

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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Scope of deliverable

The following report summarises the information and the activities undertaken during the demand side workshops. It includes a brief overview of the participants as well as the slides presented during the day. The demand side workshops focused on the following topics:

- Solutions for avoiding risks of legionella
- Solutions for local integration of renewable energy sources, by local exploitation of renewable energy sources at the buildings
- Substation solutions
- System solutions for multifamily houses and tertiary buildings

Context of deliverable

The following table shows the workshops series as part of to the activities in WP1 of the COOL DH project, where knowledge sharing and best practice examples workshops were organised in relation to the activities in WP2. The first meeting aimed to share and build a solid background knowledge about the state of the art within the interest field and a starting point for further development during the project. The following ones aimed to share the experience and the new results obtained with the work conducted on the single tasks of the project, so that the information can be directly used in the following work packages (WP3 and WP4).

Thematic workshops				
	<i>First workshop</i>	<i>Second workshop</i>	<i>Third workshop</i>	<i>Site visit</i>
<i>Demand side</i>	March 20 th , 2018	November 15 th , 2018	March 26 th , 2019	
<i>Distribution side</i>	April 6 th , 2018	November 15 th , 2018		
<i>Supply side</i>	April 5 th , 2018	November 15 th , 2018		March 21 st , 2018

The three workshops regarding the demand side installations were held at COWI's office in Lyngby (Denmark). The first one on the 20th of March 2018, the second one was held on the 15th of November 2018 and the third one on the 26th of March 2019.

Perspective of deliverable

The workshops aimed to give an overview of the work conducted in the different demand side tasks and share the knowledge among the partners involved in the project. The following bullet points show the topics covered by the demand side workshops and the possible application of the results obtained by the work conducted in the different tasks.

- Solutions for avoiding risks of legionella → generic catalogues of the available solutions

- Solutions for local integration of renewable energy sources, by local exploitation of renewable energy sources at the buildings → of which some will be tested in Xplorion/Høje-Taastrup townhall and City 2 (it will also serve as generic catalogue of available solutions to be used in further projects)
- Substation solutions → which will be tested in Xplorion and Østerby
- System solutions for multifamily houses and tertiary buildings → for Brunnshög area

During the workshops the results achieved in the single tasks were presented and discussed to make them clear for all the participants, so that the inputs can be used in the following task of the WP3 and WP4.

Involved partners

COWI A/S (COWI-DK).

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Summary

The workshop series about demand side installations helped the partners understanding the concepts and the problems regarding low temperature district heating networks.

The first workshop was held at COWI Denmark on the 20th of March 2018. It gave a deep overview of the necessary solutions that must be considered for the safe production of domestic hot water. During the workshop, participants from the industry and the university gave insights about the state of the art of Legionella control and low temperature DH network issues.

The second workshop was held at COWI Denmark on the 26th of March 2019. This meeting focused on the results obtained during the project's tasks about the demand side. The results were presented and discussed, so that the final findings can help all the partners in the following task of the full-scale demonstration in COOL DH (WP3 and WP4).

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1 Minutes of the meetings

1.1 First workshop: Thursday, March 20th, 2018

Title: COOL DH – Workshop Demand Side Installations WP1

Date: 20-03-2018

Place: COWI, Parallelsvej 2, Lyngby, Room P181

Prepared by: Jenny Jamot, 23-03-2018

1.1.1 Agenda

Thursday, March 20 th – Location: Lyngby		Time + QA, min.
8:45	Check in and coffee	
9:10	Welcome and introduction to the day, COWI	10
9:20	Round the table, presentation of participants and expectations for the workshops	20
9:40	Legislation and Research in Sweden Lund, Lunds Universitet	20
10:00	Legionella Problems and Ways to Avoid Risks, Krüger Aquacare	40
10:40	Questions and discussions, how can solutions be improved (pro et cons)	20
11:00	Coffee break	15
11:15	Idea sharing from the group discussion	15
11:30	Holistic Approach towards Avoiding Legionella and Legislation in DK (vs EU guideline 2017), Guldager Elektrolyse	45
12:15	Discussion and questions	15
12:30	Lunch	
13:15	Low Temperature DH Solutions on Demand Side, DTU BYG	20+5
13:40	Integration of Renewables on Demand Side, Alfa Laval	20+5
14:05	Explorion Introduction and Planned Solution, LKF	20
14:25	Questions and Discussions, How Can Solutions be Improved (pro et cons)	15
14:40	Coffee break	15
14:55	Alternative Solutions, RES, Electrical Top, Booster HP, PVT, Wastewater, COWI	20
15:15	Group work/discussion (What info are we missing and how can we improve)	30
15:45	Evaluation of day 1 – Did we meet the expectations?	10
15:55	Next steps	5
16:00	Free time for discussion of open points	60

1.1.2 Participant list

The following list gives an overview of the companies represented in the meeting (with one or more participants). At the meeting, there were both partners from the COOL DH project as well as external participants, which presented available technologies or research areas interesting for the project.

- DTU BYG (University) - Technical University of Denmark, Civil Engineering
- Krüger Aquacare (Industry)
- Guldager Elektrolyse (Industry)
- COWI A/S

- COWI AB
- Lunds Universitet
- LKF - Lunds Kommuns Fastighets AB
- Alfa Laval Corporate AB
- Høje Taastrup Fjernvarme
- Krafringen Energi AB

1.1.3 Introduction

COWI opened the meeting with a short introduction of the COOL DH project for external guests and speakers.

The meeting continued with a round of presentation of all the participants who also shared their expectations for the day.

1.1.4 Legislation and Research in Sweden, Lunds Universitet

No specific legislation on an EU level, concerning Legionella, exists. However, directives regarding water quality exists and the European Working Group for Legionella Infections (EWGLI) provides several technical specifications and recommendations for the prevention of Legionella, which a lot of European countries follows.

In Sweden prevention of Legionella is managed in several acts/codes, e.g. Miljöbalken, Plan- och byggförordningen. Specific technical regulations (Boverkets Byggregler, BBR) dictates a number of rules for the installation of domestic water to minimise the risk of growth of microorganism, hereunder Legionella. For example, cold water installations must be designed so that cold water is not heated inadvertently, and hot water installations must ensure at least 50°C, which corresponds to the EWGLI recommendations. The rules do not specifically target Legionella, but rather set limits for the water temperature.

Legionella is a notifiable disease in Sweden, which means that health institutions must report any case of Legionella. Statistics from the Public Health Agency of Sweden (Folkhälsomyndigheten) show that incidents of Legionella in Sweden and for swedes abroad are rising.

A comparison between the number of Legionella incidents for different EU countries were presented which e.g. showed quite high numbers for France and low numbers for Finland. It was pointed out by a participant from Krafringen that France has a very good reporting rate, and Alfa Laval added that Finland has a 70°C limit in their hot water installations.

The Rise research project on control of Legionella was presented. Which investigates the implementation of limited water volumes e.g. the so called 3-litre rule, applicable in Germany.

Another project mentioned was research done by Teknikmarknad at KTH, the Royal Institute of Technology in Sweden, where lower tap water temperature and increased Legionella prevention was investigated.

A participant from Krüger mentioned that the company has tried something similar in Denmark. From their experience it implies that all areas of the system must be clean, and it must be ensured that nothing comes into the system that cannot be caught.

Alfa Laval's participant shared an experience from a solar panel project in Brazil where Alfa Laval was involved. In this project the main concern was scolding from the hot water, which was solved by storing the

water in buffer tanks in the attics, where it was allowed to cool down for some time. This evidently created optimal conditions for Legionella growth, and the Legionella abundance were at the time 4-5 times higher than the rest of the country.

A participant from Lunds Universitet pointed out that some people exposed to a very low doses of Legionella have been shown to develop immunity, while Krüger added that these antibodies disappears after 5-10 years.

1.1.5 Legionella Problems and Ways to Avoid Risks, Krüger Aquacare

Krüger presented some main characteristics of the Legionella bacteria, such as optimal growth parameters for temperature, pH and iron content.

Legionella is a natural bacterium found in fresh water and damp environments, and there will always be a small risk for bacteria entering the domestic water systems, regardless of the treatments at the water treatment plant. It is an opportunistic pathogen, and many different groups exist. The Legionella bacteria can cause Legionnaire's disease and the Pontiac fever.

Not all that is exposed to the Legionella bacteria develops Legionnaire's disease, only approx. 5%, which is mainly people with low immune defence, smokers also have an increased risk.

The largest risk of exposure is the shower, where aerosols which we inhale are produced, and the Legionella bacteria can therefore affect the lungs. The exposure time is very relevant as the Legionella bacteria must get into the bottom of our lungs and the small alveolus to form the infection. There is only a minimal theoretical risk of getting infected when drinking the water, since our digestive system is excellent at breaking down bacteria.

The Legionella bacteria typically lives in biofilm on the internal surfaces of pipes and vessels, from where the bacteria are released. In the biofilm the Legionella bacteria are protected from high temperatures, why it might not be sufficient to rise the temperature periodically as bacteria in the film will survive and later can be released to the water.

This also means that testing for bacteria must be done with precaution and awareness of this cycle.

Preventive measures therefore include keeping biofilm away from the internal surfaces to minimise the growth rate of Legionella, which has been done by temperature control.

The death rate of Legionella is ca 2 minutes if exposed to 66°C and 20 seconds at 70°C. That is IF the temperature gets to the bacteria.

Another important issue is responsibility. Krüger mentioned a case in Helsingør Swimming pool where Legionella in the showers caused one death and left one-man lame. The commune was later ruled to pay compensation for damages since it was shown that sufficient preventive measures against Legionella were not taken.

According to Krüger a risk assessment for the installation should be made, where the design, temperature at tanks and tap places and water samples are analysed. A yearly emptying, cleaning and chlorination of tanks are recommended. The owner can also keep a logbook, to show the preventive measures taken.

Most importantly, do not let the water stand still, keep a continuous flow at preferably 50-55 °C. This might however be hard to reach with a Low DH net. If the temperature alone cannot control the Legionella growth, there are other methods, such as chemical treatment.

Compared to for example UV lights, chemical treatment is designed to cover the full water installation, while the UV light only affect the bacteria that passes underneath the lamp.

Krüger presented two of their chemical treatment methods.

1. BacTerminator safe

The BacTerminator generates chlorine from salt and water, which means that no chemical handling is needed. A typical concentration is 0.5 ppm.

COWI asked whether the water would smell of chlorine, and the answer was that at about 1 ppm you might begin to smell something.

2. Oxiperm

The Oxiperm unit produces chlorine dioxide using diluted solutions of sodium chlorite and hypochloric acid. Chlorine dioxide is very efficient against all type of bacteria and degrades the biofilm.

Kraftringen asked about corrosion of pipelines, and Krüger agreed that it is a relevant issue, but with these low levels of chlorine Krüger has never experienced increased corrosion. Krüger however mentioned that they have seen corrosion attacks from levels of chlorine dioxide above 100 ppm.

COWI asked about the typical chlorine level in swimming halls, and Krüger estimated it to be between 0,8-1,2 ppm.

Krüger emphasized that if chemical treatment is installed it is important to learn how to test the chlorine level which is done with a simple test.

In acute situations, where Legionella has been confirmed, there are other solutions, such as point of use filters on tapping points, special shower heads, etc. which lasts up to 92 days. These should only be used in a fire extinguishing type of treatment.

COWI enquired how Krüger would work with the system if an existing building where to be converted to low DH. What would be the safe procedure?

Krüger explained that they would start with going through the system, making sure it works optimally, has working valves, no dead ends, fully insulated. If there is just a short bend without insulation, Legionella may grow there. They would install a chemical unit and start dosing the complete system. The temperature could then slowly be reduced, e.g. 5°C, and operated this way for a few months with regular tests for Legionella and free chlorine. Step by step the temperature could be lowered in this way. It would be possible to do while people are living in the houses but must be implemented in a safe and careful way, it is a large responsibility.

COWI asked about whether online measurements were used, and Krüger explained that their company works with accredited laboratories when testing of Legionella, no online measurement exists for bacteria. To measure the chlorine level, there is a possibility to add online sensors in the dosing units, but it is normally not used by building owners.

Finally, Krüger pointed out that there is a possibility to run these systems at lower temperatures and avoid Legionella. The most important parameter is to keep biofilm off any surfaces.

Lunds Universitet made a comment about how harder water results in more sediment and therefore a better environment for biofilm and wondered whether Krüger had investigated this and if they had experienced any correlation with levels of Legionella bacteria and hard/soft water? Lunds Universitet mentioned reading about a building in Germany with problems with Legionella, where they started to soften the water, and Legionella decreased. Krüger agreed that there could be a correlation, but they had not experienced it and they would never use softening water as a solution against Legionella.

Krüger emphasized that they advise all pipes to be insulated as close to the tapping point as possible and mentioned that they have seen examples where one apartment got renovated and never got the insulation fully back on. This affected the whole building, but the issue was found in this apartment, where the concentration of Legionella bacteria was highest.

COWI asked whether Legionella can spread "backwards" from a dead end or a tapping point, and the answer from Krüger was that this is possible, the bacteria will travel backwards and infect the rest of the system. A small uninsulated dead-end can be enough.

Krüger added that it is therefore important that there is a demand on all pipe branches for the chemical treatment to work. Dead ends and tapping points that are not used, will not be chlorinated, and Legionella can therefore grow at these places.

COWI commented that e.g. basement installations that are rarely used will be optimal growth places for Legionella. Krüger agreed but added that there is always a possibility to create an artificial demand, with solenoid valves for example. We should always look at the complete solution when controlling Legionella. Finally, it was added that with a lower temperature, the water demand and flow will rise, which is good for the prevention of Legionella.

1.1.6 Holistic Approach towards Avoiding Legionella, Guldager

Guldager presented a typical installation in a multi-family house and the critical points for the growth of Legionella.

At the boiler the heating coils can get deposits of salts or thermophilic bacteria can grow and cover the coil, this hinders the heat transfer and makes it less efficient. Organic material from the thermophilic bacteria will also increase biofilm growth downstream.

A way to avoid thermophilic bacteria is to perform "temperature gymnastics". Another important parameter is that the boiler should be dimensioned according to the demand in the building. A too large boiler volume will not ensure cold water going through the boiler at the desired rate.

Regulating valves ensure that we get flow through all bypasses. Some, like the Circon valves, are temperature controlled, but this can cause low temperatures during low consumption periods such as the nights. A better solution is a flow-controlled valve, to ensure continuous flow through the system. Lunds Universitet added that it sounds like a good approach to control on flow.

Shower heads produce aerosols which we inhale and are therefore a very critical point. In the shower hose hot and cold water is mixed and water is standing still. It is not uncommon that Legionella infections that

arise after a holiday comes from your own shower, rather than water abroad. "Legionella are not on holiday when you are".

A participant from Krafringen asked how long time it takes for Legionella to regrow in a system and the answer from Guldager was that 4 days is possible, but normally a little longer. Krüger agreed and mentioned 4-7 days. The advice is to open the shower for a minute or so to rinse thorough the system completely before showering.

Alfa Laval commented that Jacuzzis must be a classical risk for Legionella, with their warm stagnant water and bubbles creating aerosols. Guldager agreed, and added that another example is cooling towers, which spray water and create aerosols which can spread widely. An example from France was mentioned where a factory caused several deaths and got such a bad reputation that it had to close down. Krafringen added that normally we have chlorine in swimming pools and Jacuzzis. Guldager agreed but added that it might not be the case at home.

COWI asked about Guldager's opinion about the Grundfos small circulation pump, which switches off in adjustable intervals down to intervals of 15 minutes to reduce the flow. Guldager stated that they believe that water should be flowing all the time, even if it is not a long stop. If Legionella once has entered the system, it is extremely difficult to eliminate it, we can only control it.

Lunds Universitet asked about the most common location for Legionella to develop. The answer from Guldager was that it is in the dead ends, which can then act as a dosing pump for Legionella into the rest of the system. If dead ends are eliminated, we have enough temperature and continuous flow that is a good start to control Legionella. Old systems should be flushed through, the dirtier a system is, the more risk of biofilm and consequently Legionella.

Krafringen pointed out that in practice all systems have dead ends, and therefore realistically we should see Legionella in all systems. Guldager agreed but added that most systems have Legionella to some extent, it is very difficult to get rid of.

Krüger pointed out that in 56% of water samples taken, the company found Legionella over 100 000 CFU. COWI asked how much it costs to take a test for Legionella and both Krüger and Guldager mentioned that it can cost around 100-200 Euros.

COWI wondered if there is a rule of thumb for sample frequency. Guldager replied that ideally it would be every 3-4 months, but the customer will not cover the cost of this, so in cases with intense measurement it is more likely to be a couple of times per year, which is not very frequent. Guldager added that there is no law in Denmark covering the frequency of sampling, it is only specified that you as an owner are responsible for the state of the installation.

Høje Taastrup Fjernvarme asked what additional measures there are, if we are not sure about the state of the installation. Guldager replied that common additional measures, for example if there is a family member with an immune deficiency, are to install filters in the shower heads, hospitals typically use this. Lunds Universitet added that we can also flush the shower hose with cold water after the shower and flush it before taking a shower. There are also self-draining shower heads. Guldager agreed and added that we should also change the shower hose frequently. Høje Taastrup Fjernvarme remarked that this is all related to people's habits and difficult to control.

Guldager pointed out that they would not recommend lowering the temperature on the hot water below 50°C. There will always be a trade-off between energy efficiency and controlling Legionella. He added that Guldager would be happy to see low temperature DH working, in the end it would probably generate more work for Guldager, but at this point they would not recommend it.

Krüger disagreed slightly and commented that we see these temperature levels in for example cooling tower. Guldager agreed but added that in cooling towers chlorine is used, and he expressed doubt whether this is what the customer wants for their domestic hot water.

Alfa Laval added that when we are talking about waste heat in low temperature DH networks, we typically do not even have 40°C, but rather 35-38°C. Some topping up of the temperature might be needed anyway.

Guldager showed that even though high temperature kills Legionella bacteria, a higher temperature also leads to more thermophilic bacteria, increased corrosion, increased precipitation, all which leads to coatings, decreased heat transfer, less efficient systems, slower circulations, which increases the growth of biofilm and Legionella bacteria. A vicious cycle.

In addition to Legionella there are also other waterborne pathogens, in the future we might for example see an increased risk of MRSA.

Guldager presented a list covering additional measures for the control of Legionella:

- End filtration on shower heads and tapping points. E.g. used in hospitals.
- Thermal chock. Like pasteurising, increasing the temperature at e.g. nighttime, when there is less risk for scolding. Will however not affect the full system.
- Tracing. To avoid biofilm and reduce Legionella.
- Ultra-filtration on incoming water.
- UV, ozone, chloramine treatment.
- Copper and silver
- Chlorine generator, hypochlorite, chlorine dioxide.

The literature indicates that chlorine dioxide is the most efficient of the chlorine solutions. It can penetrate the biofilm. Overall, all the chlorine solutions are advantageous over the other methods.

Alfa Laval commented that they have implemented solutions for thermal shock at hospitals. All incoming water was held for around 60 minutes at 70°C.

Guldager stated that in controlling Legionella a lot of different solutions must work together. That is why Guldager is sceptical to reducing the temperature, since one measure to control is taken away.

Guldager presented the new SSI guidelines. It is not a requirement to follow them, but if something goes wrong and you as an owner have not followed them there can be legal consequences. Guldager pointed out that legislation can be difficult, for example in Belgium there is a legislation stating that you must control Legionella, but you don't have to measure the concentration. Therefore, many of Guldager's customers who have chlorine units will not take samples, because if the level turns out to be too high, then this is documented, and additional requirements might be necessary.

It's important to have a holistic approach and look into everything that can be done to control Legionella.

Krüger added that in an ideal world we would want high enough temperature and constant flow. But most likely the future will not give us that, we are going towards lower temperature, and there will be more work for Krüger and Guldager and the likes. But we will have to do it responsibly and slowly. A lower temperature will put a stretch on the chemicals.

Guldager replied that a good approach would be to intensify the sampling for Legionella.

COWI inquired about the risk concerning maintenance and monitoring for these chlorine dosing units. Guldager replied that there will be alarms for low salt or chemical level, however the customer will not have to manage the chemicals, there will be filling services etc. from the companies. COWI mentioned that an alarm is not the same thing as something being done, and explained that he would rather see some type of solution where the hot water supply was closed off until a service company was called in.

Guldager said that it is usually not very popular when the water is closed off for half a day or a day when the hot water vessel is cleaned or checked, so it is doubtful what the customers would say to this type of solution. But some version with a "yellow" and "red" alarm might be possible.

Krüger added that if there is control of the system and the biofilm nothing will happen directly when the chemical treatment is closed off, and therefore they do not see the need for closing that drastically for the hot water.

1.1.7 Low Temperature DH Solutions on Demand Side, DTU BYG

The participant from DTU BYG stated that most radiators are over dimensioned in Denmark and typically runs at about 50% of their max capacity. Therefore, existing radiators should be able to work with lower temperature levels in the DH network.

The issue with typical installations is that there is a central control system and a local control system. If one is not working properly the other is typically used to compensate, which is not optimal. As an example, we can imagine a janitor raising the temperature on the central control system if one of the tenants are complaining about their temperature.

There is still a widespread habit among people that night set back is a mean for energy, and therefore cost, saving, which is rarely the case. These kinds of habits will cause higher return temperatures. In case a customer shuts off the heat during the night, and then opens in the morning, the room might have cooled down quite a bit. If the temperature is 2 degrees below the set-point, the valve opens completely. This causes the flow through the radiator to be up to 10 times higher than optimal, which will cause high return temperatures. The same effect is seen if windows are open for a long time. This is how the common thermostatic radiator valve, TRV, works.

It is difficult to change people's habits. So, it is unlikely that we will get rid of the night setbacks and long 30 minutes periods with windows open, instead of just 5 min. Instead we can help people, and one solution can e.g. be a new sensor on each radiator, which controls the radiator flow based in the return temperature. This new sensor is estimated to be on the market next fall.

In existing buildings there is a big potential for lower return temperatures. There have been examples of situations where a radiator has been removed, and the supply and return pipe simply were short-circuited, and the warm water led directly to the return line. Therefore, inspections are often necessary. There have been positive examples when monetary bonuses and penalties were introduced for low and high return temperatures.

Alfa Laval added that a return temperature of 20°C is probably impossible, but 25°C could maybe be realistic even if it would be difficult. But these limits on the return temperature also puts a limit on the supply temperature, as the heat demand still needs to be satisfied. DTU BYG agreed but mentioned that 55/25°C should be possible compared to today's levels.

The presenter from DTU BYG emphasized that it is important to follow the rules regarding Legionella but continued to state that we should not make Legionella a barrier for low temperature DH. Otherwise people might think that LTDH is only possible if we have solved all Legionella problems. But there are many problems with Legionella today. Let's not mix up LTDH and Legionella.

Flat stations are ideal for an LTDH network but not realistic today in all existing buildings where typically big hot water tanks in the basements are seen.

One problem we see today is over dimensioned valves and thermostatic controls, which loads the tank quickly, with large heat losses as a consequence. The solution can be to control the reheating of the tank and do it when we do not use hot water, typically during the night. In this way we can reheat the tanks slowly, which will have a positive effect on the return temperature, e.g. 38°C instead of 55°C. These types of control systems exist today. They will not lower the return temperature all over Copenhagen but is something that can be done right now and for maybe 20 years ahead, while other measures are worked out for these older installations.

Alfa Laval questioned whether it wouldn't be possible to remove the tanks altogether in those 20 years. DTU BYG replied that he believes that to be unlikely unless all these multi-family houses are renovated deeply, which will probably take 50 years or more. He agreed that we do not need the tanks, but now that we have them, let's make them as good as possible.

Kraftringen added that these types of accumulator tanks are rarely seen in Sweden anymore.

DTU BYG continued by stating that they still exist in Copenhagen and Denmark, in older buildings. In new buildings we should have flat stations, and in deeply renovated houses we should have flat stations, but these tanks are not a hinder for LTDH.

COWI asked if it is possible to install a valve to limit a certain kW or flow to the customer on the district heating side.

DTU BYG replied that for these installations it will never be risked someone not getting a hot shower. How do the people, the decision makers, think about their installations? The priority is to not have any problems (Legionella, cold showers etc.). The customers rarely think about energy efficiency.

Another solution with LTDH is to use it directly for floor heating, at 40°C, and supplement with direct electrical heating for the domestic hot water. Just a small amount of water needs to be heated, which is mixed with the colder water for optimal temperature levels. This means small compact instantaneous electrical heaters can be used.

Høje Taastrup Fjernvarme expressed concerns that with ultra-low DH it will be mandatory with additional electrical heating, which the end user must buy themselves. What is the benefit for the customer when some of the expenses are moved to them?

DTU BYG agreed but also mentioned that only a little amount of additional electricity is needed and that an overall economic evaluation is needed.

Alfa Laval asked whether these solutions were only relevant for new built areas and the answer was no, it's been done with older houses that were retrofitted.

Guldager asked about the distribution between space and domestic heating and got the reply that for old houses space heating is much larger, for newer houses space heating and domestic water is approximately equal.

COWI wondered if DTU BYG knew about any examples where the cost for the electrical top up heat is provided by the district heating company, so they are responsible for the full package of heating. DTU BYG had not heard of any such examples and questioned whether it was important, we already receive power from one and heat from another company.

Høje Taastrup Fjernvarme added that as a district heating company they have another taxation than the end user, so it would be cheaper for them to buy the electricity.

Kraftringen wondered if electrical topping heaters had been tried in practice and COWI stated that it has been tried for single family houses. The participant from Lunds Kommuns Fastighets added that for multi-family houses heat pumps will probably be better. DTU BYG agreed but added that an overall investigation always should be done.

Kraftringen pointed out a potential problem in case the electrical top up heater breaks down, and there is a potential risk of Legionella. Will it be possible for the district heating company to access the heaters?

1.1.8 Integration of Renewables on Demand Side – Dos and Don'ts, Alfa Laval

The situation with local integration of supplemental heat, heat recovery or renewable sources is that there are very few experiences, most is just on paper or small-scale testing. A main point is to keep in mind that district heating is the primary source, otherwise there is a risk of losing the product. Low return temperature must be prioritised, i.e. supplemental sources must not increase the return temperature. As a key rule, don't build in storage of hot water, it will always increase the return temperature.

Some examples of possible installations were shown. E.g. an integrated heat pump where part of the return flow is sent to the heat pump, or a radiator circuit where the flow is sent through the heat pump and the radiators in three steps, to not negatively affect the return temperature. Another example showed a system combined with a solar panel and an accumulator tank, where three different scenarios are made, for low, medium and high temperature situations in the tank.

What do we do if we have a 40°C supply source? The supplemental energy needs to be of higher temperature. It can be done with a heat pump, which will boost the temperature level. It's always a trade-off between how much energy is saved and how much energy that goes into the tank, the heat pump or the electrical heater.

COWI added that the type of integration method depends in the building type, e.g. an office building has a much lower hot water demand than a resident house. Alfa Laval agreed and stated that in such a case he would not recommend a heat pump or an accumulator tank, but rather top up with electrical heating. A temperature of 40°C is sufficient for floor heating.

It is important to remember that if we top up the temperature, we must ensure that we don't get a higher return temperature.

Another question is whether we as an industry are ready yet. The district heating customers are happy because it just works and is simple. But low temperature DH is more complex.

DTU BYG asked about the bypass solution required to ensure fast provision of hot domestic water in the summer months. Alfa Laval agreed that an internal bypass is needed, but that it should be made in such a way that it cannot be over flushed. DTU BYG added that there is a possibility of redirecting the bypass flow to bathroom floor heating instead, which will act the same way as a bypass, but instead of wasted heat, which the customer pays for anyway, it is used for increased comfort. The key is for the industry to work together.

1.1.9 Xplorion Introduction and Planned Solution, LKF

LKF presented their project Xplorion which is based on the idea that people should live there and make environmentally friendly choices, without even noticing. It should be simple for the tenants.

For example, the building is simple, e.g. pipelines in straight lines, concrete floors, very few internal walls. The buildings are flexible, where a restructuring of the floorplans is possible in the future, if the demand for living spaces changes. Aspects such as smart grid and smart charging is included. The electrical meter is moved away from the tenant, and LKF distributes the electricity instead, which have been shown to work well. Extra service is provided on the ground floor with a reception, a café, the possibility to receive deliveries, get your bike fixed etc. The internal electricity demand for the building, e.g. elevator, ventilation etc., is basically as good as it can be. Stairways are not heated for example.

LKF noticed that the calculations and predictions for hot water demand and the actual data when houses were built, and the tenants moved in were usually a lot different. So, when Krafrtingen wanted to test the new LTDH, LKF wanted to part of the project.

The test is done by utilising the normal district heating water that enters the building and cool it down to simulate a LTDH source (this is of course only done during the testing period, afterwards the normal DH will be used). This water is then heated with a heat pump and sent to a tank, which is installed to act as a buffer and cover peak demands. After the tank the hot water is distributed to the apartments, which are located at most 50 meters from the tank. In the apartment the water is distributed to radiators, and hot water in the kitchen and the bathroom, there are no dead ends.

Originally the idea was to have floor heating instead of radiators, but in the end, it is a budget question, and it will be easier for the contractor with radiators. They will have a low demand, since the insulation is very good.

DTU BYG questioned whether people really wanted to look it radiators. In Denmark no new building would be built with radiators, the standard now is floor heating. LKF replied that in Sweden it is not so uncommon with radiators. Swedes typically want wooden floors for which floor heating work less efficient, and people are used to radiators, so it shouldn't be a big problem.

Krafrtingen asked if the term passive building usually means that the residents heat the building up themselves and that a good insulation is sufficient. LKF agreed but added that that type of building isn't possible for the climate in Sweden, additional heat source is needed.

Finally, LKF added that this project is a test, a lot of different things are tried, and they do not know yet which if the measures that will work. But if no one likes them, it will be redone. It is only one building with 50 apartments, of around 9000 LKF tenants. The building will be ready in 2020.

1.1.10 Alternative Solutions, RES, Electrical Top, Booster HP, PVT, Wastewater, COWI

It is most likely that electricity will be renewable in the future. We see examples of this with wind power in Denmark and hydropower in Sweden.

Some examples of different solutions were shown, e.g. an air to water heat pump that uses air in the rooms, e.g. bathroom or kitchen to heat the incoming water.

Another example is the Danfoss booster heat pump with different modification that are normally only seen on big plants, like two expansion valves, special efficient motors etc. This can increase CoP from 4 to 6 on standard units. In case better refrigerants are used the CoP can increase up to 40% more and come up to around 9. Høje Taastrup Fjernvarme expressed concern about these new refrigerants, which are typically propylene or butane, and can be explosive. COWI emphasized that this depends on how they are used, and these heat pumps are only small units.

Another solution is to work with peak shaving, to take away e.g. the morning peaks with a (primary side) buffer. This can ensure a constant flow from the grid and the heat exchanger can thus be smaller. Pipe sizes can also be smaller, which decreases losses.

One example was shown where a PV panel can act as an energy absorber for a heat pump. These panels can be made in any size up to 18 m² and in any colour, even off-white, and can easily be mounted on the roof/façade of buildings. LKF enquired whether they are on the market already, and COWI replied that they can be bought, but that it is not yet the final standard product, but it is very close to be a finalised commercial product.

Alfa Laval wondered if they are water cooled, which they are. This increases the efficiency and they can even work during night since they are cooled down to below the surrounding temperature

Høje Taastrup Fjernvarme inquired about the flat station size and COWI pressed that they should not be sized too small. Alfa Laval replied that they have standard units, but since this is a new market, they would be specialised, but it would basically only be to add more plates. The flat stations have built in insulation and integrated hot and cold-water measurement. Only two moving parts which is an advantage. The integrated measurements can be a problem as on the UK market, where HSE regulations stipulates that the consumer is not allowed to take off the cover of the flat station themselves. Different regulations on different markets makes it difficult for technology suppliers.

Heat exchanger which covers both space heating and domestic hot water results in bigger pipes, and increased losses. An alternative is to use two separate lines, one for space heating and one for DHW, which means that one can be closed off during summertime, and the pipe losses are decreased. DTU BYG questioned what the customer would think about losing the floor heating in the bathroom if the space heating is shut off? Høje Taastrup fjernvarme mentioned that this would be the choice of end user.

Another problem with LTDH is when doing the dishes in the kitchen, the grease will not dissolve with too low temperatures. This problem can easily be solved by utilising the electrical water heater. The only limit is to have a comfortable shower.

Another example is fan assisted radiators, which switches on a fan if it is very cold. The same capacity is achieved with a significantly smaller size of radiator (with visual appearance as a normal radiator).

Energy losses associated to DHW from a low energy building is often 30-40% led to sewage and wastewater. For bigger installations the investment to recover the heat from these streams can be justified.

There are systems developed where you can even use the different wastewater streams without the need for separation first. COWI is designing such a system in Växjö, and 3-4 already exists elsewhere in Sweden, they are on the market.

1.1.11 End of Day Discussions

DTU BYG pointed out that there must be a focus on the development of optimal integration and economical evaluation. There might be problems with combining central solutions together with decentralised solutions at the houses. Solutions may be feasible on a building level, but maybe not on the large scale.

COWI replied that the purpose of this project is to see what can be done from a technical point of view and the feasibility. The purpose is to highlight the different options.

COWI added that it a question about definition as well. Optimal in what point of view, environmental, economic, societal, creating jobs, for the companies, etc.? Høje Taastrup Fjernvarme agreed and pointed out that there are three perspectives that must be remembered: User economy, company economy and societal economy. If these are not positive, nothing will be done.

LKF agreed and mentioned that they have a similar perspective. They build their buildings and run them for 50 years, which is different from many other players, who build the houses and then sell them directly. There will be a big difference on the perspective. He continued to say that LKF's investments can take 20 years to pay back, which a commercial developer probably never would accept.

COWI finished off the day by ensuring that the project is not running blindly after different solutions. A lot of good players are gathered, and nothing will be redone that have already been done and shown not to work. The purpose is to collect a catalogue of different possible solutions. Only a few of the solutions will be demonstrated in practice.

What we see now is a disruption of the energy system. People are pushing for more electricity in the systems, and some people always complain when there's change. The same was seen for solar voltaic, which was expensive and unfeasible in the beginning, but very common today. This will probably also be seen for LTDH.

1.2 Second workshop (Innovation workshop WP1): Thursday, November 15th, 2018

Title: COOL DH – Innovation Workshop WP1

Date: 15-11-2018

Place: COWI, Parallelsvej 2, Lyngby, Auditorium

Prepared by: Maja Grud Minzari, 15-11-2018

1.2.1 Agenda

Thursday, November 15th – Location: COWI A/S, Parallelsvej 2, DK-2800 Kgs. Lyngby		Time min.
Meeting room: Auditorium		
09:45	Check in and coffee	
10:00	Welcome and introduction to the day, COWI	10
10:10	Short presentation of participants and expectations for the workshops	20
10:30	D2.1 Solutions to avoid Legionella – what is the essence, Lunds Universitet	20
10:50	Questions and discussion	10
11.05	Coffee break	15
11:20	D2.11 Optimising cascade couplings for optimal use of low temperature sources, Krafringen and COWI	20
11:40	Questions and discussion	10
11:50	D2.5 LTDH Connected appliances, Krafringen	20
12:10	Questions and discussion	20
12:30	Lunch	45
13:15	D2.4 Solution for multi-family houses, Krafringen	20
13:35	D2.2 Local integration of renewables on demand side, Cetetherm (Alfa Lawal) and COWI	20
13:55	D2.12 Short time and seasonal storage, Høje Taastrup Fjernvarme and COWI	20
14:15	D2.9 Innovation: New pipe products from Logstor, Logstor	20
14:35	Questions and discussion	10
14:45	Coffee break	15
15:00	Status of Xplorion, LKF	15
15:15	D2.7 New design concepts for optimization of LTDH distribution systems, COWI	20
15:35	Group discussion a) what info are we missing b) how can we improve impact	20
15:55	Result of discussion and evaluation – Did we meet the expectations?	15
16:10	Practical issues, end of the day	5
16:15	Free time for bilateral discussion of open points and coordination among local coordinators	60
19.00	Dinner at Restaurant Gordion, Ulrikkenborg Plads 10, 2800 Kgs. Lyngby	

1.2.2 Participant list

The following list gives an overview of the companies represented in the meeting (with one or more participants). The meeting was reserved only for the project's partners.

- European Commission
- Euroheat and Power
- Lunds Universitet

- LKF - Lunds Kommuns Fastighets AB
- Cetetherm (Alfa Laval)
- Høje Taastrup Fjernvarme (District Heating)
- Høje-Taastrup Municipality
- Kraftringen Energi AB
- Lund Municipality
- Logstor A/S
- COWI A/S

1.2.3 Welcome and introduction

COWI welcomed and gave an introduction of the day including practical issues. In Spring 2018 workshop series 1 was held and the workshop series 2 shall present the results from the last period of innovation process.

The aim is to get a common picture on solutions and discuss possibilities and barriers as well as good design practice.

The workshop focus is on important key elements and essential questions in the innovation process, like:

- Definition of temperature level, which is safe for DHW and alternatively use of water treatment methods to avoid risk of Legionella.
- How to raise heat from cooling facilities to usable level temperature in LTDH grid by use of heat pumps in cascade?
- What type of substation / heat exchanger solutions can be suggested for multifamily houses?
- Can some appliances be coupled directly to the DH system?
- How can some of the energy needed be produced on the buildings e.g. for after heating of DHW?
- Plans for integration of short term and seasonal energy storage in the energy system.
- Status of development of new pipe types.
- How to improve design methods of distribution grids, to reduce grid losses?
- Status of demo site at Xplorion in Lund.

1.2.4 Introduction of participants

Introduction round of every participant with name, organisation, role and expectations for the workshop (Figure 1).



Figure 1. Participants at the second innovation workshop (Thursday, November 15th, 2018)

1.2.5 D.2.1 Solutions to avoid Legionella, Lunds Universitet

Lunds Universitet's presentation contained information on Legionella legislation in several countries, presence and cause of bacteria, different requirements for temperatures in Europe, e.g. 50°C at the tap after 1 min in SE or 45°C after 10 sec. at max load in DK. Different techniques for treatment can be used also: mechanical, sterilisation, decentral dh stations (flat stations) and small water volumes. High temperature requirements are a barrier for ULTDH which needs to be tested. Statistics of cases of legionella is based on high degree of uncertainty.

Comment and questions: The project should try to push the legislation. We will try to show that it is possible with ULTDH without increasing the risk.

Water softener before heat exchanger instead of DHW tanks seem to be a good way forward especially when combined with good controls.

1.2.6 Task 2.3.1 Optimising cascade coupling, Krafringen and COWI

Presented in the deliverable "D1.4 Thematic workshops supply side".

1.2.7 D.2.5 LTDH connected appliances, Krafringen

The deliverable showed that the production of heat driven appliances has stopped. As an alternative, it is possible to use appliances with two water inlets, both cold and hot, but check with manufacturer before installation. HWC's will fit the temperature for Brunnshög area but not for Høje Taastrup area. Today professional hot fill washing machines are on the market. Dishwashers can be connected to hot water. Theoretical the technology has great electricity savings potentials.

1.2.8 D.2.4 Solution for multifamily houses, Krafringen

Presentation of work in relation to working paper. Three solutions with heat exchanger system were investigated. Traditional substation solution has been compared to flat stations (micro heat exchangers). Results showed the total heat loss (pipes+stations) from flat stations and traditional solutions with substations were approx. the same. It is necessary to improve the insulation of the flat station. Flat stations have higher installation and service costs (about 50%). If this can be reduced, flat stations will be attractive. The return temperature from the flat station may be lower than in traditional systems. Heat losses from the flat station can be used in a positive way, for example if placed in the bathroom. Good flat station insulation will result in only 20 W per unit (poor insulation will result in loss of 80-90 W per unit). There was a discussion on who to own the stations - the user or the DH company? and how to access when maintenance is needed. Individual metering and charging are easier for the flat station concept.

Cetetherm tells that 60°C is needed in flow temperature to the flat station to allow 52°C in the hot water supplied (delta T 8°C in order to ensure good operation of the control valve at varying flows).

1.2.9 D.2.2 Local integration of renewables on demand side, Cetetherm and COWI

COWI presented the aim of the deliverable and how it is going to be structured. Part of the deliverable is to create a catalogue of technologies that can be used to increase the share of renewables on the demand side. The catalogues report information about the different technologies from a technical and economic aspect, and providing some pros and cons.

The technologies selected have been divided depending on the possibility to be applied in single-family houses or multi-family houses. COWI presented shortly the technologies considered in single-family houses, while Cetetherm presented the ones for multi-family houses.

1.2.10 D.2.12 Short time and seasonal energy storage, Høje Taastrup District heating

Presented in the deliverable "D1.4 Thematic workshops supply side".

1.2.11 D.2.9 New pipe types for LTDH distribution system, Logstor and COWI

Presented in the deliverable "D1.3 Thematic workshops distribution side".

1.2.12 D3.1 & 3.2 Status of Xplorion, LKF

Multifamily house in Lund are under planning – energy consumption will be 42 kWh/m². Demand controlled ventilation will be used which result in 25% savings. Focus is also on LCA e.g. reducing energy consumption embedded in materials seen over 50 years lifespan, for example partition walls will be minimised. Procurement is done as corporation project, in 2018, LKF received two offers, both above budgets. Some project adjustments were made. Xplorion will show for other project developers that heat from research facilities can be used in a low temperature system. Tenants control the indoor temperature in their own apartments and pay for what they use. The building has a very low energy consumption and a minimum of material use.

1.2.13 D.2.7 New design concepts for optimisation of LTDH distribution systems, COWI

Presented in the deliverable "D1.3 Thematic workshops distribution side".

1.2.14 Questions and group discussions

Division into groups of four people and discussions about:

1. What information do we miss in today's presentations?
2. How can we improve impact of the project? In own organisations and in wider scale?

The following main inputs were given during the discussions:

- More info on pipe sizes that will/can be delivered.
- List pain point and pain killers.
- Don't expect one solution to be the right, we should end with a number of solutions that can be used in different circumstances.
- Today's presentations are good for wider dissemination activities but should be supplemented with short versions as well and aimed at different target groups e.g. customers and consumers.
- Do also prepare videos of the presentations (easier and can be done in connection with the planned webinars)
- Add more contact point info.
- All partners should talk with their own communication departments and make use of web pages and links
- Use your already existing networks also employer brand internally
- Make short interviews.
- Make summary of progress pr. key action, per work package and in total.
- Mention what freedom we have in the design as result of the innovation actions.
- List core messages.
- Make integration issues clear, interfaces are important.
- Improve portal structure at the internal share point.
- Make COOL DH the follower of 4DH project

1.3 Third workshop: Tuesday, March 26th, 2019

Title: COOL DH – Workshop Demand Side Installations WP1

Date: 26-03-2019

Place: COWI, Parallelsvej 2, Lyngby, Room P181

Prepared by: Maja Grud Minzari, 26-03-2019

1.3.1 Participants list

- Lunds Universitet
- LKF
- Cetetherm
- Høje Taastrup Fjernvarme
- Krafringen Energi
- Logstor
- COWI

1.3.2 Agenda

Tuesday, March 26th, 2019		Time min.
Location: COWI A/S, Parallelsvej 2, DK-2800 Kgs. Lyngby, room: P181		
09:00	Check in and coffee	15
09:15	Welcome and introduction to the day, COWI	15
09:30	D.2.2 Solutions for local integration of RES, COWI	25
09:55	Questions	5
10:00	D.2.3 Substation solutions for single family units, COWI	25
10:25	Questions	5
10:30	Coffee break	15
10:45	D.2.6 Improved use and individual metering, Lunds Universitet	25
11:10	Questions	5
11:15	D.6.4. Investigation of legislative framework (Status of deliverable), COWI	15
11:30	Questions	5
11:35	D.2.10 Calculator on high-efficient pipe type (in buildings), COWI	25
11:55	Questions	5
12:00	Lunch	45
12:45	D.2.8 Design manual for LTDH underground (near buildings), Logstor	20
13:05	Questions	5
	- End of WP1 Workshop -	
	Project meeting*	
13:10	WP6 D.6.1. New innovative business plans, Krafringen	15
13:25	Questions	5
13:30	Financial reporting and administration, COWI	30
14:00	Questions	10
14:15	Coffee break	15
14:30	WP3 Status meeting, Krafringen (Room P181)	Time available for internal meetings or bilateral discussions (Room P186)
		90

16:00	End of the day	
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** Not part of the WP1 workshop on the demand side installation*

Part 1 – WP1 Workshop

1.3.3 Introduction, COWI

Welcome to the final workshop in the series of WP1-workshops regarding knowledge sharing on the demand, distribution and supply side. The purpose of the workshop is to present results of innovation work, give input to WP3 and WP4, share general knowledge and discuss to make results clear.

Short presentation of the program of the day.

Status of deliverables in WP2 – almost finished.

- Thematic workshops held
 - Demand side 20 March 2018 + 26 March 2019
 - Distribution side 6 April 2018 + 15 Nov 2018
 - Supply side 21 March 2018 + 5 April 2018 + 15 Nov 2018

1.3.4 D.2.2 Solutions for local integration of RES, COWI

Presentation of the final version of the deliverable. The purpose was to investigate technologies for preparation of domestic hot water (DHW) by pre-heating with LTDH and local supplementary heating with integration of RES. The report includes a catalogue of solutions for single-family houses and apartments and for multi-family buildings and an economic evaluation.

Video from Metro Therm with the new Micro Booster heat pump:

<https://www.youtube.com/watch?v=ONmssKuXBF4>

Discussion:

Q: Maybe the small service pipes are not an advantage as a report mentioned that the pipes needs to be bigger dimension close to the power plant?

A: A constant small flow with a buffer/accumulation tank can be used as peak shaving.

1.3.5 D. 2.3 Substation solutions for single family units, COWI

The purpose of the deliverable was to investigate and give advice on the use of various district heating units for single-family houses and apartments.

The presentation included an overview of different heat exchangers hereof LTDH in Denmark and Sweden and single/double HEX units from several manufacturers and with technical specifications leading to the units selected for demonstration in Xplorion in Lund and Østerby in Høje Taastrup.

Break

LKF showed Xplorion in augmented reality which is open for trail when scanning the QR-code (requires download of an app):



Figure 2. QR code to see Xplorion demo-site in augmented reality

1.3.6 D.2.6 Improved use of individual metering, Lunds Universitet

The purpose of the task is to investigate which requirements are necessary to give the energy meter suppliers to ensure enough dynamic evaluation of the LTDH system in real time.

The work performed included several smaller investigations such as baseline of requirements for meters today and which factors are driving the development for new functions. Price models at energy suppliers differs widely between being based on energy-, load-, flow demand or fixed components.

1.3.7 D.2.8 Design manual for LTDH underground (near buildings), Logstor

Presentation of draft design manual for low temperature pipes, including design guides on welding and connections, transportation, installation, mounting and metering.

New flexible pipes were developed with less heat loss and water permeation.

1.3.8 D.2.10 Calculator on highly efficient pipe types (in buildings), COWI

The presented deliverable is an Excel-based calculator tool to determine the heat losses from internal pipes for domestic hot water. Heat loss from internal pipes in buildings often cover 15 % of total energy need of new dwellings, so there is a great potential for energy savings. On basis of input parameters such as material, thickness, single or twin and insulation the tool calculates the heat losses from both horizontal, vertical and service pipes. The tool requires the Excel-add in "Solver" (what-if-analysis).



Figure 3. Participants at the third "Demand Side" thematic workshop (Tuesday, March 26th, 2019)

Part 2 – Project meeting

1.3.9 D.6.1 New innovative business plans, Kraftringen

A short introduction of preliminary work with the new business models. Definition of five prerequisites have been made as basis for the business model. The purpose is to make customers behave as what is optimal for the system. Price model A, B and C differs between being based on flow components, differentiated prices on level of return temperature and a combination.

1.3.10 D.6.4 Investigation of legislative framework, COWI

COWI introduced Danish legislation and barriers regarding energy planning on Municipal level. For at new district heating/cooling project to become successful, several authorities and agencies need to approve the project as most district heating companies are publicly owned and must be in equilibrium.

We discussed the CITY 2 setup where the challenge is to plan the project, so it fulfils the legislation but taxes on surplus heat and electricity are kept to a minimum.

1.3.11 Financial reporting, COWI

Not part of the deliverable.

2 Presentations

First workshop on demand side: Thursday, March 20th, 2018



Demand side workshop 1

Reto M Hummelshøj

"This project has received funding from the European Union's Horizon 2020 research and innovation programme

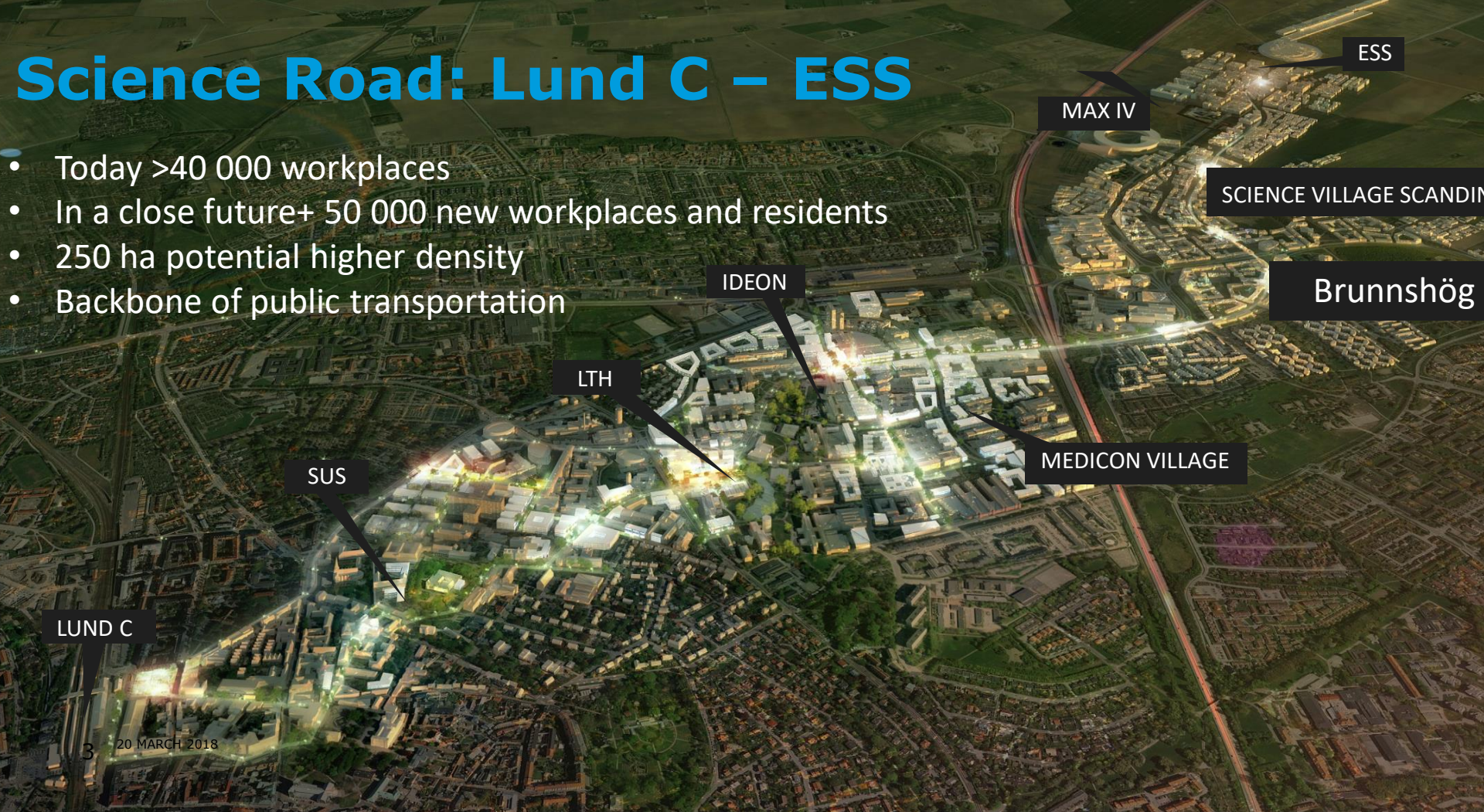
under grant agreement No 76779"

COOL DH – a Danish/Swedish collaboration

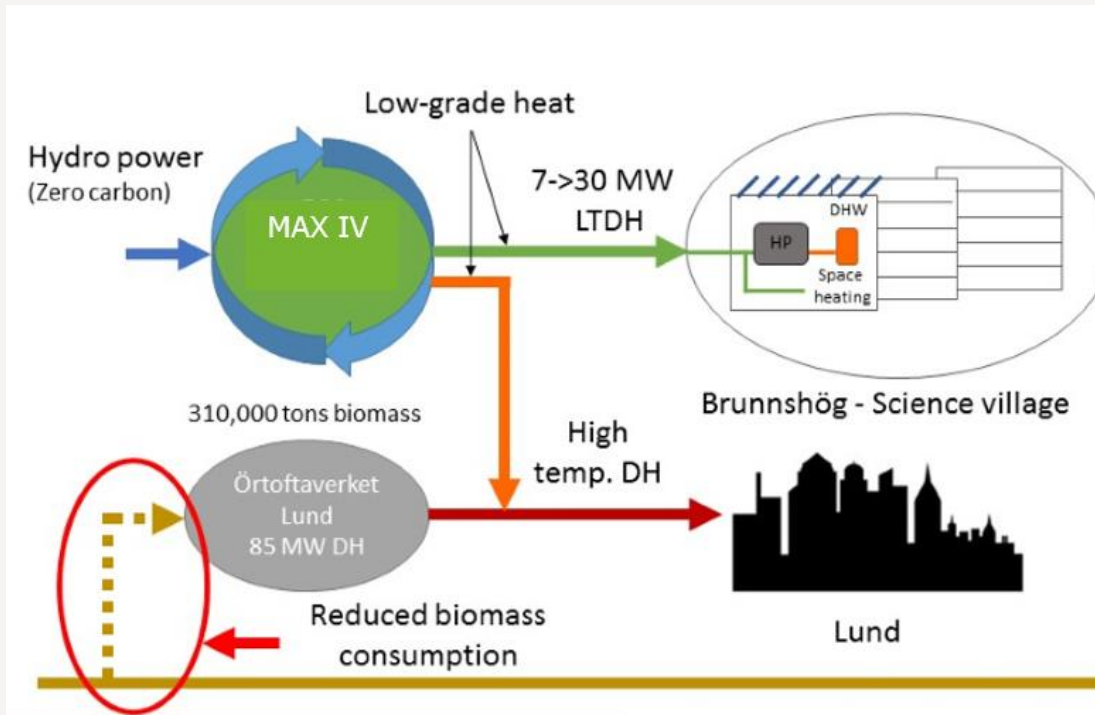
- A Horizon 2020 project with 11 partners
- 2 demonstration sites: **Lund and Høje-Taastrup**
- Budget: 5.3 M€ running from October 2017-September 2021
- Coordinator: COWI
- **Innovate**, design and build cooling and heat recovery process systems
- **Design** and build a low-temperature district heating grid with non-conventional pipe materials
- **Utilise low grade heat sources**, cooling and surplus heat for heating of energy efficient buildings
- **New buildings** in Lund and **existing buildings** in Høje-Taastrup
- Develop business models and new pricing systems
- **Demonstrate full systems** with all needed components suitable for ultra-low DH temperatures (down to 40°C)

Science Road: Lund C – ESS

- Today >40 000 workplaces
- In a close future+ 50 000 new workplaces and residents
- 250 ha potential higher density
- Backbone of public transportation



Low temperature district heating at Brunnshög



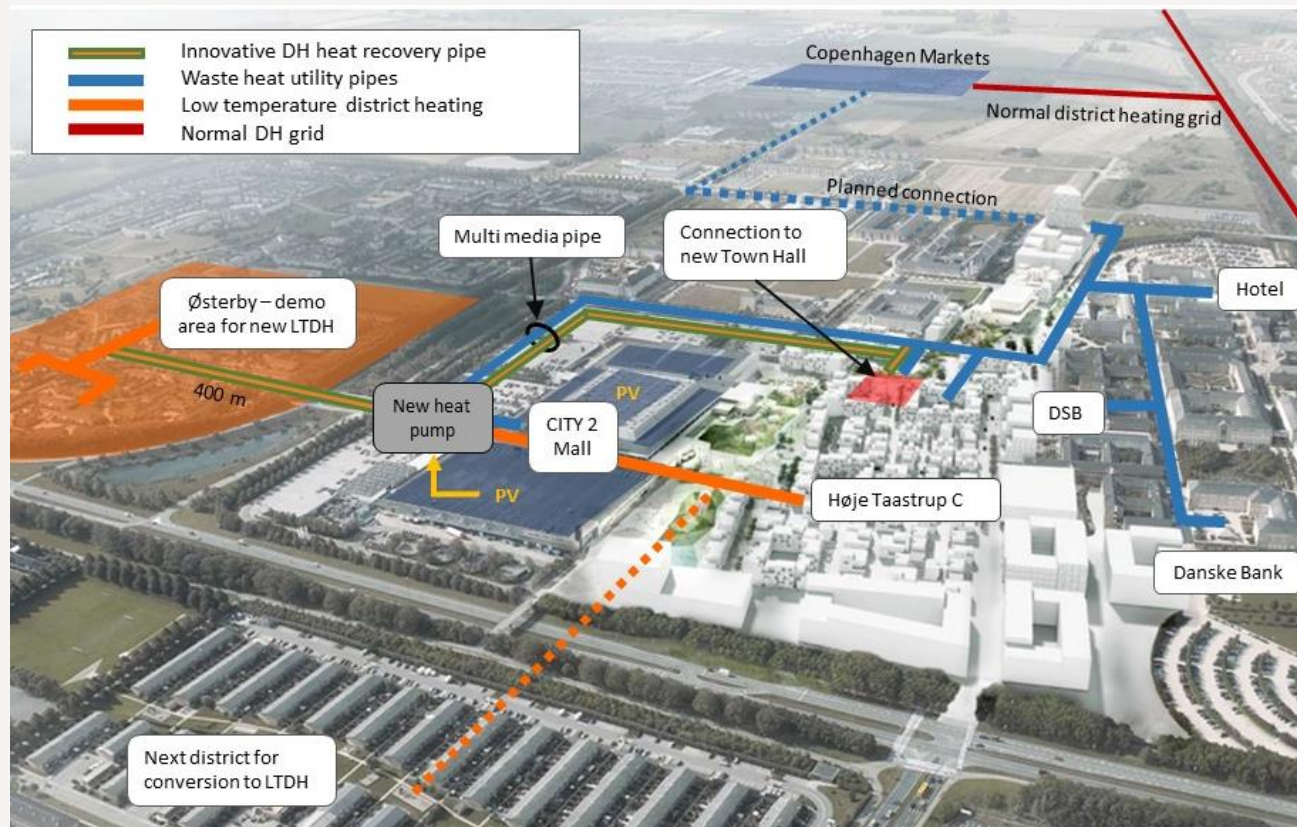
Waste heat ESS

- 90 GWh/y, 80°C
- 60 GWh/y, 50°C
- 130 GWh/y, 20°C
- Increasing from 2019 to 2025

Waste heat MAX IV

- 25 GWh/y,
- Increasing from 2015 to 2017

Høje-Taastrup



Questions, challenges, opportunities

Visualize?

