low temperature heating of rooms

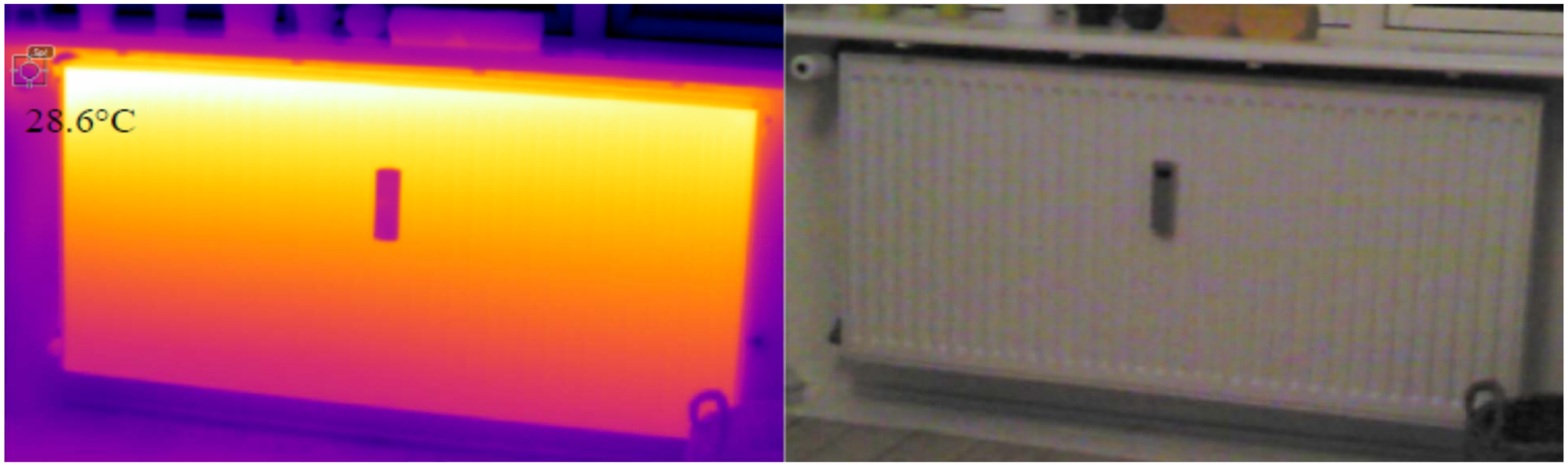
- Focus on existing buildings with radiators
- Problem areas:
  - Type of pipe systems
  - Type of radiators
  - Type of control system
  - Design heating load and temperatures
  - Actual heating load of rooms

# Type of pipe systems

- One-string connections of radiators
  - Return temperature from radiators mixed with supply flow
  - Low return not possible
  - Convert to:
- Two-string connections of radiators
  - New smaller dimension pipes

# Type of radiators

- Low radiators / convectors
  - High return temperature
  - Replace with
- High panel radiators
  - No need for radiator below new windows



# Type of control system central

- Central supply temperature control – weather compensation
  - In 'bad' systems with high heat loss from pipes outside heated rooms and errors in control low supply temperature reduces the errors
  - In systems with correct function high supply temperature reduce the return temperature

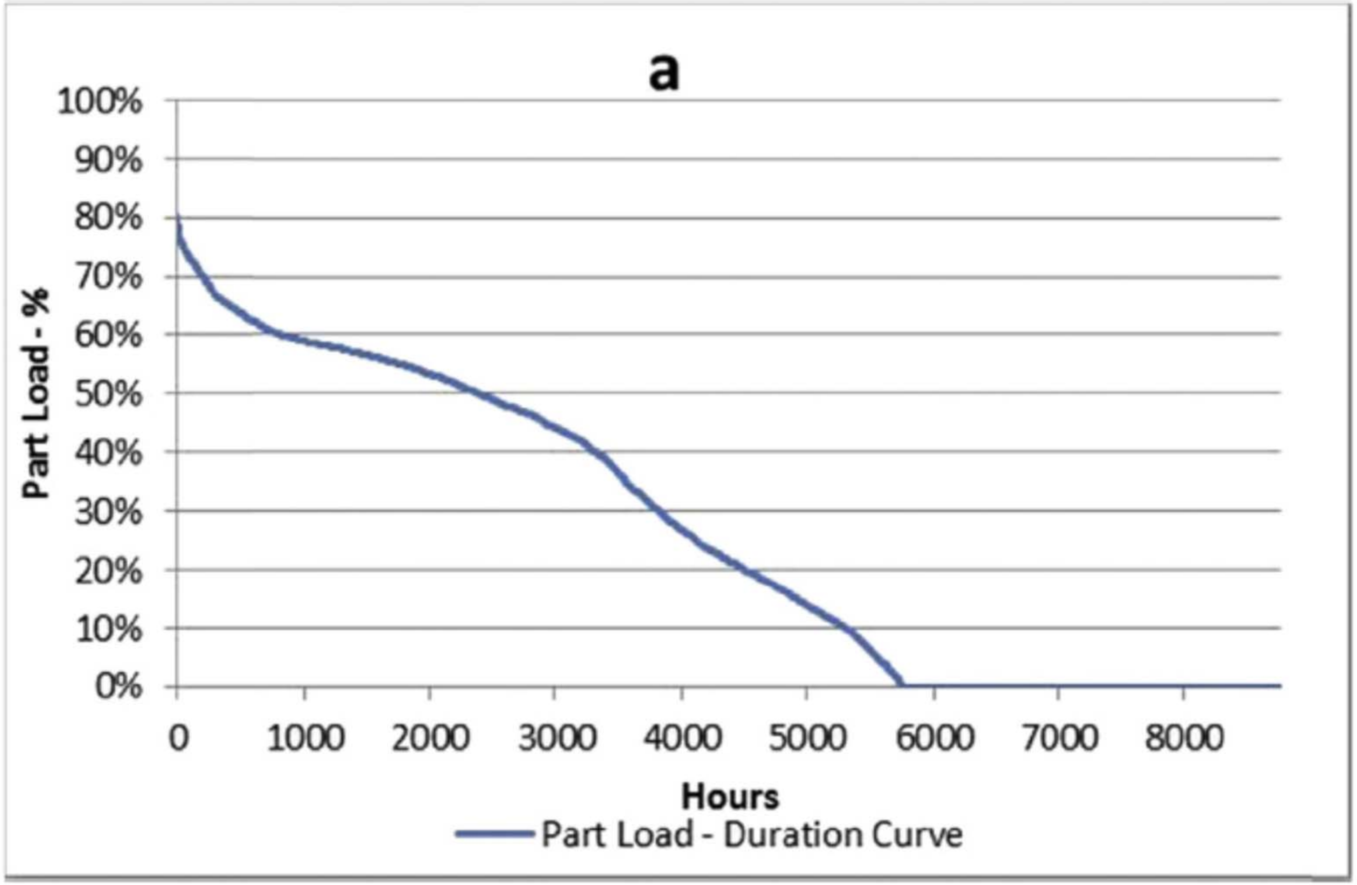
# Type of control system – on each radiator

- Thermostatic radiator valves, TRV
  - Room temperatures outside the 2˚C P-band opens the valve fully
  - Open windows and night set back results in reheating with fully open valve and high return temperature
  - Can be avoided by use of:
- TRV with return temperature sensor
  - Heat room with low return temperature

# Design heating load and design operation temperatures

- Return temperature depends on:
  - Heat demand during the heating season
  - Heating power of radiators versus temperature difference of water and room

# Heat demand during heating season



# The heating power of radiators

$$\varphi = \left(\frac{LMTD}{LMTD_0}\right)^n \varphi_0 \quad (1)$$

where $\varphi$ and $\varphi_0$ present the heating power at operating temperatures and design conditions (W), $LMTD$ and $LMTD_0$ denote the logarithmic mean temperature difference between radiator and surroundings at the operating temperatures and design conditions (°C), whereas $n$ is the radiator exponent and describes the exponential relationship between the mean temperature difference and the heat emitted from the radiator – 1.3 is the typical value for hydraulic radiators [12].