Pipes available? (dimensions?, pressure?, leakage detection?, suppliers?)

Low temp and legionella? (regulations?)

Demand side effects?

Demo
possibility

Applicability
in other DH
area

Prosumers

Services?

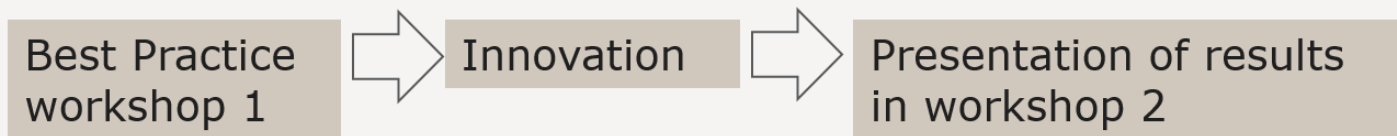
Price structure?

Function?

Remote control? (customer, utility?)

Workshops

- > 3 themes (supply, distribution and demand side)



- > Lund University lead on **supply side**
- > COWI lead on **distribution** and **demand side**



Alternative solutions for integration of RES on demand side

Process

- > Sketching of solutions
 - > Technology descriptions for technology catalogue
 - > Evaluation and recommendations
-
- > => Deliverables

The future combines DH and green electricity

- > Electric power from the grid will be dominated by wind and other renewable with in few years
 - > All new buildings as well as renovated buildings will have PV
 - > PV DSM will be balanced by local batteries
 - > Local PV powered heat pumps will supplement central supplies
-
- > The issue is develop the system with combination of non conventional components and to learn how to design the system correctly

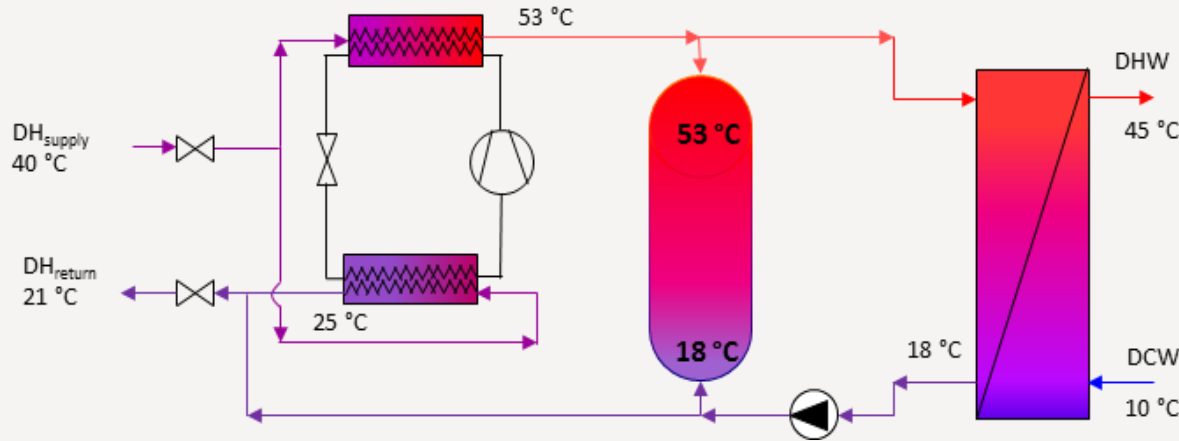
Heat pumps e.g. for toilet- / tea kitchen groups in office and tertiary buildings

- > Air to water HP on room air
 - > with ducts on extraction air or
 - > with-out ducts
- > no central hot water distribution or circulation system



Booster heat pump on multi family house/block level

- > **Booster demo by Danfoss at eHub Nordhavn CPH 12-14 kW** (comissioned March 2018)
40-60°C on supply side and 40-25°C on return side (mixed refrigerants => 40% better COP than 134a)
Also small 2-4 kW micro-booster is developed for circulation line



Peak shaving and further development

- > The primary side buffer tank is used for load levelling of morning peaks and is used to reduce the needed size of heat pump
- > Consumer sub-station for DHW, with Heat Pump and day buffer tank - to be further developed with
 - > Integration of Photo Voltaic for operation of Heat Pump, possibly with battery storage
 - > Possible direct integration of solar heating & PVT
 - > Integration of other sources of heat for Heat Pump

Split flow & Heat Pump on return water for uLTDH

- > If the LTDH is already based on RES, the heat pump can use the return line as a heat source. This split-flow principle => stable performance of the booster heat pump.
- > The benefits of the booster heat pump are that it opens up for very low supply and return temperatures => heat loss reduction in the network and increased heat plant efficiency.

Flat stations / micro heat exchangers also for single family houses and low temperature



- > High water consumption
 - > primary side buffer
 - > oversized heat exchangers

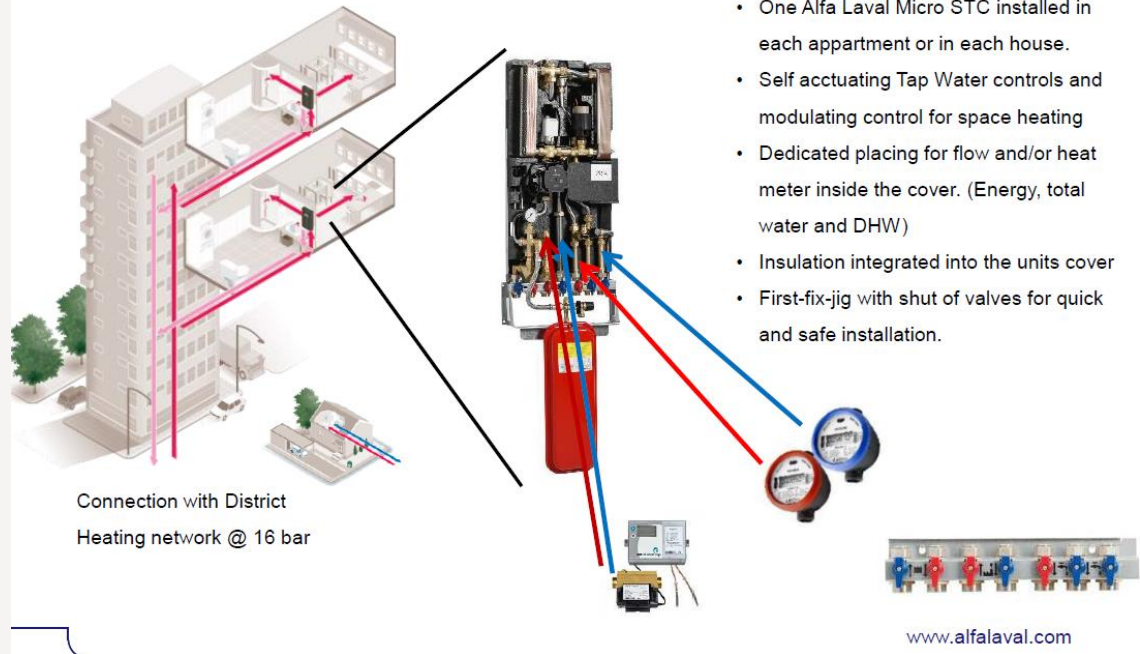
Optimised flatstations

> Advantages

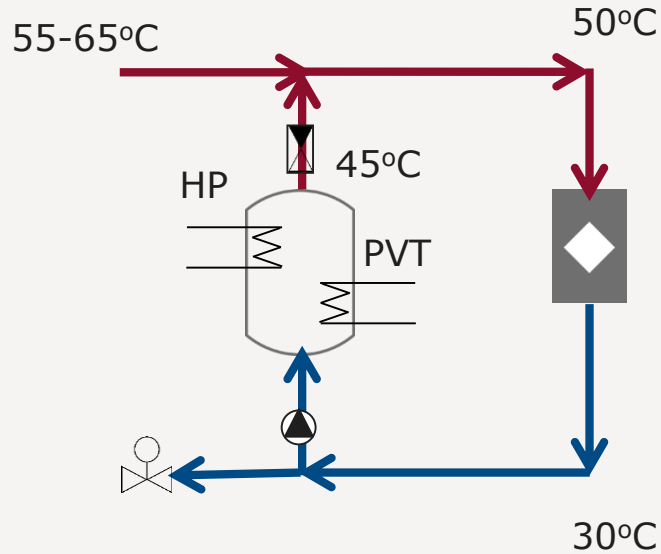
- > designed for low temperature DH
- > insulated to lowest heat loss in market
- > superefficient heat exchanger HEX
- > cold HEX under idle load $e_{\text{save}}^{\text{TM}}$
- > integrated differential pressure control
- > no circulation of hot water max 4 l vol.in pipes
- > stainless steel
- > no limestone fouling
- > no legionella



Flat stations (indirect), primary connected

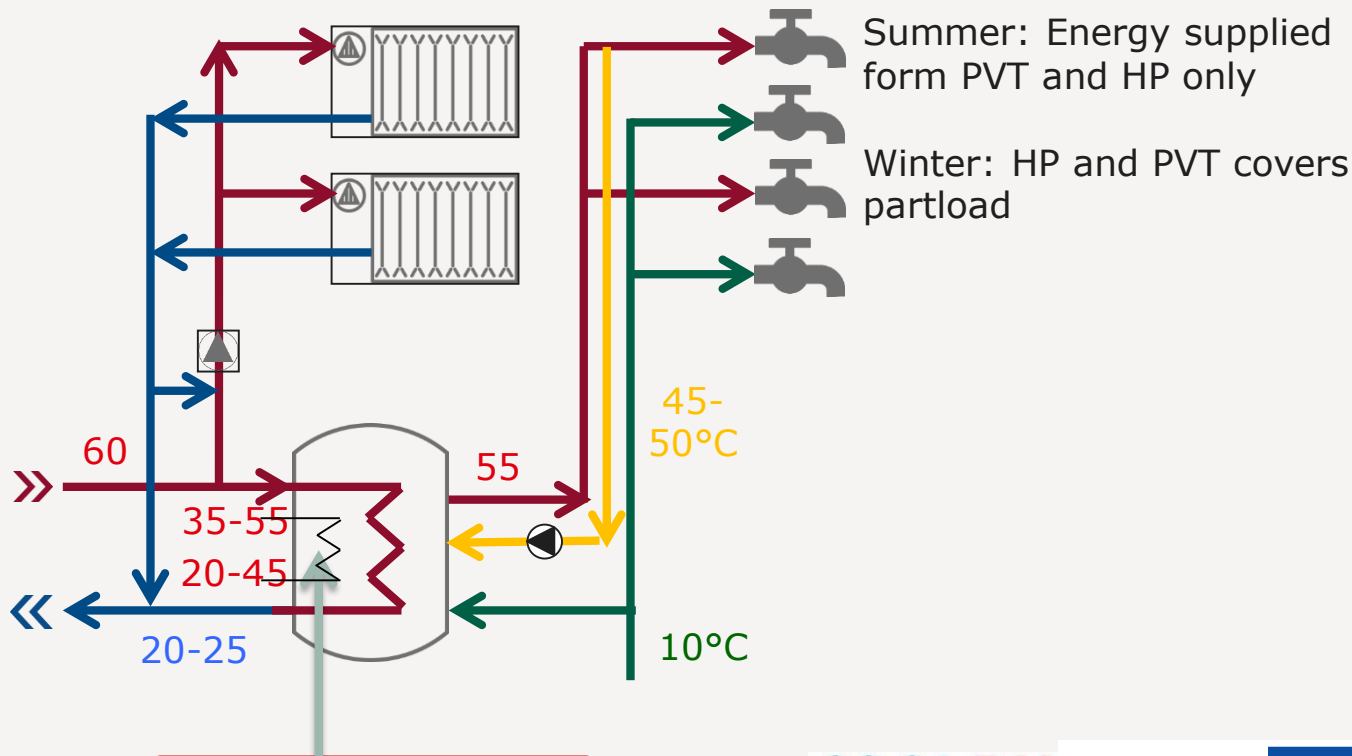


Solution with micro heat exchangers



- DH water doesn't charge the storage tank
- Storage tank is used to mix with DH water
- Coil can be placed wherever without affecting DH return temperature
- Beware of **bypass** in flat station that will increase return temp especially under idle load.

Solution with DHW storage solution



Fuel shifting / topping

- > Electrical immersion heater in domestic hot water wessel
- > Run-trough topping from 40 to 45°C possiblebut sets high demands to the strengths of the power supply
- > Cooker 4 litres 5800 DKK e.g. from Grohe



Low temperature space heating

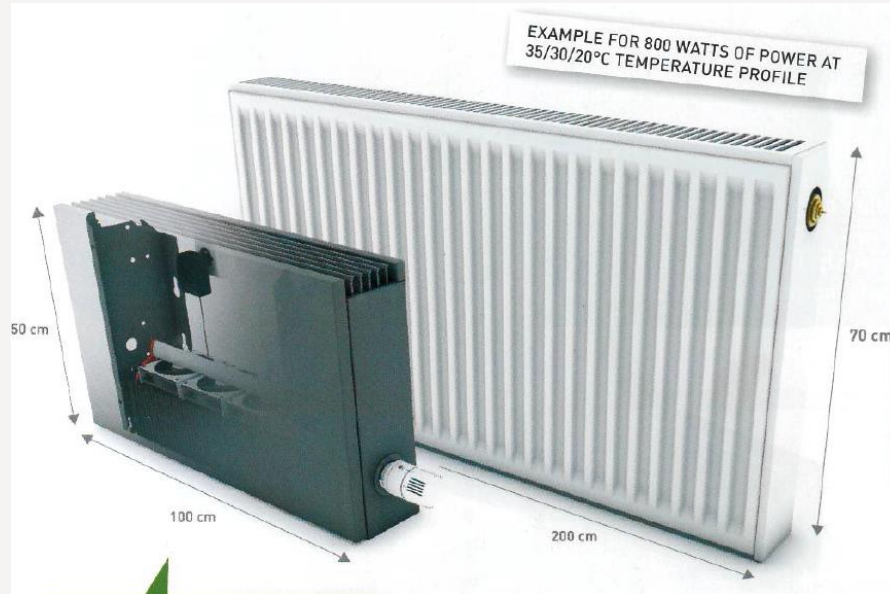
1. Intelligent floor heating – base load – TABS

2. Low temperature radiators (35 to 28°C design flow temperature)

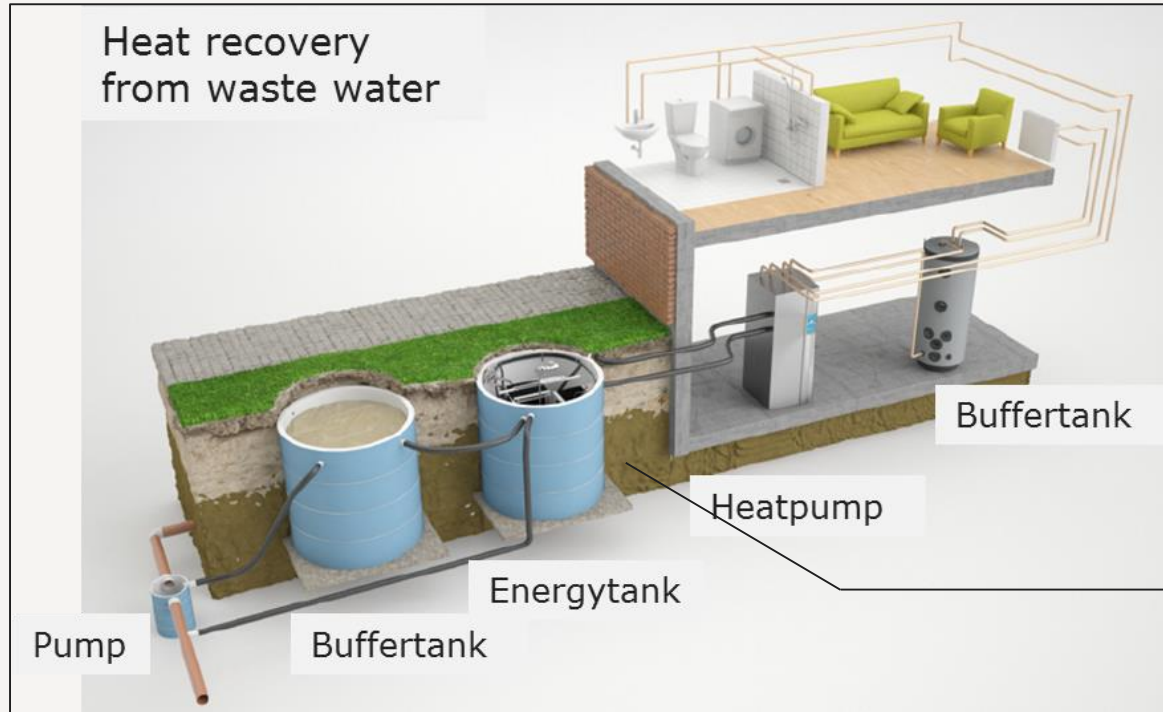
> Fast response, cheaper and better delta T



Fan assisted radiators for capacity boosted operation, only when very cold outside – Factor 3 in boost



Waste water heat recovery



Heat exchanger – polymeric material

Waste water heat recovery



39 apartments

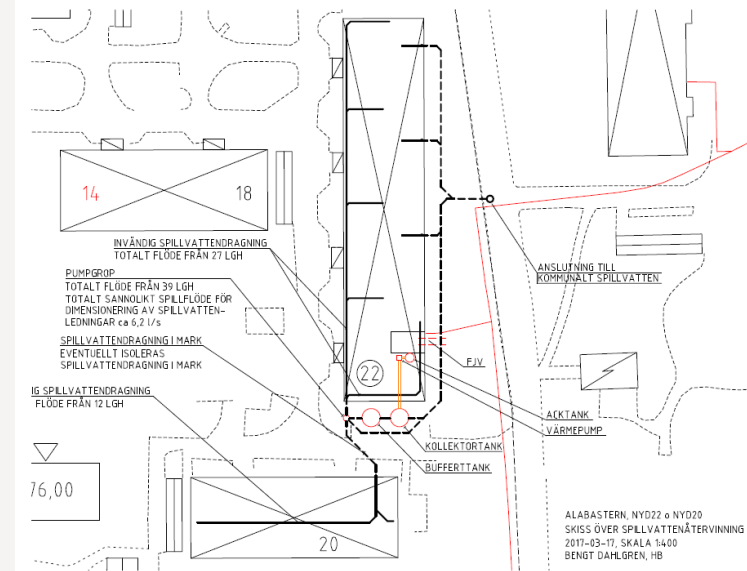
76 MWh thermal

Waste water heat recovery system

Waste water from apartments;
>21°C;
3300 m³/year

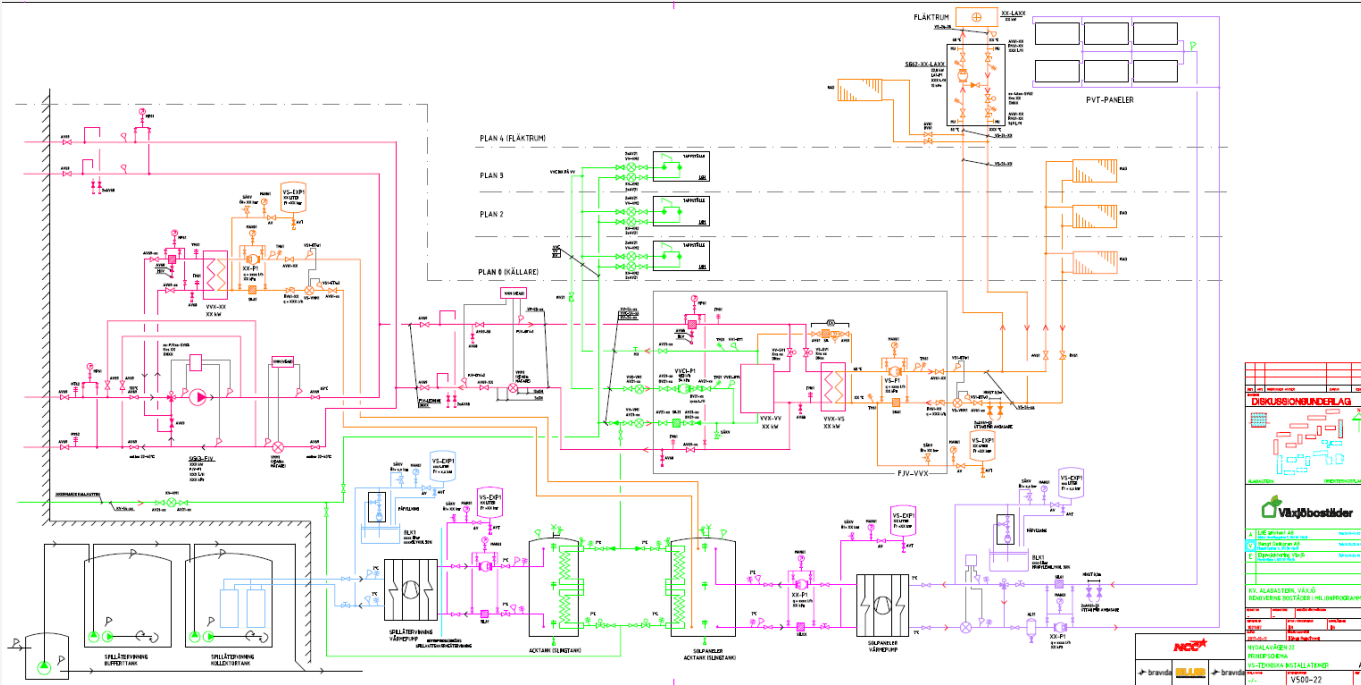
17 MWh electric

Waste water to sewer ; < 6°C



27

20 MARCH 2018
COWI POWERPOINT PRESENTATION



COOLDH
COOL DISTRICT HEATING

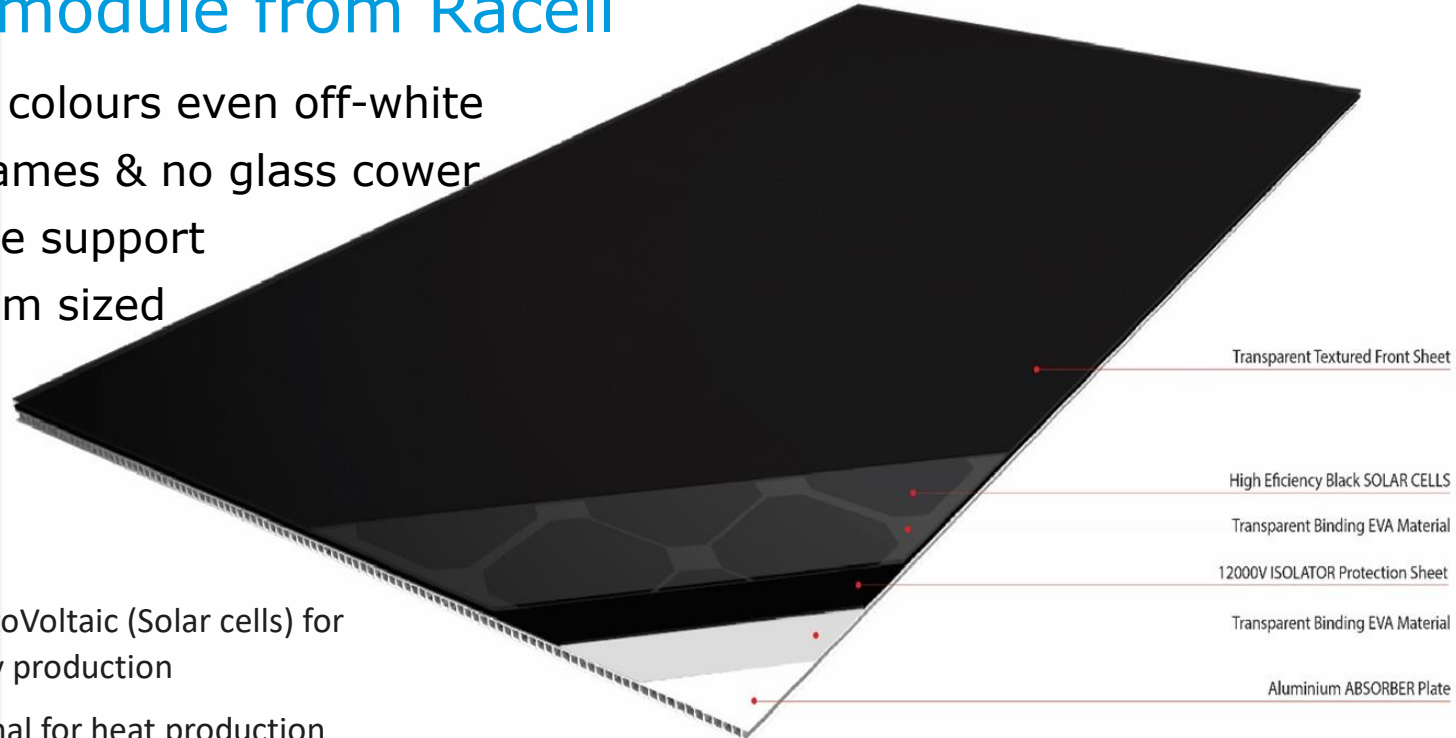
Co-funded by
the European Union



COWI

PVT module from Racell

- > Many colours even off-white
- > No frames & no glass cover
- > Simple support
- > Custom sized



PV = PhotoVoltaic (Solar cells) for electricity production

T = Thermal for heat production

Example of installation



RACELL modules on roof in Gladsaxe, Copenhagen

Generic Report format

Report

- > Standard project front page (title, revision, date, responsible, level of confidentiality)
- > Disclaimer, QA (prepare, checked and approved)
- > Scope of deliverable
- > Context of deliverable (what can it be used for in this project)
- > Perspective of deliverable
- > Involved partners
- > Summary

Core text

- > List of content
- > Introduction
 - > Background
 - > Purpose
 - > Presumption
- > Price structures
- > Legislation
- > Technologies investigated
 - > a
 - > b
 - > c

- > Results
 - > Overview tables
 - > Technology data sheets
- > Economic feasibility comparison
- > Recommendations
- > Innovation demands / further research

Technology Catalogue

Technology datasheet (one set for each solution)

- > Solution name
- > Short description (10-20 words)
- > Keywords

- > Principle diagram & photo

- > Description (1/3 page)
 - > what does the solution solve

- > Pro et cons (in table)

Cont'

- > Characteristics

- > e.g. efficiency, COP, temperature levels, life span, availability factor

- > Environmental issues

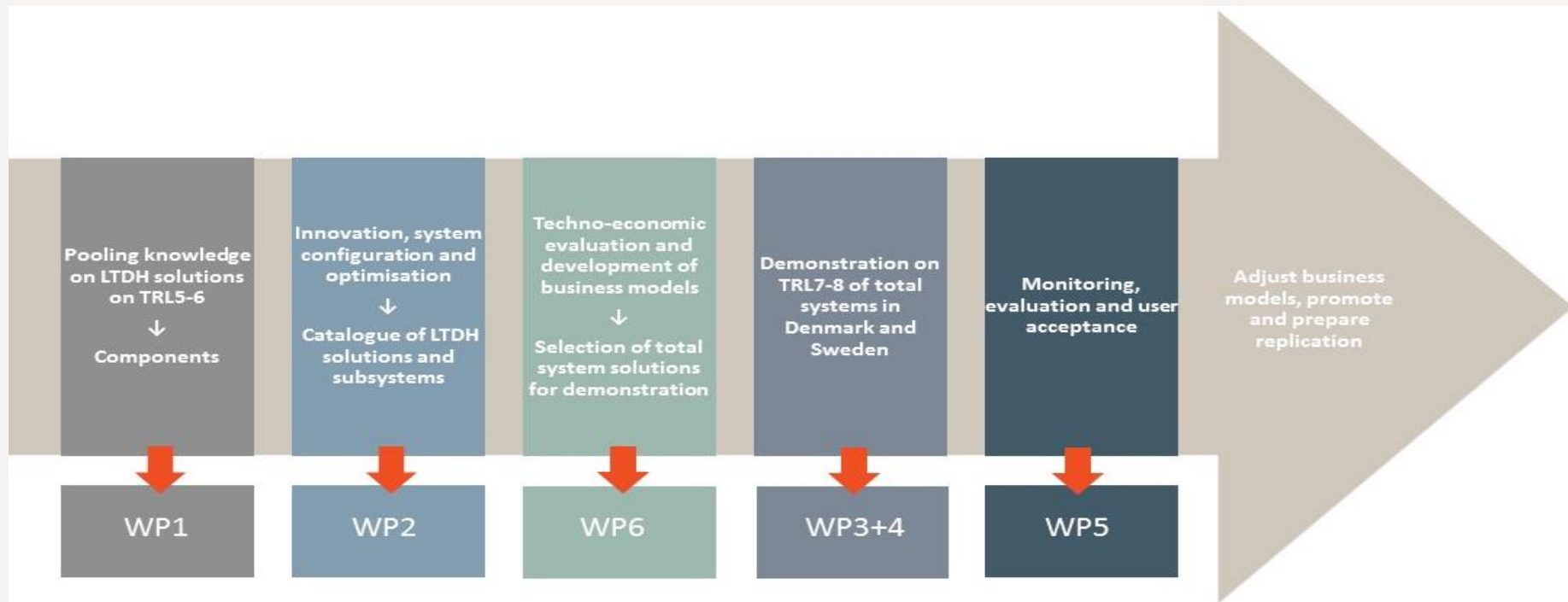
- > waste products

- > Demands to installation

Cont'

- > Investment cost (specific for different sizes)
- > O&M costs
 - > chemicals (which)
 - > electricity
 - > service
 - > reinvestments
- > References
 - > maturity of technology, expected further improvements in 5 and 10 years from now

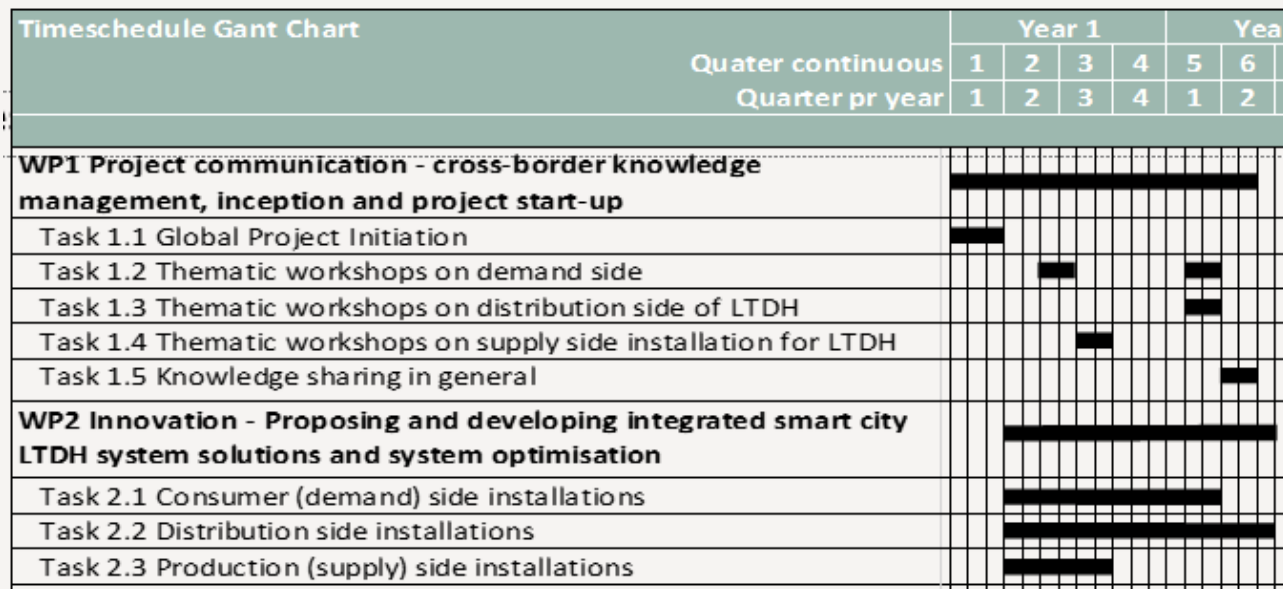
Workprocess



Key elements in COOL DH

1. Innovative substation design at consumers, integrating supplementary renewable energy sources exploited at building level.
2. New DH pipes for internal distribution in building (1/3 heat loss compared with traditional pipe systems).
3. New/price/business models that stimulate substation services and achievement of vital low return temperatures and load levelling, and hereby ensure optimal operation and low life cycle costs.
4. Business plans from the project will support the further exploitation and export of the demonstrated solutions.

WP 1 Timeschedule



WP1 Task 1.2

Thematic workshops on demand side

COWI together with Kraftringen et al

- > Solutions for avoiding risk of legionella
- > Solutions for local integration of renewable energy sources, by local exploitation of renewable energy sources at the buildings
- > Substation solutions for single family houses, Workshop 2
- > System solutions for multifamily houses and tertiary buildings
- > LTDH connected appliances, Workshop 2
- > Individual metering concepts, Workshop 2

WP 1 Ways of working

- > Presentations of **Best Practice and cases** at workshops
- > Invitations of **externals** with focus on products
- > Standard format to present options – catalogue
 - > Principle diagram, potentials, barriers, legal issues, cost indication

- > 8:30 Samlet bestilling
- > 11:00 Frisk kaffe, te og isvand + frugt
- > 12:30 Rugbrudssandwich, sodavand og isvand evt salatbar i kantinen for veganer
- > 14:40 Samlet bestilling + dagens kage
- > 16:00 Øl og vand

“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 76779”

Legislation and research about legionella in DHW systems in Sweden

Kerstin Sernhed, Lunds Universitet

Presentation at a Cool DH workshop 20180320



Co-funded by
the European Union



European union



No specific law concerning legionella!

- Water quality is mentioned in several directives:
 - Directive 2000/54/EC: **Directive regarding biological agents at work**
 - Council Directive 98/83/EC: **Directive on the quality of water intended for human consumption**
 -But no specific requirements on legionella control



European working group for Legionella infections (EWGLI) – Technical specifications



1. Parts of the system should be **kept at a temperature that does not promote microbial growth**
2. The system should be designed in such a way that **water stagnation does not occur**
3. The components should be **made in materials that do not promote microbial growth** (e.g by limiting the growth of biofilm)

EWGLI recommends that:

- hot water should be **stored at a temperature no less than 60°C**
- circulating water should be at a temperature that **allows at least 50°C at the tap** within one minute of opening the tap



Swedish legislation



Prevention of Legionella are mainly handled in:

- The Swedish Environmental Code (Miljöbalken)
- The Building and Planning Act (Plan- och Bygglagen)
- The Building and Planning Ordinance (Plan- och Byggförordningen)
- The Work Environment Act (Arbetsmiljölagen)
- The Diseases Act (Smittskyddslagen)



Swedish legislation



The Swedish environmental code (Miljöbalken):

”Buildings meant for public use should be constructed in such a way that **there is no or limited risk to human health and well-being**” (SFS 1998:808)

The Building and Planning Act (Plan och Bygglagen):

”A construction should be safe with regard to **hygiene, health and environment**” (The Building and Planning Act, chapter 8:4)



Swedish legislation



The Building and Planning Ordinance (Plan och Byggförordningen):

“A construction should not expose citizens to unacceptable health risks. **Including, but not limited to, exposure to polluted or contaminated air or water**” (SFS 2010:900, SFS 2011:338).



Swedish legislation



The Work Environment Act (Arbetsmiljölagen):

Installations for water, sewage, cooling and heating:

“Hot and cold water outlets should exist where it is needed for the work operation. It should be possible to wash the hands adjacent to the workplace if the work tasks so requires. **In showers, the hot water system should be designed to prevent the risk of growth and spread of legionella bacteria.**”
(AFS 2009:2).

“To further insure the well-being of employees the employer is required to **perform risk analysis to identify potential sources of threat to human health**” (AFS, 2005:1).



Swedish legislation



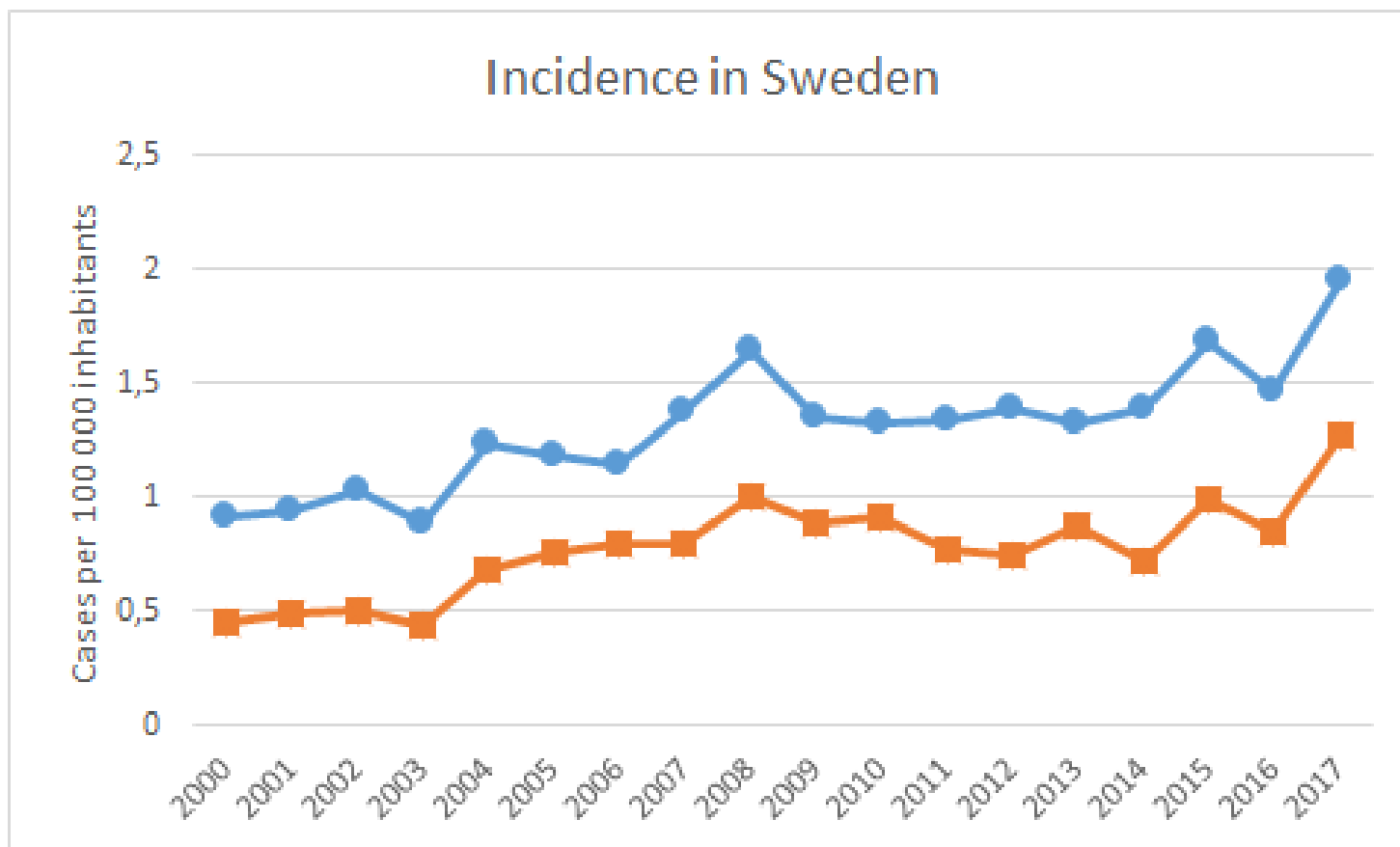
Legionellosis is a notifiable disease

The diseases act (Smittskyddslagen):

“A treating physician who suspects or detects cases of common disease or other notifiable disease **must report this without delay to the infectious healthcare practitioner in the county where the notifying doctor has his or her occupation and to the Public Health Authority.** Notification must also be made for any other disease which is or is suspected to be infectious, if the disease has been remarkably spread within an area or appears in a malignant form.”
(Chapter 2 § 5)



Incidence of Legionellosis in Sweden



Incidence of cases of Legionellosis in Sweden. Total incidence in blue top line, incidence with Sweden as source of infection in orange bottom line.

Source: Karlsson & Ottosson, master thesis (not published yet).

Incidence of Legionellosis in six countries in Europe

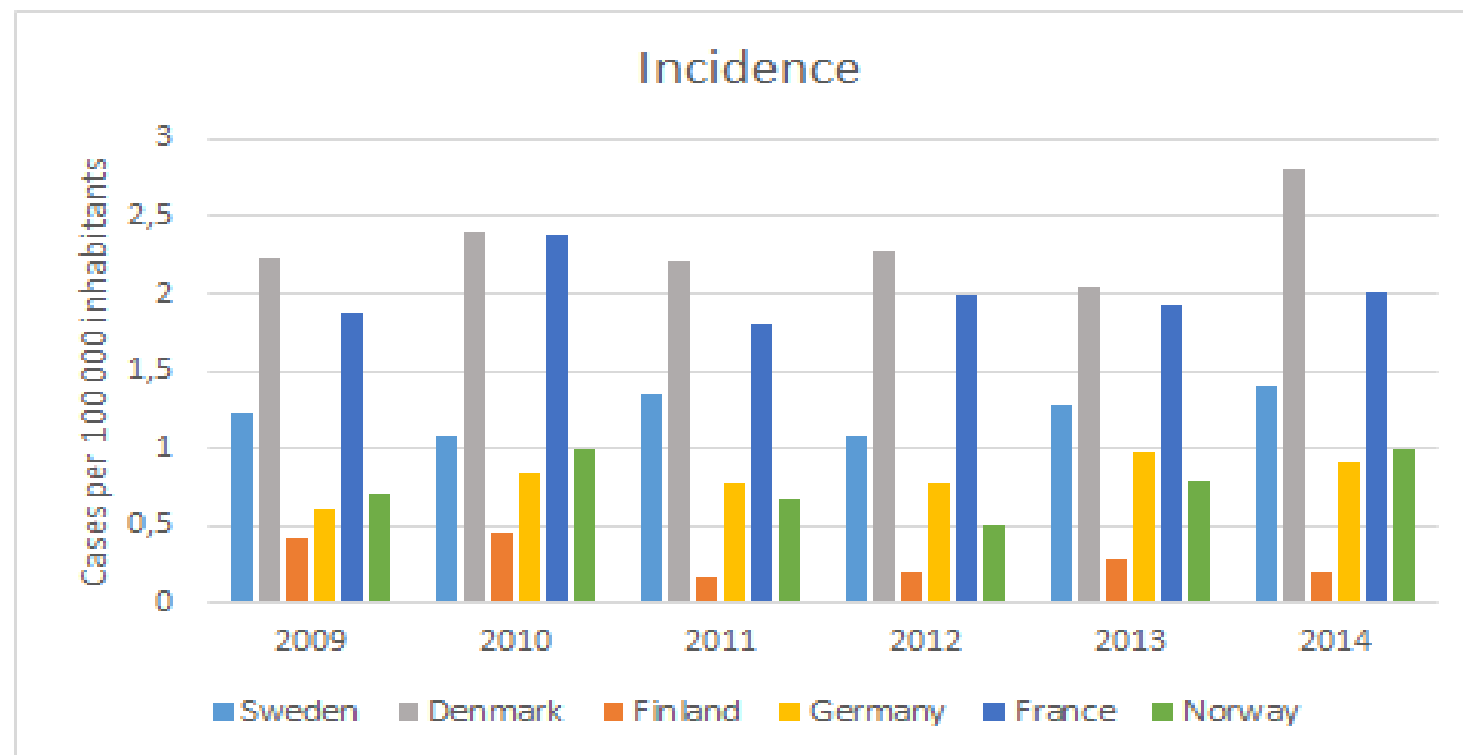


Diagram compiled from data obtained from ECDC (European Centre for Disease Prevention and Control, 2016).

Source: Karlsson & Ottosson, master thesis (not published yet).

Technical regulations in Sweden

The specific technical regulations are determined by the National Board of Housing, Building and Planning (Boverkets byggregler 6.6):

Tap water installations:

- Tap water installation must be designed so that the tap water after the tap is hygienic and safe, and comes in sufficient quantity.
- Tap water must meet the quality requirements for drinking water after the tap point.
- Tap water should be sufficiently hot to enable taking care of personal hygiene and household chores.
- Tap water installations must be carried out with materials where no detrimental concentrations of harmful substances can be initiated in the tap water.
- The installations must not emit odor or taste to the tap water.



Technical regulations in Sweden

The specific technical regulations are determined by the National Board of Housing, Building and Planning (Boverkets byggregler 6.621):

Hot water temperatures for personal hygiene and household purposes:



- Installations for hot water must be designed so that a water temperature of at least 50 ° C can be reached at the tap. To reduce the risk of scalding, the hot water temperature must not exceed 60 ° C after the tap.
 - However, the temperature of the tap water may not exceed 38 ° C if there is a particular risk of accidents.
 - Devices for the control of the tap water must be designed so as to limit the risk of personal injuries through the confusion of hot water and hot water.

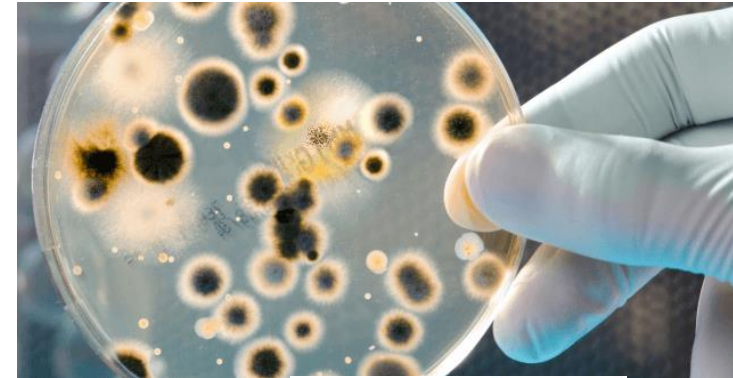


Technical regulations in Sweden

The specific technical regulations are determined by the National Board of Housing, Building and Planning (Boverkets byggregler 6.622):

Microbial growth:

- Installations for tap water should be designed to minimize the potential for growth of microorganisms in the tap water.
- Installations for (cold) tap water must be designed so that the tap water is not heated inadvertently.
- Circulating pipes for hot tap water must be designed so that the temperature of the circulating tap water is not less than 50 ° C in any part of the installation.



Recent research about Legionella in Sweden



Rise:

Safe and energy efficient domestic hot water

- control of Legionella biofilm formation through innovative implementation of limited water volumes

- The purpose of the project is to investigate how an installation principle, the 3-liter rule, affects the Legionella growth in pipe systems and how it can be implemented in real estate.
- The 3-liter rule is based on instantaneous heating of tap water and limitation of the tap water volume to 3 liters.

3-litre rule

- Rule applicable in Germany (DVGW Arbeitsblatt W551)
- The rule says, among other things, that there are no strict requirements for temperature maintenance in distribution pipes and pipes for tap water in:
 1. one-and two-family house
 2. other buildings where the domestic hot water system can be classified as "small".

3-litre rule

- Domestic hot water systems are considered to be "small" if the total water volume of the water heater is not more than 400 liters and the volume of the diluted water in pipes between the water heater and the system's longest drain is not more than 3 liters.
 - (The latter can also be expressed so that the largest volume of cooled tap water that needs to be drained at any of the system's drainage points must not exceed 3 liters.)
 - Note that the total volume of system pipes may be greater than 3 liters because the volume of currently non-active pipes is not taken into account. If there is a circulation loop in the system, the return pipe volume is not included.

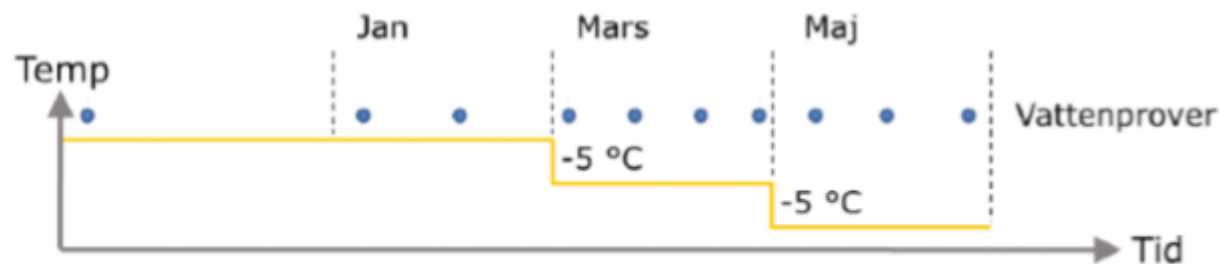
3-litre rule

- The 3-liter rule assumes that **there is a hot water source that is safe from a Legionella prophylaxis point of view.** Normally this is a tap water heater with an outlet temperature of 60 ° C (Germany) or a circulation loop where the maximum permissible temperature drop between its inlet and return is 5 K.

Teknikmarknad (originally KTH)

Reduced tap water temperatures and increased legionella protection (2011)

- The project looked at the killing of Legionella and other microorganisms in incoming cold water, as well as in circulating tap water, using so-called oxidation technology could allow lowering of temperature levels in hot water boilers with 5-10 K
- Field experiments were performed in 10 multi-family houses where outgoing hot water temperature was lowered in two stages by 5 degrees, approximately every two months.



Figur 4 Schema för provtagning och temperatursänkning i Teknikmarknads projekt. Källa: Teknikmarknad (2011).

Teknikmarknad

Reduced tap water temperatures and increased legionella protection (2011)

- Results showed that from 8 houses, which were free from Legionella from the beginning, 6 houses remained free from Legionella after the temperature cuts.
- The remaining two houses received Legionella growth, in both the VVC circuit and the apartment's shower hoses, at the first temperature reduction.
- The same problem was found in two more houses, which had Legionella in the VVC circuit from the beginning.
- It has been found that the used killing technique can not lower the bacterial levels where the bacteria were attached.

Legionella – Bacteria, illness, prevention and minimisation

questions at end....

March 2018 COWI

KRÜGER

Tim Stubbing and Charlotte Hammenshøj

19/03/2018



Chemical and Mechanical Treatment of District heating..

Keeping surfaces clean
minimising energy use
minimising scale corrosion
and bacterial growth in these systems

March 2018 COWI

KRÜGER

Tim Stubbing and Charlotte Hammenshøj

19/03/2018





legionnaires Disease Low Temperature 1999

Danish Man very seriously ill with pneumonia.

Identified cause : Legionella pneumophila s.g.1

Bacteria found in lungs and in hot shower water in mans flat in København.

- 45°C varmt vand – målt 300.000 CFU/LT
- 52°C varmt vand – 1.000 CFU/LT
- 60°C varmt vand - 10-20 CFU/LT

Hvad er legionella? "brusebad"

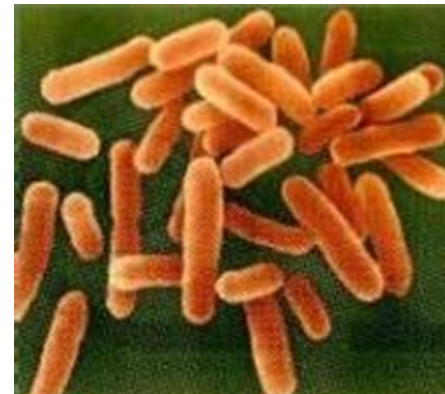


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Legionella

- *Legionella* er en miljøbakterie, der naturligt forekommer i jord og vand
- Under særlige omstændigheder kan *Legionella* være sygdomsfremkaldende (opportunistisk patogen)
- Mennesker er som sådan ikke en del af *Legionellas* livscyklus, så man kan sige, at bakterien er sygdomsfremkaldende ved et uheld
- Der findes mange forskellige *Legionella* arter og undergrupper af disse arter (serogrupper). Det er primært *Legionella pneumophila* serogruppe 1, der er forbundet med sygdom.
- *Legionella* trives især ved temperaturer på 20-45°C



Legionella – optimal growth parameters

- pH: 6,5 - 9,5
- Temperatur °C: 20 - 45
(bedst ved 37°C)
- Total bakteriekimtal / ml: $10^2 - 10^7$
- Korrosionshastigheder mm/år: 0,0001 - 1,0
- Hårdhed °dH: 0 - 30+



Legionella sygdom



Legionærsyge

Primært disponerede personer (børn, ældre, nedsat immunforsvar)

Inkubationsperiode: 2-14 dage

Symptomer: tør hoste, hovedpine, muskelsmerter, træthed, høj feber. Derefter kommer diarré, opkast, lungebetændelse samt påvirkning af lever, nyrer og centralnervesystem (confusion).

Mortalitet afhænger af patientens immunstatus, koncentrationen af Legionella-bakterier, samt typen af Legionella.