The logarithmic mean temperature distribution, included in the Danish standard [45], is expressed by Equation (2).

$$LMTD = \frac{T_S - T_R}{ln\left(\frac{T_S - T_i}{T_R - T_i}\right)} \quad (2)$$

where $T_S$ is the supply temperature (°C), $T_R$ the return temperature (°C) and $T_i$ is the indoor operative temperature (°C).

Optimized supply and return temperature

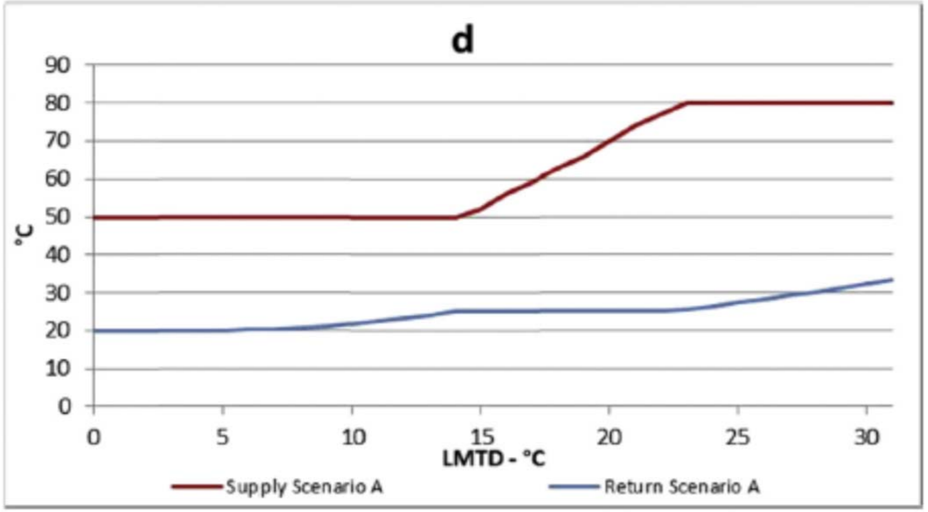



Fig. 6. Scenario A supply and return temperatures: optimization results.

reduction of return temperature

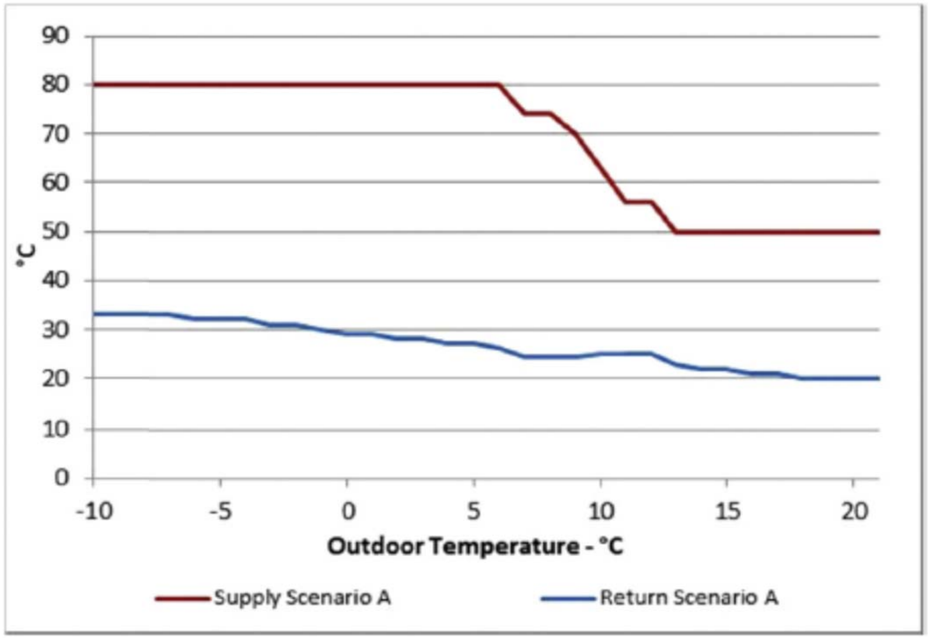



Fig. 7. Scenario A: relation between optimized supply/return and outside temperatures.

Optimized supply and return temperature

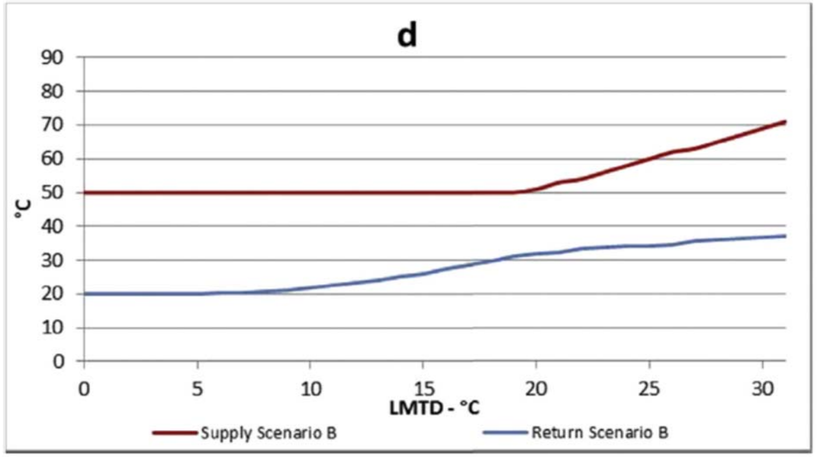



**Fig. 8.** Scenario B supply and return temperatures: optimization results.

reduction of both supply and return temperature

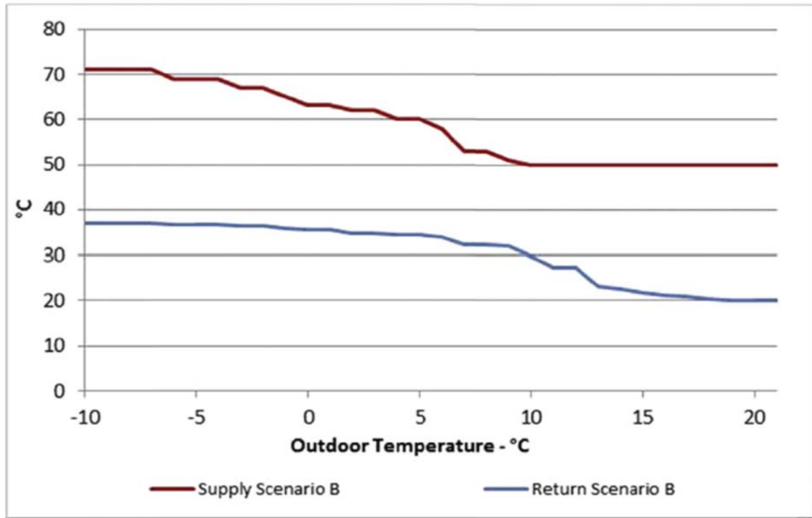



**Fig. 9.** Scenario B relation between optimized supply/return and outside temperatures.

# Actual heating load of rooms

- The real heating load of each room
  - Difficult to calculate
  - Can be found from heat allocation meters on the radiators in the rooms
- Actual heating load and heating power of existing radiators can be used to:
  - Estimate potential of lowering temperatures
  - Control function of improved control

# Evaluation of solutions for low temperature heating of rooms

- Existing buildings with existing radiators
- has a big potential for
- operation with lower return and supply temperatures
- BUT:
- Errors must be fixed
- Return temperature control necessary

# Solutions for low temperature heating of domestic hot water, DHW

- Requirements:
  - Delay time of max 10s
  - Comfort temperature of DHW: 40-45˚C
  - Legionella safe temperature for tanks and circulation lines: 50-55 ˚C
  - Legionella safe temperatures for instantaneous DHW heat exchangers with small volumes and no circulation line (flat stations): 50˚C or 45˚C
- Flat stations are ideal for low temperature district heating – to be used in new and renovated buildings
- Existing buildings with DHW tanks and circulation may be improved now to lower the return temperature

# Solutions for low temperature heating of domestic hot water, DHW

- Problem areas:
  - Type of DHW production system
  - Type of DHW distribution system
  - Type of control system
  - Design and real DHW load
  - Design and real heat transfer capacity of heat exchanger system and heat loss of distribution system

# Type of DHW production system

- Storage tank or instantaneous heat exchanger
  - Tanks require higher supply temperatures than heat exchangers
  - Heat exchangers creates a peak load in the district heating net work if DHW is used simultaneously
  - But due to short use of showers the simultaneity of DHW use is normally not a problem.
  -

# Type of DHW distribution system

- With or without circulation system
  - The suppley of heat to the flat stations may be made with the room heating loop and reduced heat loss. ( 2 pipes versus 4 pipes)
  - Quick suppply of DHW in summer can be made with use of bath room floor heating the keep the riser warm.