Pontiac feber

Alle personer

Inkubationsperiode: 5-60 timer

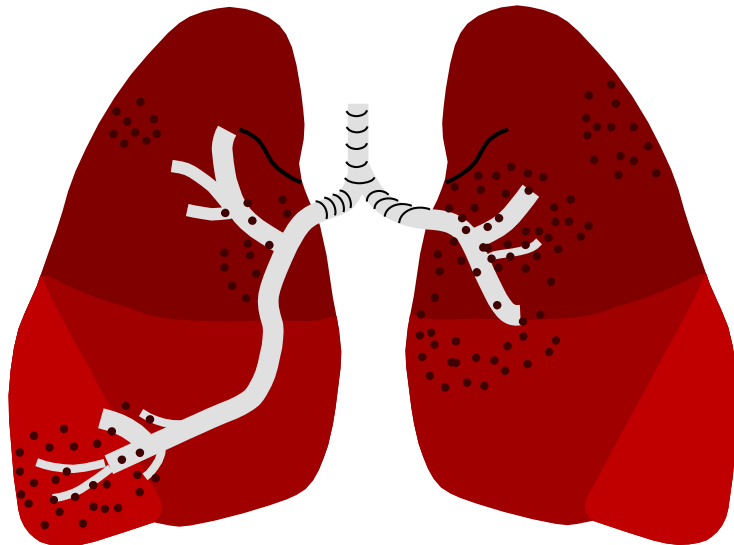
Symptomer som influenza: høj feber, hovedpine, muskelsmerter, brystsmerter og kortåndethed

Lav mortalitet

Hvordan bliver man syg ?



- Små vandpartikler (aerosoler) kan indeholde Legionella, der kan inhaleres og komme ned i lungerne – fx ved brusebad
- Mave-tarmsystemet er designet til at bekæmpe bakterieinfektioner, men lungerne er skabt til at være “sterile”
- Immunceller i lungerne (makrofager) minder meget om amøber i cellestruktur, og optager Legionella, der så bruger immuncellen til formering.



Legionella-disponerede

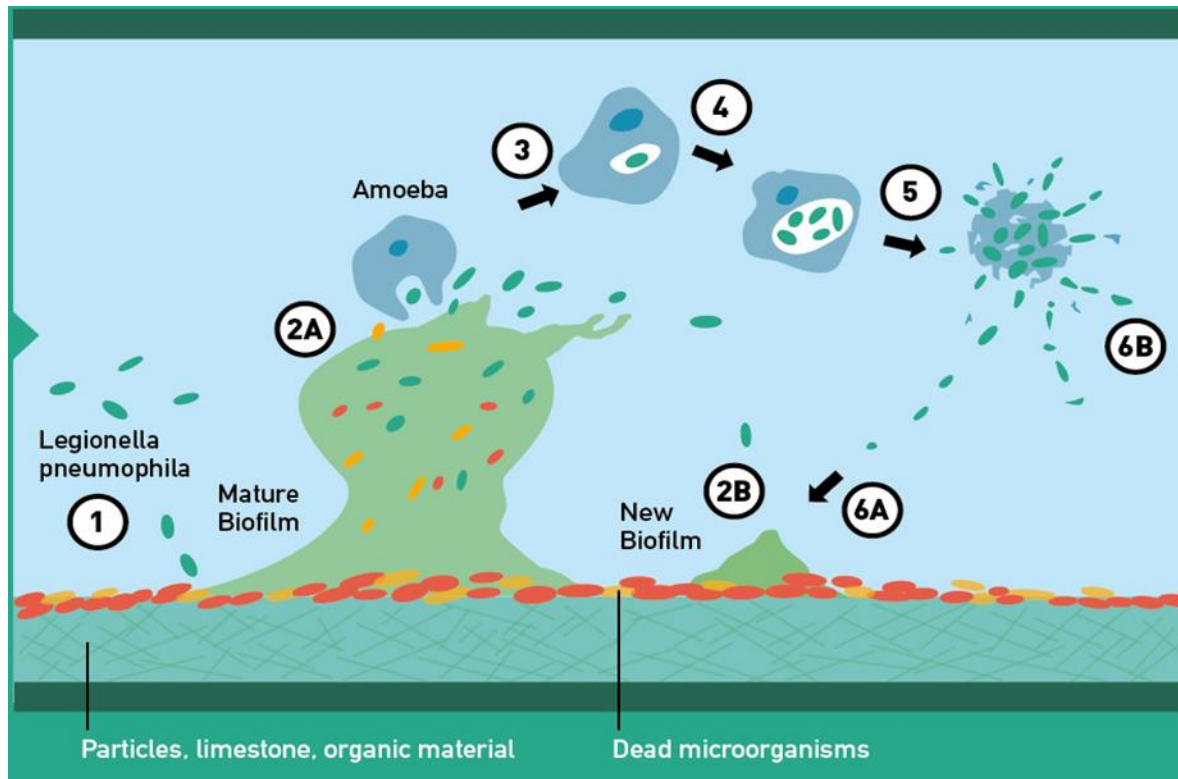
- Mindre end 5% af de personer der udsættes for smitte bliver syge.
- Det er således primært disponerede der bliver syge.
- Særligt disponerede er:
 - Personer med svækket immunforsvar
 - Personer med hjerte-, nyrer- og luftvejssygdomme
 - Rygere / Alkoholikere
 - Mænd
 - Alder > 45 år

Hvorfor skulle nogle mennesker bliver syge og andre ikke?

- Det er afhængig af:
- Antal legionellabakterier i vandet som inhaleres
- Helbred af befolkningen som inhalerer vanddråbene
- Eksponeringstid – hvor længe bliver personer udsat for disse vanddråber

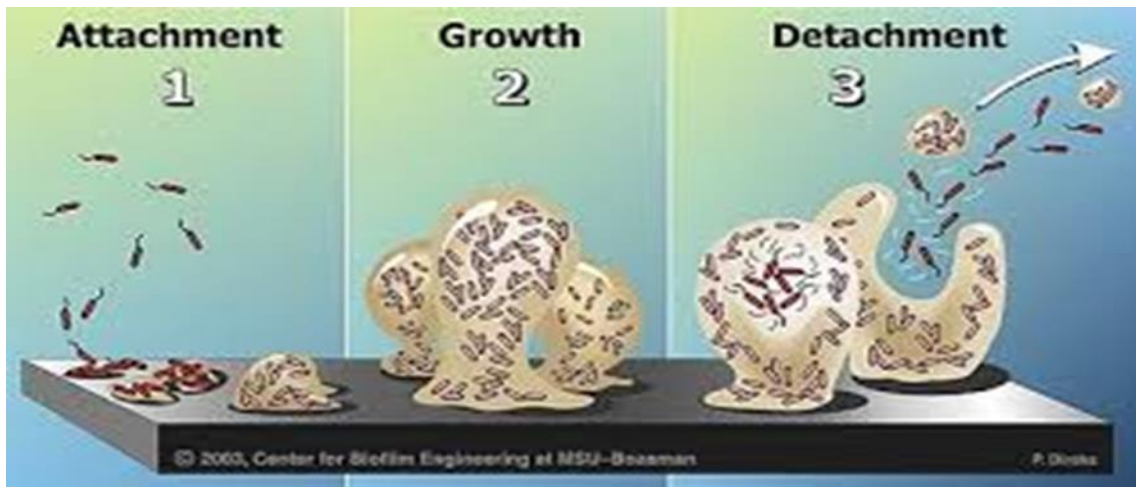
Legionella livscyklus

- *Legionella* vil gerne opholde sig i biofilm (moderat vækst)
- Amøber lever af at "græsse" biofilm, hvor bakterierne optages af amøben og nedbrydes intracellulært
- *Legionella* kan danne en beskyttende hinde (vesikel), når den optages af amøben, og vil i stedet vokste til hundredvis af bakterieceller indtil amøben sprænger.
- Amøber kan være termotolerante og beskytte *Legionella* mod høje temperaturer



Biofilm i varmtvandssystemer

- Biofilm består oftest af flere forskellige typer bakterier
- Efter fastgørelse til vandrøret, kan nogle bakterier danne en extracellulær matrix -> beskyttelse mod biocider og antibiotika
- En moden biofilm udskiller bakterier for, at disse kan påstarte en ny biofilm



Eksempler



Filterelement

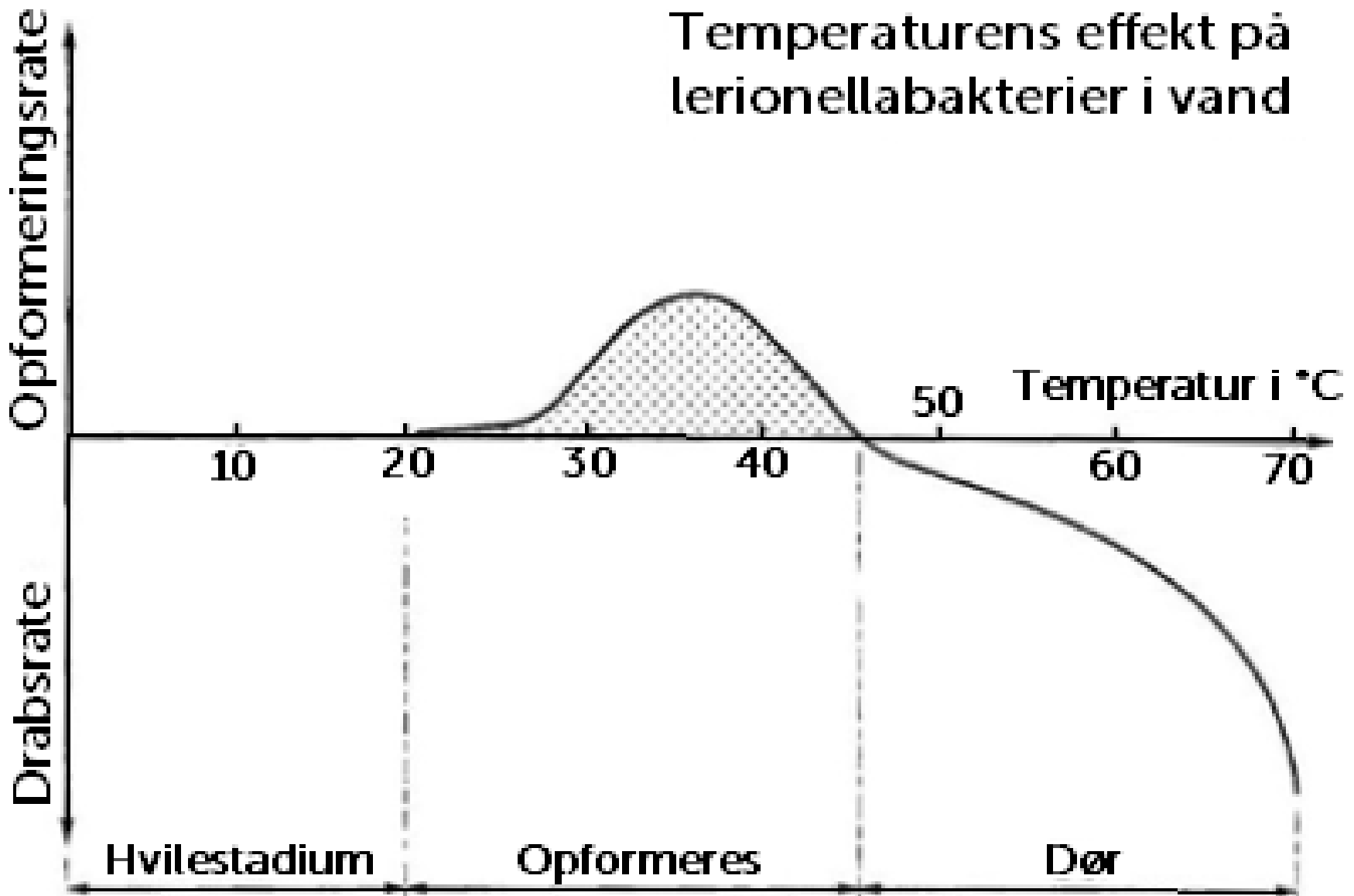


Sump i en
varmtvandsbeholder

Preventative maintenance

KRÜGER

Temperaturens effekt på lerionellabakterier i vand



Under hvilke vilkår trives de?



TEKNOLOGISK
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- Risikoen for dannelse af bakterier og Legionella er betinget af varmtvandstemperaturen i varmtvandsproduktionen og i rørsystemet.

Temperatur	Temperaturens effekt på vækst af Legionella
Under 20 °C	Legionella kan overleve, men er oftest i et hvilestadie
20 °C - 50 °C	Legionella kan vokse – det optimale temperaturniveau er 35 °C til 46 °C
Over 50 °C	Legionella kan overleve, men der sker ikke vækst
55 °C	Legionella dør inden for 5 – 6 timer
60 °C	Legionella dør inde for en halv time, men der er øget risiko for kalkdannelse
66 °C	Legionella dør inden for 2 minutter

ANSVAR



I 2009 kom Legionærsyge især i fokus da Helsingør svømmehal var årsag til at 6 blev smittede, hvor en ældre mand døde og en 72-årig mand blev invalid som følge.

Retten i Helsingør slog senere fast, at Helsingør Kommune, som bygningens ejer, bærer ansvaret for invalideringen af den 72-årige mand.

Erhvervs- og Økonomiministeriet præciserede efterfølgende, at byggeloven entydigt pålægger ejeren af bygningen som ansvarshaver for, at VVS-installationerne bliver holdt i forsvarlig stand.

Den 72-årige man fik tildelt omkring 200.000 Kr. i erstatning.

Vigtigste elementer for at undgå sygdomstilfælde



- **Afgør hvem der er ansvarlig for varmtvandssystemet!**

- **Risikovurdering:**

- designmæssige udfordringer (dead legs) – flow

- Temperatur i beholder og på tapsteder

- Vandprøver – kimtal og Legionella

(det er vigtigt også at tage af kimtal, da et højt kimtal indikerer meget biofilm, hvilket kan medføre høj vækst af Legionella, hvis bakterien kommer ind i systemet.

Immunstatus på forbrugerne, hvor mange forbrugere?
(plejehjem, hospitaler, skoler, svømmehaller, idrætshaller)

Risikovurderingsrapport og Log-bog

- **Risikovurdering** – gennemgang af systemet, infektionsrisiko, kvalifikationer af driftansvarlig, tiltag for at optimere infektionskontrol
- **Log bog:**
- Kunden kan bevise over for myndigheder at fornuftige praktiske tiltag er på plads, for at mindske risikoen.
- Kunden er fri for ansvar og erstatningskrav.



Driftsforbedringer til minimering af Legionella



- 1) Udslamning af beholderen.
- 2) Rensning og klorering af beholderen.
- 3) Skyl sjældent brugte tappesteder to gange ugentligt i 5 minutter.
- 4) Udskift bruseslange og brusehovede mindst hvert 2. år.
- 5) Lad bruseslangen hænge ned. Hæng den ikke op efter brug!
- 6) Grove filtre renses



Der SKAL være cirkulation / flow igennem hver rør mindst ugentligt.

Retningslinjer

KRÜGER

Retningslinjer - SSI



Reaktion på vandprøver afhænger af typen af Legionella, typen af system, hvem og hvor mange der kan blive eksponeret

Påvisning af *L. pneumophila* serogruppe 1 Pontiac er en skærpende omstændighed, specielt steder, hvor mange kan blive udsat (brusere i svømmehaller, køletårne, forstøvere, og større bebyggelser), og specielt, hvor særligt modtagelige personer bliver eksponeret (plejehjem og hospitaler). På plejehjem og hospitaler bør der være < 100 cfu/L, andre steder under 1000 cfu/L.

Reaktions grænser efter Legionella prøvetagning i varmt og koldt vand systemer

Legionella bakterier (cfu/liter)	Handling påkrævet
Flere end 1000, men mindre end 10.000 (>1000, men < 10.000)	<ol style="list-style-type: none">1. Hvis en mindre del af prøverne (10-20 %) i systemet er positive, skal der tages opfølgende prøver. Hvis et lignende antal genfindes, bør der laves en gennemgang af kontrolforanstaltninger og risikovurdering bør udføres for at identificere eventuelle afhjælpende foranstaltninger.2. Hvis størstedelen af prøverne er positive, er systemet muligvis koloniseret med Legionella, om end i lavt antal. Desinfektion af systemet skal overvejes, men der bør udføres en umiddelbar gennemgang af kontrolforanstaltningerne. En risikovurdering bør udføres for at identificere eventuelle andre relevante afhjælpende foranstaltninger.
Flere end 10.000 (>10.000)	Der bør tages opfølgende prøver og en øjeblikkelig gennemgang af kontrolforanstaltninger og en risikovurdering bør udføres for at identificere andre relevante afhjælpende foranstaltninger, blandt andet desinfektion af systemet.

Retningslinjer – Europa (ESGLI)



- **Temperaturkontrol:**
- Cirkulation: 50-55° C
- Forøget risiko for Legionellavækst hvis temp. er mellem 20-45° C

- **Kontrol med biocider**

Anvendes hvis det ikke er muligt at opretholde den nødvendige temperatur

Ligesom temp. Bør tjekkes jævnligt, skal biocidniveauet tjekkes

Der bør løbende tages prøver for Legionella

- Klor skal være min. 0,2 ppm

PERMANENTE LØSNINGER

MAINTENANCE

KRÜGER

1

BacTerminator Safe

- Saltspalting (Elektrokemisk aktiveret vand)



ECA – Electrochemically activated water

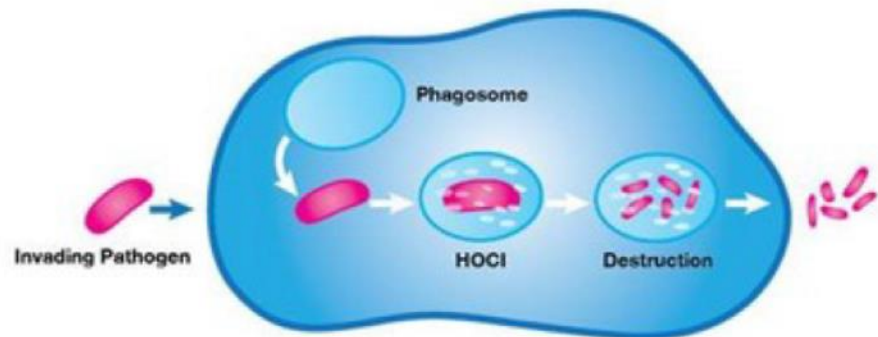
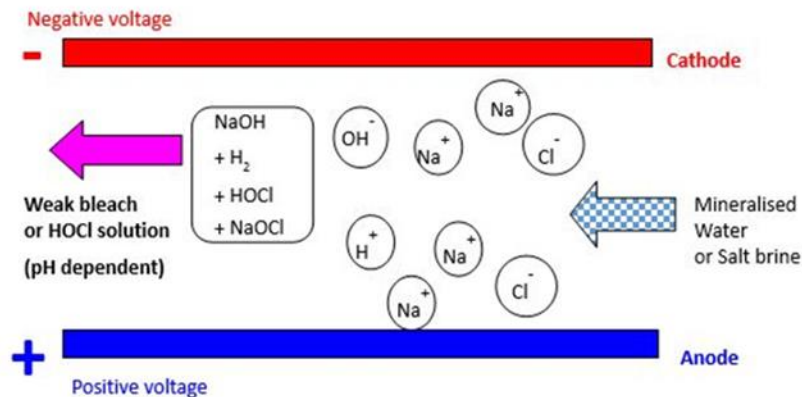


- Vandet er dansk drikkevand, der er blevet filtreret og blødgjort, men stadig har et naturligt indhold af salte.
- Saltet er økologisk havsalt, der er testet i forhold til EN 14805 (standard for salt til elektrolyse uden membran som bruges i forbindelse med drikkevandsproduktion)

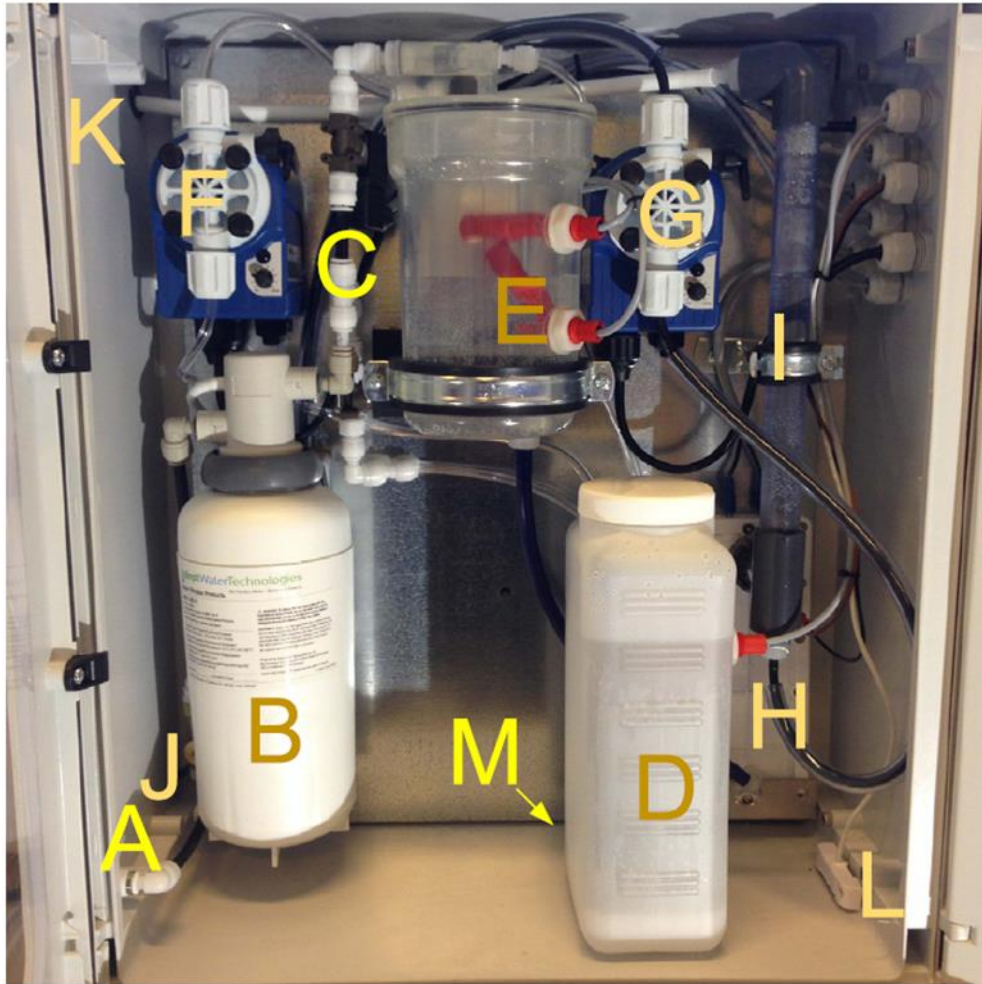


ECA – Hvad er det?

- Der dannes forskellige stoffer, men de fleste er ikke til stede ret længe.
- Det primære aktive stof, der dannes ved elektrolysen er klor
- Klor er en betegnelse, der dækker både hypoklorsyre (HOCl) og hypoklorit (OCl⁻)
- Ved neutral pH er der lige meget hypoklorsyre og hypoklorit
- Hypoklorsyre er mest effektivt mod bakterier, men hypoklorit er mere stabilt.
- Vores egne immunceller danner også hypoklorsyre mod bakterieinfektioner



BacTerminator Safe proces



Mark	Content
A	Water in (8mm hard tubing)
B	Softener cartridge and head
C	Filling valves for salt tank and water tank
D	Salt tank with lid and level sensor
E	Mixing tank with level sensors
F	PNaCl – Brine dose pump
G	PDose ECA water dose pump

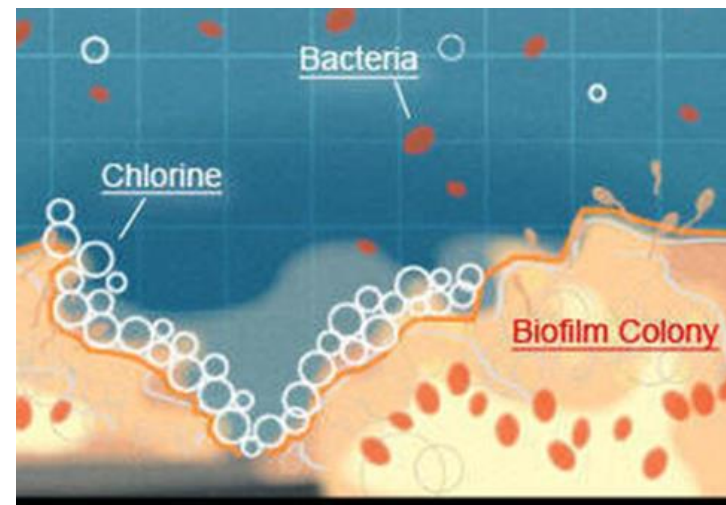
Mark	Content
H	Electrolysis chamber
I	Air discharger
J	ECA water outlet
K	Air outlet
L	Water leak sensor
M	Overflow (not visible)

Infektionskontrol - Virkemåde



- BacTerminator Safe sørger for at dosere ECA vand ud i systemet, så der (næsten) hele tiden er en koncentration af fri klor på min. 0,2 mg/L ved forbrugeren.
- Den fri klor stresser og nedbryder biofilmen og inaktiverer frie bakterier
- Så længe der kan måles fri klor, er vandsystemet mikrobiologisk sikkert
- Hypoklorsyre er meget effektivt både mod planktoniske (frie) bakterier og biofilm

Temperaturgymnastik eller højere
Koncentrationer af klor kan ikke fjerne
biofilm 100%
Det handler om kontrol!!



Infektionskontrol – Virkemåde og test

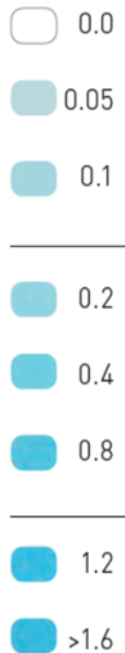
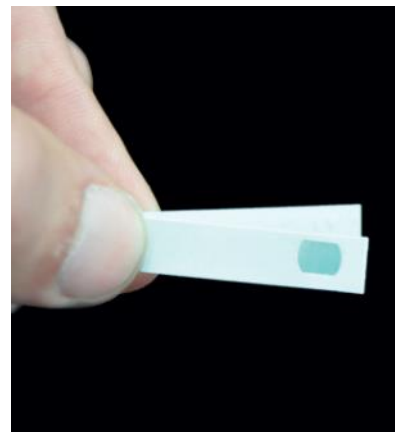


- Det er vigtigt at tjekke, der er fri klor i systemet –både ved installation og ved løbende test.
- Der bør ofte testes ved et par målepunkter fx afgang og retur. Et par gange om året bør der tages et større udsnit af prøver ved forskellige taphaner.
- I opstartsperioden kan der muligvis ikke måles fri klor på retur eller nogle tapsteder. Der kan muligvis måles total klor (klor der har reageret med biofilm)
- Der kan godt være lugtgener i starten. Klor der reagerer med biofilm eller anden organisk materiale har ”klorlugt”. ”Ren” klor lugter ikke på samme måde.

Verifikation af fri klor

- Vigtigt at I gør det og vigtigt at I lærer det videre til dem der skal håndtere anlægget til daglig
- Optimalt mellem 0,2-0,5 mg/L
- Det er ikke farligt hvis det er højere, men over 0,5 begynder lugten at være tydeligere.

WHO tillader op til 5 mg/L i drikkevand, så det er rørmateriale m.m. lavet til at kunne håndtere.



BacTerminator Safe

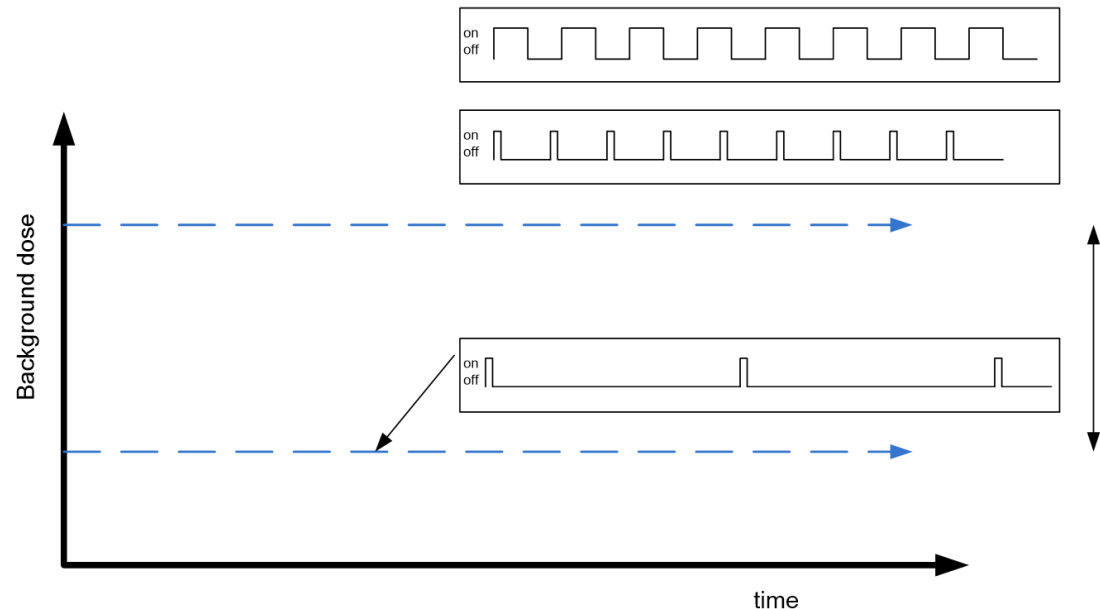


- Kun NaCl, ingen farlige kemikalier - Miljøvenligt
- Ingen opbevaringstanke. Der produceres efter behov
 - Konstant klorkoncentration
 - Ingen degradering af klor, og dermed minimalt med biprodukter.
- Kan operere med og uden ORP sensor
- Alarm og advarselsrelæ er standard
- Indbygget blødgøreropatron. Ekstern blødgører kan også installeres.
- **Vedligehold:** årlig service, påfyldning af salt, skift af blødgøringspatron, klormålinger

BacTerminator Safe - Dosing



- Baggrundsdoseringen doserer, så det volumen af varmt vand der er i vandsystemet modtager en dosis klor, uanset om der er forbrug eller ej.
- Når der tilsættes koldt vand, tilsættes også en dosis klor.
- For at sikre en ensartet dosering, kører pumpen mindst 10 sekunder af gangen.
- Hvis ORP-sensoren er installeret, stopper den doseringen, såfremt ORP-setpunktet er overskredet



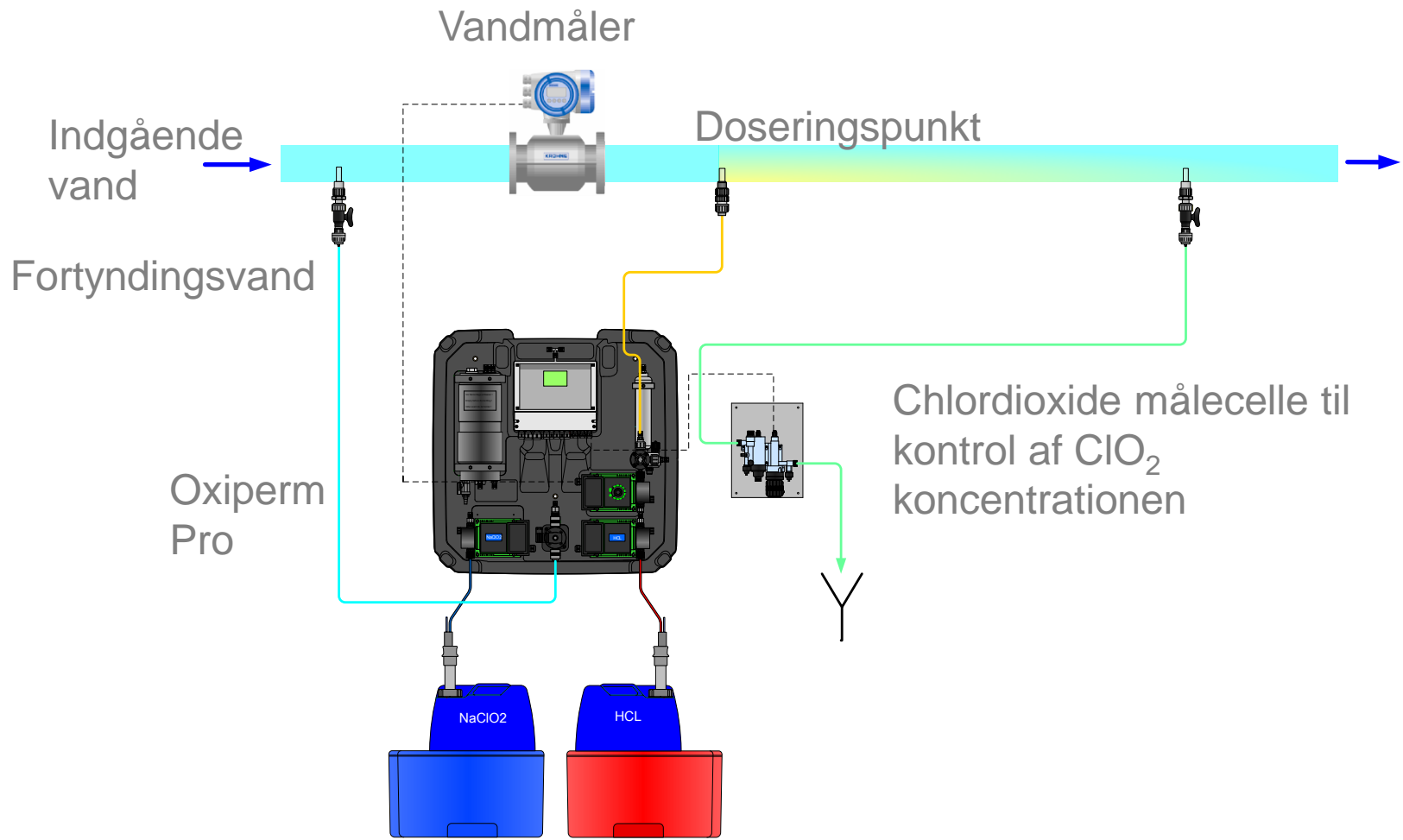
2

Oxiperm - Chlordioxid

- Som permanent løsning eller i stedet for chokklorering
(4 ppm ClO_2 i 6 timer eller 2 ppm i 12 timer)
- Kræver særlig træning for at anvende systemet
- Bliver primært brugt til større systemer, industri, hospitaler og lign.

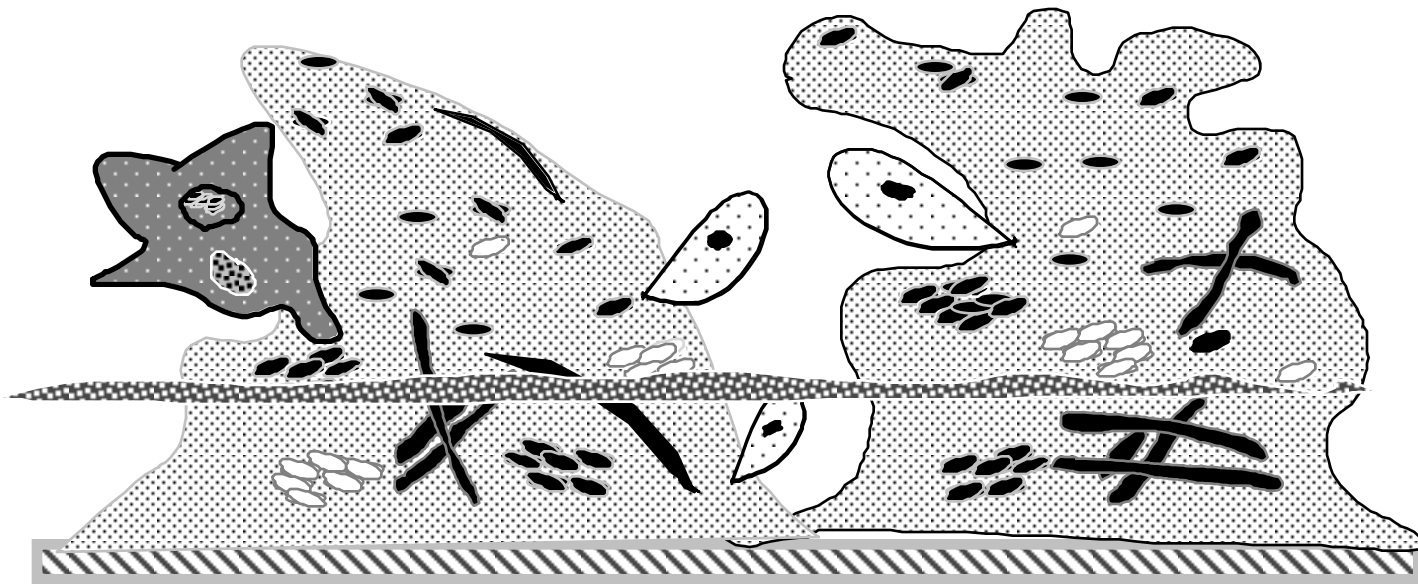


Typisk installation



Legionella trives bedst i et beskyttet miljø som biofilm og protozoer.

Amøber kan indeholde op til 15.000 Legionellabakterier (typisk 1.000).



3



Point of use filtrering - Tandrup

- Sterilfilter ($<0,2 \mu\text{m}$) – hollow fiber
- Brusehoveder, vandhaner
- Straksløsning (midlertidigt) – når uheldet er ude
- Permanent løsning fx. Hospitaler – særligt udsatte patienter





Tak

Legionella and Hot Water Systems

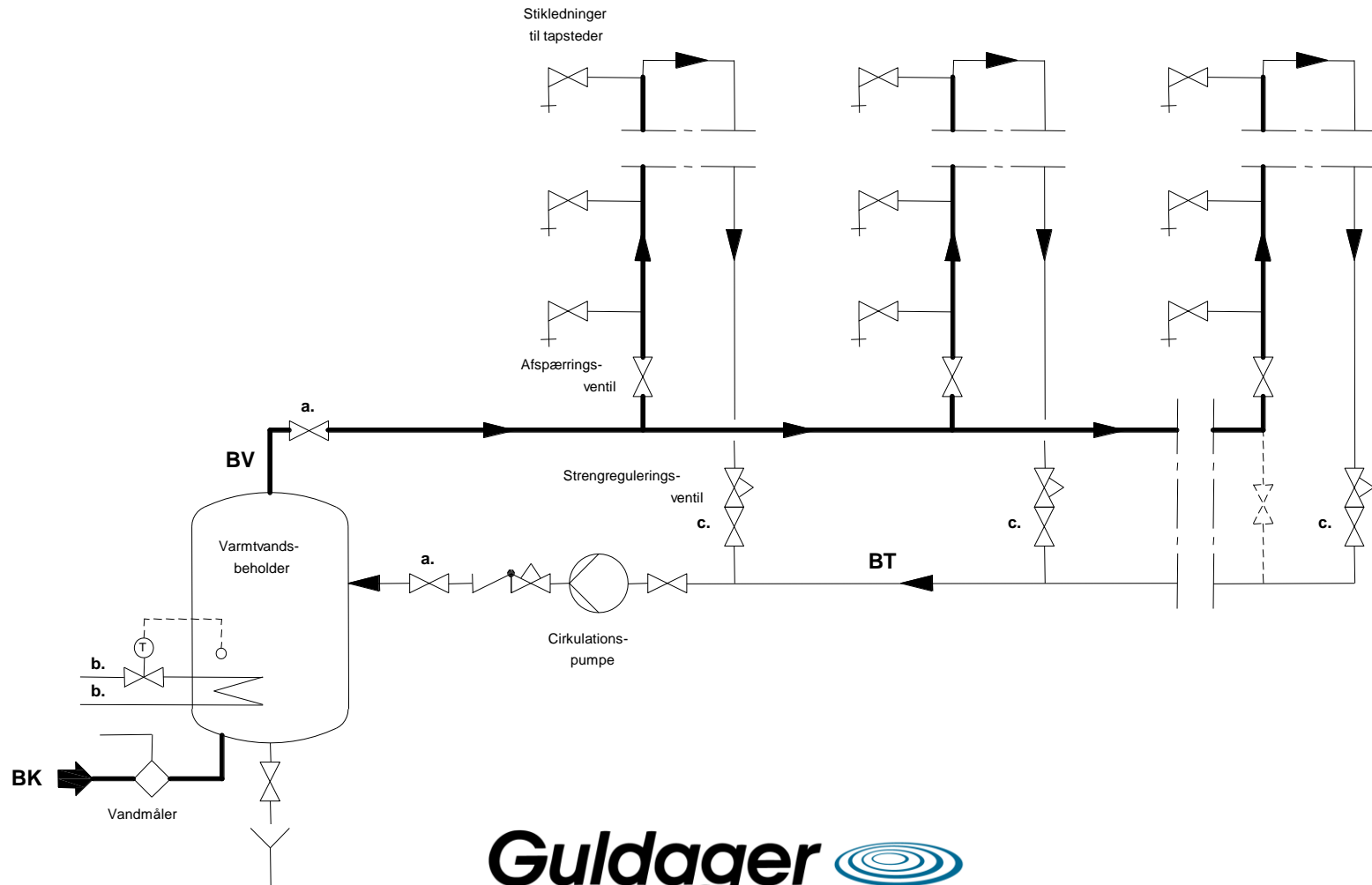
-a holistic approach

Lars Eger

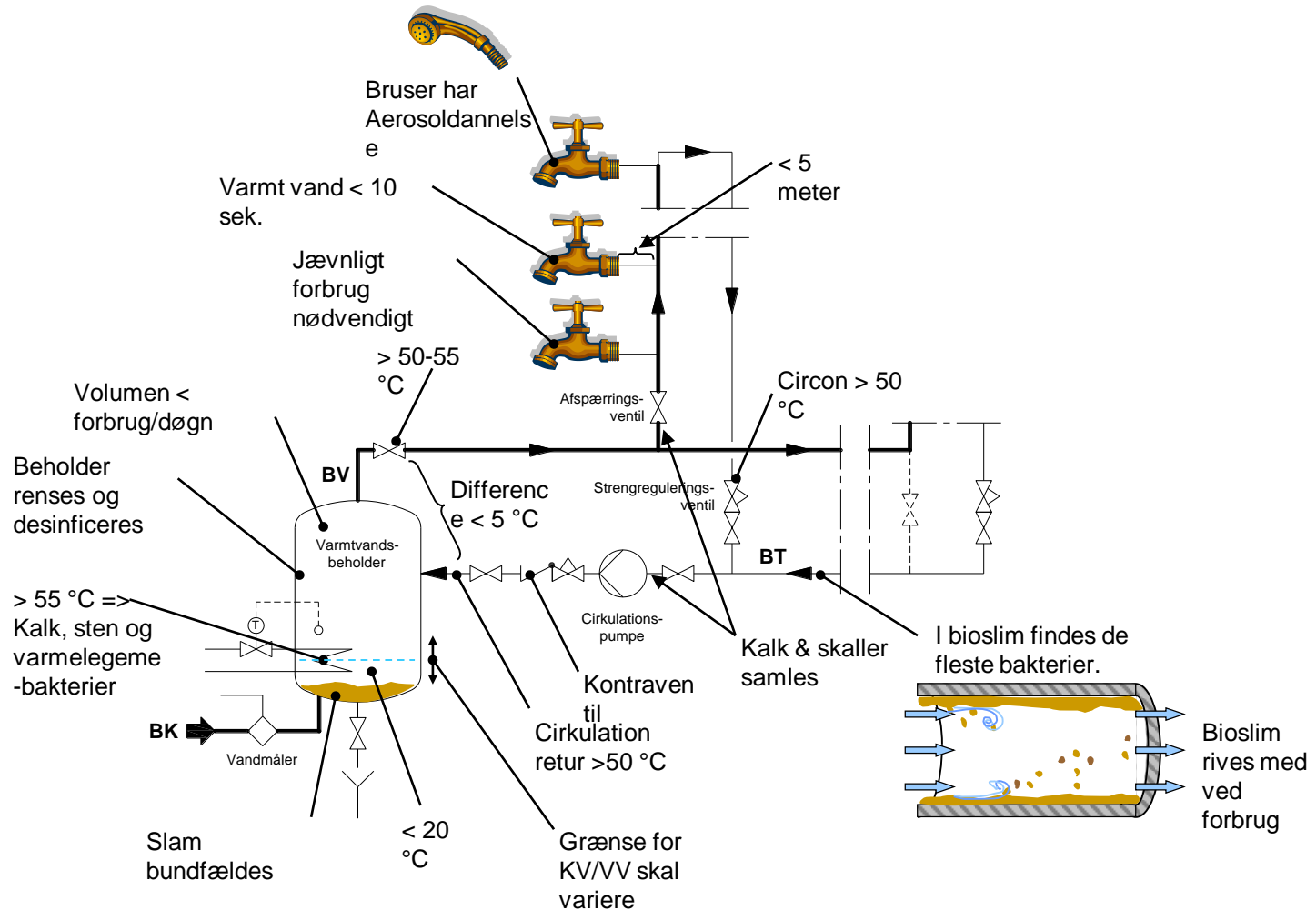
- Chemical Engineer
- Technical chemistry
- Development- and process engineer



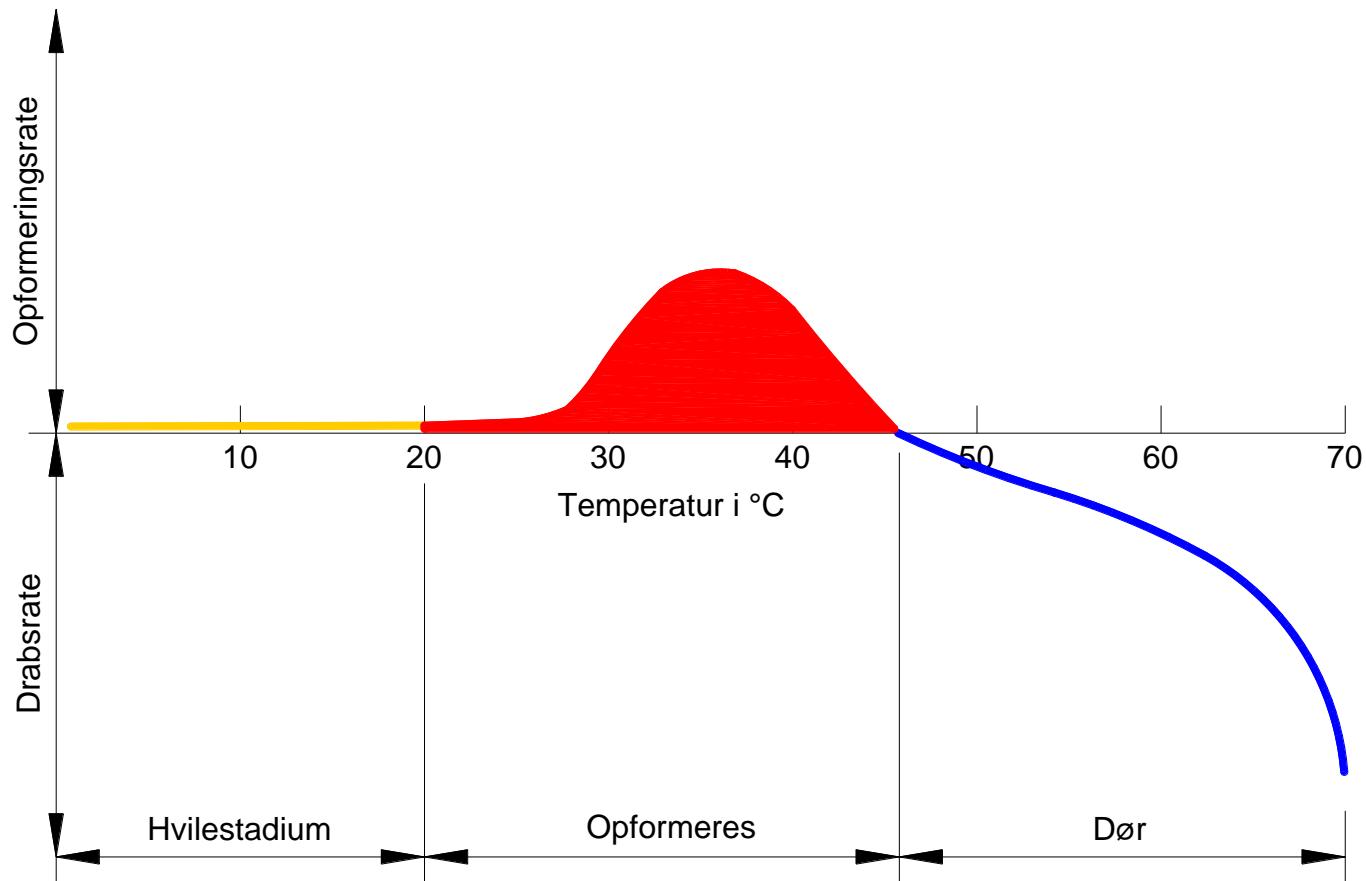
The Installation



Critical Points



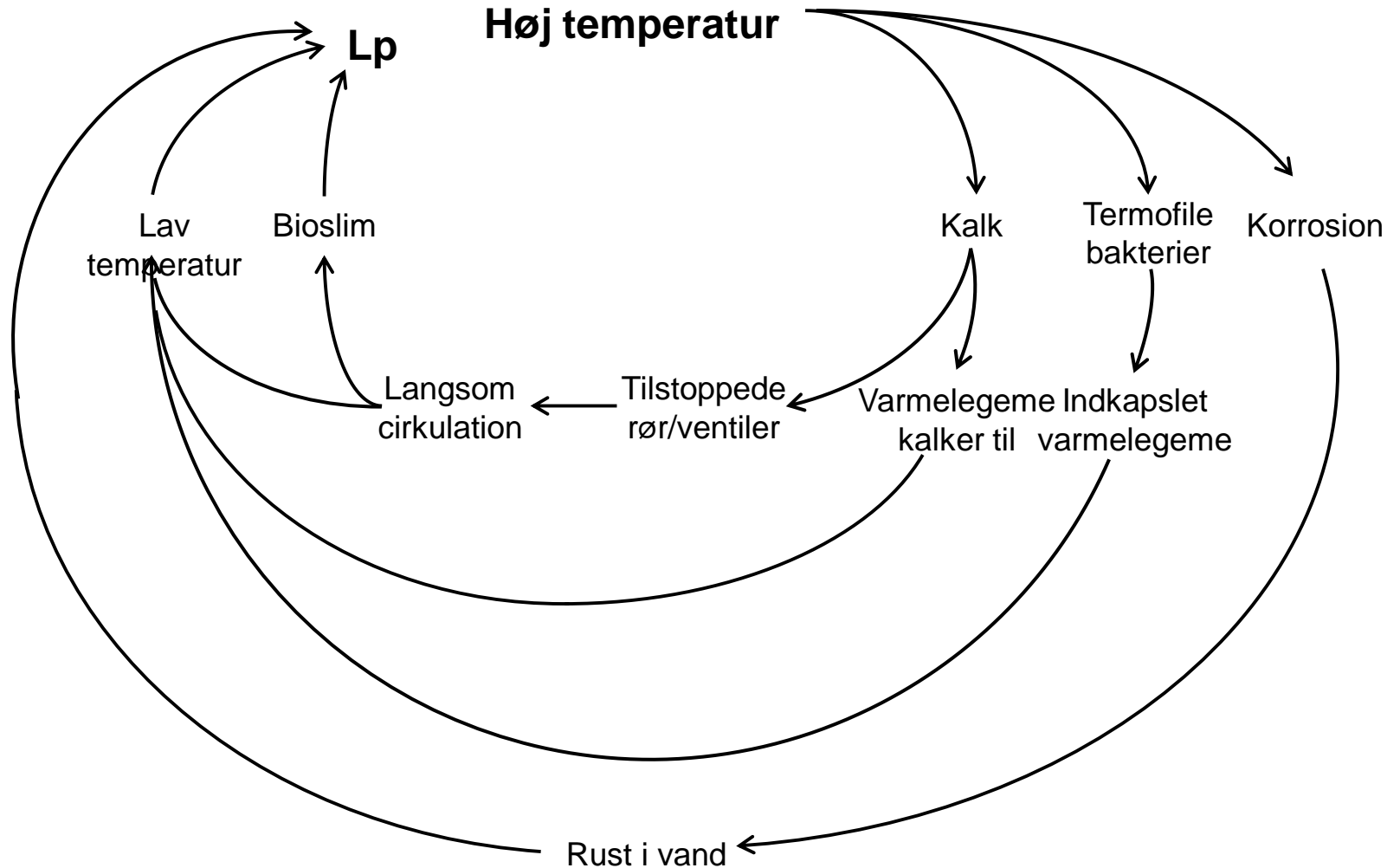
Temperature



Temperature

Temperatur	Effekt på vækst af <i>Legionella</i>
< 20°C	<i>Legionella</i> kan overleve, men er som oftest i et hvilestadie.
20-50°C	<i>Legionella</i> kan vokse, men det optimale temperaturinterval er mellem 35°C og 46°C.
> 50°C	<i>Legionella</i> kan overleve, men der sker ikke vækst
55°C	<i>Legionella</i> dør indenfor 5 til 6 timer
60°C	<i>Legionella</i> dør indenfor 32 minutter. Der er øget risiko for kalkdannelse.
66°C	<i>Legionella</i> dør indenfor 2 minutter

The Vicious Circle



Temperature

T < 50 °C	T = 55 °C	T > 60 °C
Lower energy consumption High risk of Legionella	Normal energy consumption Low risk of Legionella	Higher energy consumption Low risk of Legionella Risk for vicious circle

Waterborne pathogens

- Legionella
- Pseudomonas Aeruginosa
- Stenotrophomonas Maltophilia
- Chryseobacterium
- Aspergillus
- MRSA

Additional Measures

- End filtration
- Thermal chock
- Tracing
- Ultra filtration
- UV
- Ozone
- Chloramine
- Copper and silver
- Chlorine generator
- Hypochlorite
- Chlorine dioxide

Statens Serum Institut

Reaktions grænser efter Legionella prøvetagning i varmt og koldt vand systemer 2018	
Legionella bakterier (cfu/liter)	Handling påkrævet
$1.000 < X < 10.000$	<p>Hvis en mindre del af prøverne (10-20 %) i systemet er positive, skal der tages opfølgende prøver. Hvis et lignende antal genfindes, bør der laves en gennemgang af kontrolforanstaltninger og risikovurdering bør udføres for at identificere eventuelle afhjælpende foranstaltninger.</p> <p>Hvis størstedelen af prøverne er positive, er systemet muligvis koloniseret med Legionella, om end i lavt antal. Desinfektion af systemet skal overvejes, men der bør udføres en umiddelbar gennemgang af kontrolforanstaltningerne. En risikovurdering bør udføres for at identificere eventuelle andre relevante afhjælpende foranstaltninger.</p>
$10.000 < X$	<p>Der bør tages opfølgende prøver og en øjeblikkelig gennemgang af kontrolforanstaltninger og en risikovurdering bør udføres for at identificere andre relevante afhjælpende foranstaltninger, blandt andet desinfektion af systemet.</p>

Statens Serum Institut

- *Skærpelse af retningslinierne i "Legionella i varmt brugsvand - SSI vejledning".*
- *Legionella pneumophila serogruppe 1 Pontiac er en skærpende omstændighed*
- *På plejehjem og hospitaler bør der være < 100 cfu/L, andre steder under 1000 cfu/L*

Bekendtgørelse om bygningsreglement 2018

- **§ 388.** Brugsvandsanlæg skal dimensioneres og udføres, så risikoen for vækst af legionellabakterier i det varme vand minimeres. Dimensionering og udførelse skal ske som anvist i *DS 469 Varme- og køleanlæg i bygninger* og i overensstemmelse med kapitel 21.
- Rørcenteranvisning 017 Legionella – Installationsprincipper og bekæmpelsesmetoder.