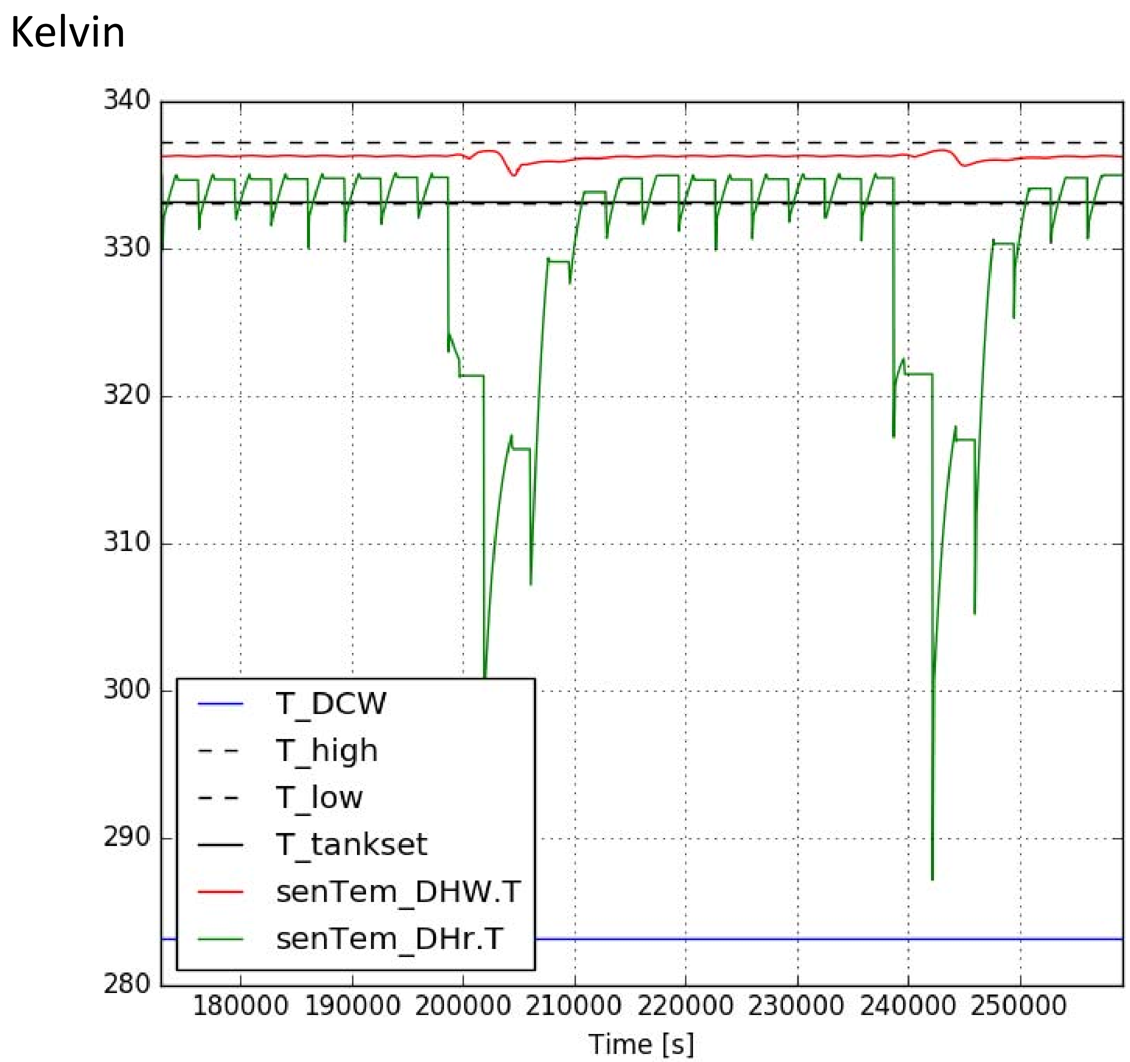
# Type of control system

- Tanks are typically reheated with very high capacity in short time after peak draw off due to oversized valves.
- Supply of heat to the circulation line during night periods with out use of DHW results in high return temperatures