Low temperature DH solutions on demand side

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Technical University of Denmark
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Introduction

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

Solutions for existing buildings and existing DH network:

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

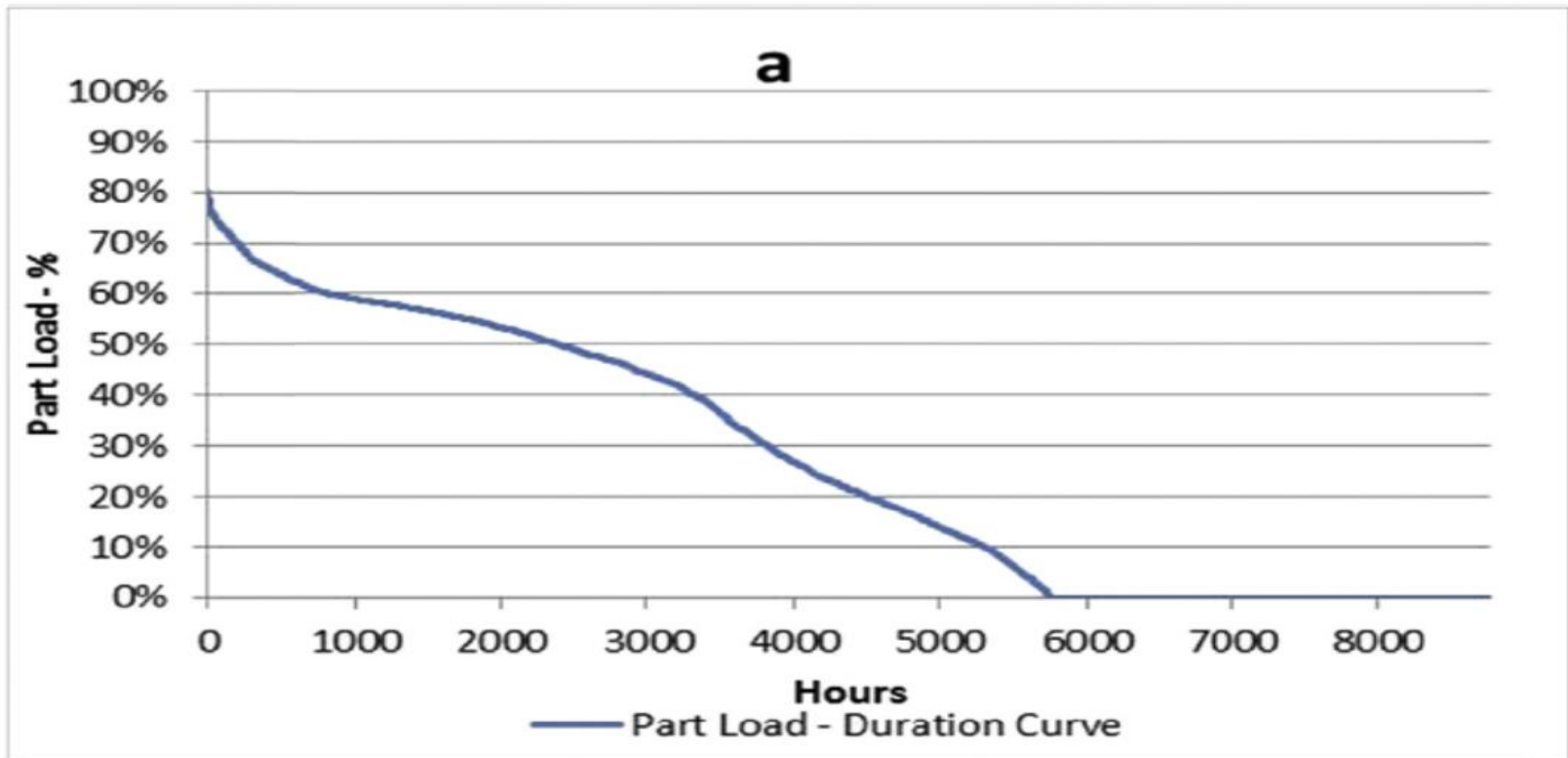
Solutions for new buildings and new DH network:

- **LTDH in medium and high heat density areas**
- **UTDH in low heat density areas**

Solutions for existing buildings

low temperature heating of rooms

- Focus on existing buildings with radiators
- Radiators are OK for LTDH due to part load



Solutions for existing buildings

low temperature heating of rooms

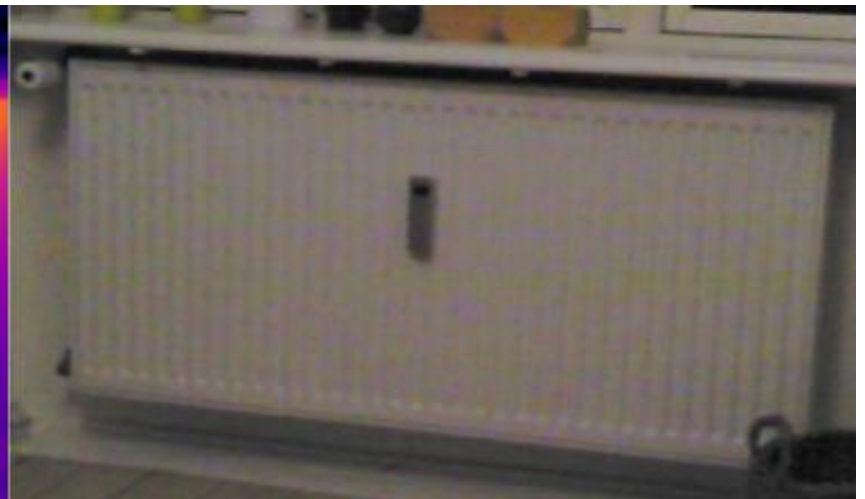
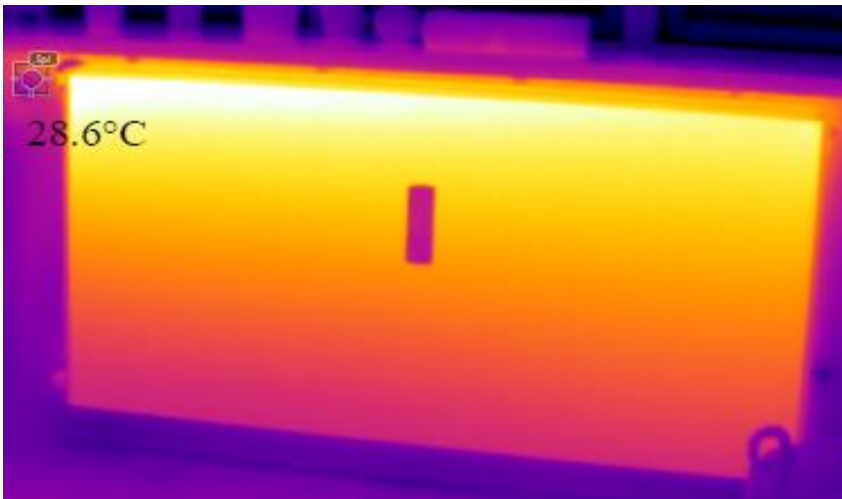
- Problem areas:
 - Type of pipe systems
 - Type of radiators
 - Type of control system
- Optimization of supply / return temperature

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 is a benefit for reduction of return temperature
- Make the system function correct instead of compensating for errors

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
 - Secures a robust solution in the real world

Optimization of supply and return temperature

Optimize the benefit
of lower T_s and T_r in
district heating system for
required LMTD of buildings

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

where φ and φ_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 ($^{\circ}\text{C}$), 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 ($^{\circ}\text{C}$), T_R the return temperature ($^{\circ}\text{C}$) and T_i is the indoor operative temperature ($^{\circ}\text{C}$).

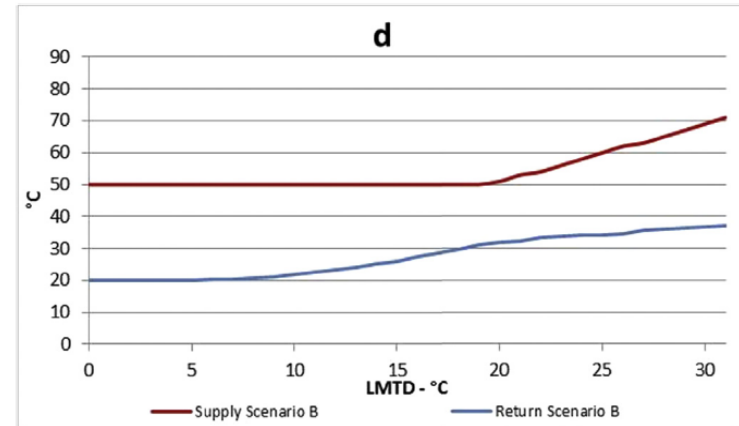


Fig. 8. Scenario B supply and return temperatures: optimization results.

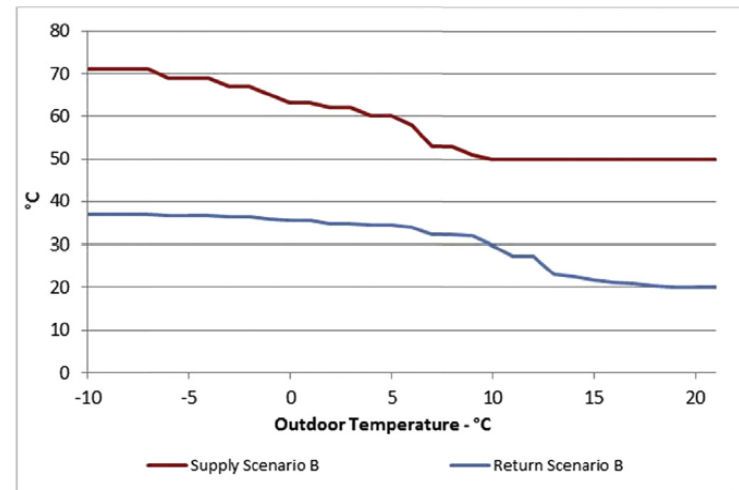


Fig. 9. Scenario B relation between optimized supply/return and outside temperatures.

Evaluation of solutions for low temperature heating of rooms in existing buildings with existing radiators

- 1. Lower return temperatures:
 - **Big potential BUT:**
 - Errors must be fixed
 - Return temperature control necessary
- 2. Lower supply temperature:
 - When the heating system is working correct based on step 1 the supply temperature can be lowered
 - When windows are replaced T_s can be lowered

Solutions for low temperature heating of DHW in existing buildings

- 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 – in renovated buildings
- **Existing buildings with DHW tanks and circulation may be improved now to lower the return temperature**

Problem with existing control system

- Tanks are typically reheated with very high capacity in short time after peak draw off due to oversized valves and thermostatic control
- Supply of heat to the circulation line during night periods without use of DHW results in high return temperatures

Solution:

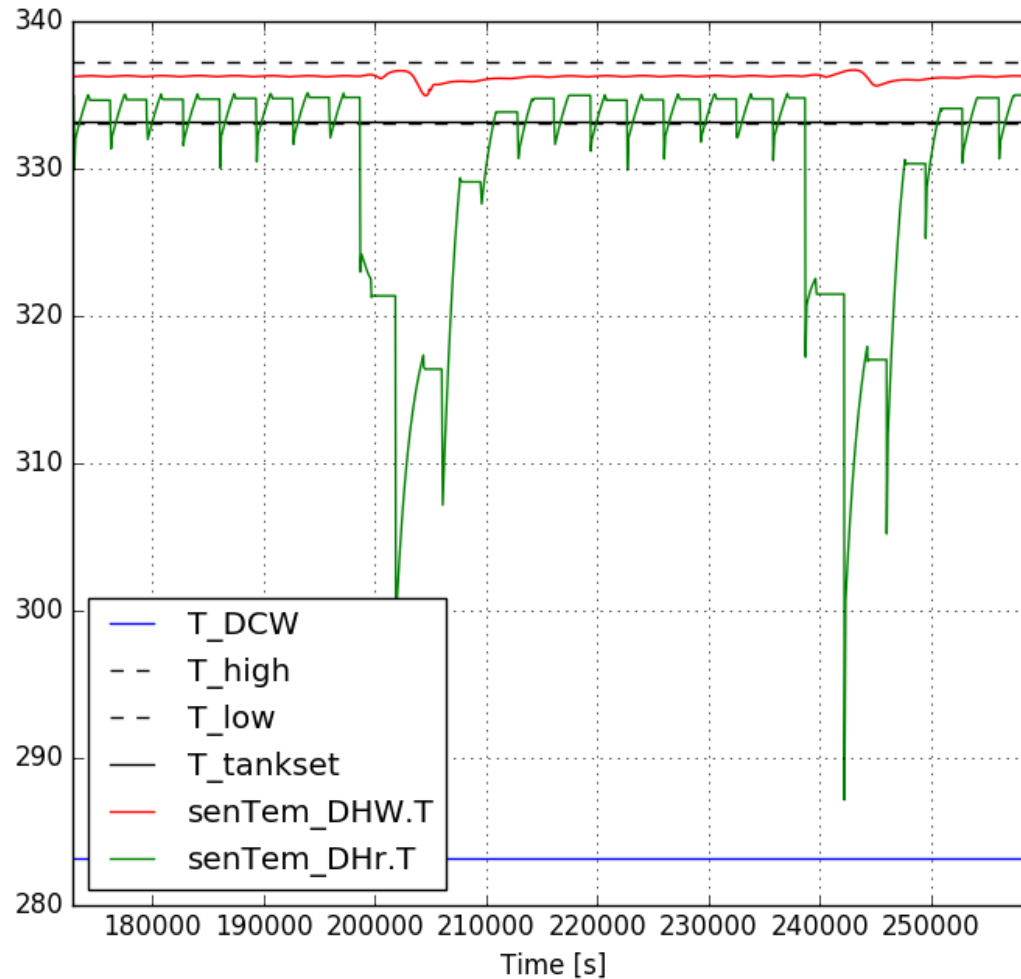
Improved control of DHW tanks

- Measure use of DHW in some weeks and set up typical daily profiles of DHW use
- Measure DH to DHW tank and use power signal for control of reheating
- Reheat the tank with a low power that just reheat the tank before the next peak load.
- This can combine heat supply for circulation heat loss and heating of cold water in the tank and lower the return temperature

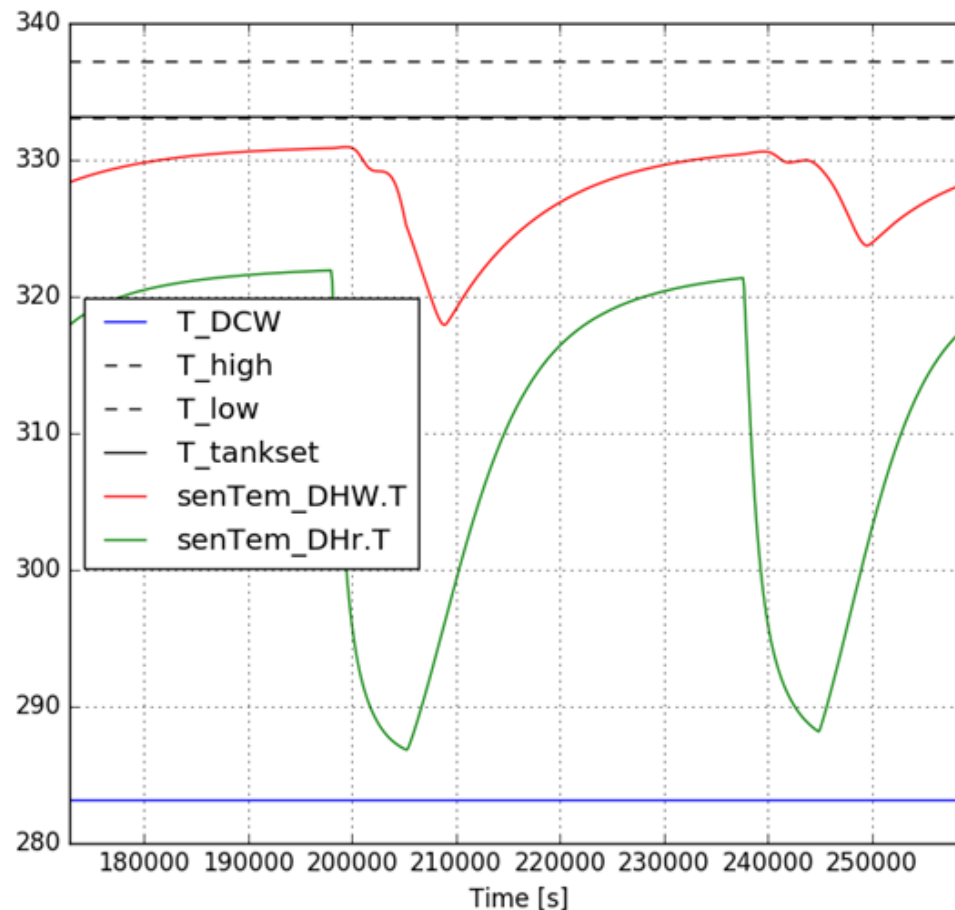
Typical system with high charging flow (0.25kg/s)

Average return temperature of 56°C

Kelvin



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



Implementation of solutions in existing buildings with existing DH

Step 1: low return temperature NOW

- 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 improved motivation tariffs.

Step 2: low supply temperature (when change in production in 0-20 years makes it beneficial)

- based on step 1 and general renovation over time

Solutions for room heating in new buildings with LTDH and UTDH

- Usual 40°C supply and on-off thermostat results in high return temperature and over heating
- Floor heating from flat station with improved control:
 - minimum supply temperature: 23- 30°C
 - Thermostat with pulse width modulation control
- Secures low return temperature and minimum overheating

Solutions for DHW heating in new buildings with LTDH

- Flat station with direct production of DHW in each flat.
 - The supply of heat to the flat stations for both room heating and DHW heating reduces heat loss. (2 pipes versus 4 pipes)
 - Quick supply of DHW in summer can be made with use of bath room floor heating to keep the riser warm. (Bypass as back up)

Solutions for DHW heating in new buildings with UTDH

- Same solution as for LTDH but with supplementary direct electrical heating of DHW to 50- 45°C
- If power supply to electrical heater is a problem limitations of DHW flow may be developed to secure comfort temperature of DHW (shower flow less critical than shower temperature)

Evaluation of solutions for low temperature heating of new buildings

- Big potential (easy) – optimization relevant:
- Realistic fine time based simultaneity data may be important to optimize the design the systems.
- Operation must be controlled and serviced
- **Network** with supply and return loops to:
 - Avoid bypass mixing of supply and return temp.
 - Improve transfer of heat input from prosumers

“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 76779”



Integration of renewables on demand side – Dos and Don’ts



Mårten Ahlm
KAM & Specification
District Heating & Cooling Systems



Co-funded by
the European Union



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828 cool meters

COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union



www.alfalaval.com

10 tallest buildings in the world



Burj Khalifa
UAE
828 m/163 floors



Shanghai Tower
China
632 m/121 floors



Makkah Royal Clock Tower
Saudi Arabia
601 m/120 floors



Ping An Finance Center
Shenzhen China
599 m/115 floors



Lotte World Tower
Seoul
544.5 m/123 floors



One World Trade Center
USA
541 m/104 floors



Guangzhou CTF Finance Center
China
530 m/101 floors



Taipei 101 Taiwan
508 m/101 floors
Ready: 2004



Shanghai World Financial Center
China
492 m/101 floors



International Commerce Centre
Hong Kong
484 m/118 floors

A global company, key figures 2016



- Founded in 1883
- Represented in > 100 countries
- ~17 500 employees globally
- Turnover of 4 billion €

3 Key technologies

- Heat transfer
- Separation
- Fluid handling



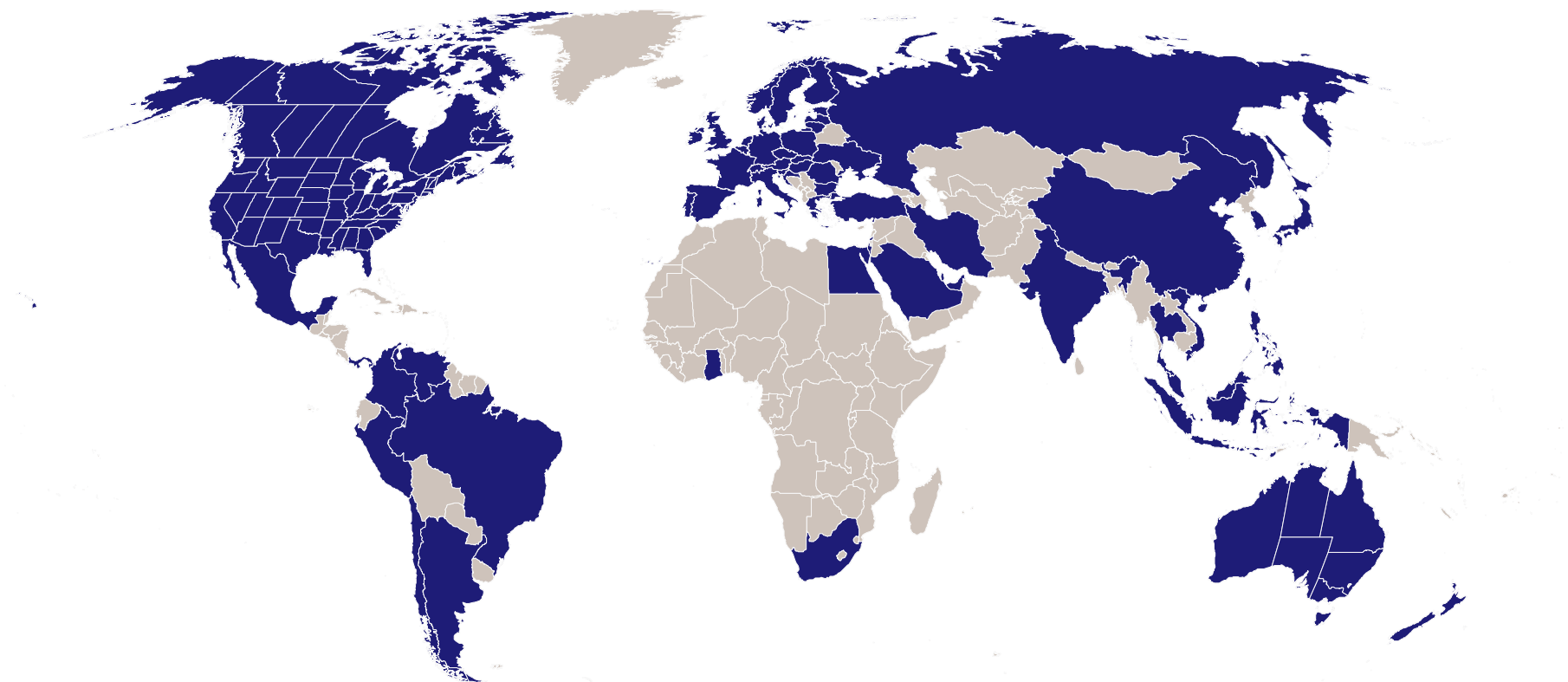
COOLDH
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..with strong local presence



COOL DH
COOL DISTRICT HEATING

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District Heating, DHW, District Cooling

- a full range of optimized systems/solutions



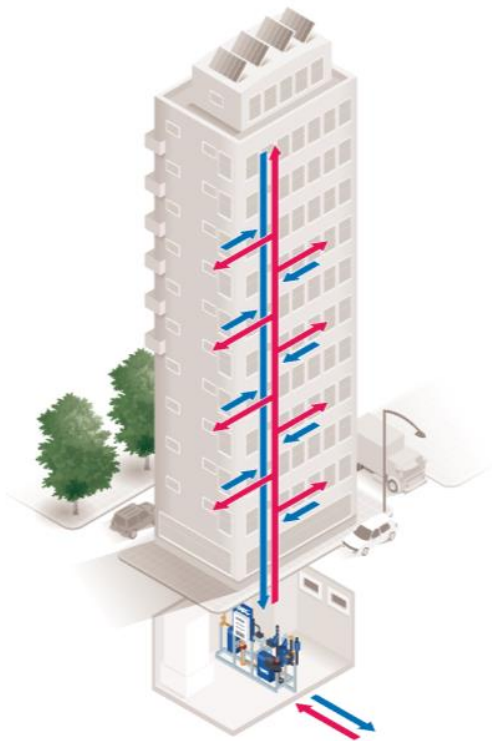
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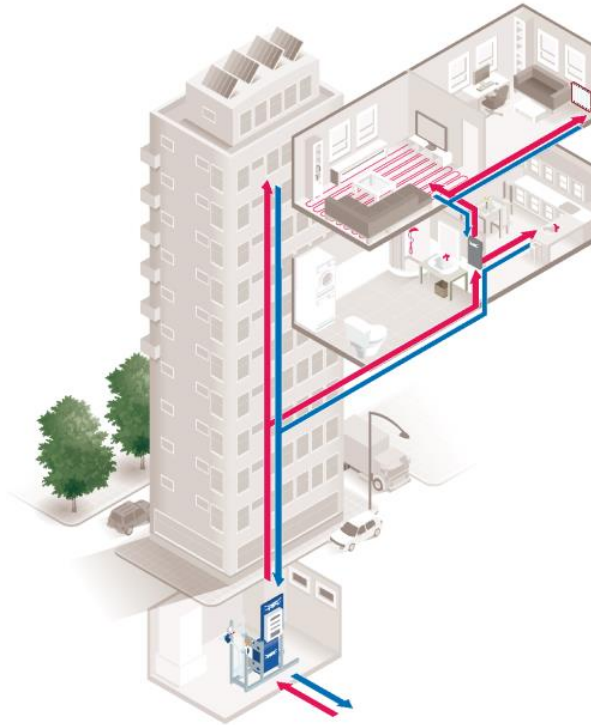


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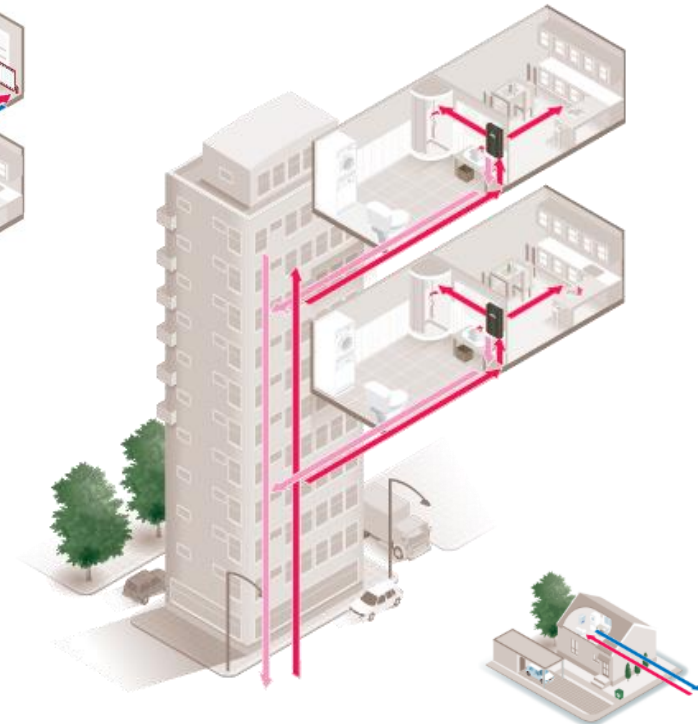
Substations, Heating and DHW



**Traditional
Substation**

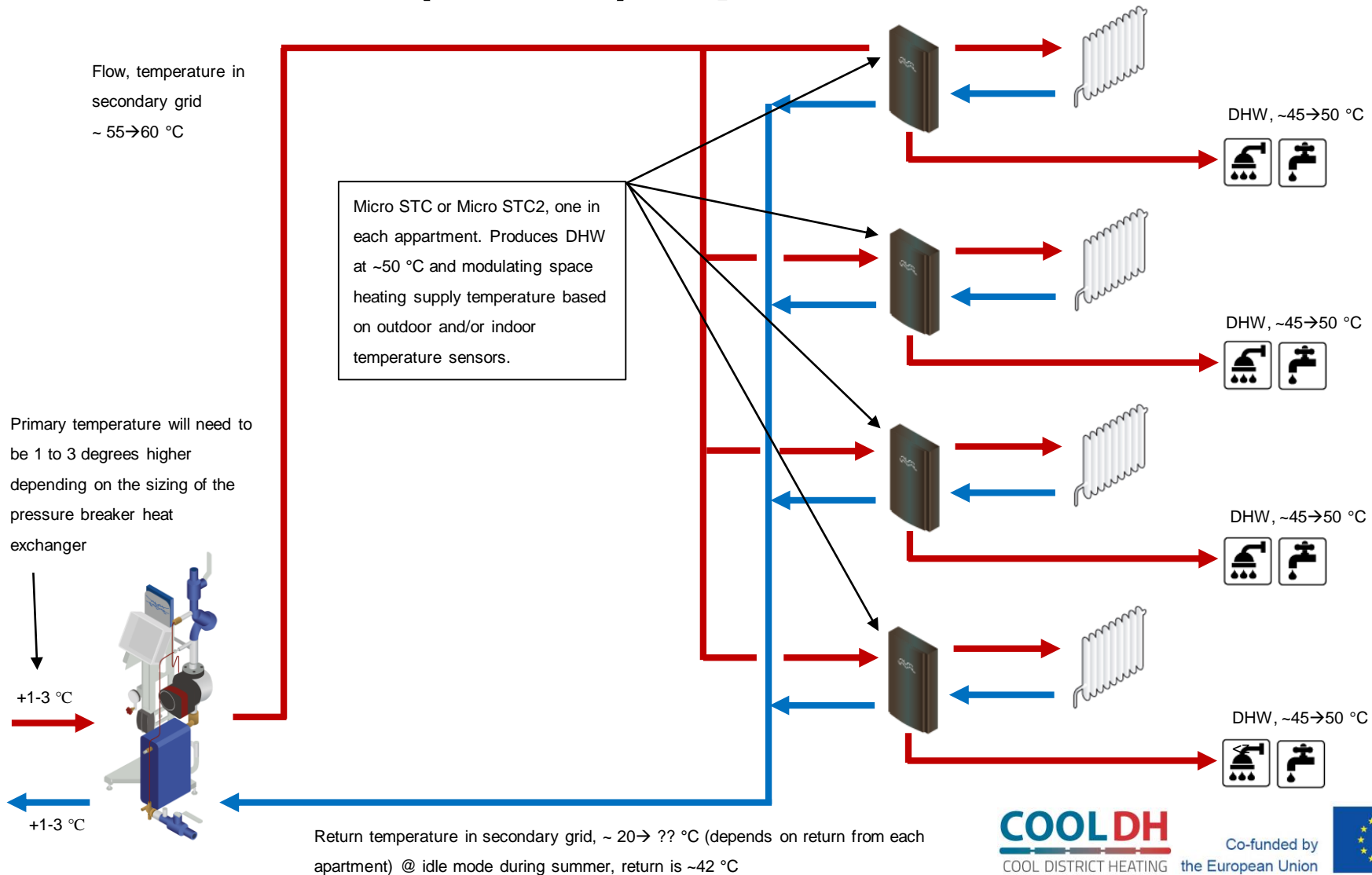


HIU, Direct units
In combination with
substation in basement



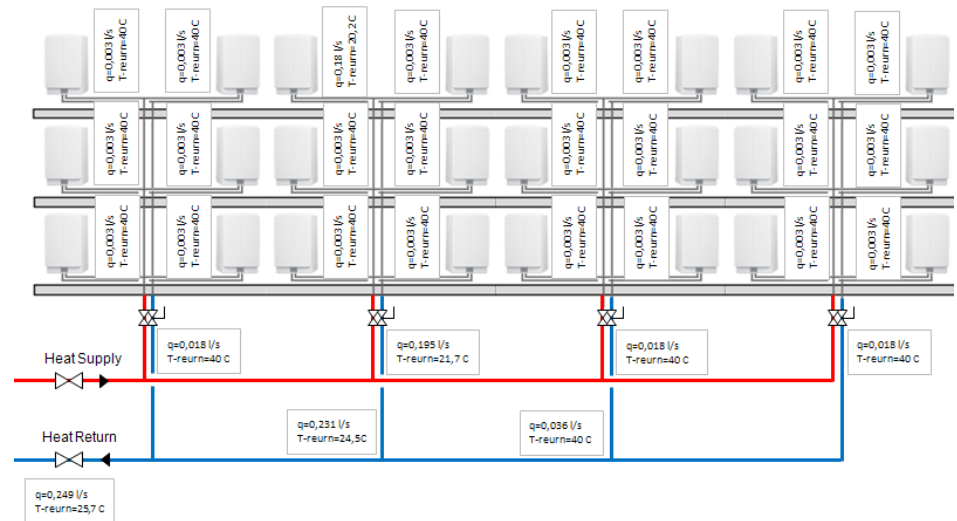
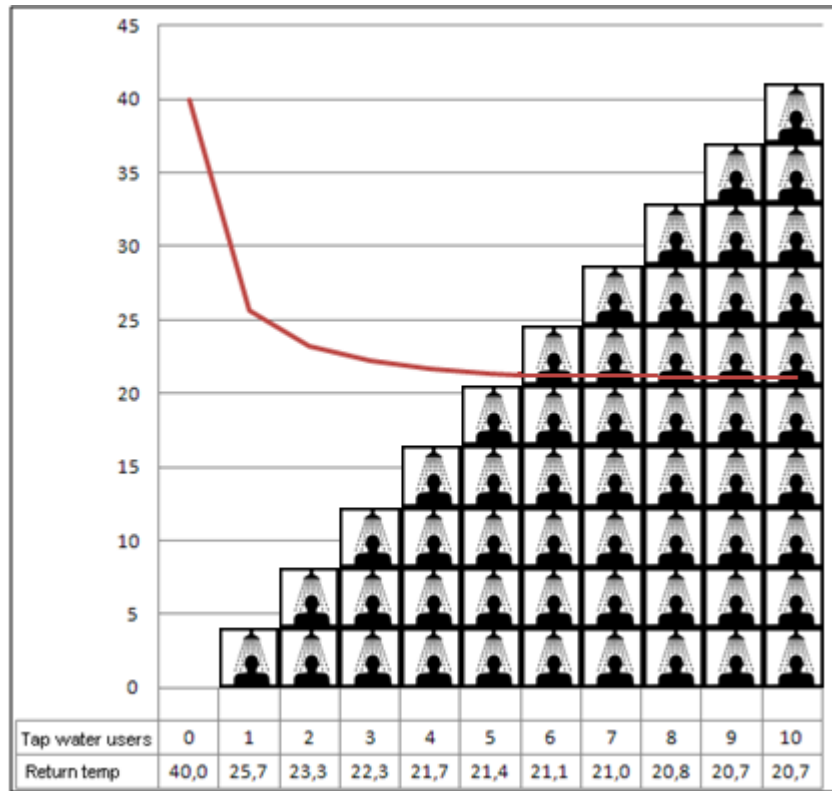
HIU, Indirect units
No added pressure breaker needed

HIU's (direct) + pressure breaker



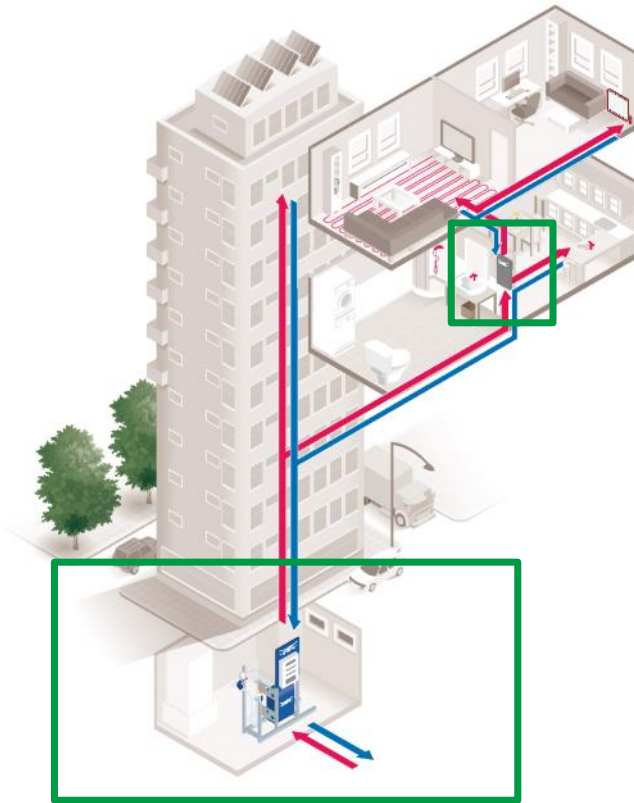
Success factors for high efficiency systems and integration of Renewable

- Low return temperature from hot water system
- Simulation of hot water use for 24 apartments (no heating in use)



Local integration of supplemental heat

- Heat recovery or renewable sources



Integration of heat recovery
sources in substations in
basement

Local heat sources could be

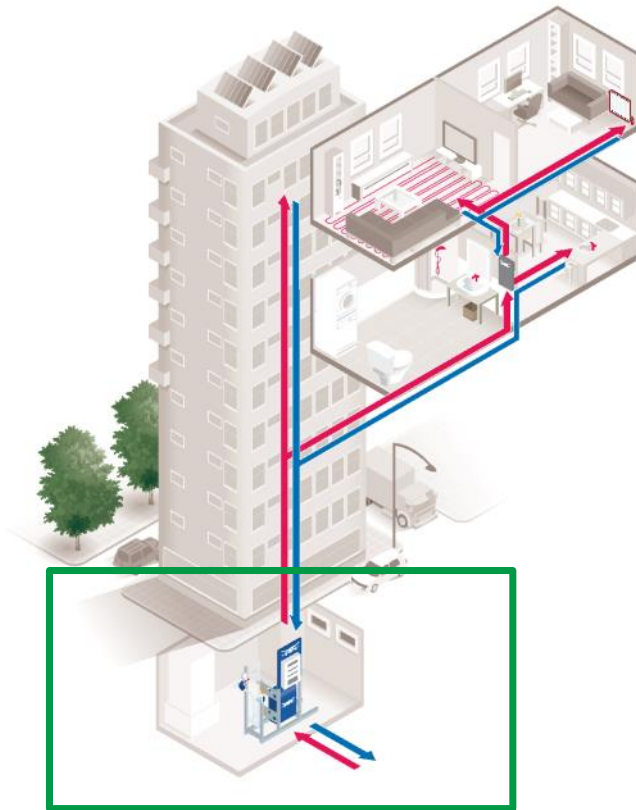
- Exhaust air, waste water etc. (heat pump)
- Thermal solar panels

Have in mind that:

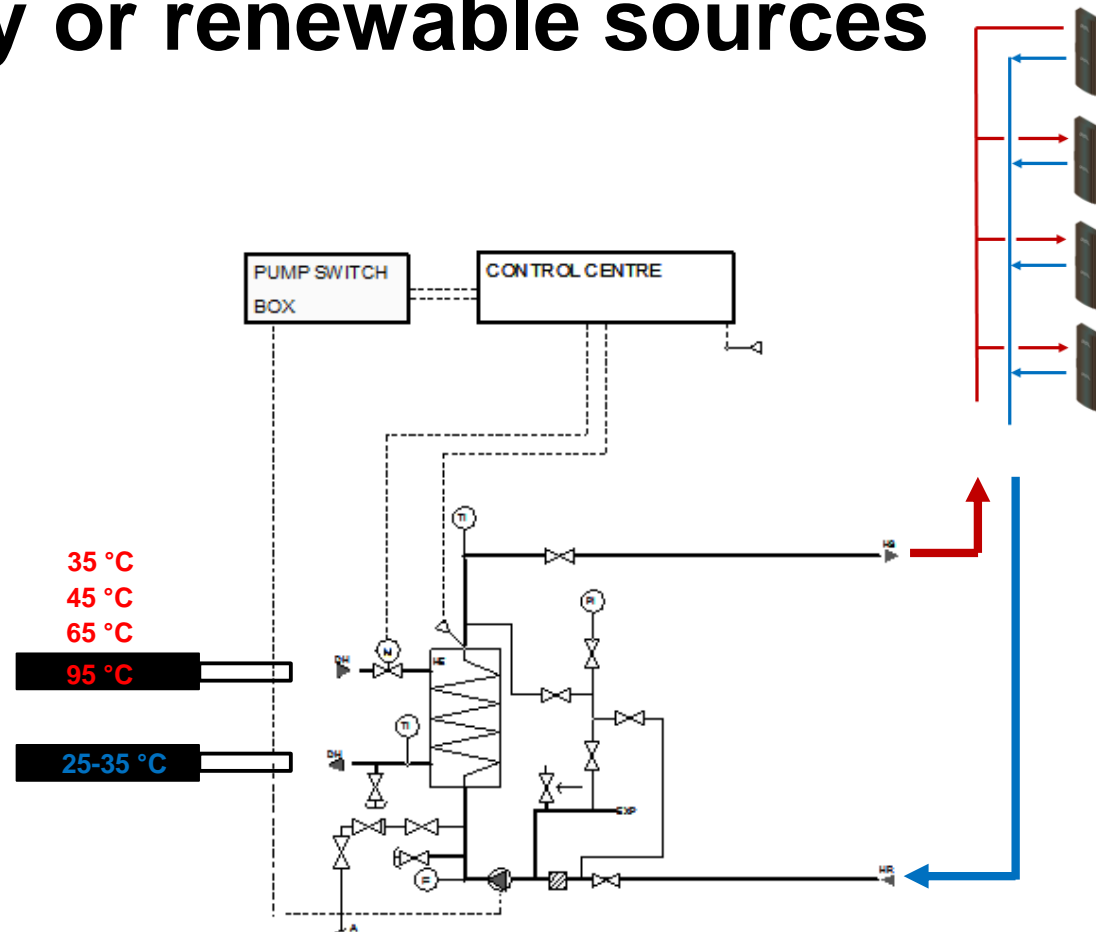
- District heating is **the primary** heat source
- → Local supplemental heat recovery or renewables is **not** the primary heat source
- District heating **return temperature** have to be prioritized = be as low as possible
- Keep the design as **simple and reliable** as possible
- Always **avoid** to design systems with **storage** of tap water

Local integration of supplemental heat

- Heat recovery or renewable sources



Integration of heat recovery
sources in substations in
basement



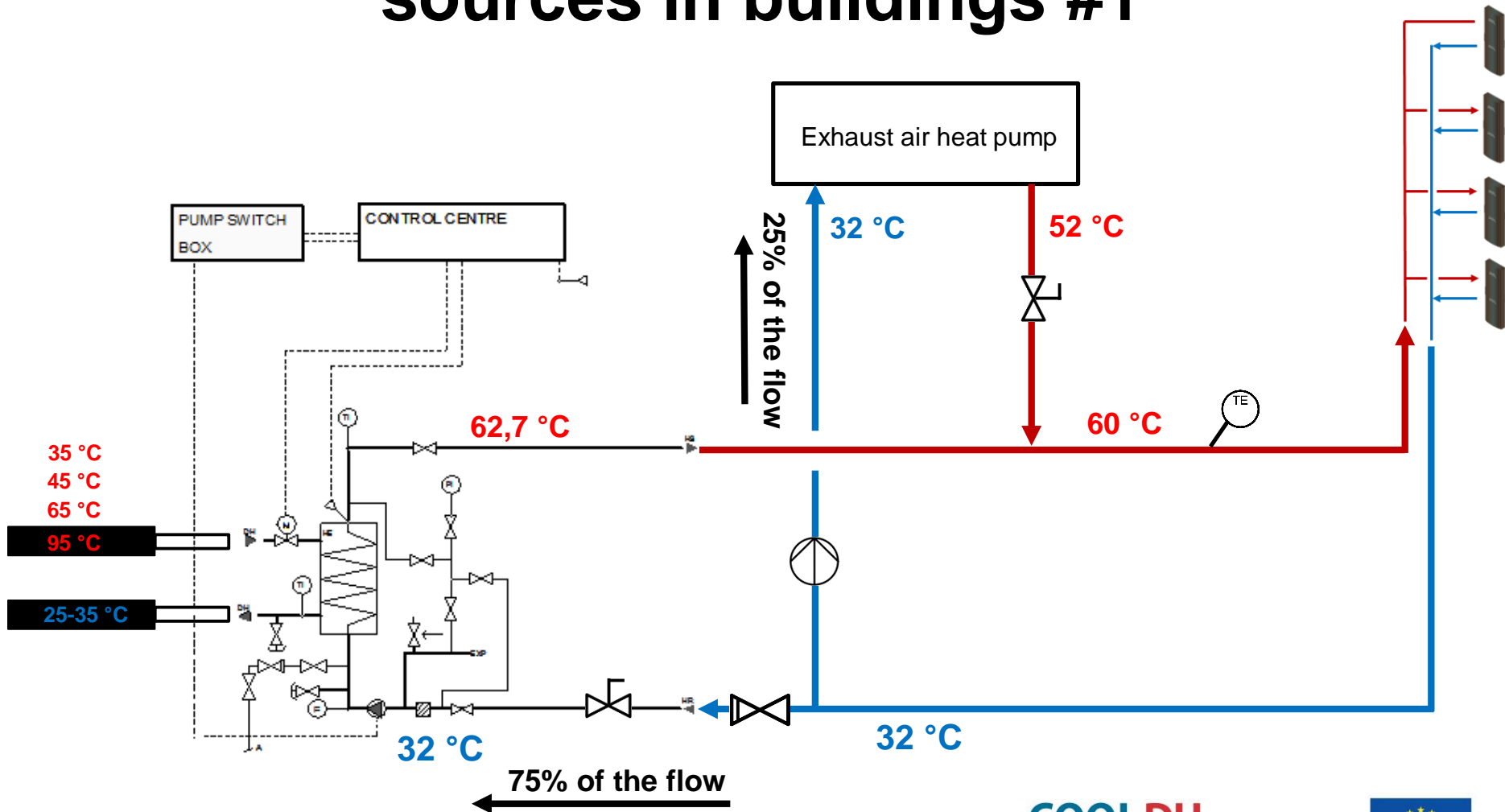
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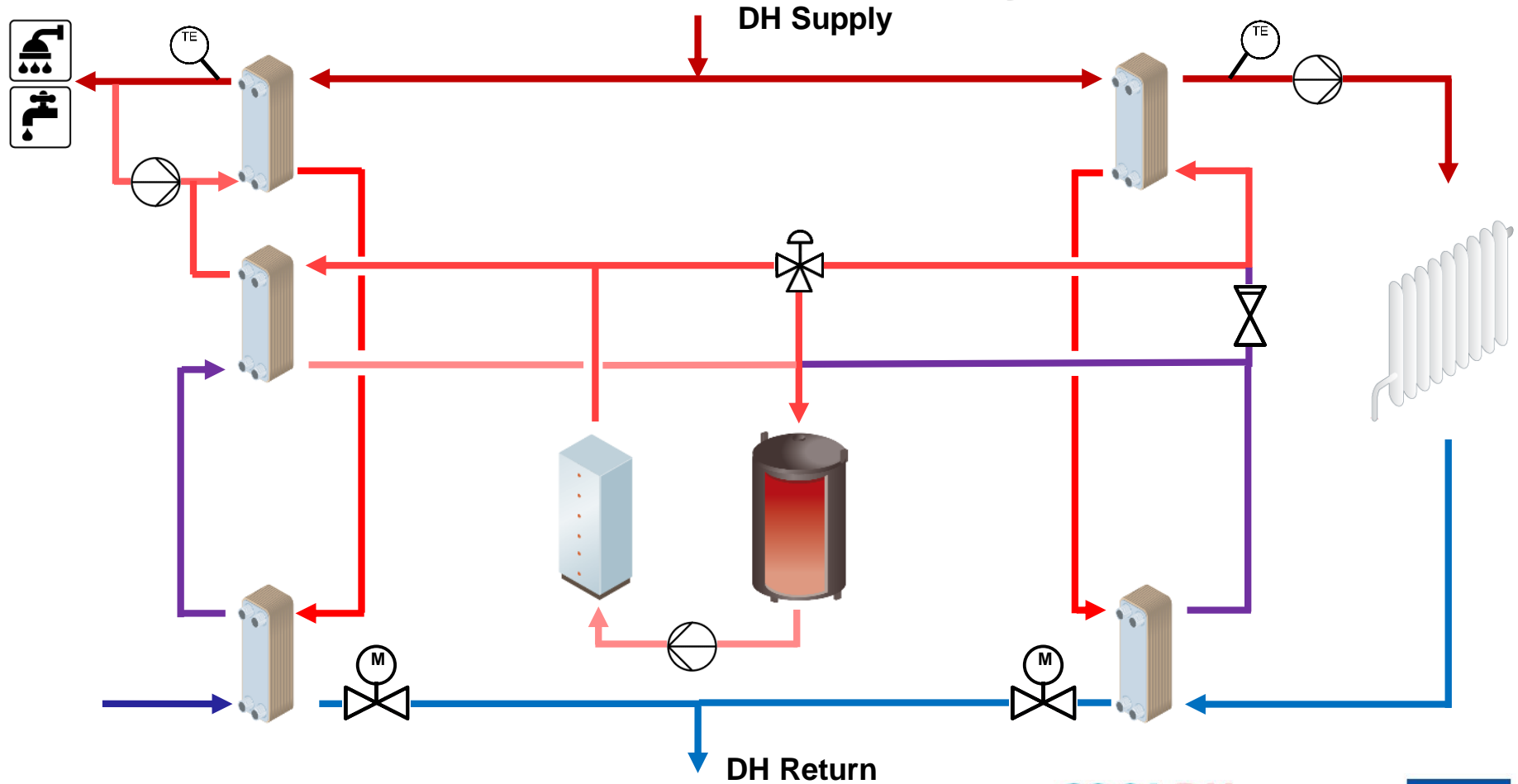


www.alfalaval.com

Local integration of supplemental energy sources in buildings #1



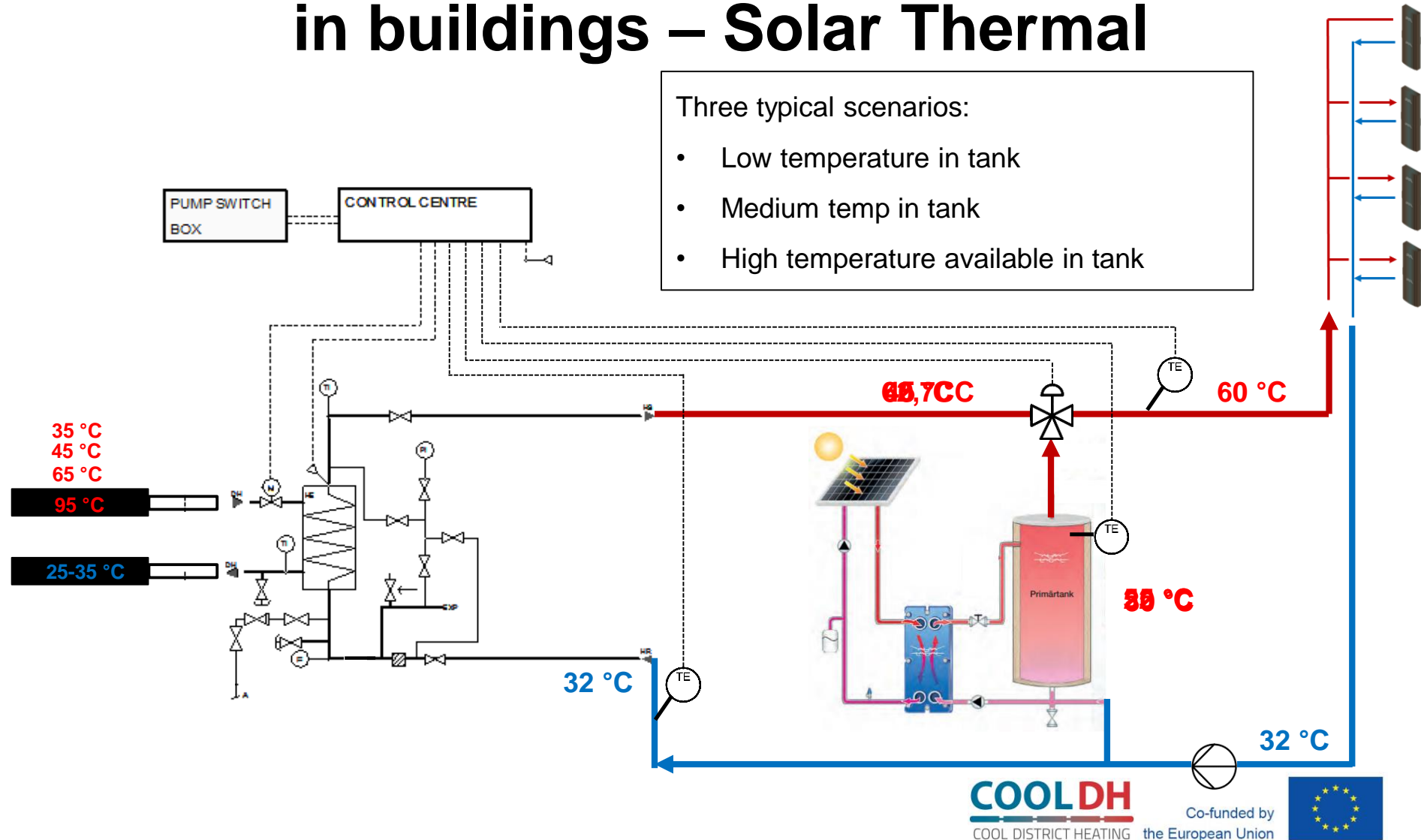
Integration of supplemental energy sources in buildings #2



Integration of supplemental energy sources in buildings – Solar Thermal

Three typical scenarios:

- Low temperature in tank
- Medium temp in tank
- High temperature available in tank

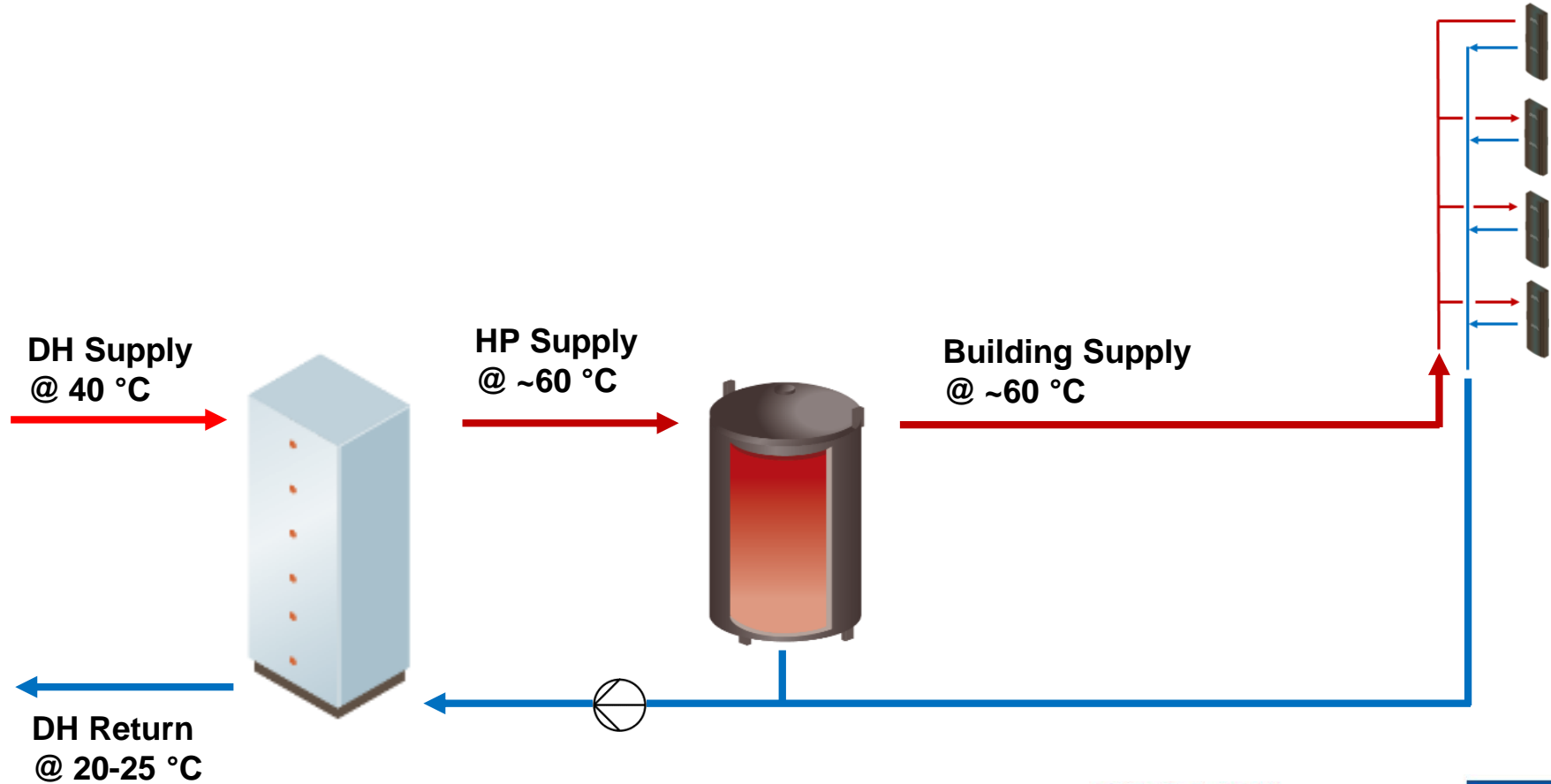


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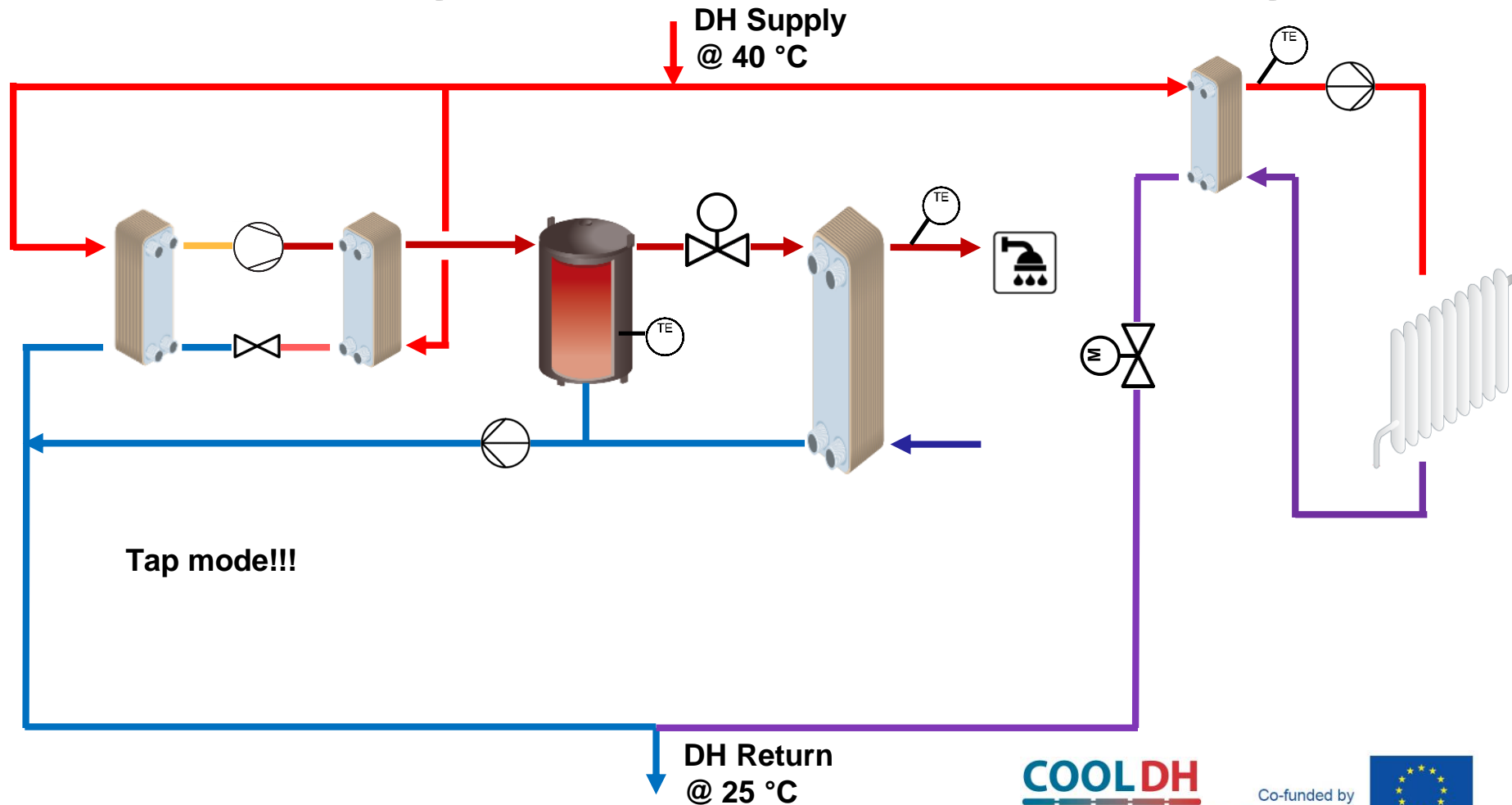
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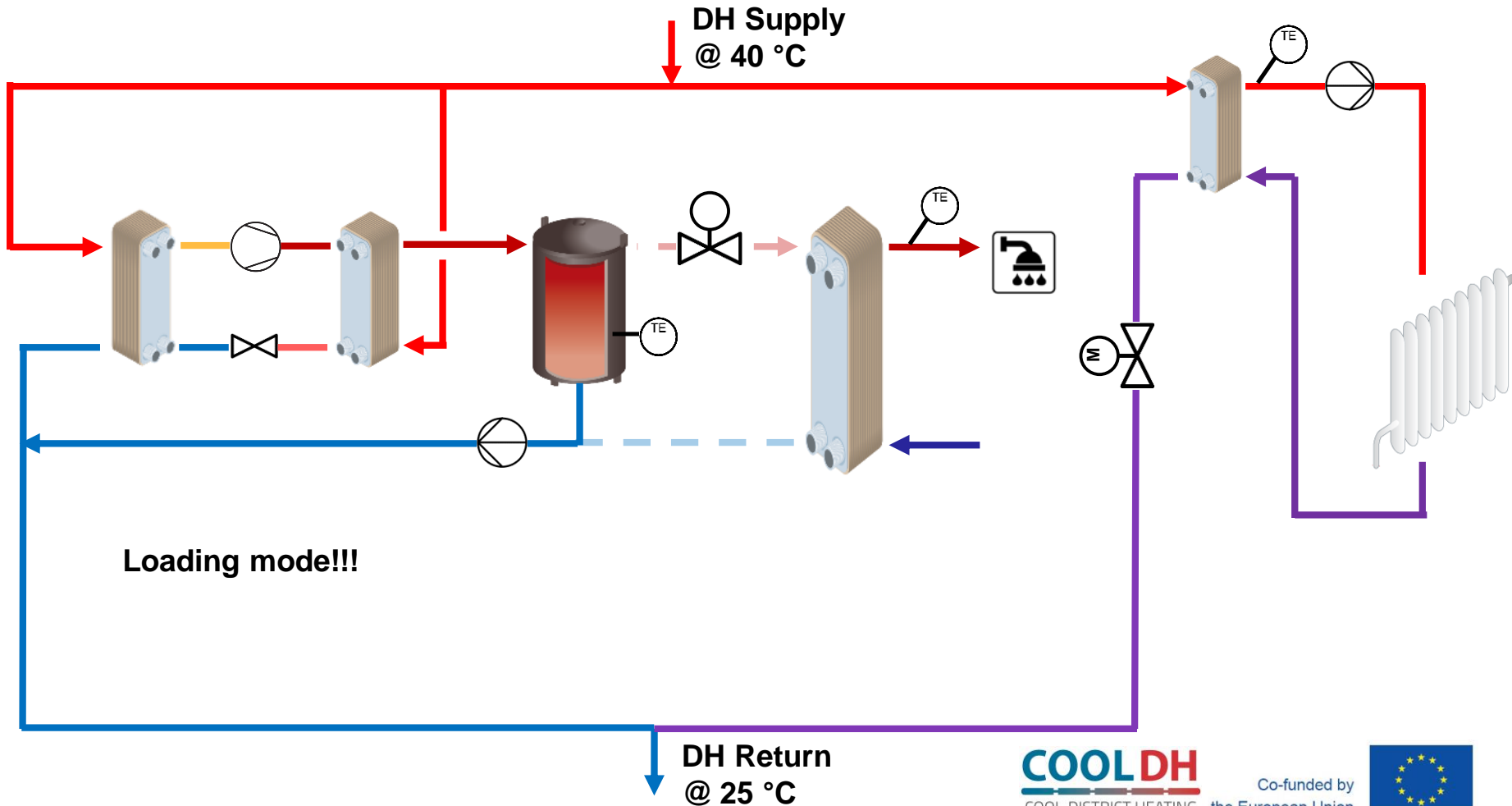
Integration of supplemental energy sources in buildings – Temperature Topping #1



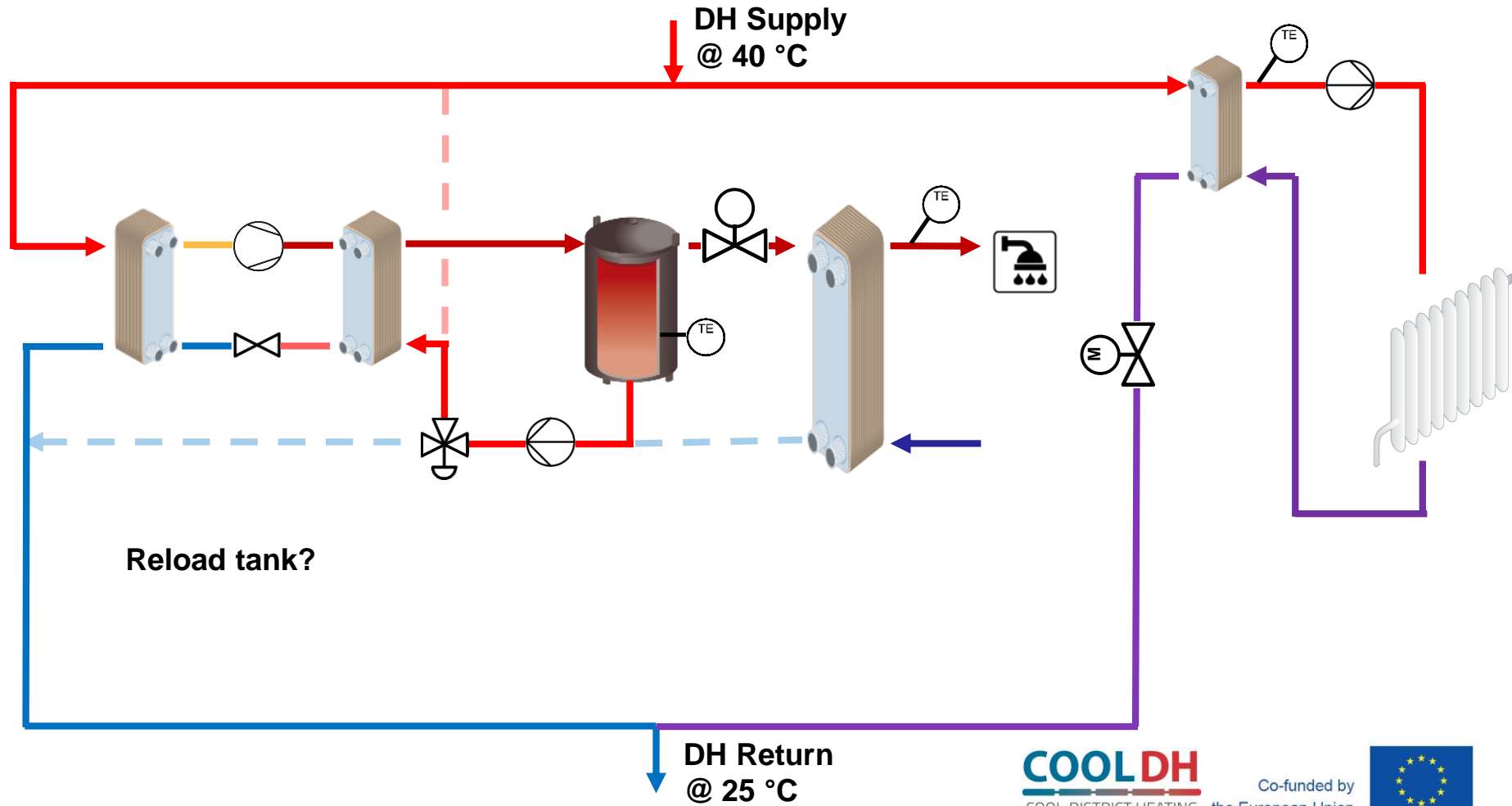
Integration of supplemental energy sources in buildings – Temperature Topping #2



Integration of supplemental energy sources in buildings – Temperature Topping #2



Integration of supplemental energy sources in buildings – Temperature Topping #2



Xplorion



“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 76779”

Vision

- Apartments where tenants can influence their environmental impact in a new way.
- It should not just be possible to choose environmentally friendly, but even to not use energy, materials and products.
- This way of thinking will be used throughout the entire project from planning to maintenance. Our wish is to minimize use of products and materials as much as possible.

*'To play football is very simple,
but playing simple football is the
hardest thing there is'*

- Johan Cruijff

Xplorion, out of the ordinary

Structural:

- Passive house
- All pipelines in straight lines (horizontally and vertically)
- Flexible structure
- Smart floorplans 'without' inner walls
- Concrete floor
- Modern laundry room

Ventilation:

- Ventilation based on air quality
- Water and air heat exchange in every apartment

Xplorion, out of the ordinary

Electricity:

- Solar panels, battery, smart charging
- Tenants are 'off grid'

Övrigt:

- Carfree/Smart mobility
- Café with added services to tenants

Vatten/Värme:

- Low temperatur district heating
- No warm water circulation

Xplorion

Varm vatten System

Simulerad
Lågtemp. fjärrvärme

$\pm 40^{\circ}\text{C}$

värmepump i
källaren
cop 6

Förräds kärn
i källaren
 $60-65^{\circ}\text{C}$

varmvatten till
lgh, max 50 m'

$60-65^{\circ}\text{C}$

LÄGENHET

TEKNIKSKISCH

Fjärrvärmecentral per
lägenhet med värme
växlare och shunt
och temp. mätare

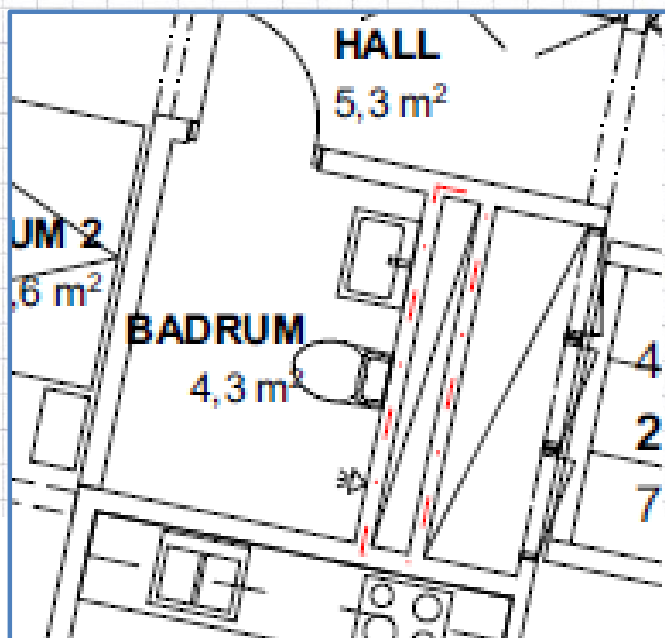
$\pm 35^{\circ}\text{C}$

$\pm 60^{\circ}\text{C}$

golvvärme
 $\pm 1\text{m}$ in från
fasaden

varmvatten
dusch och vask
i badrum

varmvatten
i köket



	Byggnadens energibehov kWh/m ² A _{temp} , år
Värme	21,4
Varmvatten (inkl. VVC)	22,5
Fastighetsenergi	8,3
Lokal energiprod.	-10,5
Sub total	41,7
Marginal (10 %)	4,2
TOTALT	45,9
Hyresgästenergi	28
U-medel (W/m², K):	0,26
Effektbehov vid DVUT -11,6 °C (W/m²)	16,1
VFT (DVUT med hänsyn till tidskonstant enligt FEBY, W/m²)	Ca 14

*'You have to shoot otherwise
you cannot score'*

- Johan Cruijff



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Second workshop on demand side (Innovation workshop WP1): Thursday, November 15th, 2018



Meeting 15 Nov 2018

WP 1 workshop

Reto M. Hummelshøj

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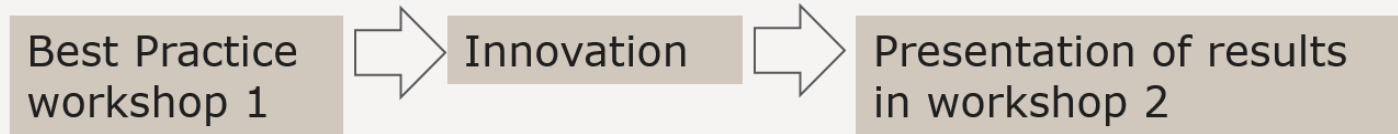
under grant agreement No 76779"

Introduction

- > **Objective of meeting**

- > DAY 1: Knowledge sharing

- > Based on innovation work in WP2



- > Day 2: Annual meeting - Status of work packages & next steps

- > COOL DH is now in M14

Text

Presentations –what will we touch

Results

- > What were the objective(s)?
- > What did we do?
- > What are the results?
- > What can we and other learn from it?
- > Who are the potential users?



What is innovation?

- > The process of translating a ideas or inventions into goods or service that creates value or for which customers will pay.
- > ... In business, *innovation* often results when ideas are applied by the company in order to further satisfy the needs and expectations of the customers.
- > In COOL DH the innovation is to combine and integrate existing and new components & knowledge to create new and better solutions
- > **=> this is what we will hear about today**

Keep the perspective in mind

Perspective

- > Exploitation and replication:
 - > How will results be exploited and where?
 - > Who can make business?
 - > Planned dissemination activities?
- > This will be topic for tomorrows discussions in relation to WP5 and WP6
- > But it is also a relevant question in the sessions for discussions after each presentation – PLEASE DON'T HESSITATE TO ASK QUESTIONS

Program

Thursday, November 15th – Location: COWI A/S, Parallelvej 2, DK-2800 Kgs. Lyngby		Time min.
Meeting room: Auditorium		
09:45	Check in and coffee	
10:00	Welcome and introduction to the day by Reto M. Hummelshøj, COWI	10
10:10	Short presentation of participants and expectations for the workshops	20
10:30	D2.1 Solutions to avoid Legionella – what is the essens Kerstin Sernhed, University of Lund	20
10:50	Questions and discussson	10
11:05	Coffee break	15
11:20	D2.11 Optimising cascade couplings for optimal use of low temperature sources, Martin Gierow, Krafringen and Niklas Bagge Mogensen, COWI	20
11:40	Questions and discussson	10
11:50	D2.5 LTDH Connected appliances, Sara Kralmark, Krafringen	20
12:10	Questions and discussson	20
12:30	Lunch	45
12:45	D2.4 Solution for multi-family houses – Anna Le Krummrich, Krafringen	20

Cont'd

13:15	D2.4 Solution for multi family houses - Arnela Kursumovic, Krafringen	20
13:35	D2.2 Local integration of renewables on demand side – Mårten Ahlm Cetetherm (Alfa Lawal) and Emanuel Zilio, COWI	20
13:55	D2.12 Short time and seasonal storage – Uffe Schleiss Høje Taastrup Fjernvarme & Reto Hummelshøj, COWI	20
14:15	D2.9 Innovation: New pipe products from Logstor – Klaus Grønnegaard Lauridsen, Logstor	20
14:35	Questions and discusssion	10
14:45	Coffee break	15
15:00	Status of Xplorion, Dennis Kerhof	15
15:15	D2.7 New design concepts for optimization of LTDH distribution systems, Emanuel Zilio, COWI	20
15:35	Group discussion a) what info are we missing b) how can we improve impact	20
15:55	Result of discussion and evaluation – Did we meet the expectations?	15
16:10	Practical issues, end of the day	5
16:15	Free time for bilateral discussion of open points and coordination among local coordinators	60



Short presentation

- [illegible]

Group discussion 10-15 minutes

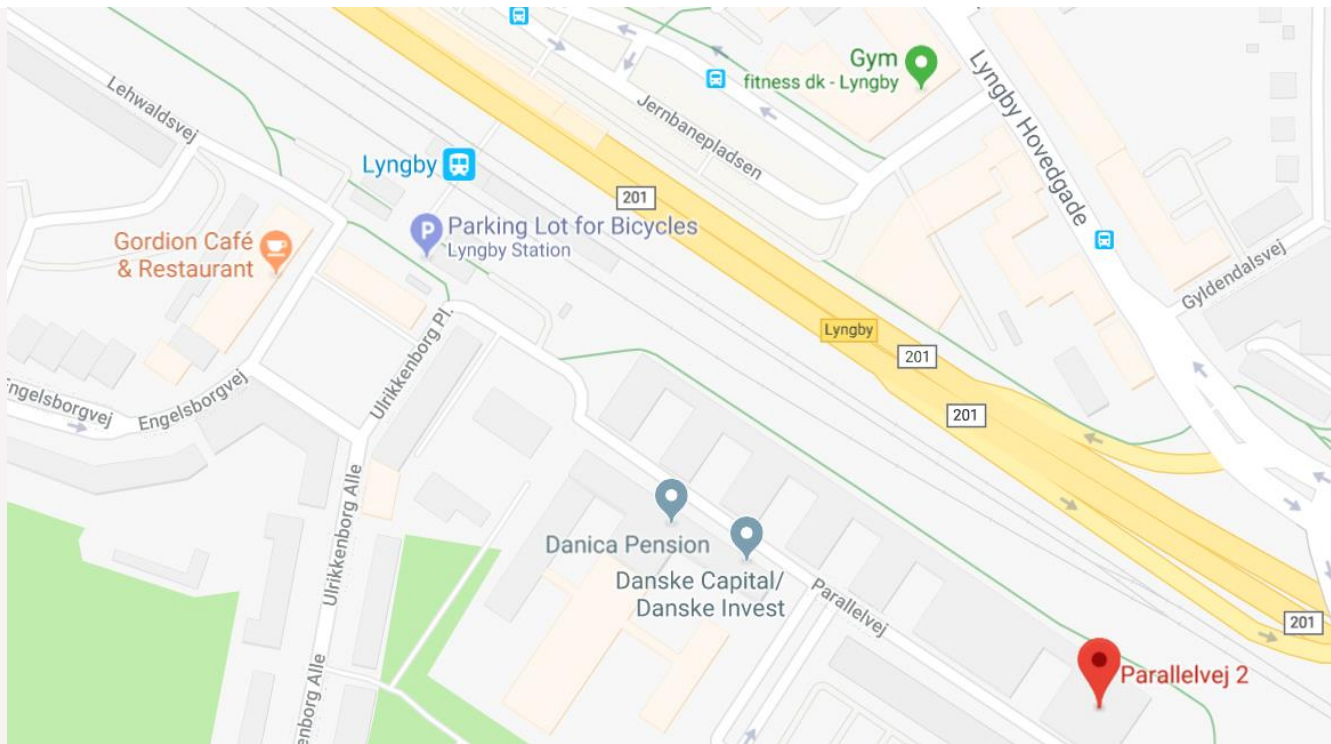
- > 5-10 min: What information do we miss in today's presentations?
- > 5-10 min: How can we improve impact of the project+
 - > In own organisations
 - > In wider scale
- > Hereafter present in plenum 15 minutes

Bilateral discussions

- [illegible]

19.00

Dinner at Restaurant Gordion, Ulrikkenborg Plads 10, 2800 Kgs. Lyngby





D2.1 Solutions to avoid Legionella – what is the essence

COOL DH Innovation Workshop - series 2

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 76779"

Kerstin Sernhed & Per-Olof Johansson Kallioniemi 20181115

Task 2.1.1

- > This task will gather information on the legislative rules for Sweden, Denmark, Germany etc., and
- > further study and evaluate different solutions to avoid legionella (micro electrolysis, Cl-dose, UV treatment, use of substations in the dwellings, also called flat-stations, thermal gymnastics etc.)

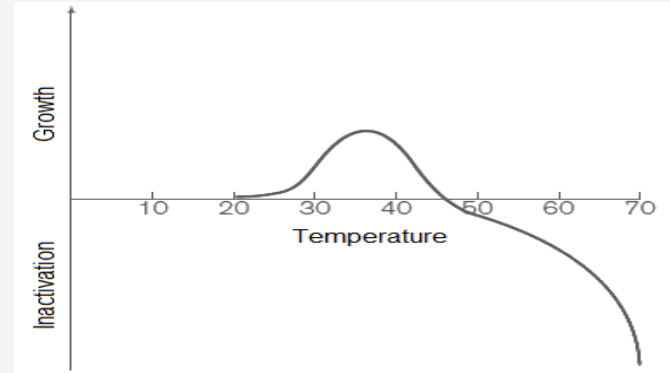
What did we do?

We conducted a literature study with the aims to answer the following questions:

1. What is the legislation associated with legionella in domestic hot water systems? (In Sweden, Denmark, Finland, Norway, France and Germany)
2. What is the incidence of Legionnaires disease in the six included countries? How does this comply with the legislation?
3. What techniques could be used for legionella prevention in DHW systems?
4. How do the techniques comply with the legislation and the use of low temperature district heating?

Legionella

- > *Legionellae* are common bacteria in freshwaters, seawater and soils
- > Causes Legionnaires disease and Pontiac fever
- > The bacteria thrives in:
 - > Temperature levels of 32-42 °C
 - > Stagnant water
 - > Presence of biofilm and protozoa



Source: Brundrett, G. W. (1992)

Legislation



European working group for Legionella infections (EWGLI) – Technical specifications









1. Parts of the system should be **kept at a temperature that does not promote microbial growth**
2. The system should be designed in such a way that **water stagnation does not occur**
3. The components should be **made in materials that do not promote microbial growth** (e.g by limiting the growth of biofilm)

EWGLI recommends that:

- > hot water should be **stored at a temperature no less than 60°C**
- > circulating water should be at a temperature that **allows at least 50°C at the tap** within one minute of opening the tap



Regulations for DHW system temperatures in six countries

Country	Min. system T	Min. tank T	Min. tap T	Max. tap T
Sweden 	50 °C	60 °C	50 °C	60 °C/ 38 °C*
Denmark 	55 °C (45 °C)**	55 °C (up to 60)		
Norway 	65 °C (circulating)			55 °C/38 °C*
Finland 			55 °C	65 °C
Germany 	50 °C, unless small system	60 °C		
France 	50 °C, unless V < 3 litres	55 °C		

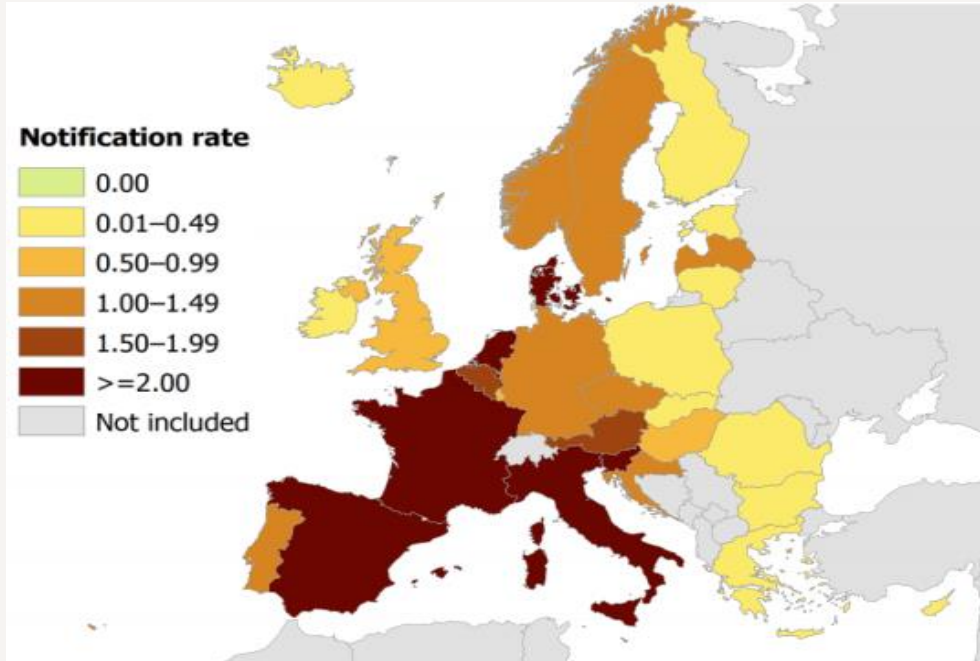
* Only for locations with increased risk of scalding

** Exceptions of temperature requirements are made at peak hours

Incidence

EWGLI statistic on cases of illness caused by Legionella

- > Presented as reported incidence per 100.000 inhabitants.



Incidence of Legionellosis in the six countries

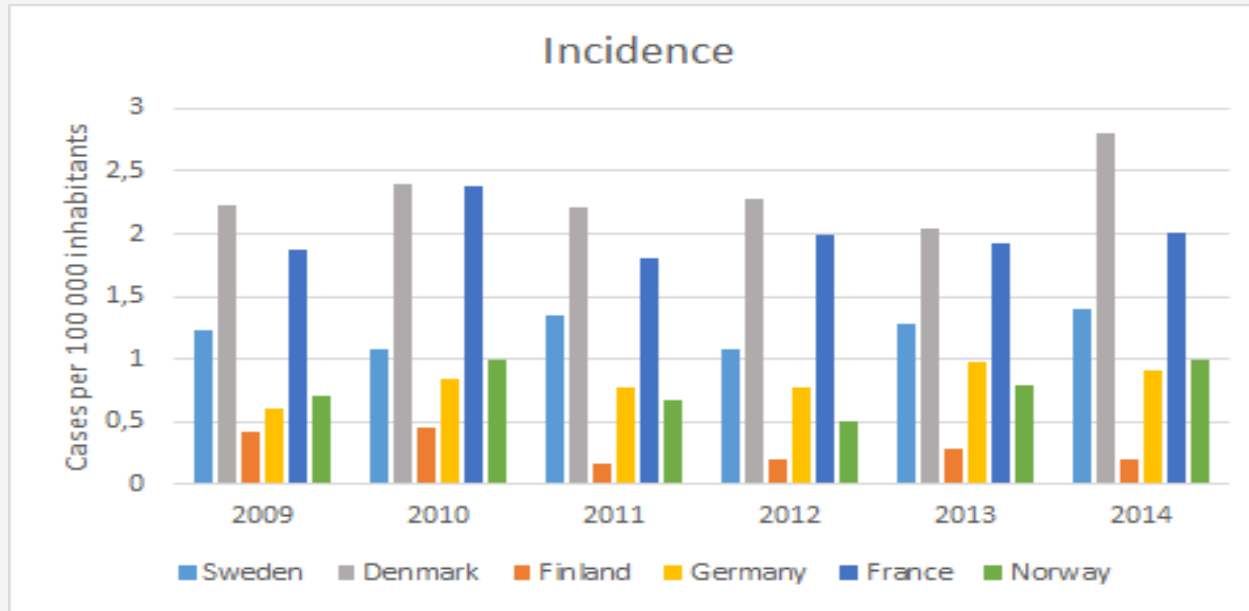
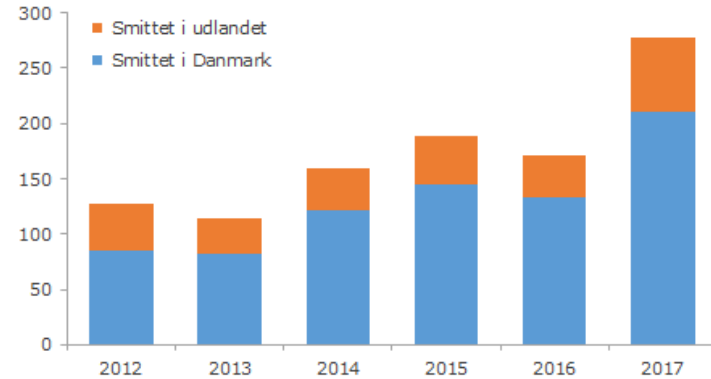


Diagram compiled from data obtained from ECDC (European Centre for Disease Prevention and Control, 2016).

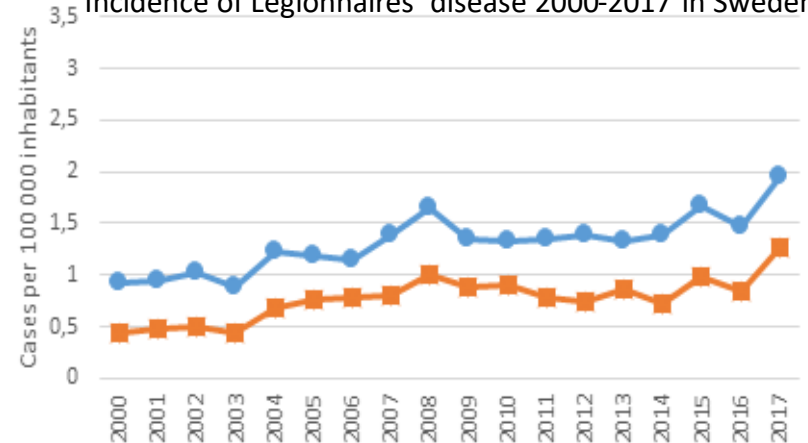
Legionella – not a diminishing problem...

Figur 1. Antal anmeldte tilfælde af legionella-pneumoni fordelt på formodet smitte i Danmark og udlandet, 2012 til 2017



Source: <https://www.ssi.dk/Aktuelt/Nyhedsbreve/EPI-NYT/2018/Uge%2045%20-%202018.aspx>

Incidence of Legionnaires' disease 2000-2017 in Sweden




Source: Folkhälsomyndigheten (2018)

Techniques in DHW systems to prevent legionellosis


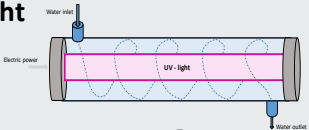
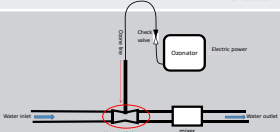
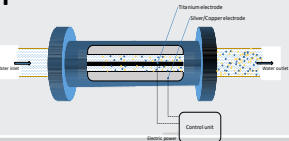
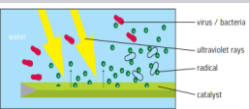
Techniques in DHW systems to prevent legionellosis

1. Mechanical treatment
2. Sterilization
3. Alternative system design

Mechanical treatment

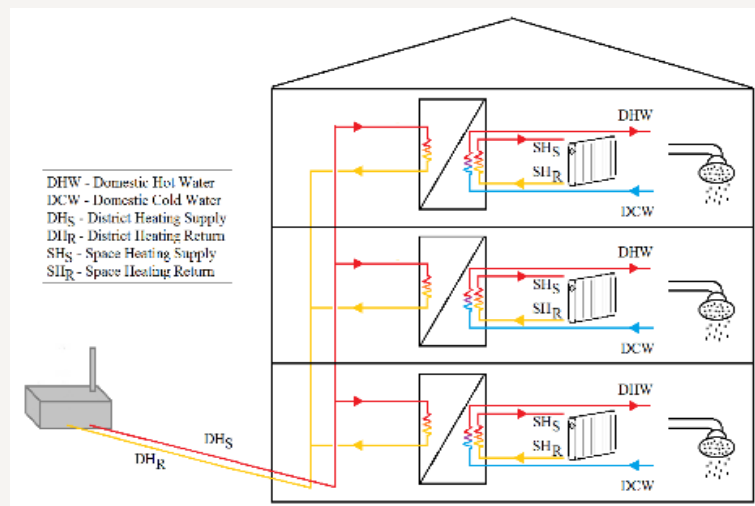
Technique	Advantages	Disadvantages	Fulfil temperature requirements in regulations?
Filters 	<ul style="list-style-type: none">• Instant effect• Very effective	<ul style="list-style-type: none">• Short lifetime; frequent maintenance required• High cost• Local effect, not residual	No

Sterilization

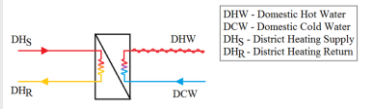
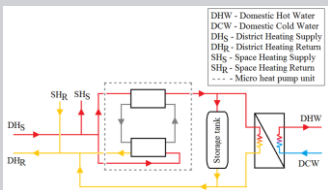
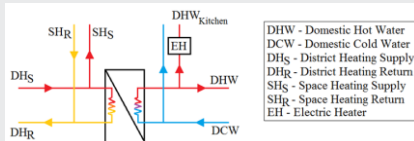
Technique	Advantages	Disadvantages	Fulfills temperature requirements in regulations?
Chlorination 	<ul style="list-style-type: none"> • Mature technology • Residual control 	<ul style="list-style-type: none"> • Less effective on protozoa • Local legislation • Potential health hazard, chemicals added • Can be corrosive for pipes 	No
UV-light 	<ul style="list-style-type: none"> • Instant effect • Mature technology 	<ul style="list-style-type: none"> • Not sufficient on its own • Less effective on protozoa • Local effect, not residual 	No
Ozone 	<ul style="list-style-type: none"> • Highly oxidizing, effective in low concentrations 	<ul style="list-style-type: none"> • Corrosive: pipe maintenance required • Local effect, partly residual 	No
Ionization 	<ul style="list-style-type: none"> • High efficiency • Mature technology 	<ul style="list-style-type: none"> • Can be prohibited by national legislation because of potential health hazard • Copper and Silver ions added 	No
Photocatalysis 	<ul style="list-style-type: none"> • Pilot studies show high efficiency 	<ul style="list-style-type: none"> • Not commercialized for residential properties • Local effect, not residual 	No

Alternative system design

Technique	Advantages	Disadvantages	Fulfils temperature requirements in regulations?
Decentralized substations	<ul style="list-style-type: none"> No need for DHW circulation: reduces heat losses 	<ul style="list-style-type: none"> Investment cost 	No



Alternative system design

Technique	Advantages	Disadvantages	Fulfil temperature requirements in regulations?
Auxiliary heating devices:			
Electric heat tracing  <p> DHW - Domestic Hot Water DCW - Domestic Cold Water DHs - District Heating Supply DHr - District Heating Return </p>	<ul style="list-style-type: none"> No need for DHW circulation: reduces heat losses 	<ul style="list-style-type: none"> Only partly commercialized for residential properties 	Yes
Micro heat pump  <p> DHW - Domestic Hot Water DCW - Domestic Cold Water DHs - District Heating Supply DHr - District Heating Return SHs - Space Heating Supply SHr - Space Heating Return - - - Micro heat pump unit </p>	<ul style="list-style-type: none"> Energy efficient 	<ul style="list-style-type: none"> Higher investment costs 	Yes
Instantaneous electric heater  <p> DHW - Domestic Hot Water DCW - Domestic Cold Water DHs - District Heating Supply DHr - District Heating Return SHs - Space Heating Supply SHr - Space Heating Return EH - Electric Heater </p>	<ul style="list-style-type: none"> Compact installation 	<ul style="list-style-type: none"> High electric effect required at peak times: may need upgrade of main fuse 	Yes

Conclusions

- > Legislation: temperature requirements not bacterial levels
- > Different temperature requirements in different countries
 - > Norway - 65 °C
 - > Germany and France – 3-litre rule
 - > Denmark - Exception for peak flows where a temperature of 45 °C at the tap is acceptable.
- > In case of ULTDH
 - > Sterilization techniques and filters are not possible to use as single methods
 - > Decentralized substations only where 3-litre rule is applied
 - > For COOL DH with real demonstrations this means that tests with ULTDH in Xplorion only is possible before tenants move in

Conclusions

- > Countries with higher temperature requirements also showed fewer cases of Legionella.
 - > Causal relationship is not possible to establish in this study
 - > Other factors could play a role: climate, number of detected cases, aging population, pattern of smoking and drinking

Info om tasken

- **Mål:** Ett "Working paper" (konfidentiellt, endast för medlemmar i konsortiet) om värmedrivna och varmvattenanslutna vitvaror avseende deras möjlighet att minska elenergibehovet och öka värmeenergibehovet i områden med LågT-fjv.
- **Instruktioner:**
 - Rapporten ska innefatta både svenska och danska förhållanden, varför COWI ska delta.
- **Tidsåtgång:**
 - Kraftringen, 18 arbetsdagar.
 - COWI, 9 arbetsdagar.





Heatdriven Appliances

"Heating Water Circuit, HWC"

- Dishwashers, washing machines and tumble dryers with integrated heat exchangers



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Heatdriven Appliances

- Developed in research projects in 2004-2014
- Asko Appliances Ltd – the company behind the development
- Were never commercialized
 - Asko's production was moved to Slovenia
 - No plans to resume the production
- Required at least **55 °C** and max **80 °C heating water**



Heatdriven Appliances and LTDH

- **Brunnshög**

- Supply temperature 65 °C → Secondary circuit approximately 55-60 °C depending on customer heat exchanger → **OK** for HWC machines



- **Høje Taastrup / Østerby**

- Supply temperature 55 °C → Secondary circuit approximately 45-50 °C depending on customer heat exchanger → **Not OK** for HWC machines



Annual potential energy saving in a home: 594 kWh

*Table 4 Values of electric energy usage in Asko's heat driven appliances. *Assuming an annual number of process cycles of 280.
Assuming an annual number of process cycles of 280. *Assuming an annual number of process cycles of 160.*

Asko HWC appliance	Average electric energy usage per cycle (kWh)
HWC dishwasher	1
HWC washing machine	0.72
HWC tumble dryer	3.51
SUM:	5.23



Appliances with alternative tap water connections

Dishwashers connected to hot water

Washing machines connected to both hot and cold water



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Dishwashers connected to hot water

- As the process temperature is often continuously $> 65\text{ }^{\circ}\text{C}$ anyways, a connection of up to $60\text{ }^{\circ}\text{C}$ can give electricity savings of about 35 %
 - Corresponding to 0,3 kWh per wash cycle or 84 kWh / year*
 - Can be compared to the 48 % of the HWC dishwasher
- Requires a machine design with heat resistant hoses
- Manufacturers that accept hot water connection:
 - Asko
 - Miele
 - Bosch

*280 wash cycles / year



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Washing machines connected to both hot and cold water

- Only available as **professional** machines
- Requires a machine design with heat resistant hoses and double water intake
- Manufacturers:
 - Asko
 - Miele
 - Podab
- 60 – 87 % energy saving
 - Depending on capacity (drum size) and temperature
 - Can be compared to the 74 % of the HWC washing machine

Table 11 Electric energy need and reduction in dishwashers at double tap water connection. *Assuming a standard number of wash cycles per year of 220.

Manufacturer Washing machine capacity Program temperature	Average electric energy usage per cycle (kWh)
Miele 5.5-6.5 kg capacity machines 60 °C program	1
Podab 8 kg capacity machine 60 °C program	1.5
Podab 8 kg capacity machine 40 °C program	0.8



Conclusion



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Conclusions

- **Heatdriven appliances** are no longer manufactured and are therefore not applicable to COOL DH. If they had been manufactured, they would have been suitable at Brunnshög but not in Høje-Taastrup / Østerby. This is because the secondary circuit must keep at least 55 °C without the addition of electricity (This is the case at Brunnshög but not at the Danish site). Possible energy saving:
 - Dishwasher 48 % (0.48 kWh / cycle)
 - Washing machine 74 % (0.43 kWh / cycle)
 - Dryer 65 % (2.27 kWh / cycle)
- Regular **dishwashers** can, if approved by the manufacturer (with respect to plastic parts and warranties) be connected to hot tap water instead of cold tap water. Possible energy savings (roughly based on three suppliers):
 - Around 35 % (0.3 kWh)
- Some **professional washing machines** have two possible water intakes. By connecting both, as well as making certain program settings, substantial energy savings can be made (from three suppliers):
 - 60 – 87 % (0.6-1.3 kWh)



Households



Shared laundry rooms



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THIS IS

A message about
Cool District Heating

THIS IS

A message about
Cool District Heating



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10/1 2018



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Task 2.1.4. System solutions for multifamily houses and tertiary buildings like offices and institutions



Arnela Kursumovic, Mårten Ahlm, Rolf Jönsson, Reto Michael Hummelshøj

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 76779"

Flat station solution for multifamily houses and tertiary buildings.

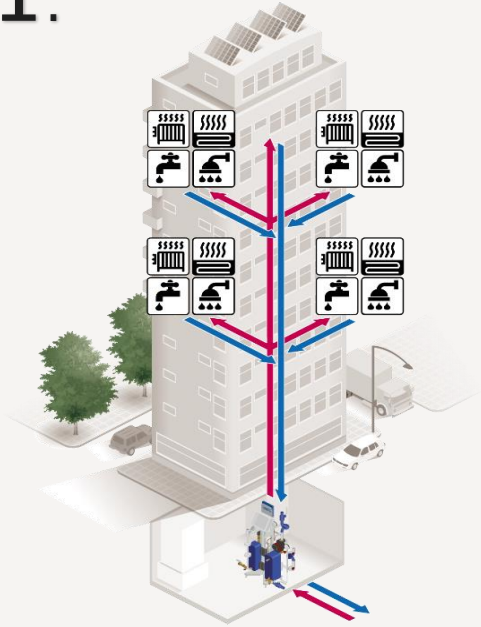
Hypothesis

- > Lower heat losses, 6-8 kWh/m²y. Decrease by half!
- > Easier to implement IMC – lower energy use in total?
- > Lower the temperature in the primary net

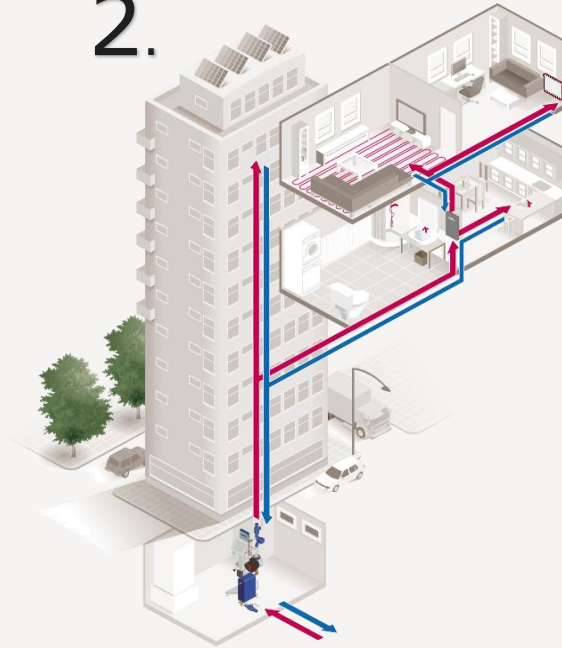


Three cases were evaluated

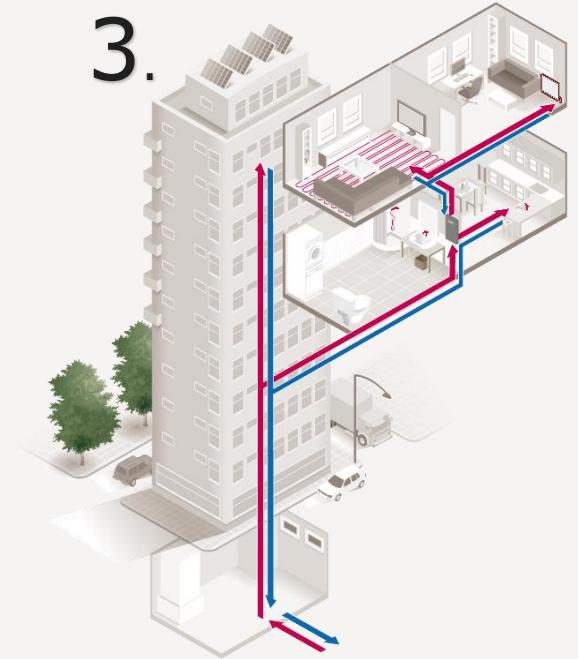
1.



2.



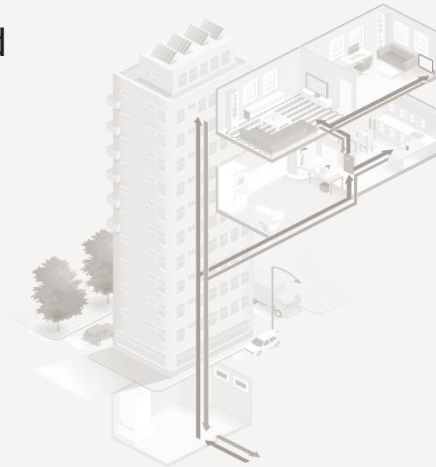
3.



Case 3

Pros:

- The temperature loss in HEX is avoided
- The cost for HEX is avoided
- WWC is removed

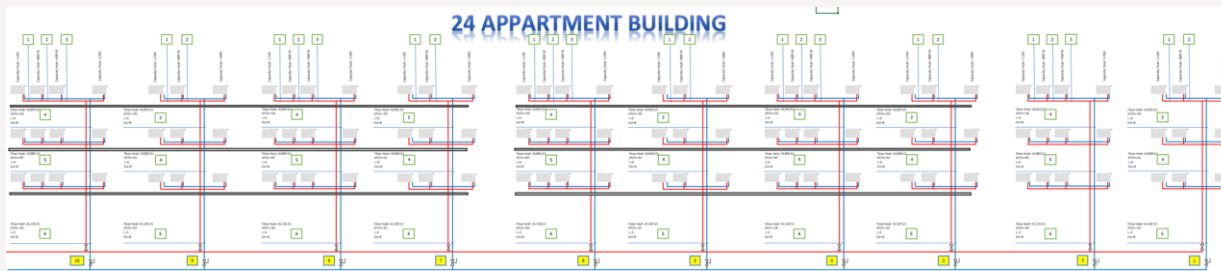


Cons:

- Higher pressure in the pipes inside the building
- "Unlimited" water if leakage occurs – but there is a solution to this
- Who is the owner of the pipes?
- Emergencies



Traditional solution

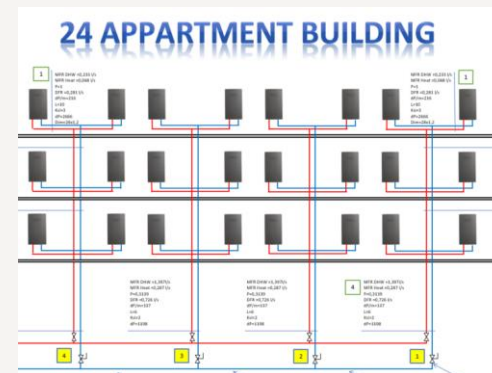


Substation

- Varies, 6300 EUR in this report



Flat-stations



Flat-station

- Around 1000-1100 EUR

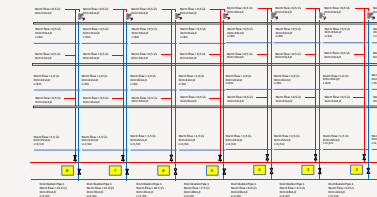


Method and results – heat losses

> Excell calculation

> Traditional solution

Subject	Heat loss [W]	Time [h]	Heat loss [kWh]
Heating distribution			3636
Substation with two heat exchangers	500	8760	4380
Domestic hot water distribution			6365
Domestic hot water circulation			4975
Total			19356



> Flat-station solution

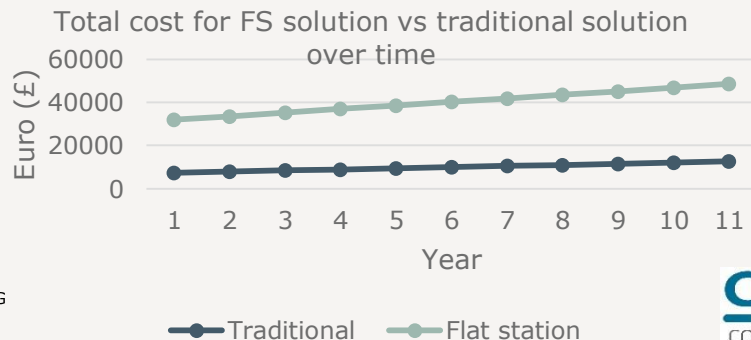
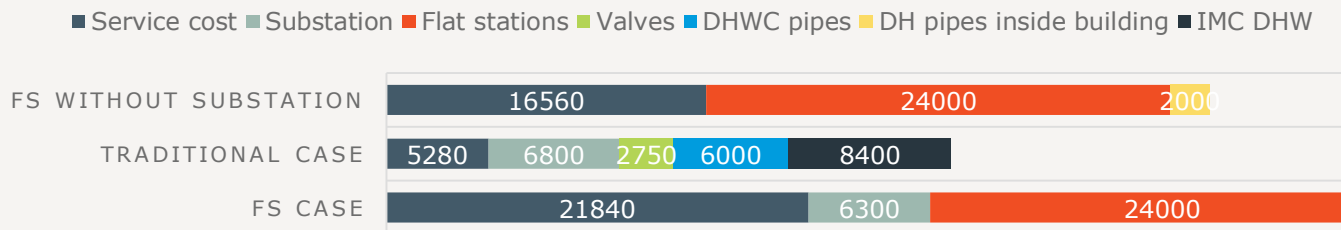
Subject	Heat loss [W]	Time [h]	Heat loss [kWh]
Distribution and flat stations			18279
Substation with one heat exchanger	300	8760	2628
Total			20907

Method and results - costs

> Calculations

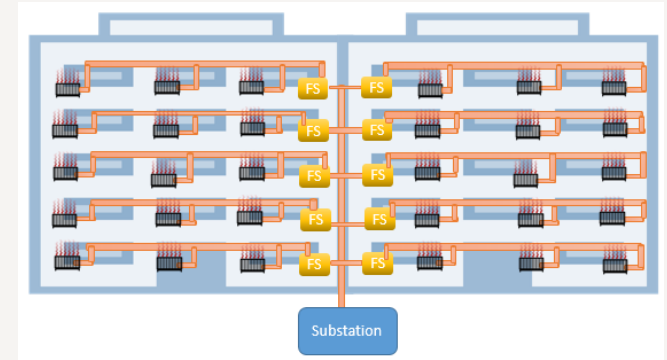
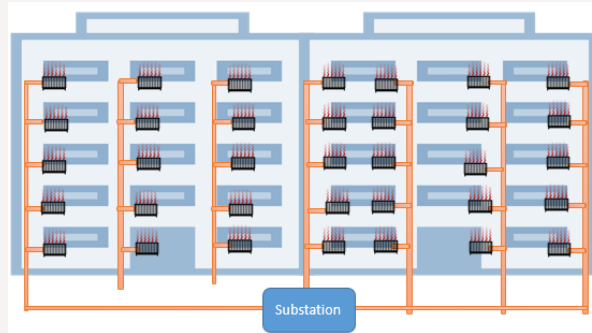
Total cost (EUR)
42 560
29 230
52 140

TOTAL COST FOR ALL THREE CASES OVER A 10 YEAR PERIOD



Other aspects

- Longer horizontal pipes
- No guarantee that there will be a lower energy use – could back-fire
- Material for production of flat station
- Future buildings (nZEB)
- This solution fits better in Denmark
 - Non-profit business
 - German standard
 - IMC is a must
(with dispensations from municipality)



Conclusions

- > Not economically beneficial
- > Makes IMC easier
- > Almost the same amount of heat losses
- > Makes it possible to lower the temperature in the primary water where the German standard is applicable
- > More service, bigger risks

Thanks!





D2.2

Solutions for local integration of renewable energy sources

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 76779"

Mårten Ahlm, Cetetherm AB
Emanuele Zilio, COWI DK

Agenda

- > Aim of the deliverable
- > Technology catalogues
- > Single-family houses
- > Multi-family houses
- > Perspective

Aim of the deliverable

Innovate

Preparation of domestic hot water (DHW) by pre-heating with LTDH and local supplementary heating with integration of sustainable sources.

- > Technology for DHW:
 - > Single-family houses
 - > Multi-family houses
- > Introduction of renewable energy

Technology catalogues

Which technologies?

Technologies available on the market (or close to be available)

- > Single-family or terraced houses
- > Multi-family houses
- > Possible integration/coupling with sustainable heat sources

Datasheet that describes the main characteristics and give an overview of the technology (cost, installation, etc.)