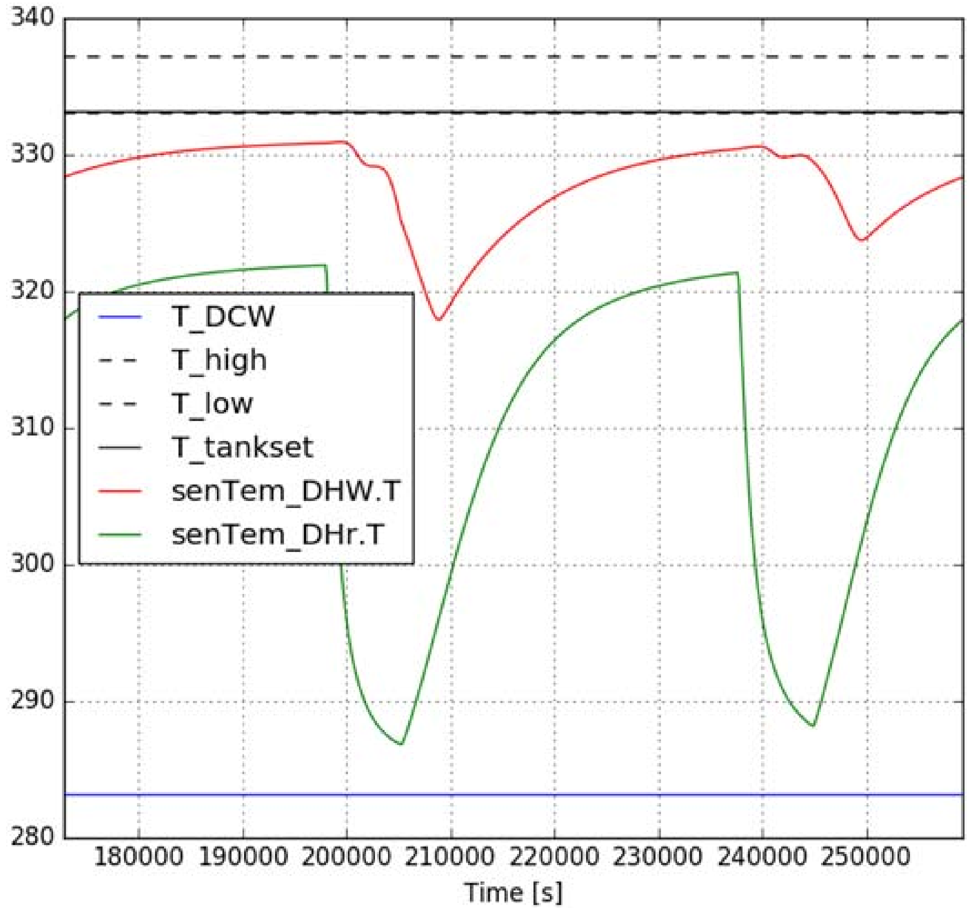
# Design and real DHW load

- DHW systems are typically oversized
- New improved control:
- Measure use of DHW in some weeks  and set up typical daily profiles of DHW use
- Reheat the tank wit a low flow that just reheat the tank before the next peak load.
- This can combine heat supply for circulation heat loss andheating of cold water in the tank

# Typical system with high charging flow (0.25kg/s)
# Average return temperature of 56˚C



# New system with low charging flow of 0.04 kg/s
# Average return temperature of 38˚C



## Design and real heat transfer capacity of heat exchanger system and heat loss of distribution system

- Heat loss of distribution system can be very large compared to use of DHW
  - Insulation of DHW system made be possible by use of a special insulation that fits into the limited space available of the existing pipes.
  - Then improved control can be made useful

# Implementation of solutions

- Step 1:
- may be realized by developing technical solutions and documenting results in real cases in guideline
- Develop and implement a business model based on external investments paid back by motivation tarif.
- Step 2: based on step 1 and some renovation