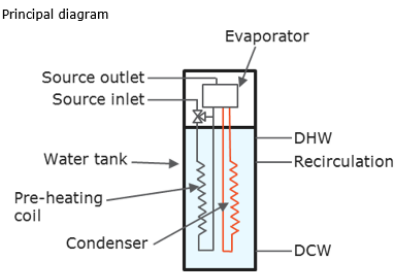

Technology catalogues

Short description

- > Brief introduction of the technology

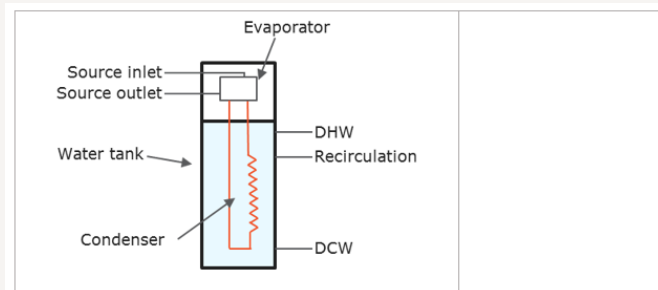
Illustrations

- > Principal diagram and picture of the technology

Booster heat pump at single-house level	
1. Short Description	
A solution to fulfill domestic hot water preparation in single-family houses is to use a booster heat pump, which can use low temperature district heating or other low temperature sources (e.g. solar energy) as heat source and boost the water temperature inside the tank in order to avoid the problem of Legionella contamination.	
2. Key words	
<ul style="list-style-type: none">> Domestic hot water> Low temperature district heating> Sustainable heat source> Booster heat pump	
3. Illustrations	
Principal diagram	Picture
	
Source: Metro Therm	

Keywords

Technology catalogues



Technical description

- Technical and operation characteristics of the technology

4. Technical description

The booster heat pump can use different low temperature heat sources, such as low temperature district heating, solar energy or geothermal energy, to produce domestic hot water for a single-family house.

The heat pump has two main configurations:

- The first configuration, considers a pre-heating coil in the water tank, where, if the temperature of the source is higher than the water in the tank, the supply flow passes through a pre-heating coil in the water tank to release part of the heat, and afterwards it goes through the evaporator. Then it returns with a lower temperature.
- The second configuration does not consider a pre-heating coil in the water tank. The supply flow goes directly through the evaporator and afterwards it returns with a lower temperature.

Perspective:

- Suitable for new or refurbished buildings
- Suitable for single family houses or terraced houses

5. Characteristics

The heat pump itself can increase the water temperature up to 65 °C, avoiding the risk of Legionella contamination. If the heat source is not enough to fulfill the water temperature requirement, the heat pump is equipped with an electrical heater.

The heat pump can use a heat source with the lowest temperature equal to 10 °C in case of water, or 5 °C in case of brine. On the other hand, the maximum source temperature is 55 °C, for the solution without pre-heating coil, and 60 °C for the solution with pre-heating coil. The COP varies with the supply temperature between 4.8, with supply temperature equal to 24 °C, and 8.0 with 40 °C.

Characteristics

- Why is the technology interesting?

Technology catalogues

Demand to installation

6. Demands to installation

- > Space requirements for installation at the final user
- > Maintenance access
- > Connection to water and power
- > Maintenance requires skilled and certified labor

Pros and cons

7. Pros and cons

Pros

- + The technology uses a sustainable heat source.
- + Easy installation since the device is pre-assembled and it needs just to be connected to the domestic hot water system, to the power and to the heat sources.
- + It ensures a high COP.
- + The temperature reached in the water tank is high enough to avoid legionella contamination.
- + The buffer tank can implement peak shaving solutions.
- + It is equipped with a smart control of the operations.
- + It can be integrated with a PVT system.

Cons

- It requires space for installation at the user side.

Economic data

8. Economic data

Capacity range [kW]	Equipment cost excl. VAT, [€]	Total cost incl. installation price excl. VAT, [€]	O&M cost [€/year]
Metro Therm - METRO MICROBOOSTER 201 2,1-2,5 kW COP: 4.8-8.02 190 liters water tank Single-house 3-4 pers Lifetime 15 years	Ca. 1800-2100 €**	Ca. 300 €**	Ca. 100-200 €/year**

**Prices reference 2018

> Overview of the main costs

Technology catalogues

Environmental issues

9. Environmental issues

> Recycling options

10. Example of suppliers

> Metro Therm

Example of suppliers

References

11. References

1) Metro Therm "MICROBOOSTER 201" datasheet (courtesy of Metro Therm. Not available online)

Single-family houses

Technologies

- > District heating
- > Electricity
- > Surplus heat
- > Possibility of integration with PV or solar systems

Electric heater

- > traditional
- > with DH-coil
- > smart control



Heat pump

- > air-to-water
- > water-to-water external heat source or DH return



DH-units (micro HEX)



Low temperature space heating

- > Fan assisted radiators



Single-family houses – economic evaluation

DHW use

- > 40 l/person per day (4 people)
- > Energy consumption 3000 kWh/yr
- > Heat losses 800 kWh/yr
- > Water temperature 10-45°C fulfilled by DH
- > Water temperature 45-55°C fulfilled by topping (or DH for DH-unit)
- > Evaluation of the total installation costs, operation and maintenance costs

Single-family houses – economic evaluation

Evaluation

- > DH-unit compared to a water-to-water heat pump (on return DH)

	Total system cost [€]	Operation [€/yr]	Maintenance [€/yr]	Total O&M [€/yr]
DH-Unit direct	1690	276	47	323
Micro booster heat pump - COP 4.7	2330	233	51	284
Difference	640	43	4	39

- > 39€/yr of savings with the heat pump

Single-family houses – economic evaluation

Denmark loan case:

- > Loan from the bank: 640€
 - > Annual payment after tax: 1.77% (considering a larger loan)
 - > Amortisation: 20 years
 - > Yearly payment: 38€

The savings from the heat pump cover the yearly payment

Single-family houses – economic evaluation

Denmark case without loan:

- > Extra cost for the heat pump: 640€
- > Yearly savings: 39€/yr
 - > $\text{Yearly savings/Extra cost} = 39/640 = 6\%$ interest

Investing the extra money in the heat pump is better convenient than keeping the money in the bank

Multi family houses

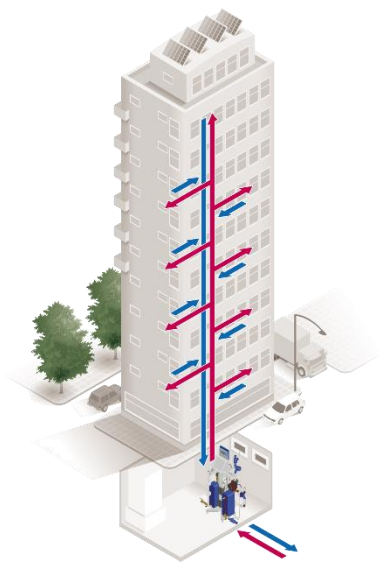
Technologies

- > DHW &/or space heating
- > Pre-heating + final heating
- > Part of load/seasonal addition

Added heat sources

- > Electricity
- > Surplus heat
- > Solar heat

Local integration of supplemental heat - Heat recovery or renewable sources

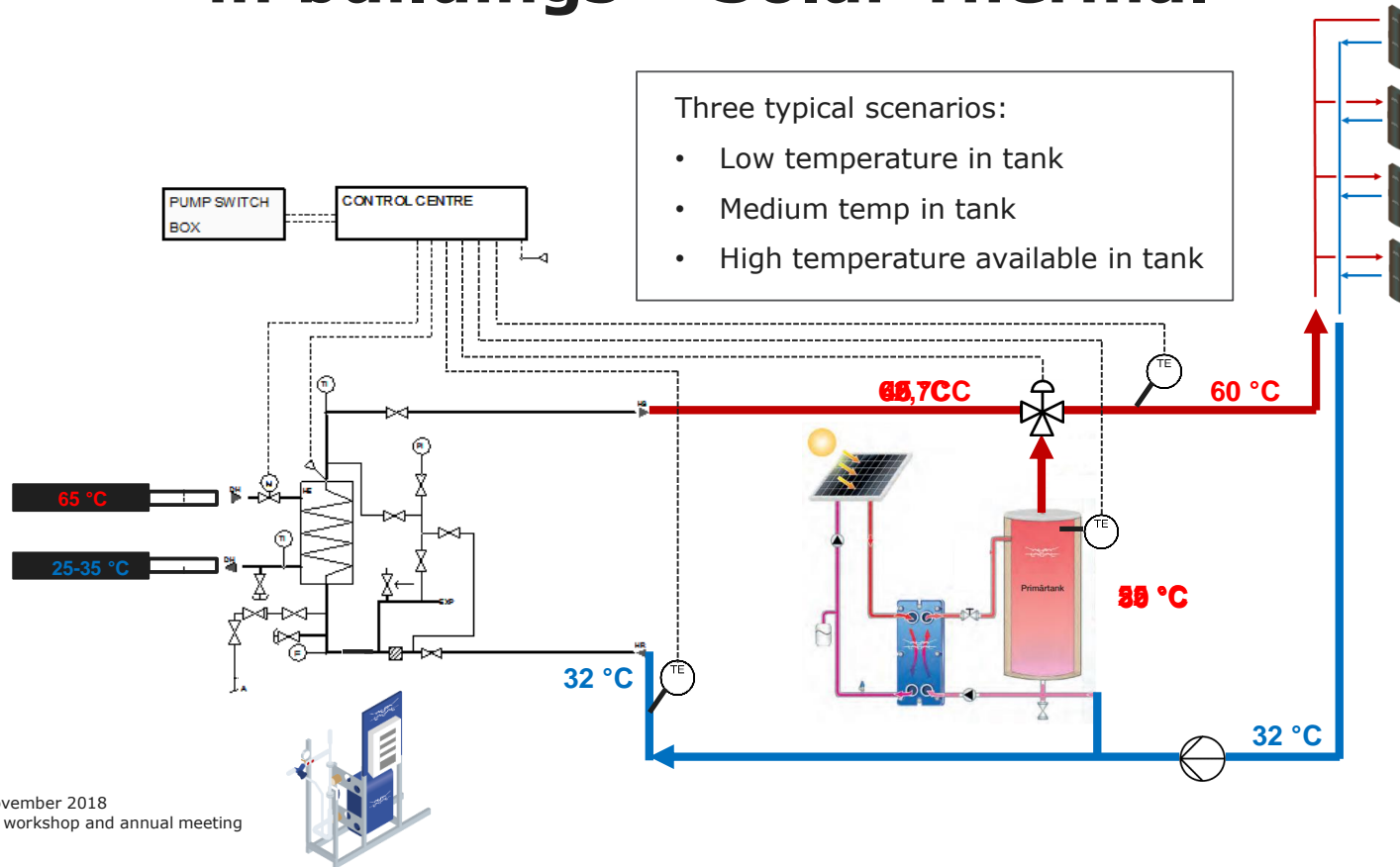


Integration in multi family buildings

But –Always have in mind that:

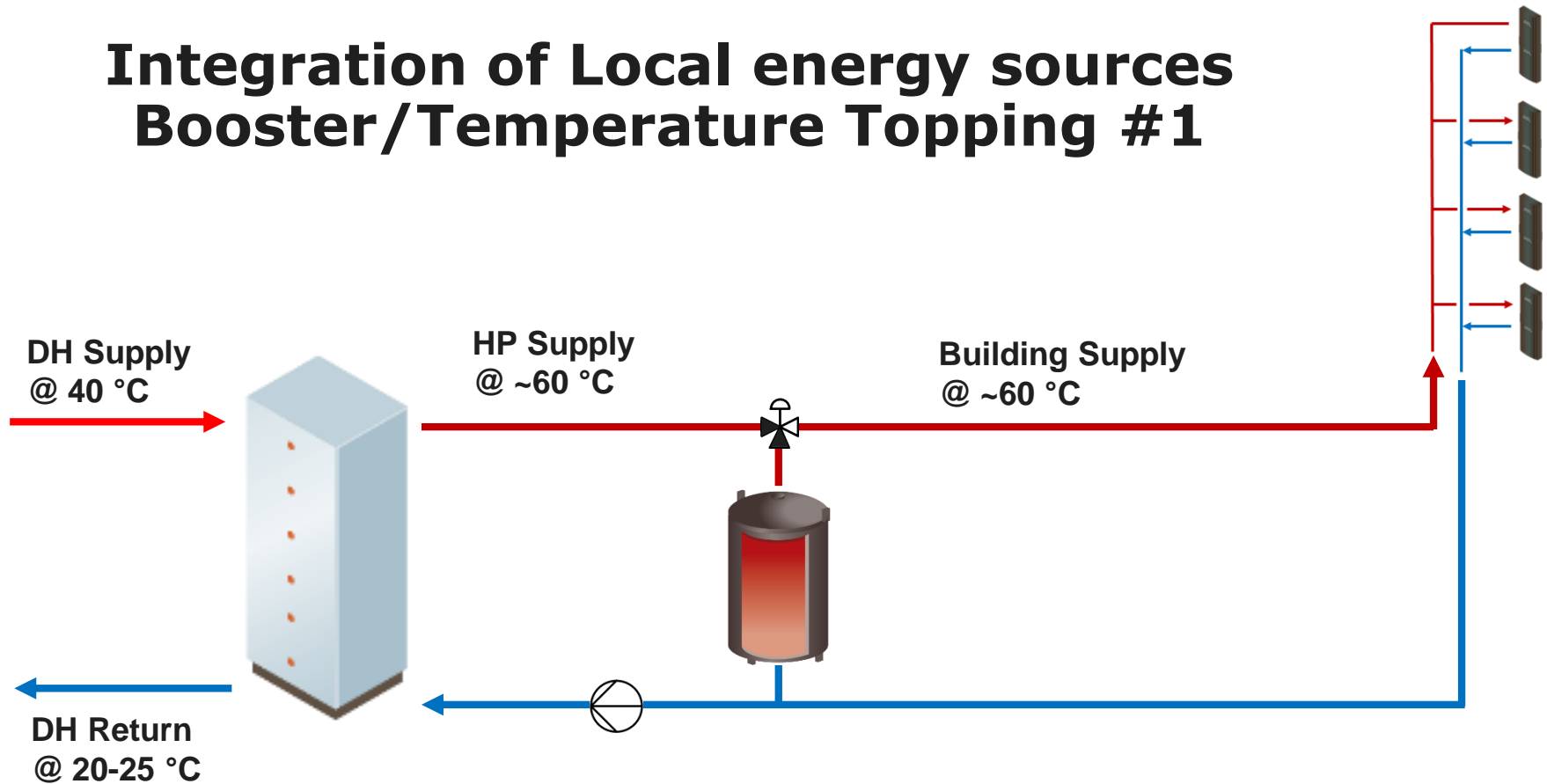
- District heating is **the primary** heat source
- → Local supplemental heat recovery or renewables is **not** the primary heat source
- District heating **return temperature** have to be prioritized = always be as low as possible
- Keep the design as **simple and reliable** as possible
- Always **avoid** to design systems with **storage** of hot tap water

Integration of supplemental energy sources in buildings – Solar Thermal

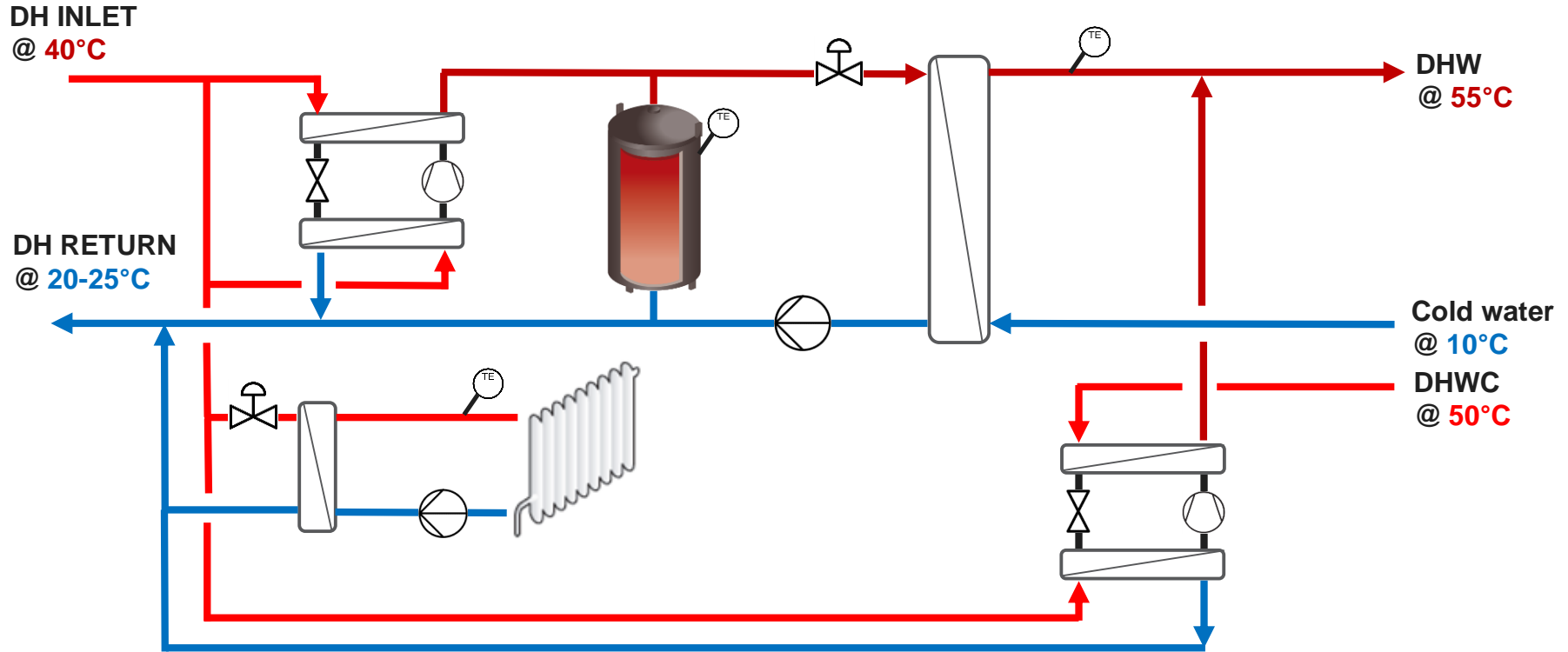


Integration of Local energy sources

Booster/Temperature Topping #1

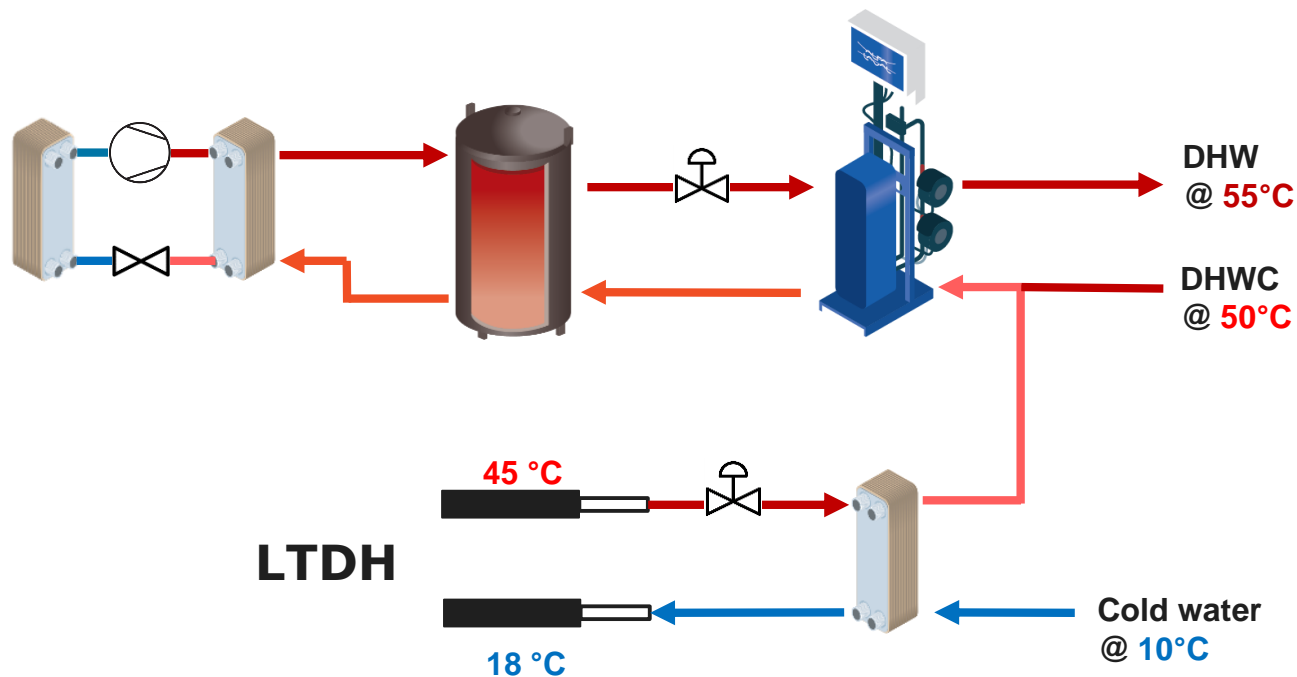


Integration of Local energy sources Booster/Temperature Topping for DHW



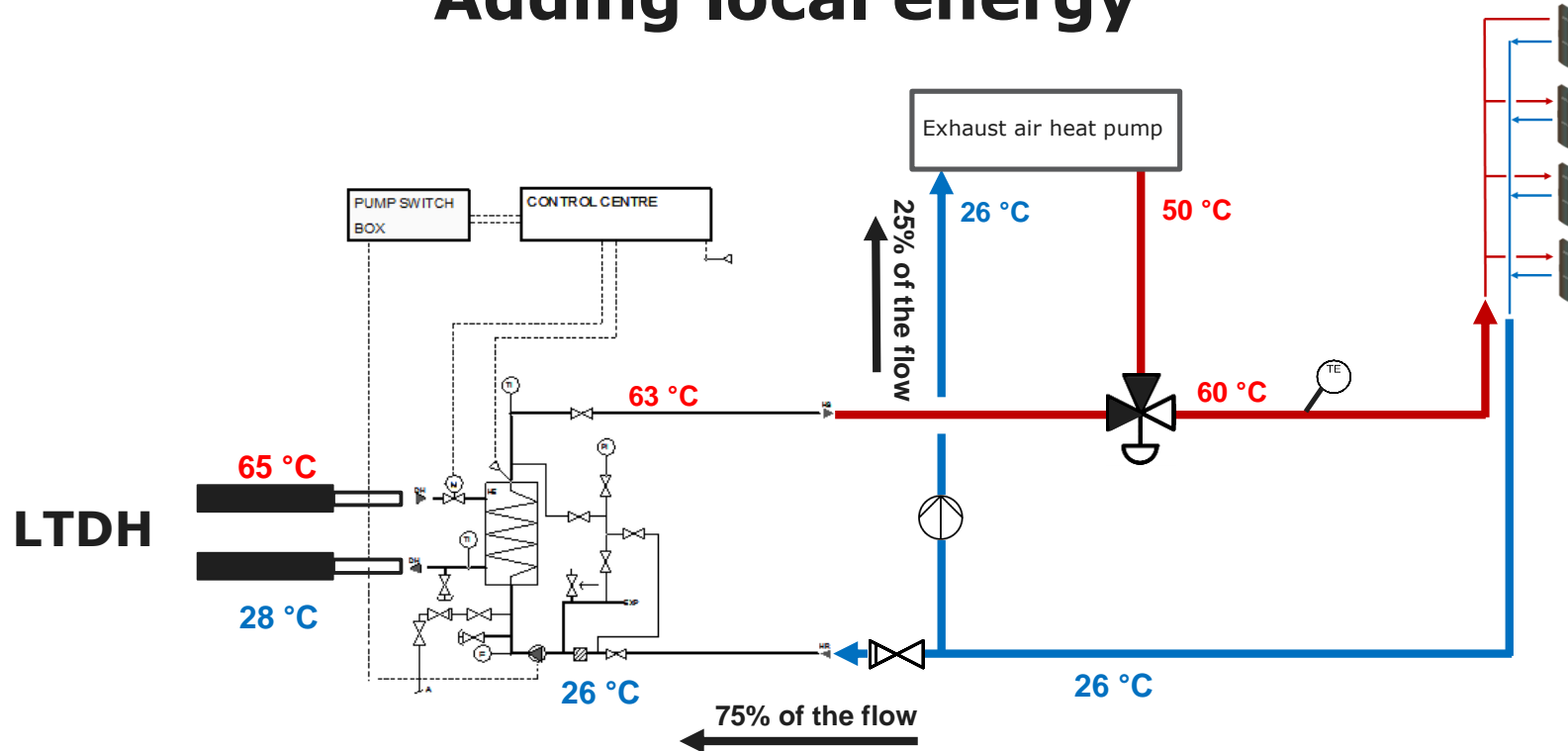
Integration of Local energy sources

Pre-heating + temperature Topping of DHW



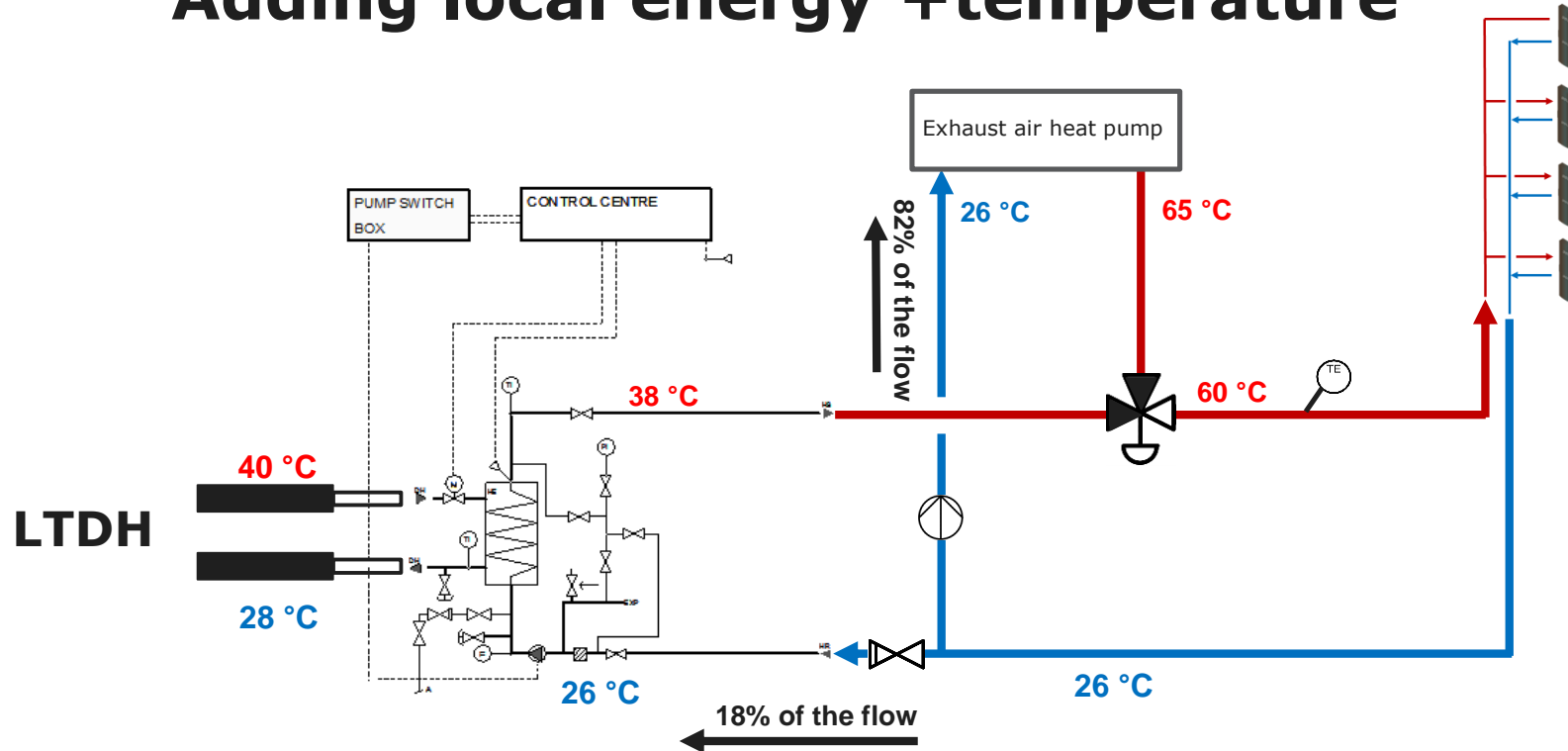
Integration of Local energy sources

Adding local energy



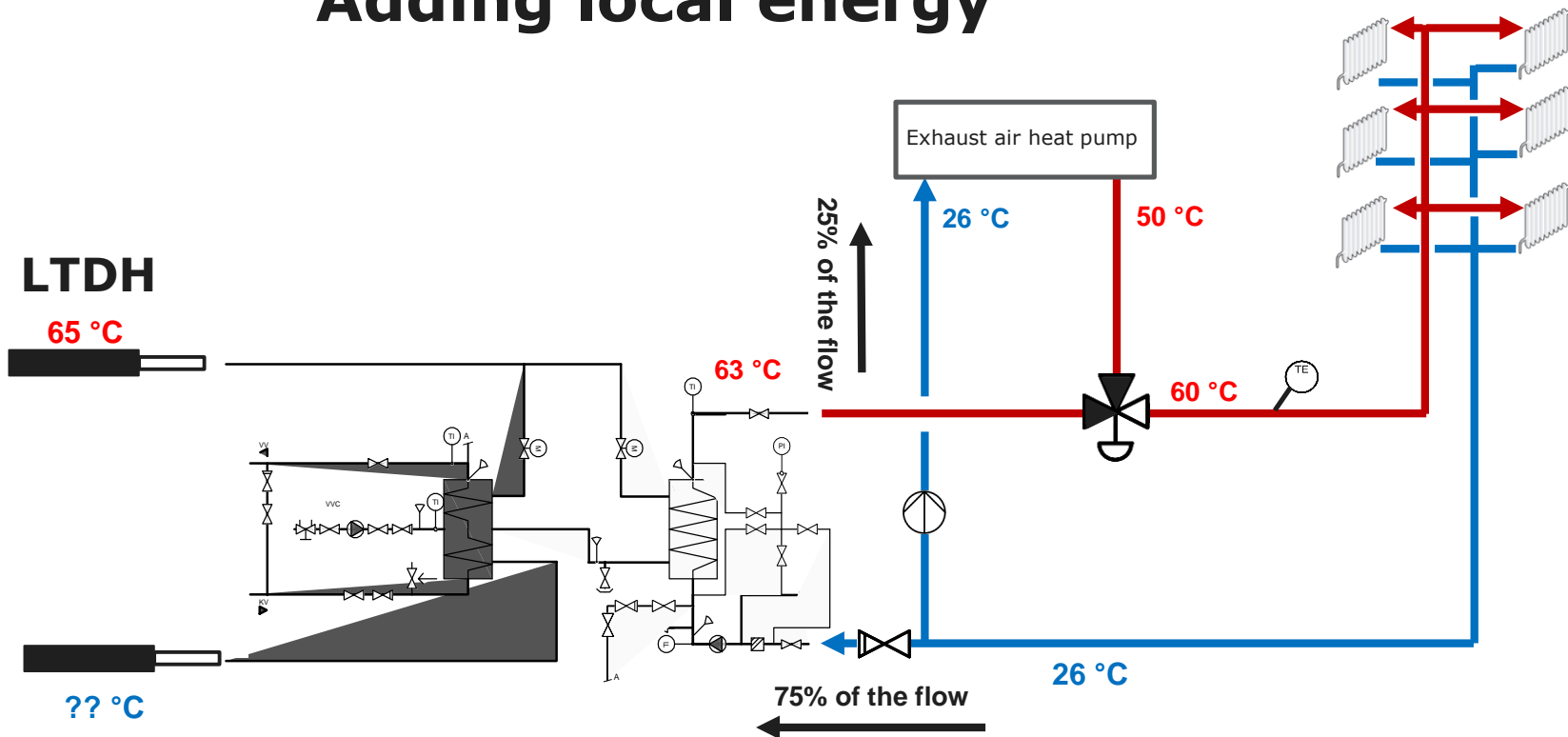
Integration of Local energy sources

Adding local energy +temperature



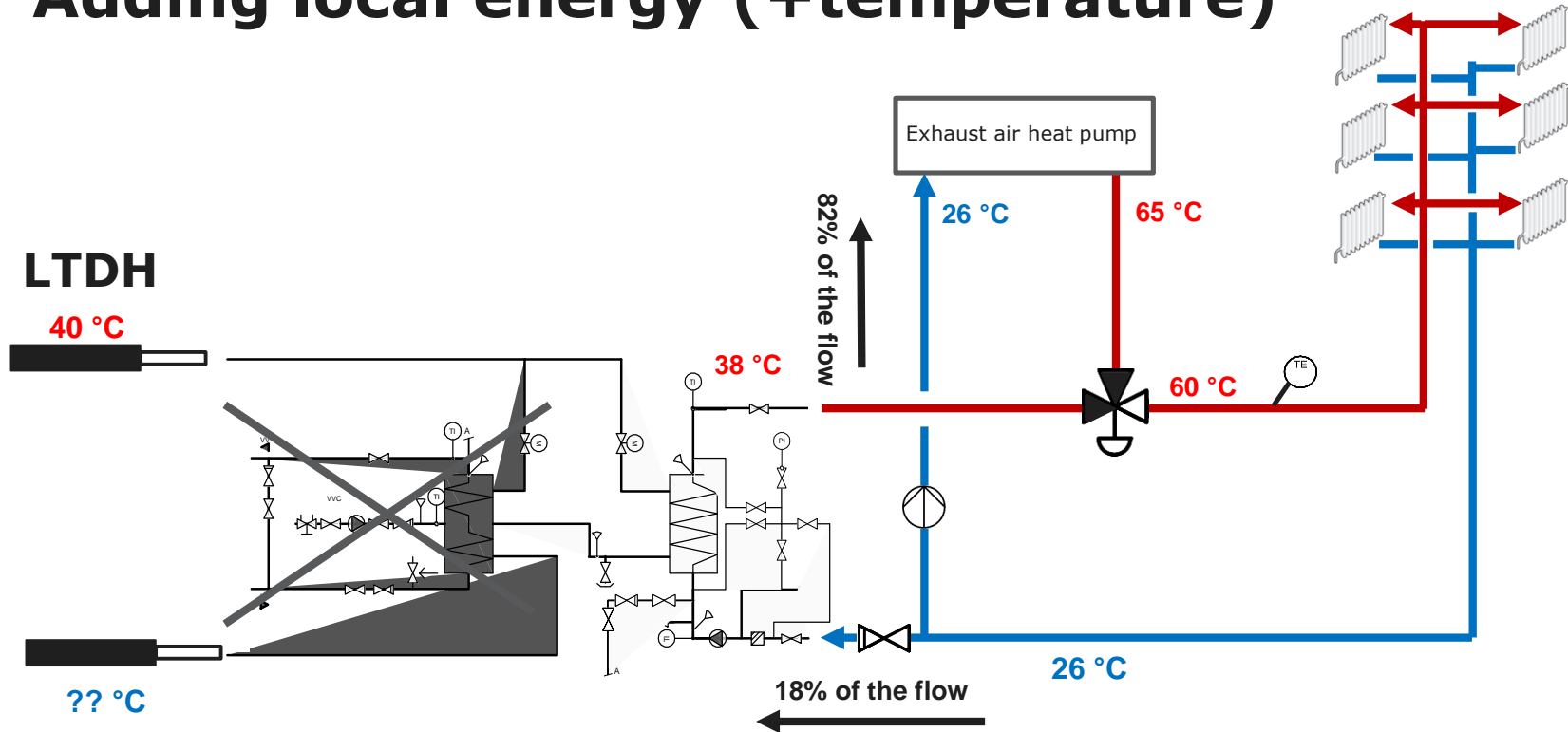
Integration of Local energy sources

Adding local energy



Integration of Local energy sources

Adding local energy (+temperature)



Perspective

Results

- > Technology catalogues
- > New inputs/ideas for introducing RES in the DHW production
- > Evaluation and comparison of technologies

Available for the members of consortium

- > Future use for the members

Thank you for your attention!

Xplorion

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PROCES

- Procurement Q3-2017
1 offer, 108 Mkr
- Procurement as cooperation project Q1-18
2 offers, 90-94 Mkr (budget 75 Mkr)
- Subsidies
- Extra income
- Projectchanges
 - Floor heating, concrete finish
 - Architecture
 - Kitchenmachinerie

XPLORION



COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union



XPLORION



COOL DH

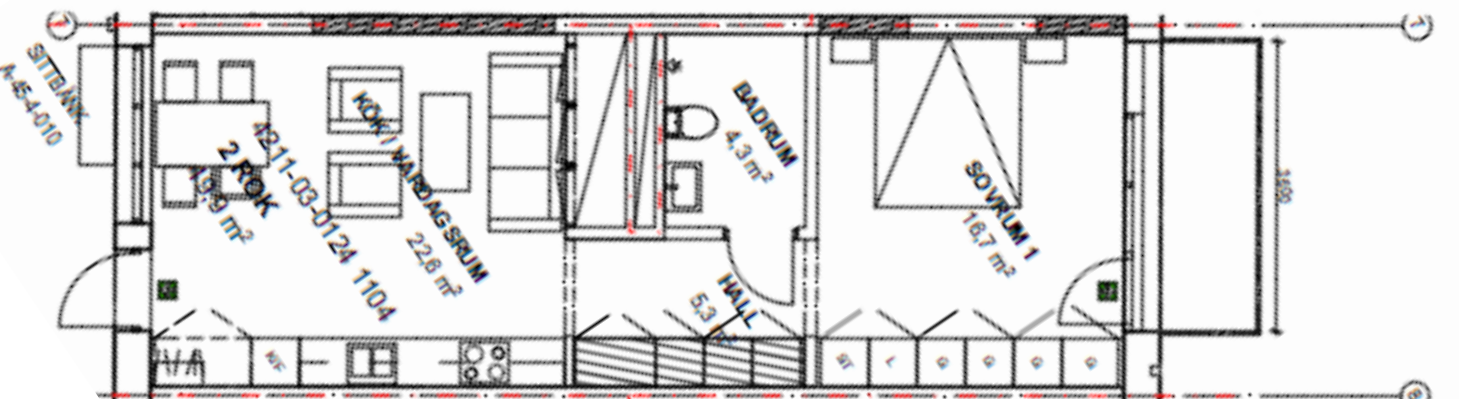
- Heat from research facilities will be used in a low temperature system
- Xplorion will show for other project developers that this works
- A heat exchanger will be used in every apartment
- Tenants control temperature in their own apartments and pay for what they use

'LOW ENERGY' HOUSE (42 kWh/m²)

- Trias Energetica
- High insulation values and good airtightness
- Warm area minimized

MATERIAL

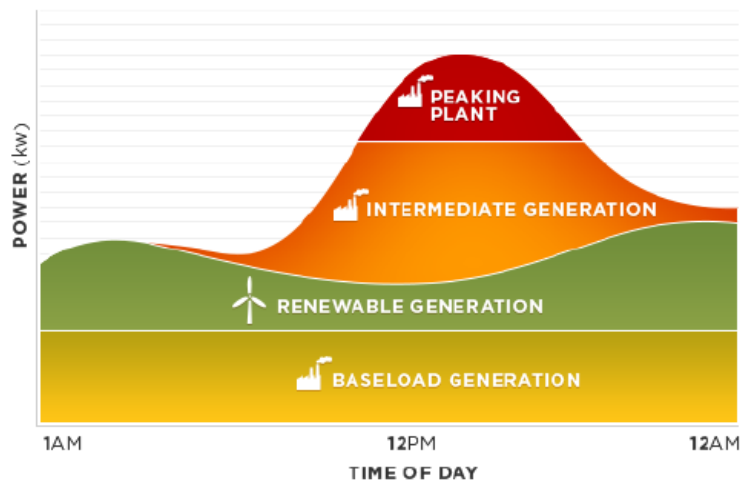
- Buildingphase has a proportionally large impact in environmental footprint of a building
- Xplorion uses a absolute minimum of material. Building without innerwalls and a well thought out structure



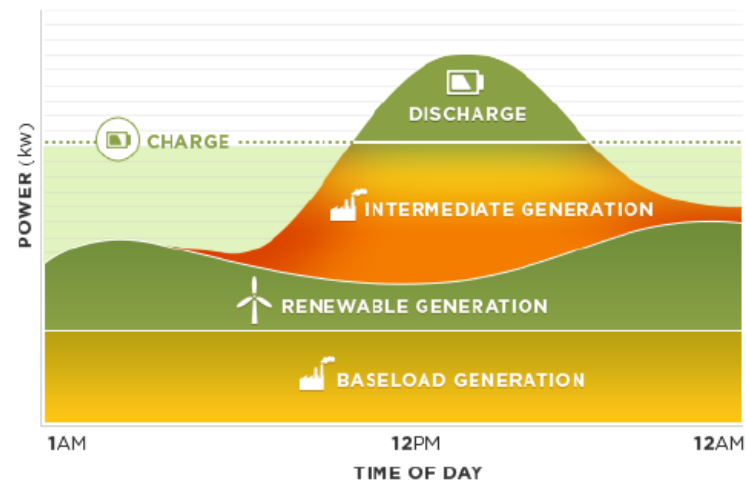
ENERGY, USED WHERE IT IS PRODUCED

- PV panels on the roofs
- LKF sells electricity to tenants
- Battery is being used during consumption peaks

GENERATION PROFILE *WITHOUT* STORAGE



GENERATION PROFILE *WITH* STORAGE



SMART MOBILITY

- No parkingspaces
- We want to seduce tenants with good alternatives to owning a car
- Cargobike can be taken up to every apartment door
- All bicycles can be parked dry and safe
- Cargobike sharing service is included
- Car sharing service is included

VENTILATION

- Ventilation based on air quality
- Research suggests that up to 25% can be saved on heating

Third workshop on demand side: Tuesday, March 26th, 2019

COOL DH

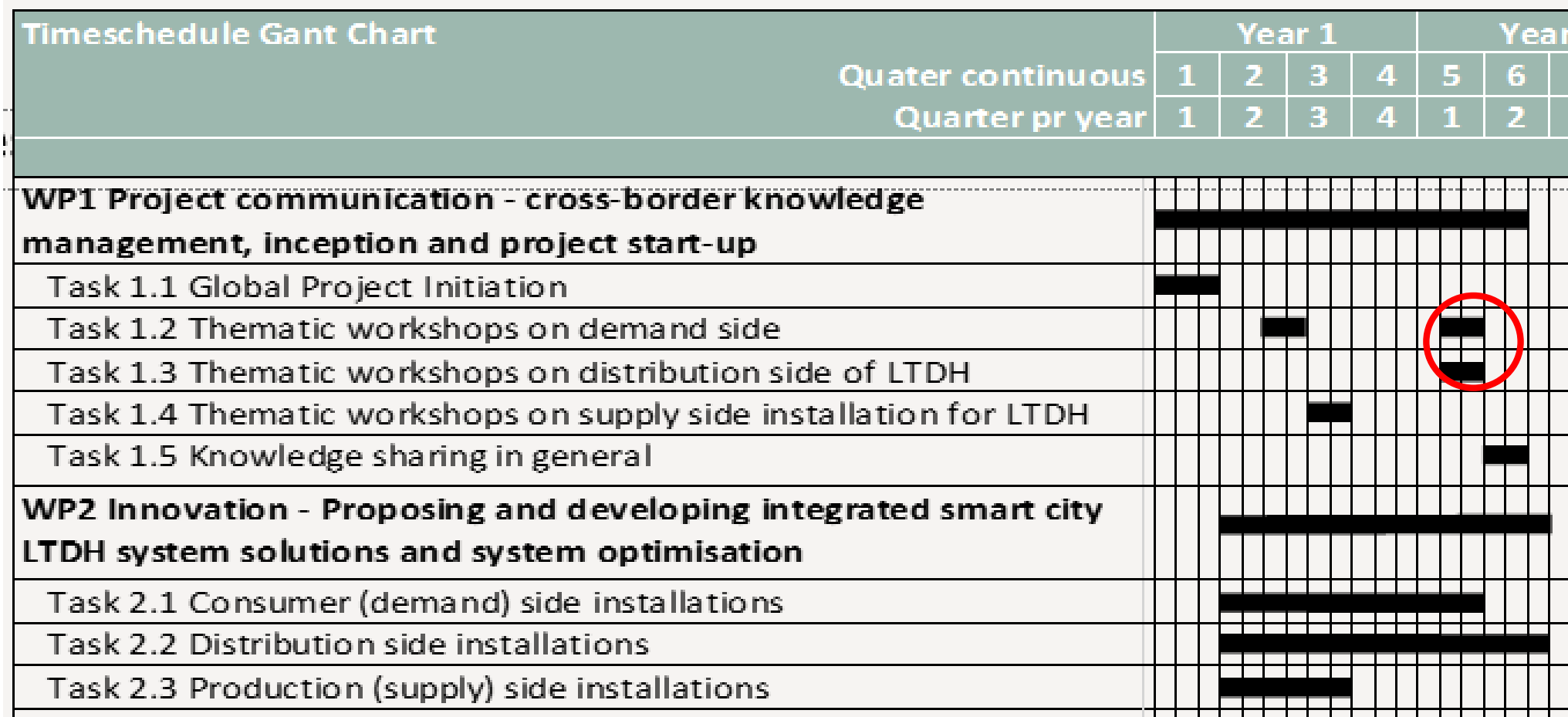
WP1 - Innovation Workshop

Introduction by Reto Hummelshøj, COWI A/S



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Final Demand and Distribution Side Workshop + Knowledge sharing...



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Workshop dates

- Thematic workshops held
 - Demand side 20 March 2018 + 26 March 2019
 - Distribution side 6 April 2018 + 15 Nov 2018
 - Supply side 21 March 2018 + 5 April 2018 + 15 Nov 2018



Program thematic workshop

Tuesday, March 26th 2019 Location: COWI A/S, Parallelvej 2, DK-2800 Kgs. Lyngby, room: P181		Time min.
09:00	Check in and coffee	15
09:15	Welcome and introduction to the day by Reto M. Hummelshøj, COWI	15
09:30	D.2.2 Solutions for local integration of RES, Emanuele Zilio, COWI	25
09:55	Questions	5
10:00	D.2.3 Substation solutions for single family units, Emanuele Zilio, COWI	25
10:25	Questions	5
10.30	Coffee break	15
10.45	D.2.6 Improved use og individual metering, Per-Olof Johansson Kallioniemi, Lund University	25
11.10	Questions	5
11:15	D.6.4. Investigation of legislative framework (Status of deliverable), Jacob Nyman Rud, COWI	15
11:30	Questions	5
11:35	D.2.10 Calculator on high efficient pipe type (in buildings), Emanuele Zilio, COWI	25
11:55	Questions	5
12:00	Lunch	45
12:45	D.2.8 Design manual for LTDH underground (near buildings), Klaus Grønnegaard Lauridsen, Logstor	20



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Program project meeting

13.10	WP6 D.6.1. New innovative business plans, Göran Strandberg / Sara Krallmark Krafringen		15
13.25	Questions		5
13:30	Financial reporting and administration, Reto M. Hummelshøj, COWI		30
14:00	Questions		10
14:15	Coffee break		15
14:30	WP3 Status meeting Markus Falkvall, Krafringen	Time available for internal meetings or bilateral discussions	90
16:00	End of the day		



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Deliverables overview – WP2 nearly finished

D1.1	Kick-off workshop incl. MOM	1 - COWI-DK	Other (O)	3	Complete
D1.2	Thematic workshops demand side	1 - COWI-DK	Other (O)	15	complete
D1.3	Thematic workshops distribution side	1 - COWI-DK	Other (O)	15	Complete
D1.4	Thematic workshops supply side	5 - UNI-SE	Other (O)	9	Complete
D1.5	Inception note	1 - COWI-DK	Report (R)	17	Ongoing
D2.1	Report on solutions for avoiding risk of legionella	2 - UTIL-SE	Report (R)	10	Complete
D2.10	Calculator on savings for new high efficient pipe types for internal distribution in buildings	7 - IND-DK	Other (O)	15	complete
D2.11	Working paper on optimising cascade couplings for optimal use of low temperature sources	2 - UTIL-SE	Report (R)	8	Complete
D2.12	Working paper on the development of short time and seasonal energy storage	8 - UTIL-DK	Report (R)	9	Complete
D2.13	Work document / flyer on added value of LTDH systems	4 - MUN-SE	Other (O)	6	Complete
D2.2	Working paper on solutions for local integration of renewable energy sources	1 - COWI-DK	Report (R)	15	complete
D2.3	Technical specifications for substation solutions for single family units	1 - COWI-DK	Report (R)	15	complete
D2.4	Working paper on system solutions for multifamily houses and tertiary buildings	2 - UTIL-SE	Report (R)	12	Complete
D2.5	Working paper on LTDH connected appliances	2 - UTIL-SE	Report (R)	8	Complete
D2.6	Report on improved use of individual metering concepts	5 - UNI-SE	Report (R)	18	Ongoing
D2.7	Working paper on new design concepts for optimisation of LTDH distribution systems	1 - COWI-DK	Report (R)	12	Complete
D2.8	Draft design manual for new pipe components for LTDH distribution systems underground	7 - IND-DK	Report (R)	15	Ongoing
D2.9	Prototype for new multimedia pipe types for LTDH distribution system	7 - IND-DK	Demonstration (D)	18	Ongoing
D3.1	Local energy solution with heat pump hot water topping	11 - HOUSE-SE	Demonstration (D)	15 (30)	Ongoing



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Milestones

Number		Title	Lead Beneficiary	Due Date (in months)
M1	✓	Solution for LTDH connected appliances	UTIL-SE	8
M2	✓	Solutions for avoiding legionella	UNI-SE	10
M3	✓	System solutions for multifamily houses	UTIL-SE	12
M4	✓	Draft monitoring plan	UNI-SE	12
M5	✓	Result of thematic workshops on demand and distribution side	COWI-DK	15
M6	✓	Prototype	IND-DK	18
M7	✓	Business concept	MUN-SE	20
M8	✓	950 m new PEX-pipes installed	UTIL-SE	20
M9	✓	3-pipe solution for multi storey building	UTIL-SE	20



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Purpose of meeting

- Present results of innovation work
- As working paper inputs to WP3 and WP4
- Knowledge sharing
- Get a common picture
- Discuss and ask question until all is clear 😊





D2.2

Solutions for local integration of renewable energy sources

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 76779"

Emanuele Zilio, COWI DK

Agenda

- > Aim of the deliverable
- > Technology catalogues
- > Single-family buildings and apartments - Results
- > Multi-family buildings - Results
- > Discussion
- > Conclusion

Aim of the deliverable

Innovate

Preparation of domestic hot water (DHW) by pre-heating with LTDH and local supplementary heating with integration of RES.

> Investigation:

- > Solutions for single-family buildings and apartments
- > Solutions for multi-family buildings

> Comparison:

- > Economic evaluation – payback time on extra cost compared to a reference case

Technology catalogues

Which technologies?

- > Technologies available on the market (or close to be available)
 - > Possible integration/coupling with sustainable heat sources
- > Output of the deliverable
 - > Datasheet that describes the main characteristics and gives an overview of the technology (cost, installation, etc.)
 - > Pro and cons

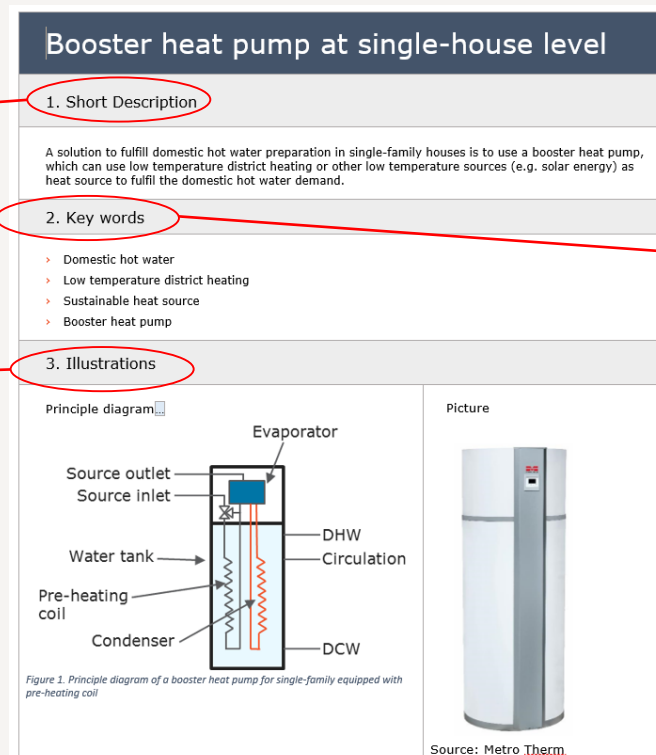
Technology catalogues

Short description

- > Brief introduction of the technology

Illustrations

- > Principle diagram and picture of the technology



Keywords

Technology catalogues

Technical description

- Technical and operation characteristics of the technology

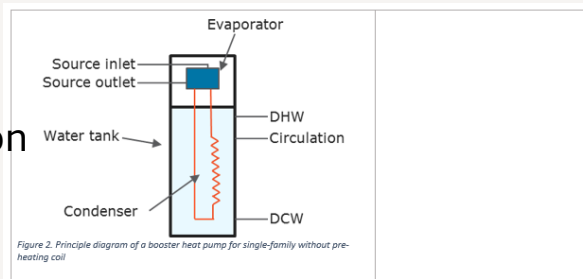


Figure 2. Principle diagram of a booster heat pump for single-family without pre-heating coil

4. Technical description

This device is a water/brine-to-water heat pump that can use different low temperature heat sources, such as low temperature district heating, space heating return or ground source heat pump. It is also under development the possibility to connect the heat pump directly to a ground source or to a solar collector system. Furthermore, an interesting development would be the possibility to connect the device to a PVT system, where the heat produced can be used for the domestic hot water production, while the electricity can be used for the heat pump operation.

The heat pump has two main configurations:

- In the first configuration (Figure 1), the heat pump is equipped with a pre-heating coil in the water tank. When the temperature of the heat source is higher than the water in the tank, the supply flow passes through the pre-heating coil in order to pre-heat the water in the tank. Afterwards, the flow goes through the evaporator of the heat pump where the heat is absorbed to be released in the water tank through the condensed in order to prepare the domestic hot water.
- In the second configuration (Figure 2), the pre-heating coil is not installed, and in this way, the supply flow goes directly through the circuit of the heat pump. Therefore, the water in the tank is heated up only through the condenser.

Perspective:

- Suitable for new or refurbished buildings
- Suitable for single family houses or terraced houses

5. Characteristics

The heat pump can increase the water temperature up to 65°C, avoiding the risk of Legionella contamination in the water tank. However, if the heat source is not enough to fulfill the water temperature requirement, the heat pump is equipped with an electrical heater.

The heat pumps ensure a certain flexibility in terms of temperature range of the source. It can be supplied with the lowest temperature equal to 10°C when water is used as refrigerant, or 5°C in case of

brine. On the other hand, the maximum source temperature is 55°C, if the heat pump is not equipped with a pre-heating coil, and 60°C when the pre-heating coil is mounted.
The wide range of supply temperatures give the possibility of achieving a good COP. In case of standard situation, for a supply temperature of 25°C, it is possible to reach a COP equal to 4.8, while for a supply temperature equal to 40°C it is possible to reach a COP equal to 8 (1).
The booster heat pump has different possibilities of connection since it can be connected either in series or in parallel to the space heating circuit. Furthermore, more devices can be coupled in order to increase the capacity and fulfill a higher domestic hot water demand.
An interesting application of the heat pump in connection to the floor heating system is shown in Figure 3. During winter the heat pump is connected in parallel to the space heating system and it can use the connection to the district heating or another heat pump as heat source. On the other hand, during summer, thanks to the integrated pump, the heat pump can use the space heating system as heat source, absorbing heat from the dwelling, fulfilling part of the cooling demand.

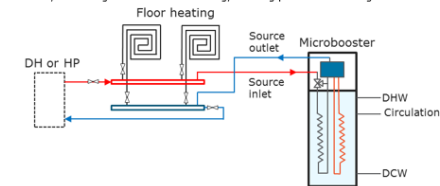


Figure 3. Booster heat pump connected to floor heating system

6. Demands to installation

- Space requirements for installation at the final user
- Maintenance access
- Connection to water and power
- Maintenance requires skilled and certified labor

Demand to installation

Characteristics

- Why is the technology interesting?

Technology catalogues

Pros and cons

7. Pros and cons

Pros	Cons
<ul style="list-style-type: none"> + It can use a sustainable heat source + It is delivered as preassembled unit + It has a wide range of sources temperatures, and possibility to reach a high COP + It minimizes the problem with Legionella contamination + Can be connected to the return temperature of the district heating system (ensuring a lower return temperature) + It is possible to lower the DH supply temperature lower than the requirements for DHW production + It can be integrated with a PVT system or ground heat source + Can be connected in series or parallel for larger installations + Smart grid ready 	<ul style="list-style-type: none"> - It requires space for installation - It is under development - It increases the heat losses in the building due to the buffer tank. - The heat pump is electrically driven

Economic data

- > Overview of the main costs

8. Economic data

Capacity range [kW]	Equipment cost excl. VAT, [€]	Total cost incl. installation price excl. VAT, [€]	O&M cost [€/year]
Metro Therm - METRO MICROBOOSTER 201 2.1 kW COP: 4.8-8.02 190 liters water tank Single-house 3-4 pers (1) (2)	Ca. 1800-2100 €* *	Ca. 2100-2300 €* *	Ca. 200-300 €/year*

*Prices reference 2018

9. Environmental issues

- > Recycling options

10. Example of suppliers

- > Metro **Therm**.

References

11. References

- (1) Metro **Therm** "MICROBOOSTER 201" datasheet (courtesy of Metro Therm. Not available online)
- (2) Danish Energy Agency and Energinet. 2016. Technology Data for Individual Heating Installations. Last update March 2018. Available online at: <https://ens.dk/service/fremskrivninger-analyser-modeller/teknologikataloger/teknologikatalog-individuelle>

Example of suppliers

Single-family houses or apartments

Technologies

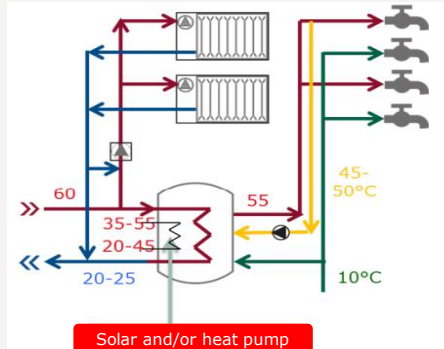
- > DH-units
 - > Direct
 - > Indirect
 - > Buffer tank on primary side
- > Heat pumps
 - > Air-to-water (with and without heating coil)
 - > Micro booster HP



Single-family houses or apartments

Technologies

- > Electric heaters (green el.)
 - > Normal
 - > With heating coil
 - > Smart controller
- > Solar collectors systems
 - > DH integrated with solar collectors (scalable)



Results

Single-family buildings and apartments

> DH-units direct

- LTDH
- Two pipes system
- Legionella control
- Centralized DHW and SH
- Require DH substation
- Temperature limit (DHW)

> DH-units indirect

- LTDH
- Two pipes system
- Legionella control
- No DH substation
- Higher cost (per unit)
- Temperature limit (DHW)

Results

Single-family buildings and apartments

> DH-units with buffer tank on primary side

- LTDH
- Small service pipe (low losses)
- Legionella control (primary side tank)
- Priority DHW-SH
- Heat losses in the building
- Temperature limit (DHW)

> Air-to-water HP – indoor air source

- LTDH/ULTDH
- Low cost
- Legionella control
- Higher SH consumption
- Require SH system installation
- Lower heat recovery ventilation

Results

Single-family buildings and apartments

> Electric heater

- Low installation cost
- PV combination
- LTDH/ULTDH
- Electricity cost (high operation cost)
- Require SH system installation
- Eventually electric system upgrade

> Electric heater with heating coil

- Low installation cost
- Preheating (LTDH/ULTDH)
- PV combination
- Electricity cost (high operation cost)
- Require SH system installation
- Eventually electric system upgrade

Results

Single-family buildings and apartments

> Electric heater with smart control

- Energy savings
- User's pattern
- PV combination
- Electricity cost (high operation cost)
- Require SH system installation
- Eventually electric system upgrade

> Integration of RES with solar collector and buffer tank

- Reduced DH cost
- Solar energy
- Implementation of HP
- High investment cost
- Water tank on secondary side
- Electric heater (backup)

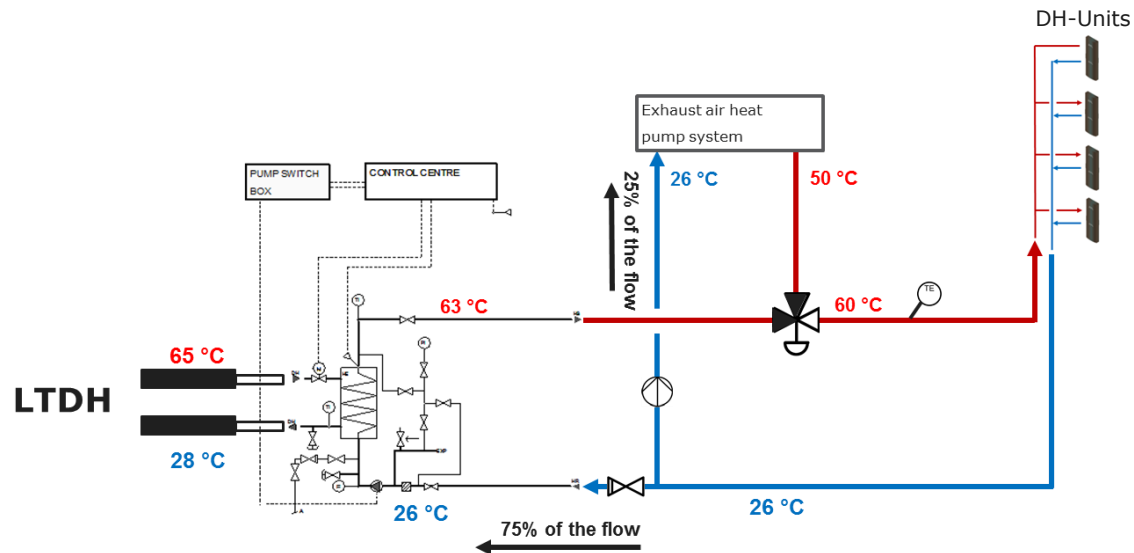
Multi-family buildings

Technologies for heat recovery or introduce RES

- > District heating is **the primary** heat source
- > District heating **return temperature** have to be prioritized = always be as low as possible
- > Keep the design as **simple and reliable** as possible
- > Try to **avoid** to design systems with **storage** of hot tap water

Multi-family buildings

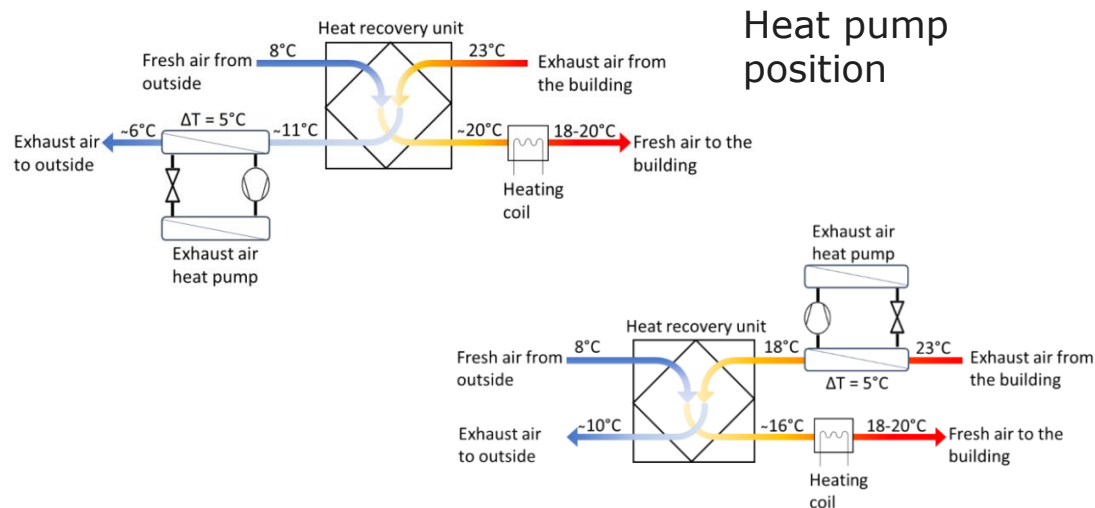
Split flow heat pump – heat recovery from ventilation system



- ➔ RES integration
- ➔ Different heat sources
- ➔ Peak load contribution
- ➔ Limited COP (high demand)
- ➔ Variable source temp.
- ➔ Higher heat demand

Multi-family buildings

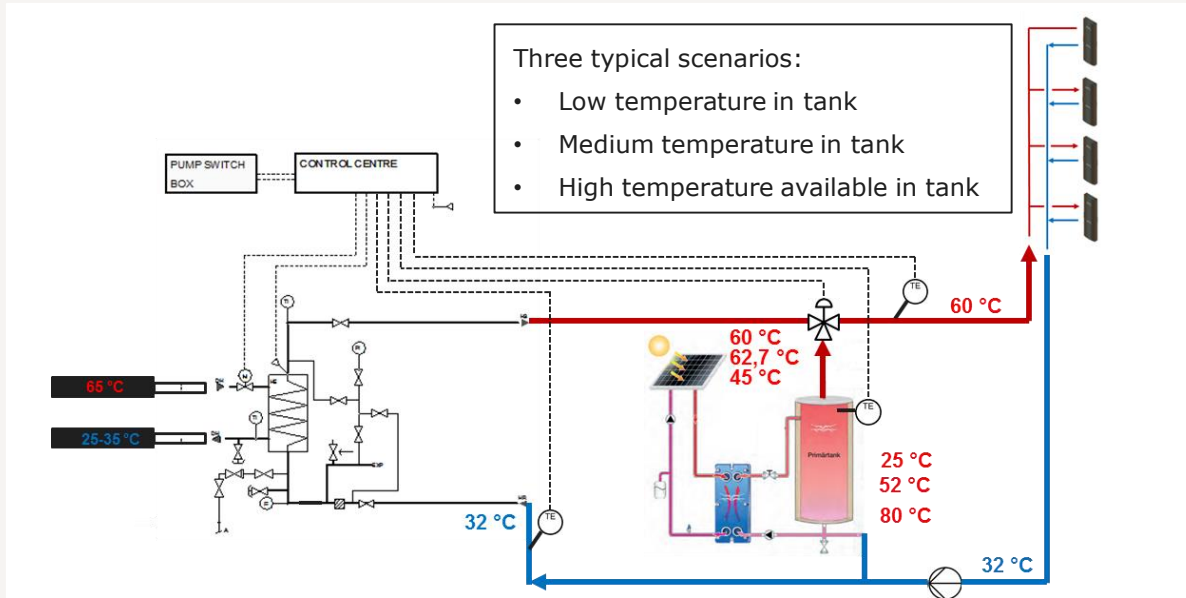
Split flow heat pump – heat recovery from ventilation system



- ➔ RES integration
- ➔ Different heat sources
- ➔ Peak load contribution
- ➔ Limited COP (high demand)
- ➔ Variable source temp.
- ➔ Higher heat demand

Multi-family buildings

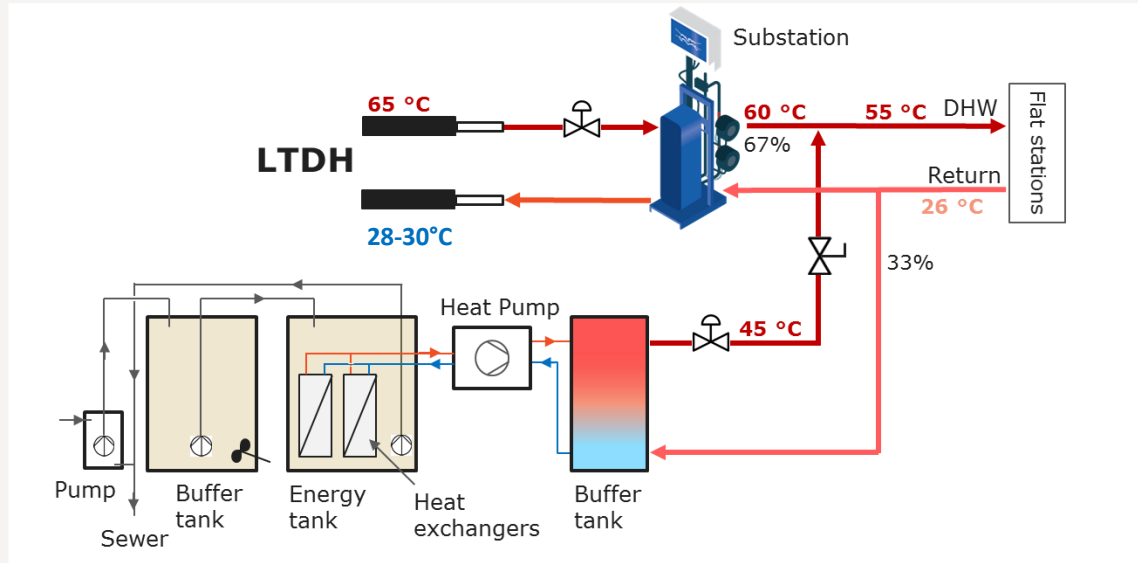
Integration of supplemental energy – solar collectors and buffer vessel



- ➔ RES integration
- ➔ Combination with DH
- ➔ Legionella control
- ➔ Peak shaving
- ➔ Winter period
- ➔ Installation cost

Multi-family buildings

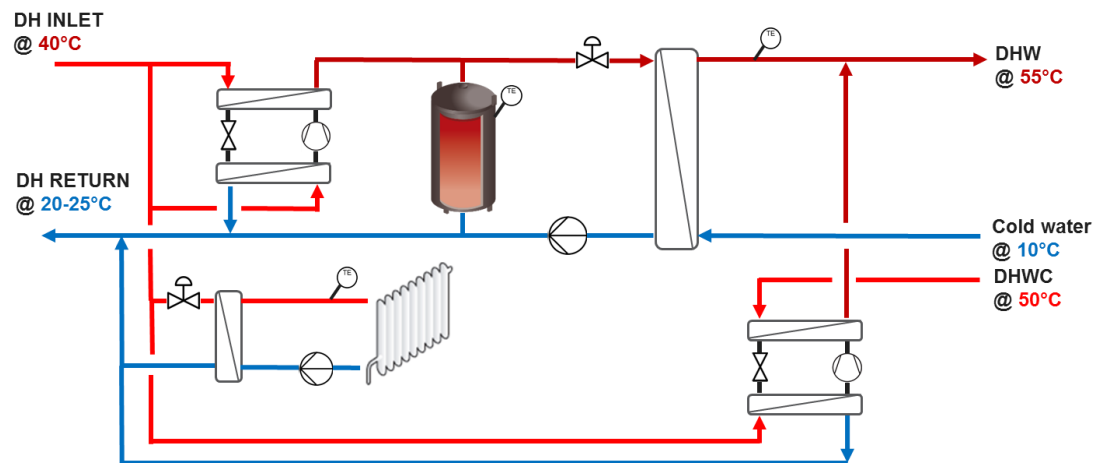
Waste water heat recovery



- ➔ LTDH
- ➔ RES integration
- ➔ Stable heat source
- ➔ High installation cost
- ➔ Affect other heat recovery installations
- ? Under development

Multi-family buildings

Booster/Temperature Topping for DHW (Danfoss solution)



- ➔ 15°C topping
- ➔ Potential high COP
- ➔ Coupled on return flow – lower return temp
- ➔ Slightly higher return temp.
- ➔ Heat source cost

Other solutions for RES integration

Low-temperature space heating

- › Low-temperature radiators
 - › Allow low-temperature supply (28°C)
 - › Good cooling of the flow/low-return temperature
 - › Smaller dimensions compared to standard radiators (same capacity)
 - › Cheaper than floor heating
 - › Booster fan (factor 3)
- › Floor heating
 - › Allows low-temperature supply
 - › Higher cost (installation and construction)
 - › Higher comfort level (temperature distribution)
 - › Hidden installation

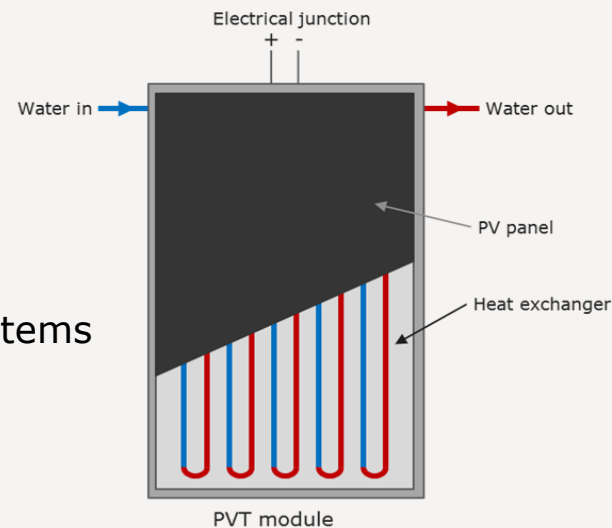


Other solutions for RES integration

Photovoltaic thermal hybrid solar collector

PVT panels

- > Combination with heat pumps
- > Work as heat source as well as electricity source
- > Higher efficiency of the PV panel
- > Lower cost compared the installation of two separate systems



Discussion

Discussion

- > Overall evaluation
- > Specific case for precise evaluation
- > Electricity from RES?

Conclusion

Conclusion

- > Guideline about new and existing technologies
- > Single-family/apartments:
 - 😊 DH-units
 - 😊 Heat pumps: air-to-water and 😊 booster
 - 😊 Solar Collectors system +DH 😊 El-heaters
- > Multi-family buildings:
 - 😊 Split flow heat pump
 - 😊 Solar collectors system
 - 😊 Booster heat pump
 - ? Waste water heat pump

Booster heat pump for single-family houses or apartments



Thank you for your attention!



D2.3

Technical specifications for substation solutions for single-family units

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 76779"

Emanuele Zilio, COWI DK

Agenda

- > Aim of the deliverable
- > Technologies
- > Single HEX units
- > Double HEX units
- > Conclusion

Aim of the deliverable

Investigate and advice on the use of various DH-units for single-family houses/apartments

- > Investigation:
 - > Products available on the market (latest development)
 - > Implementation on the two demo-sites

- > Output of the deliverable:
 - > Summarize main characteristics
 - > Give an advice about solutions



Technologies

Which technologies?

- > DH-units implemented in LTDH
 - > 55°C DH supply in Denmark
 - > 60°C DH supply in Sweden

- > Single HEX units
 - > Explorion demo site

- > Double HEX units
 - > Østerby demo site



Technologies

Important parameters:

- > Pressure [bar]
- > Supply/return temperature [°C]
- > Supply flow [l/h]
- > Power capacity [kW]

Accessories:

- > Meter connections
- > Idle load function
- > Weather compensator (or other controls)



Single HEX units

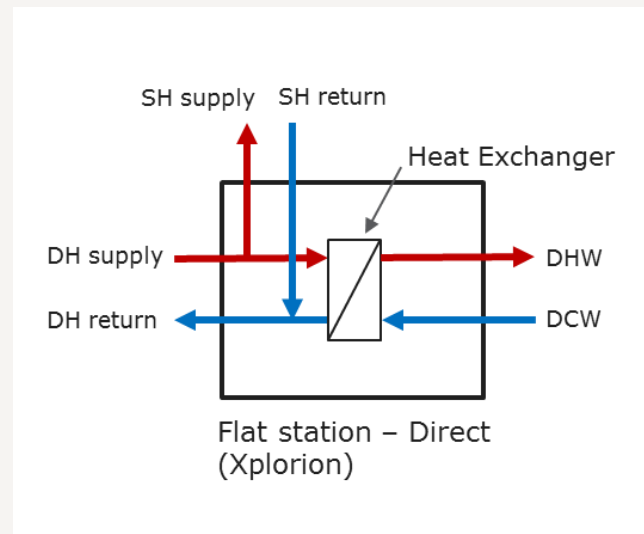
> DH-unit

- > Main substation
- > Only DHW heat exchanger
- > SH directly supplied
- > Shunt – control valve

> Metering

- > Single user

> Legionella control



Single HEX units

Cetetherm Micro RTC

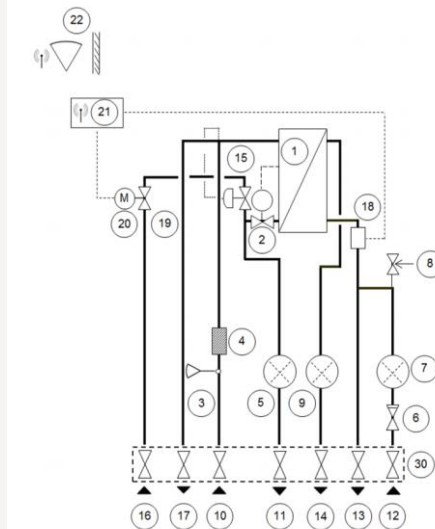
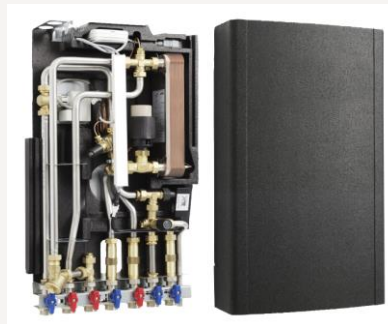
- > Primary = 10 bar
- > Secondary = 10 bar (DHW) and 10 bar (SH)

> DHW

- > $\Delta P_{DHW} = 0.5 \text{ bar (minimum)}$
- > $T_{Prim_DHW} = 65^\circ\text{C}/25^\circ\text{C}$
- > $T_{Sec_DHW} = 10^\circ\text{C}/50^\circ\text{C}$
- > $\text{Capacity}_{DHW} = 55 \text{ kW}$
- > Supply flow DH = 1188 l/h

> SH

- > $T_{SH} = 80^\circ\text{C}/50^\circ\text{C}$
- > $\text{Capacity}_{SH} = 10 \text{ kW}$
- > Supply flow DH = 288 l/h



- > LTDH
- > Pressure and temperature regulator DHW
- > Indoor temperature sensor
- > Idle load function
- > On/Off control - no return temperature optimisation

Single HEX units

Cetetherm Micro STC

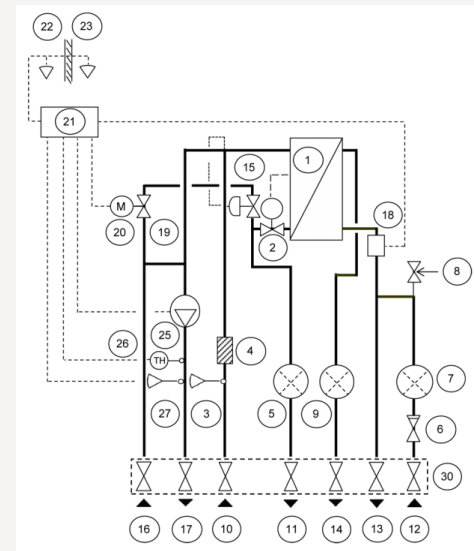
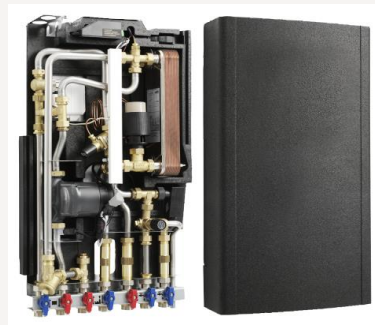
- > Primary = 10 bar
- > Secondary = 10 bar (DHW) and 10 bar (SH)

> DHW

- > $\Delta P_{DHW} = 0.5 \text{ bar (minimum)}$
- > $T_{Prim_DHW} = 65^\circ\text{C}/25^\circ\text{C}$
- > $T_{Sec_DHW} = 10^\circ\text{C}/50^\circ\text{C}$
- > $\text{Capacity}_{DHW} = 55 \text{ kW}$
- > Supply flow DH = 1188 l/h

> SH

- > $T_{SH} = 80\text{-}30^\circ\text{C}/30\text{-}35^\circ\text{C}$
- > $\text{Capacity}_{SH} = 7 \text{ kW}$
- > Supply flow_{DH} = 108 l/h



- > LTDH
- > Built-in mixing loop in the heating circuit
- > Supply temperature control – optimized return temperature SH
- > Idle load function
- > Pressure and temperature regulator DHW
- > Indoor temperature and weather compensator

Single HEX units

Danfoss Redan AKVA LUX II TDv

- > Primary = 10 bar
- > Secondary = 10 bar

> DHW

- > $\Delta P_{DHW} = 0.3 \text{ bar}$
- > $T_{Prim_DHW} = 55^\circ\text{C}/19.9\text{-}22.5^\circ\text{C}$
- > $T_{Sec_DHW} = 10^\circ\text{C}/50^\circ\text{C}$
- > Capacity_{DHW} = 32.3 kW
- > Supply flow DH = 850 l/h

> SH

- > $T_{SH} = 40\text{-}30^\circ\text{C}$
- > Capacity_{SH} = 5-10 kW
- > Supply flow_{DH} = 108-287 l/h



- > LTDH
- > Idle load function (cold HEX)
- > Pressure and temperature regulator DHW
- > Low cost

Double HEX units

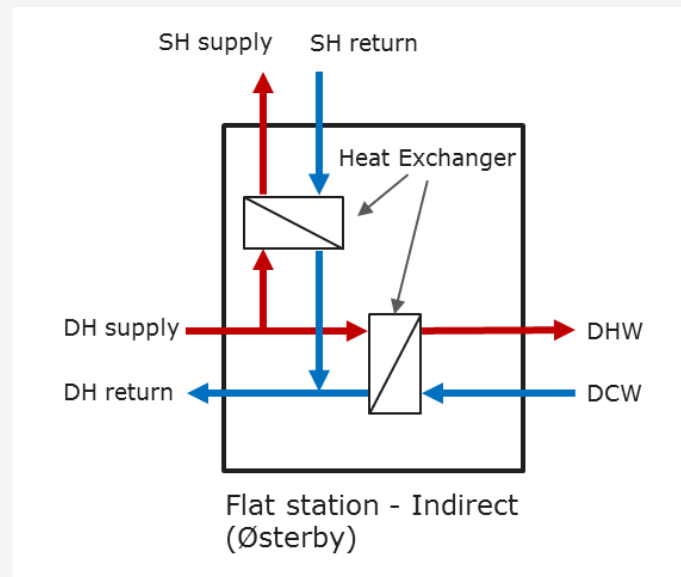
> DH-unit

- > Connected to DH network
- > DHW and SH heat exchangers
- > Circulation pump and expansion tank for SH

> Metering

- > Single user

> Legionella control



Double HEX units

Cetetherm Mini City

- > Primary = 16 bar
- > Secondary = 10 bar (DHW) and 3 bar (SH)

> DHW

- > $\Delta P_{DHW} = 0.5$ bar (minimum)
- > $T_{Prim_DHW} = 60^{\circ}C/25^{\circ}C$
- > $T_{Sec_DHW} = 10^{\circ}C/50^{\circ}C$
- > Capacity_{DHW} = 40 kW
- > Supply flow DH = 972 l/h

> SH

- > $\Delta P_{SH} = 0.5$ bar (minimum)
- > $T_{Prim_SH} = 80^{\circ}C/63^{\circ}C$
- > $T_{Sec_SH} = 60^{\circ}C/70^{\circ}C$
- > Capacity_{SH} = 11 kW
- > Supply flow DH = 540 l/h



- > LTDH
- > Indoor temperature sensor
- > Weather compensator
- > HEX temperature sensor – low return
- > Large insulation cover

Double HEX units

Cetetherm Mini ECO

- > Primary = 16 bar
- > Secondary = 10 bar (DHW) and 3 bar (SH)

> DHW

- > $\Delta P_{DHW} = 0.5$ bar (minimum)
- > $T_{Prim_DHW} = 60^{\circ}C/25^{\circ}C$
- > $T_{Sec_DHW} = 10^{\circ}C/50^{\circ}C$
- > Capacity_{DHW} = 50 kW
- > Supply flow DH = 839 l/h

> SH

- > $\Delta P_{SH} = 0.5$ bar
- > $T_{Prim_SH} = 80^{\circ}C/63^{\circ}C$
- > $T_{Sec_SH} = 60^{\circ}C/70^{\circ}C$
- > Capacity_{SH} = 13 kW
- > Supply flow DH = 612 l/h



- > LTDH
- > Weather compensator
- > Indoor temperature sensor
- > HEX temperature sensor – low return
- > Top/bottom connections

Double HEX units

Danfoss Redan Akva Les II Vxi

- > Primary = 16 bar
- > Secondary = 3 bar (SH)

> DHW

- > $\Delta P_{DHW} = 0.15-0.22 \text{ bar}$
- > $T_{Prim_DHW} = 55^{\circ}\text{C}/15-17.2^{\circ}\text{C}$
- > $T_{Sec_DHW} = 10^{\circ}\text{C}/45^{\circ}\text{C}$
- > $\text{Capacity}_{DHW} = 22-32.3 \text{ kW}$
- > Supply flow DH = 560-690 l/h

> SH

- > $\Delta P_{SH} = 0.25-0.59 \text{ bar}$
- > $T_{Prim_SH} = 60^{\circ}\text{C}/28-32.4^{\circ}\text{C}$
- > $T_{Sec_SH} = 25-30^{\circ}\text{C}/55^{\circ}\text{C}$
- > $\text{Capacity}_{SH} = 6-20 \text{ kW}$
- > Supply flow_{DH} = 730-920 l/h



- > LTDH
- > Weather compensator
- > Pressure and temperature regulator DHW
- > Idle load function (cold HEX)
- > Top/bottom connections

Double HEX units

Wavin Calefa V

- > Primary = 16 bar
- > Secondary = 10 bar (DHW) and 3 bar (SH)

> DHW

- > $\Delta P_{DHW} = 0.2-0.3 \text{ bar}$
- > $T_{Prim_DHW} = 55^{\circ}\text{C}/18^{\circ}\text{C}$
- > $T_{Sec_DHW} = 10^{\circ}\text{C}/45^{\circ}\text{C}$
- > Capacity_{DHW} = 32.3-41 kW
- > Supply flow DH = 720-910 l/h

> SH

- > $\Delta P_{SH} = 0.2 \text{ bar}$
- > $T_{Prim_SH} = 60^{\circ}\text{C}/30^{\circ}\text{C}$
- > $T_{Sec_SH} = 25^{\circ}\text{C}/55^{\circ}\text{C}$
- > Capacity_{SH} = 15-25 kW
- > Supply flow DH = 440-732 l/h



- > LTDH
- > Weather compensator (optional)
- > Idle load function (check the user consumption pattern)
- > Temperature regulator DHW
- > Pressure regulator valve SH

Double HEX units

Gemina Termix VVX

- > Primary = 16 bar
- > Secondary = 10 bar DHW

- > DHW
 - > $\Delta P_{DHW} = 0.25-0.35 \text{ bar}$
 - > $T_{Prim_DHW} = 55^{\circ}\text{C}/15.9-17.2^{\circ}\text{C}$
 - > $T_{Sec_DHW} = 10^{\circ}\text{C}/45^{\circ}\text{C}$
 - > $\text{Capacity}_{DHW} = 32.3-41 \text{ kW}$
 - > Supply flow DH $\approx 740-920 \text{ l/h}$ (calculated)

- > SH
 - > $\Delta P_{SH} = 0.35 \text{ bar}$
 - > $T_{Prim_SH} = 60^{\circ}\text{C}/30^{\circ}\text{C}$
 - > $T_{Sec_SH} = 25^{\circ}\text{C}/55^{\circ}\text{C}$
 - > $\text{Capacity}_{SH} = 4-22 \text{ kW}$
 - > Supply flow DH $\approx 120-640 \text{ l/h}$ (calculated)



- > LTDH
- > Weather compensator
- > Idle load function
- > Pressure and temperature regulator DHW
- > Pressure regulator valve SH

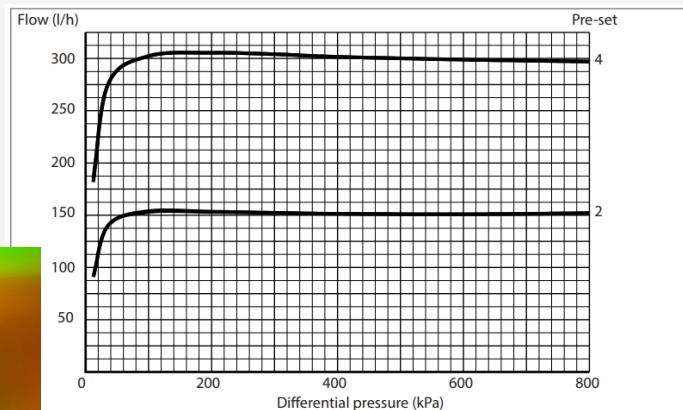
Discussion and Conclusion

Discussion

- > Heat loss: around 20 W average – up to 35 W during the heating season (Danfoss)
- > Connections outside the cover (valves, meters, pipes...)
- > Double connections top-bottom can cause heat losses – air flow

Improvements

- > Priority control to DHW
- > Frese valve on the DH return (outside the unit)



Discussion and Conclusion

Conclusion

- > Guideline about DH-units in LTDH
- > Complete and certified (quality DH connection)
- > Easy to install – pre-built unit
- > Can be financed on the bill (period)
- > **Explorion - Cetetherm Micro STC**
- > **Østerby - Gemina Termix VVX**



Thank you for your attention!



Task 2.1.6

COOL DH Innovation Workshop - series 3

Per-Olof Johansson Kallioniemi 20190326

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 76779"

Scope of task 2.1.6

- > The LTDH system is **monitored by** direct connection to the **heat meters at all the consumers.**
- > This can be used to **monitor heat losses in pipes, energy take-off and temperatures in real time** and in this way, **map consumption** pattern and **diagnose optimisation** potential etc.

What did we do?

We conducted several small studies with the aims to answer the following questions:

1. What are the requirements for the meters and communications systems today?
2. What factors are driving the development for new functions in the meters and communication systems?
3. Supplier experiences and ideas about metering
4. Applications for data analysis
5. Study on how Danish and Swedish DH companies work with “good cooling” today
6. Study about leak detection in service pipes

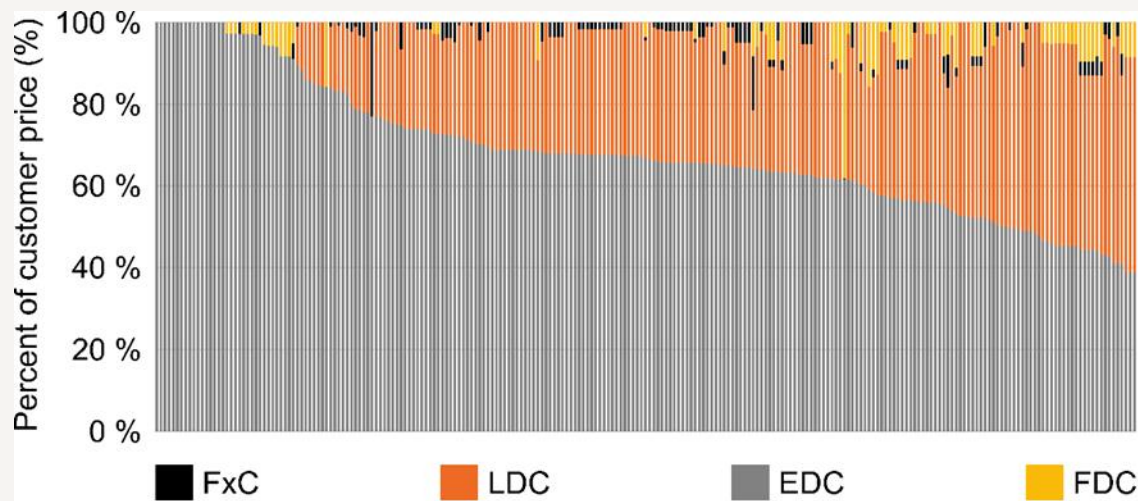
What are the requirements for the meters and communications systems today?

Swedish rules for measuring, reporting and billing delivered heat

EIFS 2014: 2 contain rules for measuring, reporting and billing the delivered heat. The following rules apply for the Swedish case:

- > The customer must be charged according to **actual consumption** which means the amount of energy actually taken out by the customer.
- > **All charge-based parameters should be based on actual measured values** from the thermal energy meter.
- > The energy supplier has a great responsibility for measuring the correct customer withdrawal and also being able to present this and the other measured values for the parameters that form the basis of price models to the customer .
- > The lowest time resolution according to the law is **daily values for the energy consumption** and other load-based measurement values. **If a price with a higher time resolution than day is applied, these measured values should be reported to the customer.**
- > In the event of an error or lack of measured values, the energy supplier has a limited opportunity to make a calculation or estimation. This may be done in exceptional cases, by using accepted methods and statistics secured for the customer group.
- > The heat supplier shall, without special expense for the heating customer, provide data on consumption per day, week, month and year for a period that includes at least the last two years or the current delivery contract term, if this is shorter. Information on historical use shall be made available quarterly if the customer so requests and otherwise at least twice a year. This applies to all billing values.

Price models in Sweden – study from 2015



- EDC (grey)- Energy demand components
- LDC (orange) - Load demand component
- FDC (yellow) – Flow demand component
- FxC (black) – Fixed component

Conclusions:

- Load components are used in 4/5 of the schemes
- Flow components are used in about one third of the schemes
- Some companies only use Energy demand components

Price models – Paying for load

- > **Five different pricing principles for capacity (identified in Song et al, 2015):**
 - > Use the customers total consumption during a certain period of time to determine the load fee
 - > Category number period - average load from a certain time period
 - > Load Signature Method - to predict peak load
 - > **Peak Load method: Based on actual measured peak load, e.g. mean value for several peaks or the highest peak**
 - > **Subscribed level method**

Peak load methods might put further requirements on meters and measurements

New price components are being developed?

Voices from some suppliers

HEX companies



If Flat stations:

- Keep track of pressure, temperature, flow
- Measure water consumption
- Regulate the distribution pump correctly
- Regulate the heating system correctly



If traditional system:

- Keep track of pressure, temperature, flow
- Measure water consumption (IMD)
- Regulate the distribution pump correctly
- Measure primary and secondary return temperature



Voices from some suppliers

Meters companies



kamstrup

- The metering will still technically be done in the same way.
- Real time values?
- Higher demands on the meters? e.g. more decimals
- More comfort agreements.
- Future adapted meters?



Application for data analysis

- examples from smart distribution network for electricity

	Application	Data Requirements	Data Analytics Approaches
Planning	Correction of topological error in database	<ul style="list-style-type: none"> Voltage magnitude active and reactive power from smart meters 	Descriptive
	Equipment diagnosis/asset management	<ul style="list-style-type: none"> Power quality data Hours in service of the equipment Frequency of overloads Time spent overloaded. 	Descriptive Predictive Prescriptive (and Predictive)
	Prediction of customer consumption considering changes in actions	<ul style="list-style-type: none"> Customers behavior information Load data Weather data Price and tariff information . 	Predictive
	Power quality management	<ul style="list-style-type: none"> Oscillography from meters installed along the feeder Power quality data e.g. total harmonic distortion flicker index. 	Descriptive Predictive Prescriptive (and Predictive)
	Integration of Renewable Energy sources (RES)	<ul style="list-style-type: none"> Weather data e.g. irradiation wind speed and direction Load data Other field measurement data . 	Descriptive Predictive Prescriptive (and Predictive)
Operation	Outage management	<ul style="list-style-type: none"> Customer calls Geographic information Oscillography from meters installed at substation or along the feeder Status of sentry devices installed along the feeders Time-of-outage Telemetered fault indicators Voltage magnitude from smart meters Weather data and/or lightning strike positions . 	Descriptive Predictive Prescriptive (and Predictive)
	Unit commitment	<ul style="list-style-type: none"> Customers behavior information Load data Power generation data Price Weather data . 	Predictive Prescriptive (and Predictive)
	Detection and location of non-technical loss	<ul style="list-style-type: none"> Load data - Voltage magnitude active power and reactive power from smart meters Social and economic data Alerts provided by the smart meters . 	Descriptive Predictive Prescriptive (and Predictive)
	Demand response	<ul style="list-style-type: none"> Customers behavior information Load data Information of the customers' appliances Price and tariff information Weather data . 	Predictive Prescriptive (and Predictive)
	Detection and location of high impedance faults	<ul style="list-style-type: none"> Voltage magnitude active power and reactive power from smart meters Oscillography from meters installed along the feeder . 	Descriptive Predictive Prescriptive (and Predictive)



Application for data analysis

- some ongoing projects/research

There is a variety of ongoing projects in the area of efficient DH- and LTDH-systems. The aim can be to find both technical solutions to make load predictions, detect and analyze malfunctions in customer installations and developing good routines for DH companies to continuously work with finding and fixing malfunctioning substations.

- > STORM project (Horizon 2020)
 - > STORM control
- > TEMPO started in 2017 (Horizon 2020)
- > K2 - Smart Energi (Smart energy)
- > Data mining projects
 - > SeMi - Self-Monitoring for Innovation
 - > DAD - Data-Analytics-for-Fault-Detection-in-District-Heating
- > SCA - Smart Cities Accelerator

Application for data analysis

- some ongoing projects/research

There is a variety of ongoing projects in the area of efficient DH- and LTDH-systems. The aim can be to find both technical solutions to make load predictions, detect and analyze malfunctions in customer installations and developing good routines for DH companies to continuously work with finding and fixing malfunctioning substations.

Common for all these projects is the use of meter data from customer installations and automated processes to continuously work with improved performance of the DH system and to reduce the primary return temperature.

Application for data analysis

- DSM – peak shaving

- Possibility to manage the heat load for DH customers by using the buildings as a virtual heat storage
- In this way, the peak loads in the grid can be “smoothened” out over a longer period, allowing for more efficient heat production.
- Commercial products already on the market, e.g.
 - Noda Smart Heat Grid utilizes substation and production data, weather forecasts and more to analyze the status of the grid and customers in order to optimize heat production
 - ngenic – smart thermostat. Can be connected to DH utility for remote control of customers heat demand (with feedback on indoor temperature)

Application for data analysis

- some products

- **A number of projects/companies are working with fault detection in customer substations:**
 - **SAM** – Smart Asset Management – is a Vinnova-project that includes a number of Swedish companies developing solutions, both technical and instrumental, on how to find and analyze malfunctioning substations.
 - **PreHeat** is an existing solution from the Danish company Neogrid, that combines hardware and software installations at the customers in order to optimize the function of the facility as well as identifying bad cooling and high return temperatures to the grid.
 - **TORNADO** is a project that includes VITO, Belgium, and Noda, Sweden, that is focused on add-on technology for DH systems and customers in order to identify and analyze the worst performing substations, thereby increasing the overall efficiency of the DH grid and allowing for lowered supply temperatures.

Limited time... two tracks

- > How does DH companies work with improved cooling
- > Study about leak detection in service pipes

TRACK I

How do DH companies work with improved cooling?

The importance of cooling

- > Reduced heat losses: more efficient use of resources
 - > Economic and environmental benefits
- > Increased efficiency of production (flue gas condensation and heat pumps)

Factors impacting return temperature

- > Supply temperature (fixed by DH company)
- > Heat exchanger (fouling, leaking, incorrect installation)
- > Control system/valves (incorrect setpoint values, mechanical error)
- > Internal heating system (overdimensioned, HWC, temperature programs)



How do DH companies work with improved cooling?

Voices from Denmark

- 90% wish to improve cooling, 78% are working actively.
- 82% use remote reading of key parameters to identify malfunctioning substations.
- Around 30% have an economic incentive such as flow fee or return temperature fee.
- 25% of DH companies offer maintenance agreements but an additional 20% offer maintenance if substation is identified as malfunctioning.

How can DH companies work with improved cooling?

- > Customer contact/relationship
 - > Spread information/knowledge on how to properly maintain substations
- > Economic incentives (price model)
 - > Flow fee
 - > Return temperature fee
- > Maintenance agreements
 - > Perform service visits free of charge or as an additional service

Key factors to success for DH companies

- > Physical access to customer installation
- > Achieving and maintaining good customer relation
- > Have clear arguments for customers to correct malfunctions causing high return temperatures in their DH substations

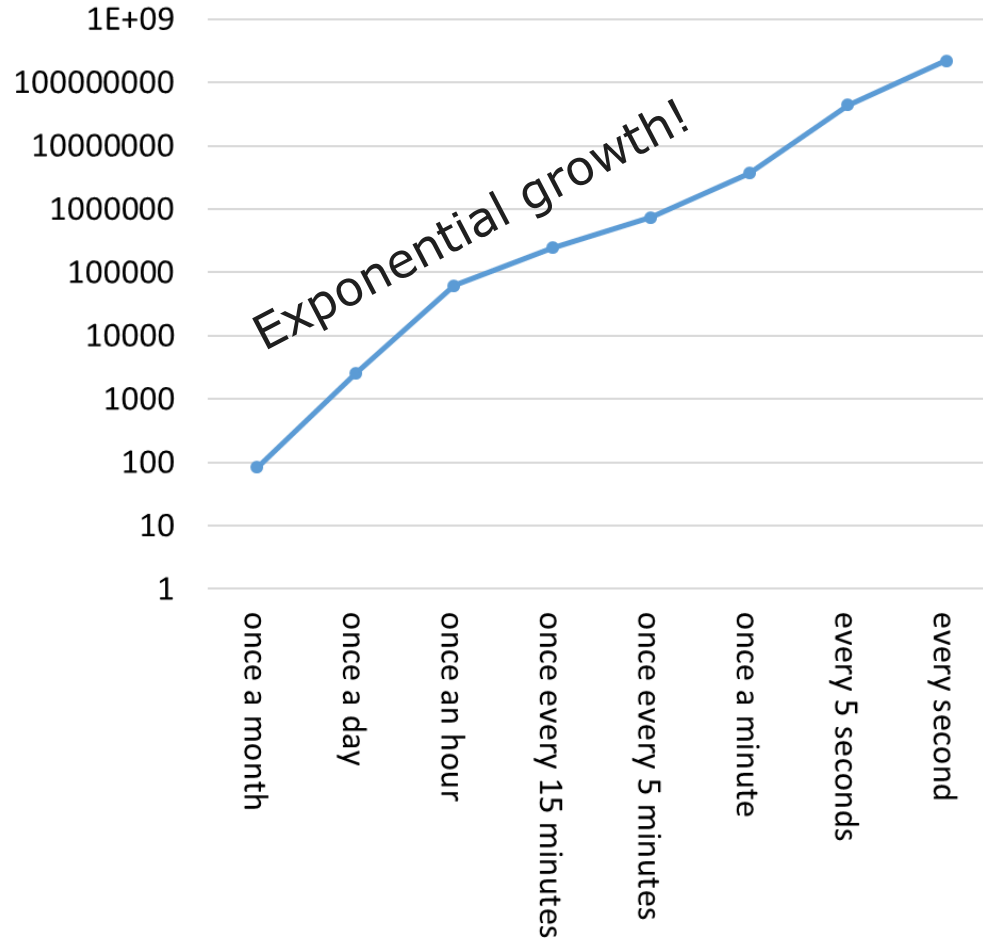
Conclusions from Månsson et. al (2018) after interview study of Swedish DH utilities

The conclusion seems to be similar in Denmark...

Some conclusions of data measurements and applications

- Price models are driving the requirements on meters and data collection
- There is no standard on frequency of collected meter readings
- The frequency may not be the main focus
 - Need for other data – customer side of installation
- With increased sampling rate the amount of data will grow fast
- Smart applications for data analysis is only started

no measurements if for different time sampling



Thank you!

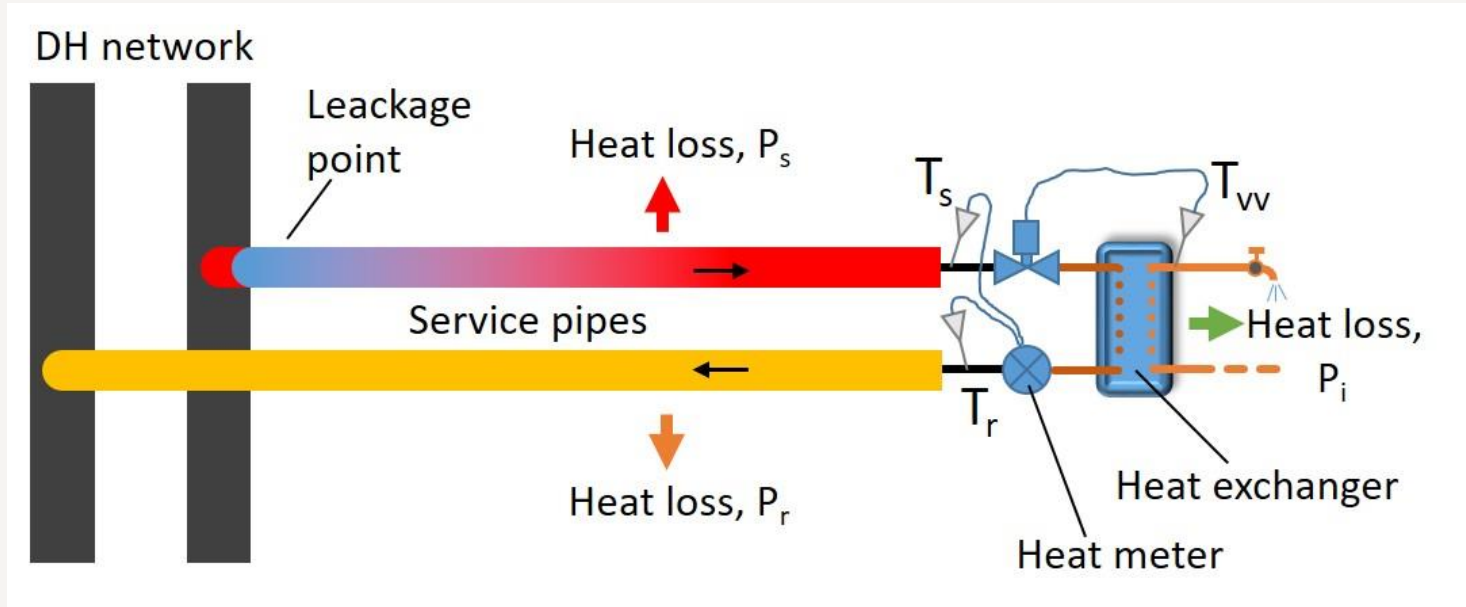
Questions?

TRACK II

Heat losses in distribution pipes

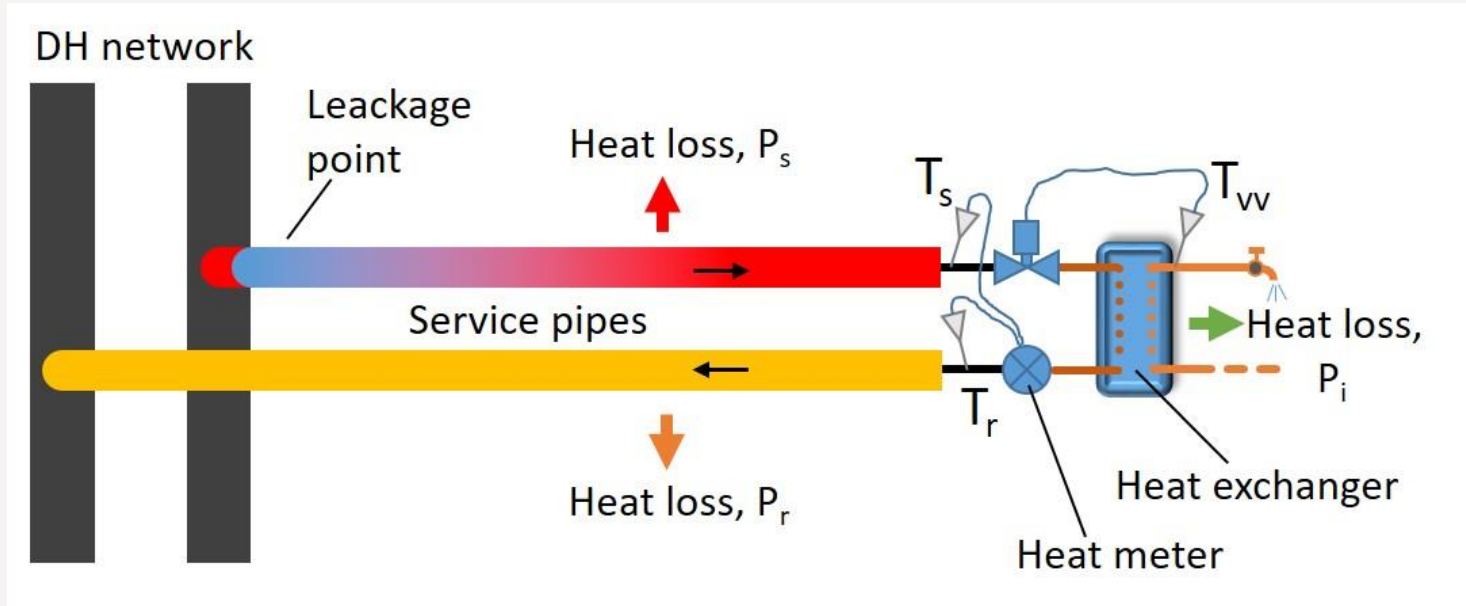
TRACK II

Heat losses in distribution pipes



Is it possible to detect damage pipes through meter readings?

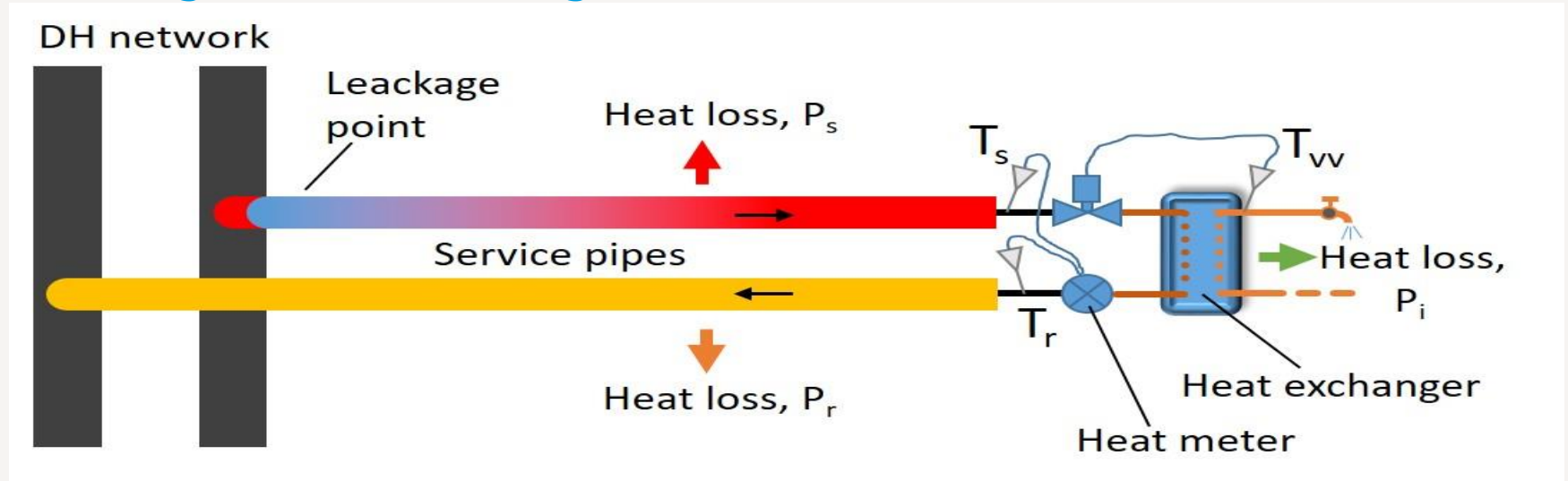
Heat losses in distribution pipes



Is it possible to detect damage pipes through meter readings?

Detection of distribution pipe leakages

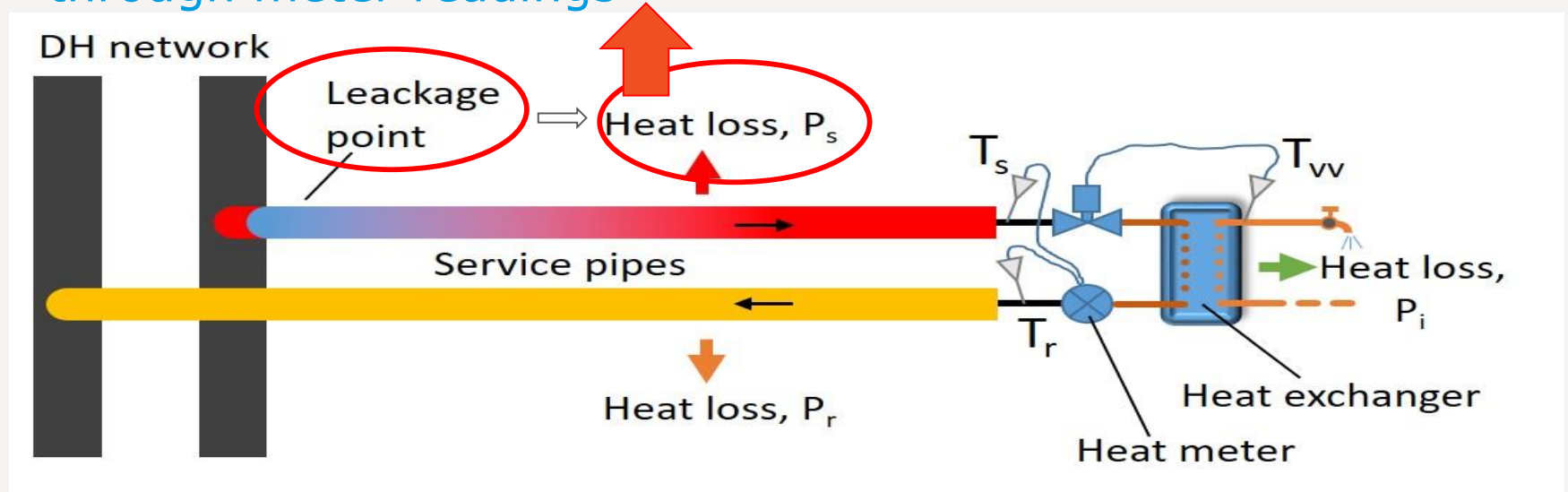
- through meter readings



- Worst case: summer
 - Nighttime – only by-pass for DHW in operation
 - Low flow
 - Relative large temperature drop

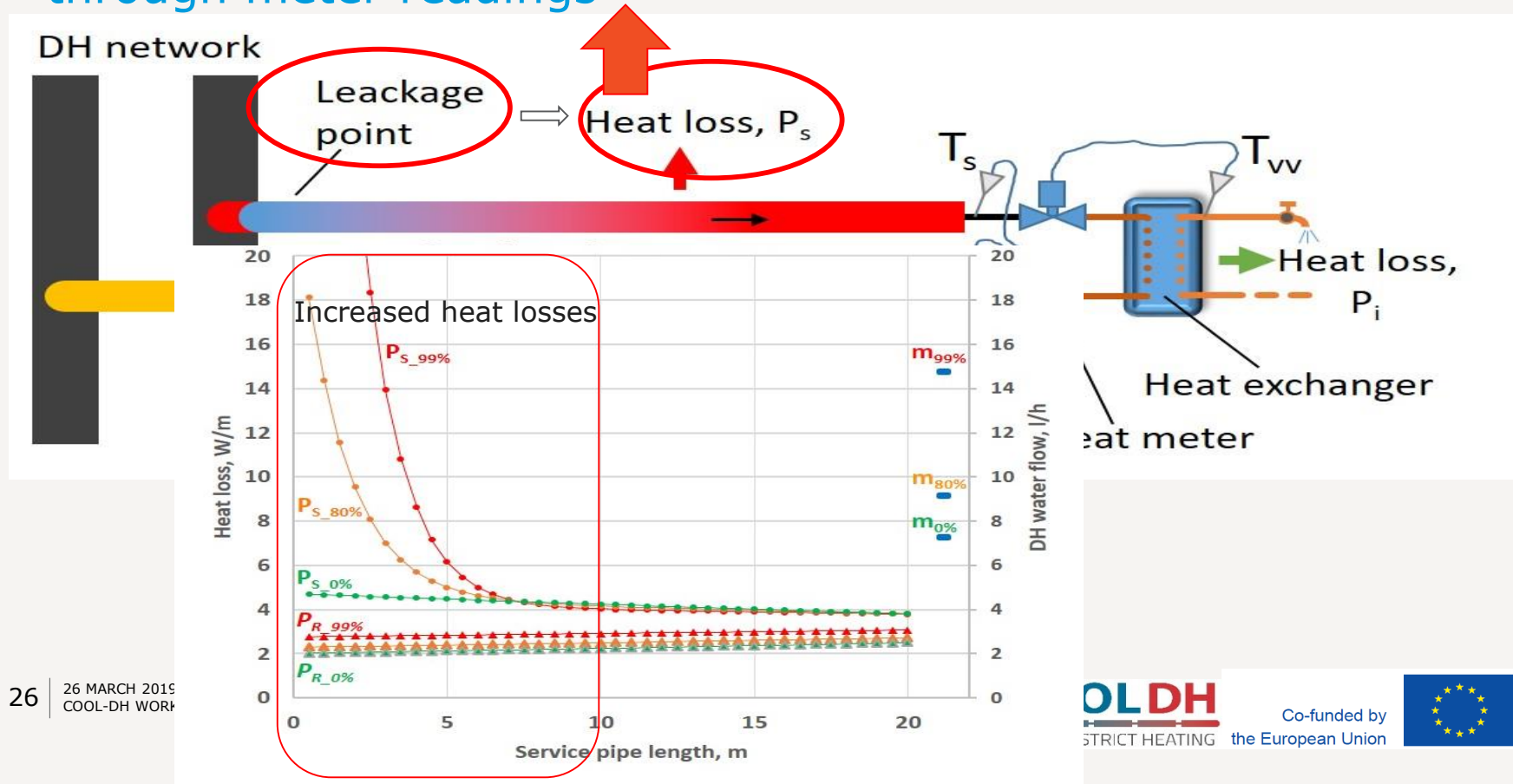
Detection of distribution pipe leakages

- through meter readings



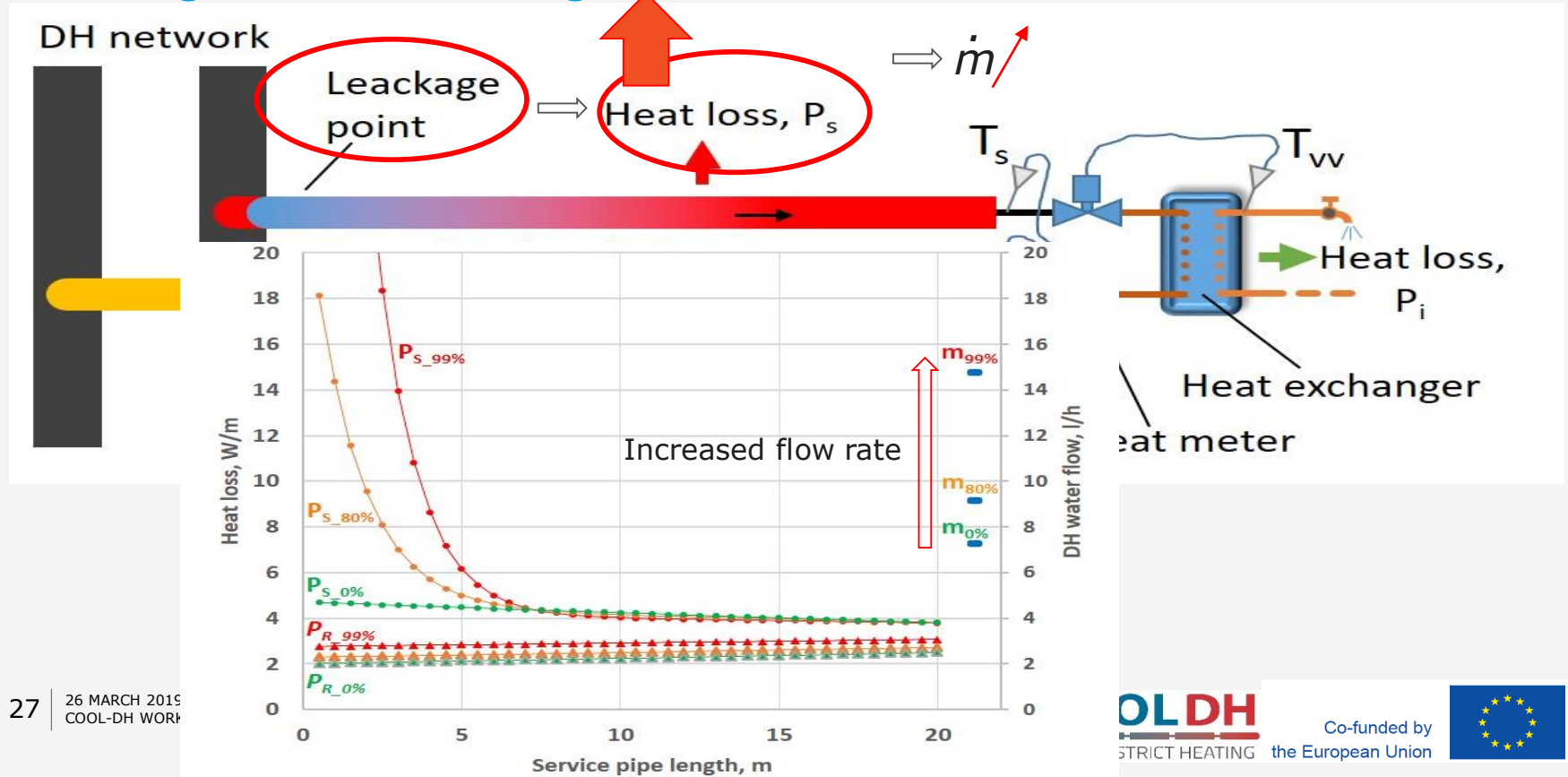
Detection of distribution pipe leakages

- through meter readings



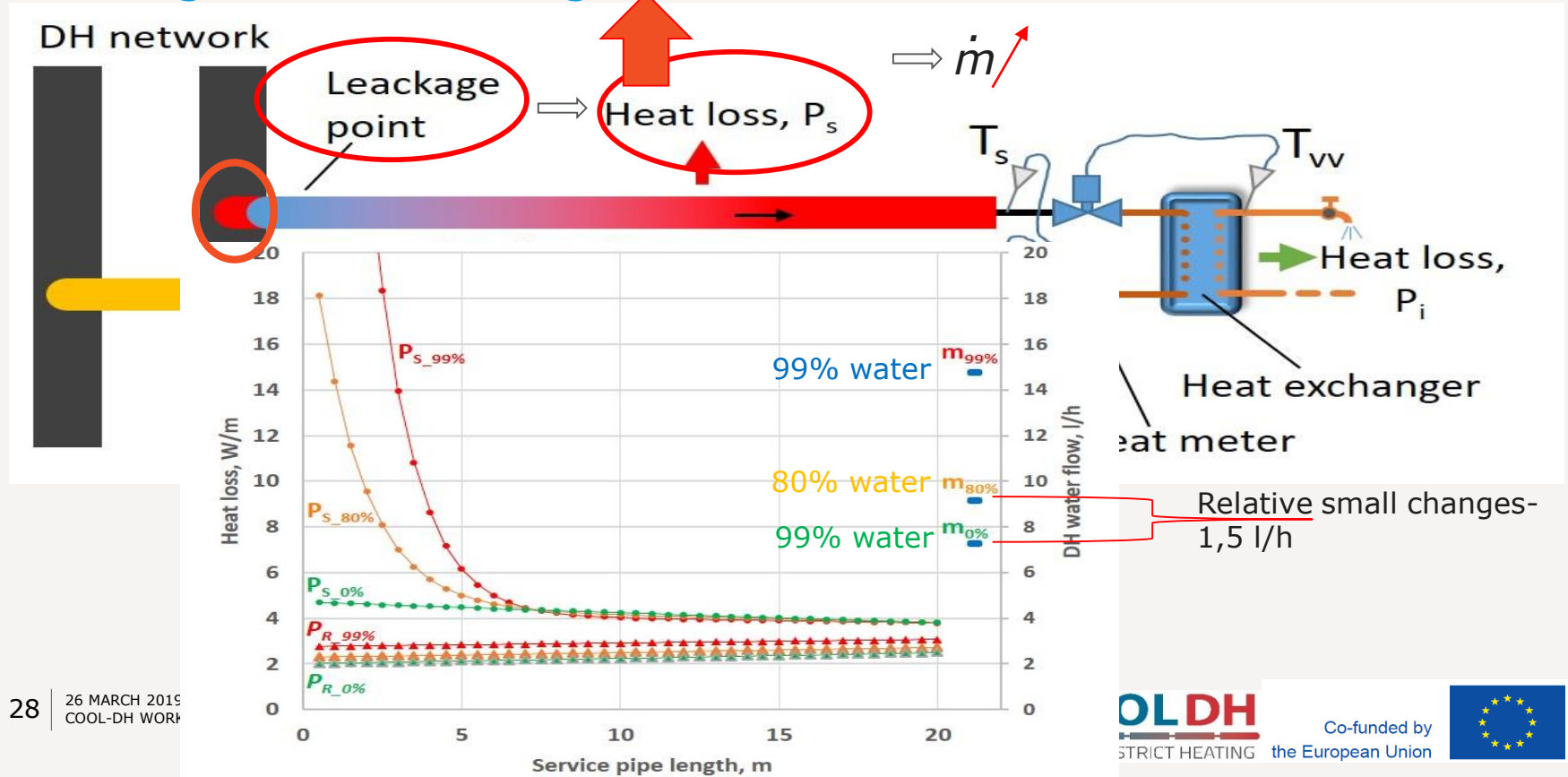
Detection of distribution pipe leakages

- through meter readings



Detection of distribution pipe leakages

- through meter readings



Detection of distribution pipe leakages

- through meter readings

- > Not possible to detect leakages (if not very serious)
- > Desires very stable and known temperature in distribution pipe
- > Desires very stable heat demand
- > Would only cover 50% of the distribution pipes (if not twin)
- > There are better solutions for leakage detection...

Stable conditions?



Temperatures and
DH flows for six
detached houses
during night-time
and summer.

Data from Landskrona Energi

△ Tr [°C]

○ Ts [°C]

● deltaT [°C]

— Flow [l/h]

Co-funded by
the European Union



Better solutions for leakage detection

Mystiskt flygplan gäckade Växjöborna

Publicerad 28 december 2016

SVT, smålandsnytt 2016-12-28

SKÅNE 19 mars 2019 00:02

Sydsvenskan 2019-03-19

Flygplan kartlägger Skånes fjärrvärmenät

Sent på måndagskvällen flög ett mindre propellerflygplan av modellen Piper fram och tillbaka mellan Glumslöv och Saxtorpsskogen. Tidigt på tisdagsmorgonen var det dags igen, denna gång över Lund och Esköv. Det är Skånes fjärrvärmenät som

www.uochd.se/article/view/594270/Ber-kunderna-bli-läckletare

Ber kunderna bli läckletare

den 3 april 2018 08:40 | Av Christer Åkerlundh | Tipsa redaktionen

Energibolaget Öresundskraft i Helsingborg ber allmänheten om hjälp med att leta läckor i fjärrvärmesystemet. Läckorna kostar stora pengar årligen.

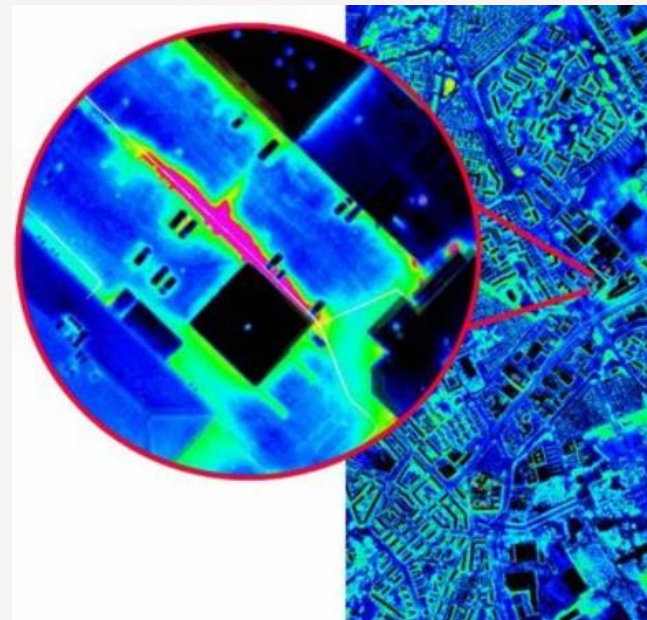
Ungefär 48 000 familjer i Helsingborg har fjärrvärme i sin bostad. Men det finns en miljöbov i sammanhanget - läckande rör. Varje dygn går 30 - 40 kubikmeter hett fjärrvärmevatten till spillo, till en kostnad av ungefär 4 000 kronor per dygn.

Läs också: [Öresundskraft flyger i luften](#)

Öresundskraft flygfotar sitt fjärrvärmenät med värmekamera för att hitta läckor. Man hittar en hel del läckor den vägen. Flygbilderna ger dock inte hela sanningen, utan störs bland annat om det står



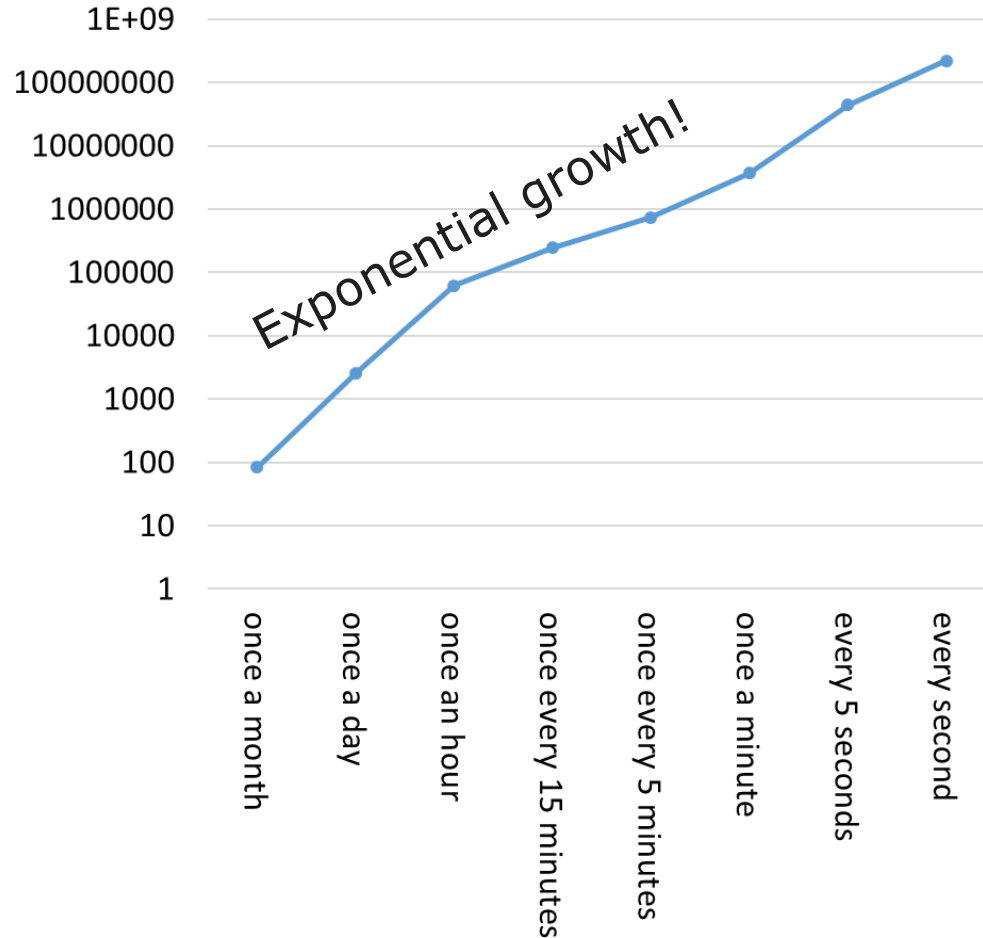
Öresundskraft



Some conclusions of data measurements and applications

- Price models are driving the requirements on meters and data collection
- There is no standard on frequency of collected meter readings
- The frequency may not be the main focus
 - Need for other data – customer side of installation
- With increased sampling rate the amount of data will grow fast
- Smart applications for data analysis is only started

no measurements if for different time sampling



Thank you!

Questions?



D2.10

Calculator on savings for new high efficient pipe types for internal distribution in buildings

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 76779"

Emanuele Zilio, COWI DK

Agenda

- > Aim of the deliverable
- > Background
- > Calculation tool
- > Discussion and Conclusion
- > Test

Aim of the deliverable

Innovate

Pipe losses inside the buildings:

- > summer season – no space heating needs
- > often constitute for 15% of the total energy need for energy renovated or new low energy houses

Pre-investigations:

- > reductions up to 50-65% with better pipe layout and use of PUR insulated pre-fab DH pipes inside buildings

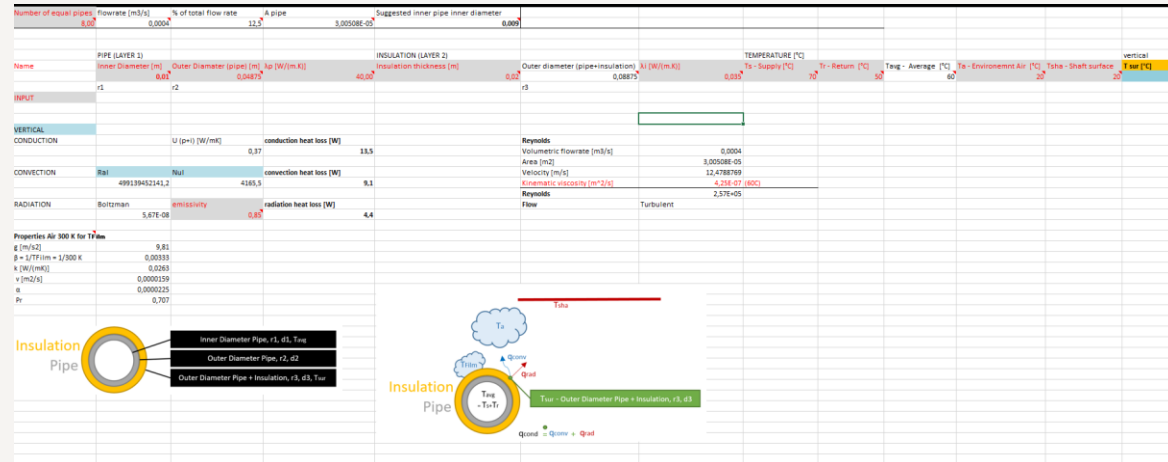
Output of the deliverable

- > Create a calculation tool to calculate the heat losses from distribution and service pipes in buildings

Background

Previous work conducted by the Technical University of Denmark (DTU)

- Microsoft Excel
- Further development of the calculation tool
- User interface



Calculation tool

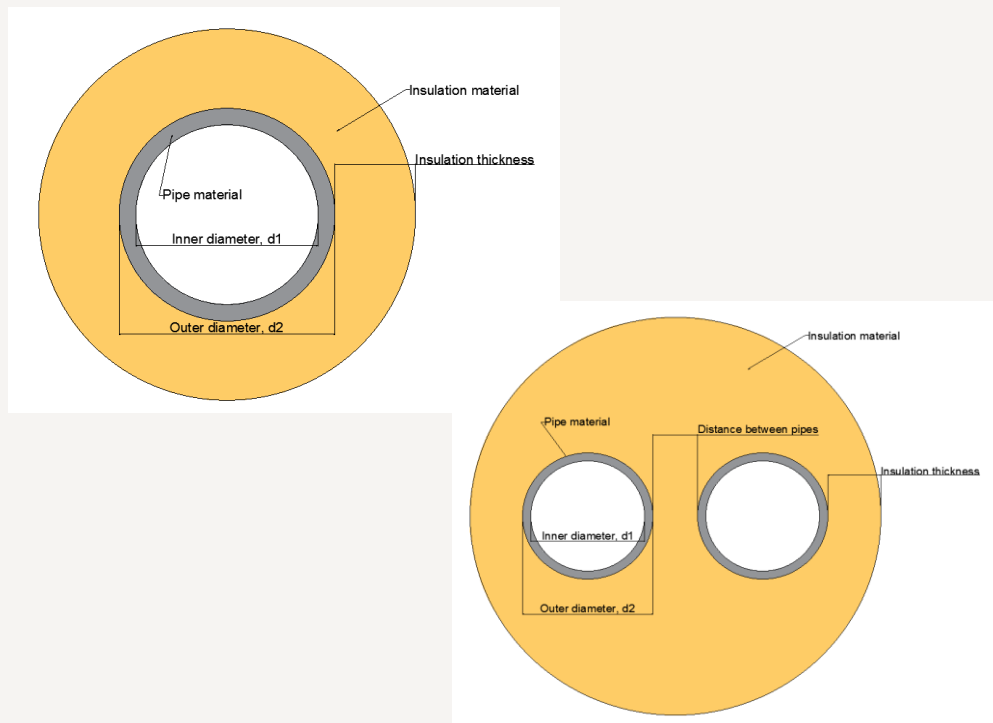
How does it work?

- > Based on the Excel add-in called "Solver" → what-if analysis
 - > Objective cell subject to constraint or limits
 - > Solver modify a group of cells/or simply cells
 - > Satisfy the limits
-
- > Solver need to be activated!

Calculation tool

Calculations

- > Single pipes
- > Twin pipes



Calculation tool

Development

> User interface

> Inputs section

- > Media pipe data (diameters...)
- > Insulation data
- > Temperatures
- > Length
- > Flow rate
- > Distance twin pipes

INPUTS

HORIZONTAL PIPES

Pipe

Name of the pipe	
Usage time [%]	
Pipe type	Single
Inner Diameter, d1 [mm]	
Outer Diameter, d2 [mm]	
Pipe material λ_p [W/(mK)]	Select ...

Insulation

Insulation thickness [mm]	
Insulation material λ_i [W/(mK)]	Select ...
Emissivity [-]	Select ...

Temperatures

Ts - Supply [°C]	
Tr - Return [°C]	
Ta - Pipe surroundings [°C]	

Length

Pipe length [m]	
-----------------	--

Flow rate

Volumetric flow rate [L/s]	
----------------------------	--

TWIN

Distance between pipes [mm]	-
-----------------------------	---

Horizontal_Calc

SaveHorizontal

DeleteRow_Hor

Calculation tool

Development

> Personalisation

> Drop down menu

> Common materials (list)

Pipe material λ_p [W/(mK)] Select ...

> User defined values

Pipe material λ_p [W/(mK)] 20,0 User defined value: 20

INPUTS

HORIZONTAL PIPES

Pipe

Name of the pipe
Usage time [%]
Pipe type Single
Inner Diameter, d1 [mm]
Outer Diameter, d2 [mm]
Pipe material λ_p [W/(mK)] Select ...

Insulation

Insulation thickness [mm]
Insulation material λ_i [W/(mK)] Select ...
Emissivity [-] Select ...

Temperatures

Ts - Supply [°C]
Tr - Return [°C]

Ta - Pipe surroundings [°C]

Length

Pipe length [m]

Flow rate

Volumetric flow rate [L/s]

TWIN

Distance between pipes [mm] -

Horizontal_Calc

SaveHorizontal

DeleteRow_Hor

Calculation tool

Development

- > Operation buttons
 - > Calculation
 - > Save data (table)
 - > Delete data (last table tow)
- > Output overview
 - > Output in watts
 - > Output in kWh/yr → yearly cost

Length
Pipe length [m]

Flow rate
Volumetric flow rate [L/s]

TWIN
Distance between pipes [mm]

Horizontal_Calc SaveHorizontal DeleteRow_Hor

OUTPUTS

Average heat loss (Supply+Return)
[W/m]

Average heat loss (Supply+Return)
[W]

Average heat loss (Supply+Return)
[kWh/yr]

Delete Outputs

Development

- > Main data
- > Results

Main data

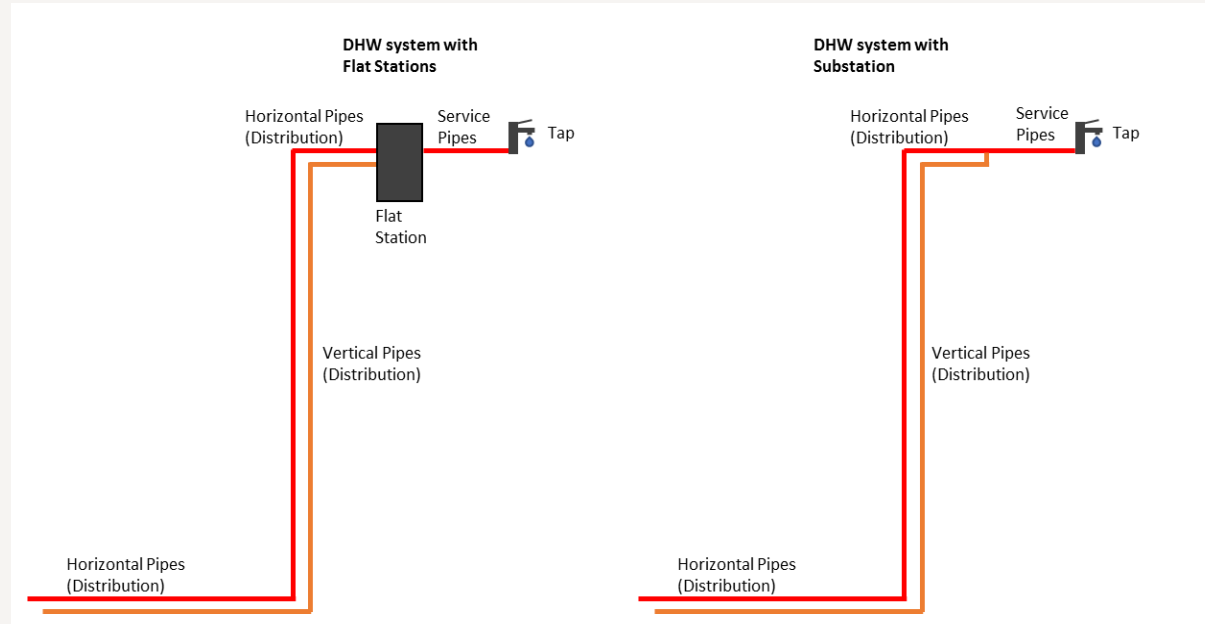
Results

Calculation tool

Development

> Distribution systems

- > Horizontal pipes
- > Vertical pipes
- > Service pipes

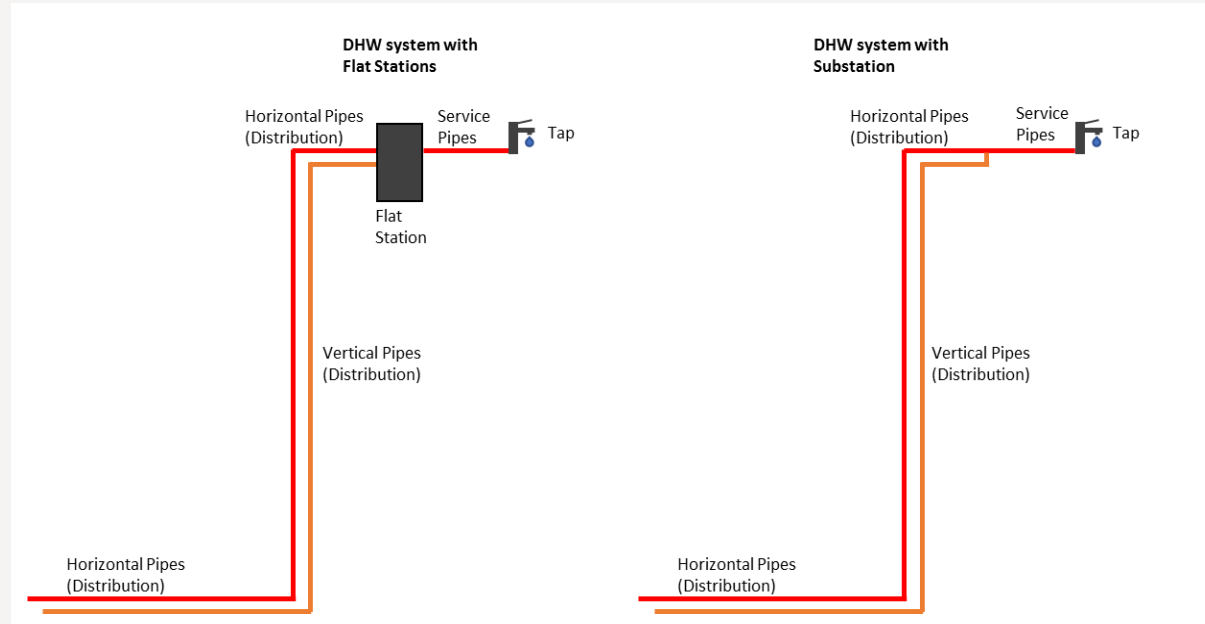


Calculation tool

Development

> Distribution systems

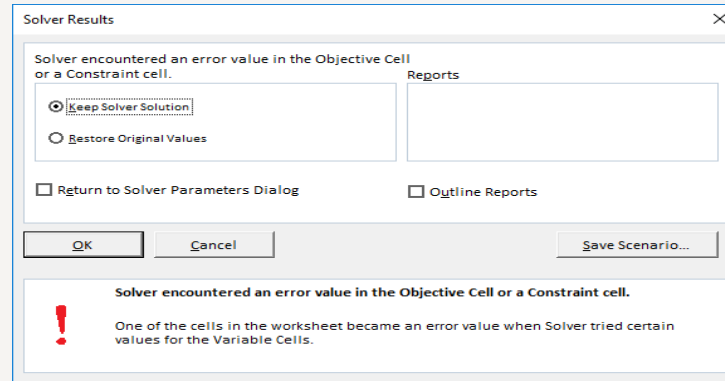
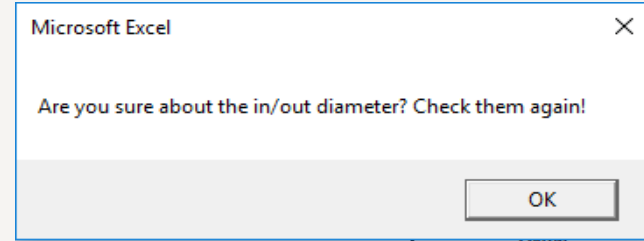
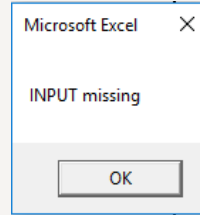
- > Horizontal pipes
- > Vertical pipes
- > Service pipes



Calculation tool

Development

- > User interface
 - > Error messages
- > Solver output message
 - > No results



Discussion and Conclusion

Discussion

- > Test with other available calculator
 - > Conservative values up to 20% on the safe side (data differences)

Conclusion

- > Gives an overview of the heat losses
- > Guideline for heat loss calculations
- > Awareness about internal heat loss (pipes in buildings)
- > Insulation material choice

Test

Calculation tool demonstration

Thank you for your attention!

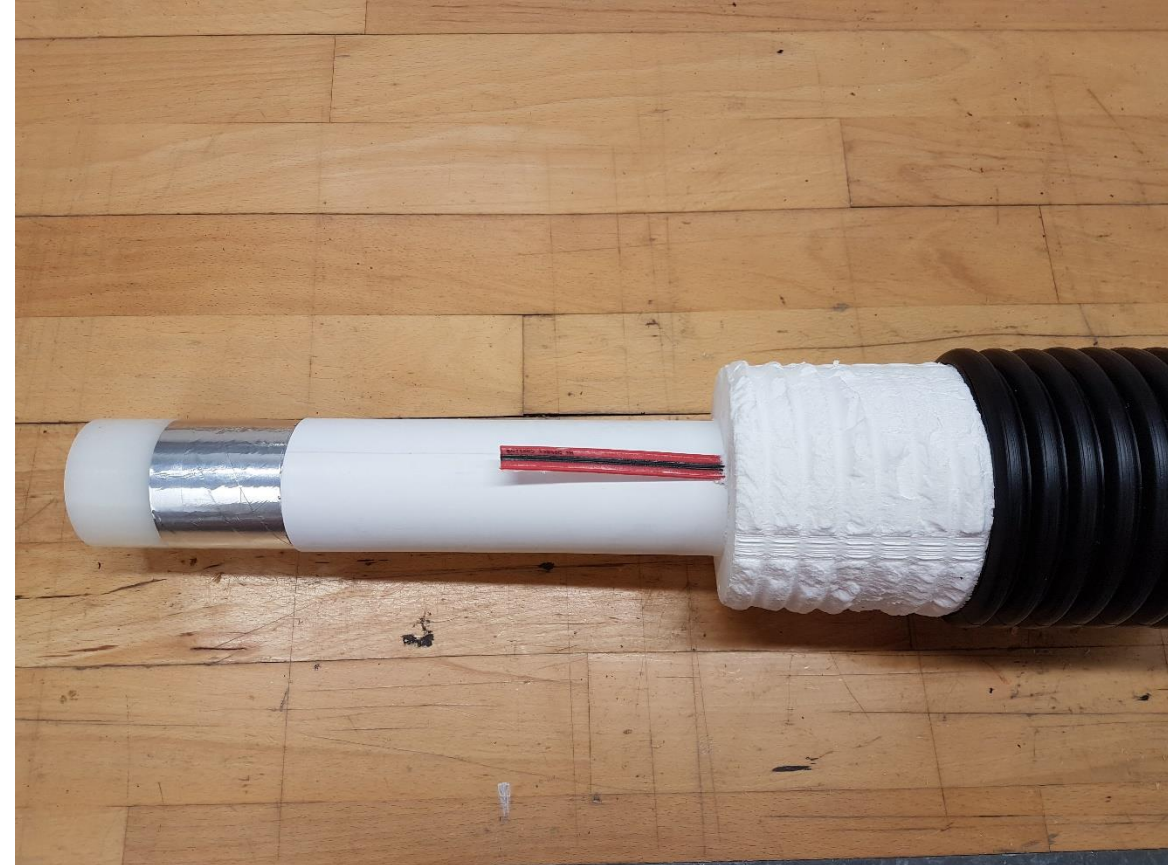
COOL DH presentation and status

“This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 76779”

Product manager Klaus G. Lauridsen 26/3-2019

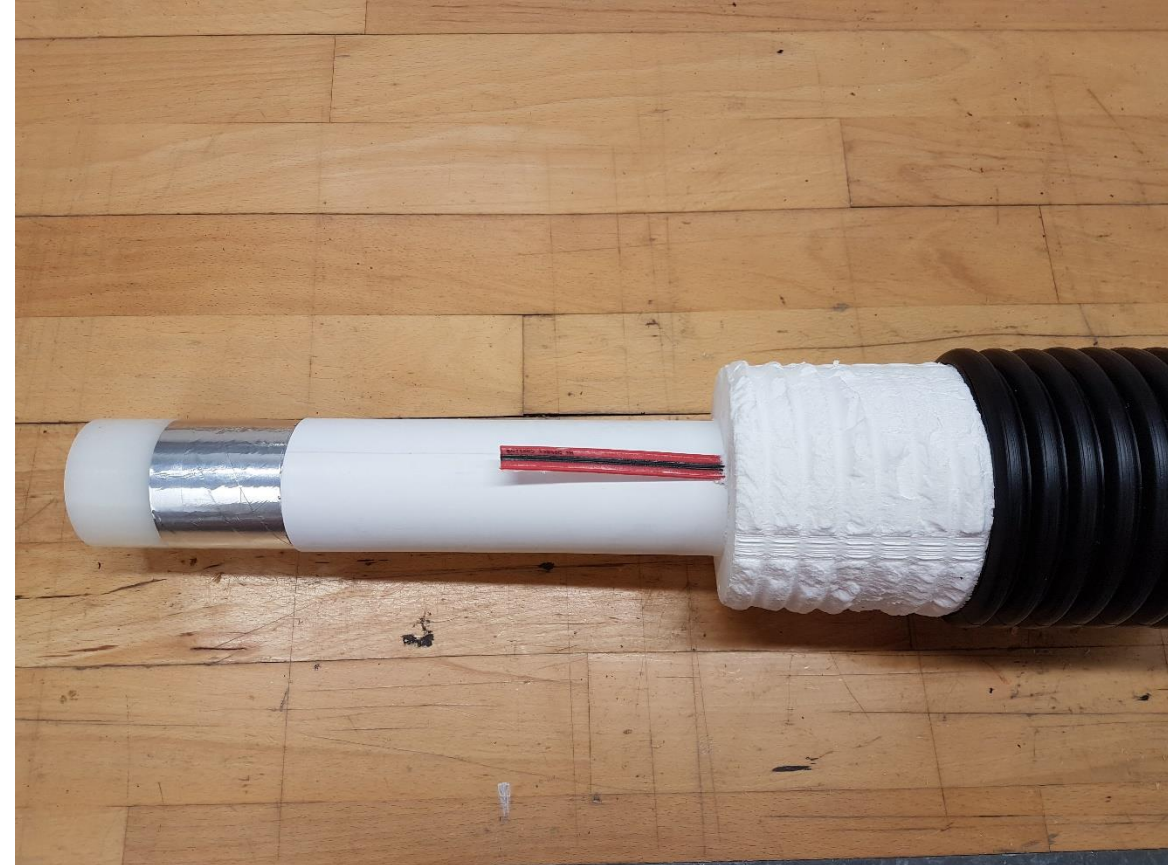
New flexible pipes – improvements of the well known PEX pipes system.

- **Media pipes single and twin with built in barrier:**
 - Mono layer pipe with **water vapour barrier**. This to insure the insulation properties during the product lifetime
 - **Oxygen barrier** to avoid rust in the heating installations
 - **Weldable PE pipe type** that open for alternative connection (butt and mirrow welding) methods compared to existing PEX couplings
 - Temperature ratings as PEX
 - SDR 7,4 up to 110 mm for higher pressure than the standard 6 bar PEX solutions as specified in the COOL DH project.



New flexible pipes – improvements of the well known PEX pipes system.

- **Moister detect**
 - Alarm wire system for “non-metal” pipes for leakage detection
- **Foam system**
 - New improved soft-foam formulation with higher insulation properties
- **Casing**
 - 5 layer casing with built in barrier to insure the insulation properties during the product lifetime
 - Corrugated design to insure optimal flexibility
- **Full testing according to EN 15632 - ongoing**



New flexible pipes – improvements of the well known PEX pipes system.

- **Dimensions 16 -32 mm**

- Logstor will recommend Press couplings type MP for twin (need to remove the alu layer) and socket welding (no need to remove the alu layer) on single pipes.

- **Dimensions 40 - 63 mm**

- Logstor will recommend Press couplings type JT (need to remove the alu layer)

- **Dimensions 75 -110 mm**

- Logstor will recommend using compression couplings type Hela (need to remove the alu layer) for twin and mirror welding (no need to remove the alu layer) for single pipes.

Dimensions 16 -32 mm



Dimensions 40 - 63 mm



Dimensions 75 -110 mm



COOL DH INNOVATION – Flexible pipes– Press couplings, type MP

LOGSTOR

Tools for press coupling MP



Ø15-Ø32

Ø16-Ø63



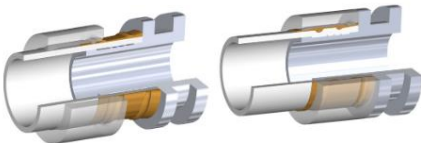
Ø63-Ø110



Hydraulic pump



Logstor standard MP press couplings:



- Press couplings is designed to be installed in both open and hidden installations.
- No expansion of the pipe end before mounting and pressing. Made of brass and weld ends in steel S235JR.
- Various reduction couplings is available as standard and specials can be designed.
- Couplings for AluPex is including o-rings due to the 10 bar rating.



AluPex	Pex	
16, 20, 26 and 32 mm	20, 25, 32, 40, 50, 63, 75, 90 and 110 mm	
10 bar pressure	6 bar pressure	
Straight	Straight	Press coupling for straight joints
90° bend		Press coupling for 90° bend – for in-house installations like in basements.
Tee	Tee	Press coupling for T- joints
Male thread	Male thread	Press coupling with male thread end for termination in a cabinet or a building
90° male thread		Press coupling with 90° bend and male thread end for termination in a cabinet/building
Weld (open)	Weld (open)	Press coupling with weld end for transition to steel pipe
Weld closed	Weld closed	Press coupling with closed weld end for transition to steel pipe later on

Flexible pipe: Flextra

COOL DH INNOVATION – Flexible pipes - Flextra system – Press couplings, type JT



Logstor standard JT press couplings:

- Press couplings designed to be installed in both open and hidden installations.
- Made of brass and weld ends in steel S235JR.
- Various reduction couplings is available as standard and specials can be designed.



Pex	
20, 25, 32, 40, 50, 63, 75, 90 and 110 mm	
6 bar pressure (and 10 bar option in some sizes)	
Straight	Press coupling for straight joints
90° bend	Press coupling for 90° bend for in-house installations like in basements
Tee	Press coupling for T- joints
Male thread	Press coupling with male thread end for termination in a cabinet or a building
Weld (open)	Press coupling with weld end for transition to steel pipe

Tools for press coupling - JT



Co-funded by
the European Union



COOL DH INNOVATION – Flexible pipes – Compression couplings



Logstor standard compression couplings:

- D20 – D32 is made with fixed insert and split ring. D40 – D110 is bolt type with clamping sleeve.
- Made of DZR (corrosion resistant) brass. Above 32 mm the expansion screw and bolts are stainless steel ANSI 316 with lubrication to insure they do not weld together.
- Various reduction couplings is available as standard and specials versions can be designed.

Pex	
20, 25, 32, 40, 50, 63, 75, 90 and 110 mm	
6 bar pressure(and 10 bar option in some sizes)	
Straight	Compression coupling for straight joints
Tee	Compression coupling for T- joints
Male thread	Compression coupling with male thread end for termination in a cabinet or a building
Female thread	Compression coupling with female thread end for termination in a cabinet or a building
90° male thread	Compression coupling with 90° bend and male thread end for termination in a cabinet/building
90° female thread	Compression coupling with 90° bend and female thread end for termination in a cabinet/building

ø20-ø32



ø40-ø110

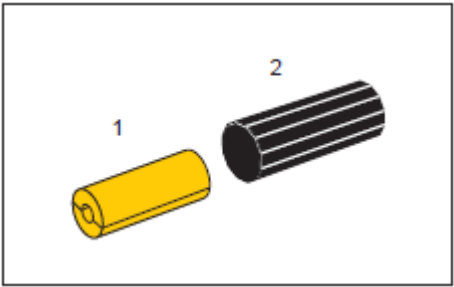


Flexible pipe: Flextra



Flextra system

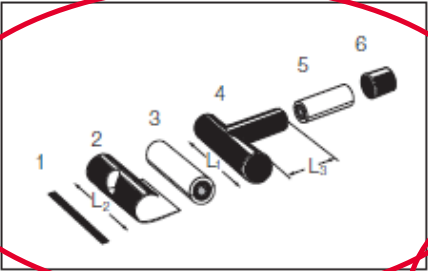
FXJoint



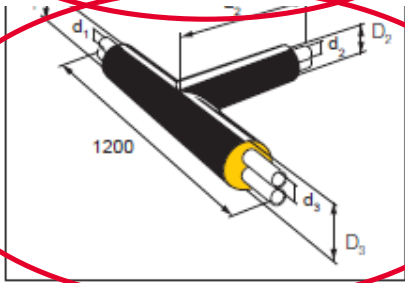
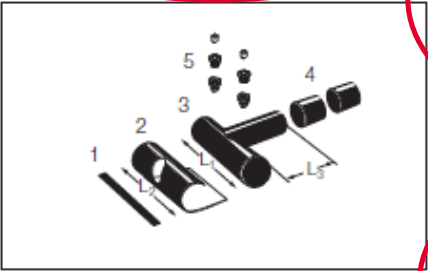
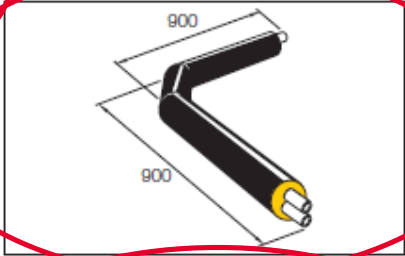
BandJoint
branch
Flextra
type 3



T-joint
straight –
can be
used with
Flextra on
main

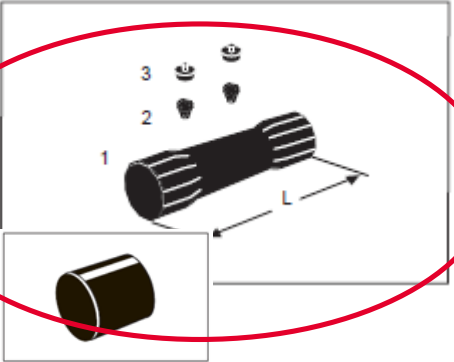


Pre-insulated
bends and T
fittings.



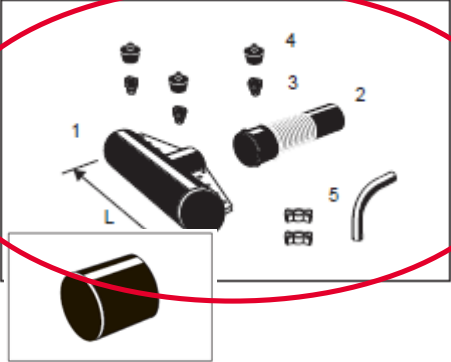
SX-
WPJoint

+ 2 x
Collars

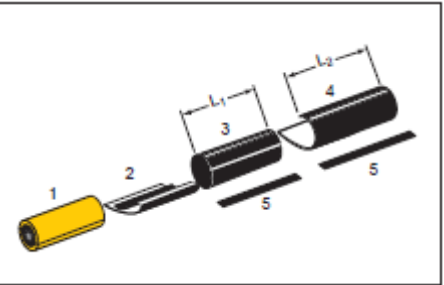


SXT-
WPJoint

+ 1 x
Collar

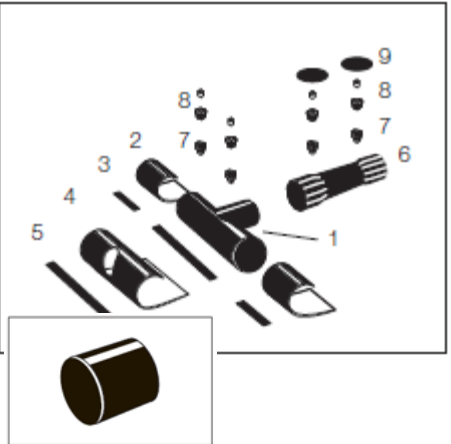


C2FJoint

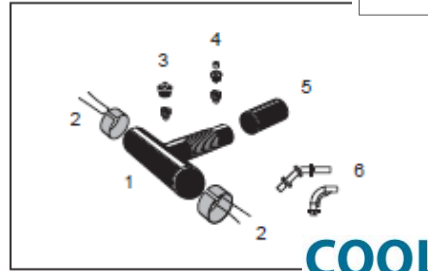
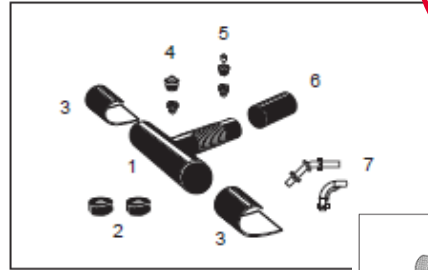


TXJoint

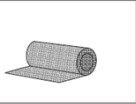
+ 1 x
Collar



TSJoint

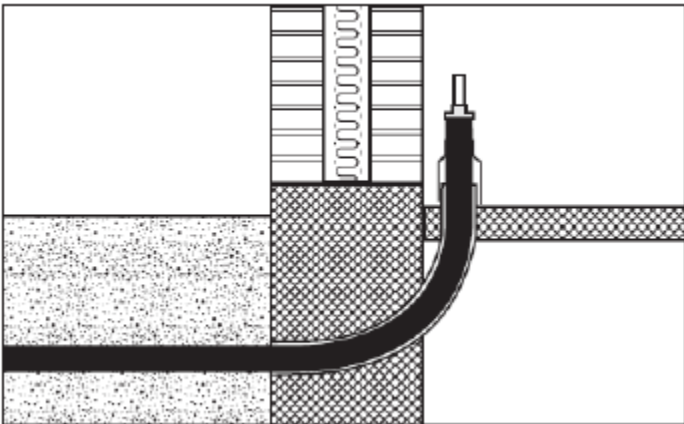


Remember
heat shield if
Flextra on
main. (Can be
difficult to make
the pipe straight
before extruder
welding of joint)



Flextra system

Inlet systems

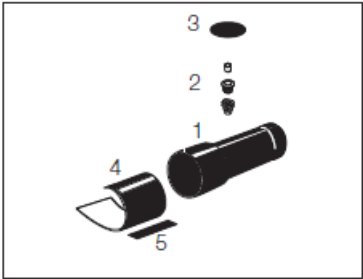
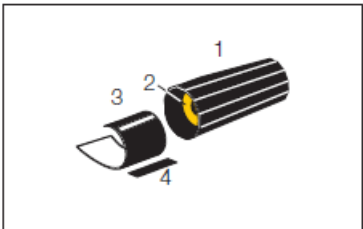


Protective caps

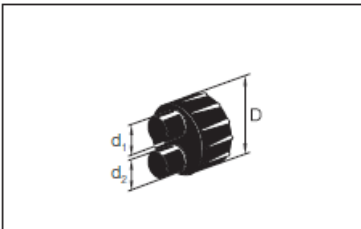
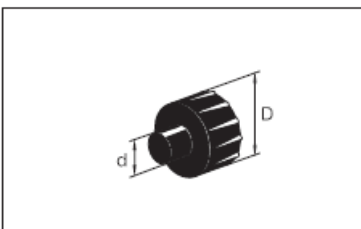


Flexible pipe: Flextra

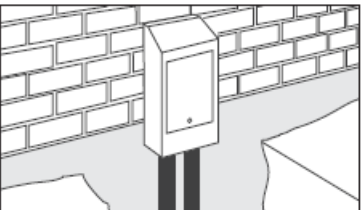
End fittings



End caps



Inlet boxes



LOGSTOR

Flexible main stop valve - DN15-32, PN40

Type 69.300

Female x Female
Flexible main stop valve for house inlets.

Materials
Fully welded steel ball valve with female ends.

Applications
Heating systems and district heating.

Surface treatment
Eco-friendly protection finish against corrosion.

Notice
As standard delivered with red and blue T-handles. Yellow T-handles or hexagon for insertion key on request.



Flexible main stop valve - DN15-32, PN40

Type 69.301

Welding x Female
Flexible main stop valve for house inlets.

Materials
Fully welded steel ball valve with welding and female ends.

Applications
Heating systems and district heating.

Surface treatment
Eco-friendly protection finish against corrosion.

Notice
As standard delivered with red and blue T-handles. Yellow T-handles or hexagon for insertion key on request.



Flexible main stop valve, for Twin pipes - DN15-25, PN40

Type 69.300.V

Female x Female
Flexible main stop valve for house inlets.

Materials
Fully welded steel ball valve with female ends.

Applications
Heating systems and district heating.

Angled flexible main stop, specially designed for twin pipes.

Surface treatment
Eco-friendly protection finish against corrosion.

Notice
As standard delivered with red and blue T-handles. Yellow T-handles or hexagon for insertion key on request.



Flexible main stop valve, for Twin pipes - DN15-25, PN40

Type 69.301.V

Welding x Female
Flexible main stop valve for house inlets.

Materials
Fully welded steel ball valve with welding and female ends.

Applications
Heating systems and district heating.

Angled flexible main stop, specially designed for twin pipes.

Surface treatment
Eco-friendly protection finish against corrosion.

Notice
As standard delivered with red and blue T-handles. Yellow T-handles or hexagon for insertion key on request.



Insulation shells - DN20-25

Type 500...

Insulation shells for flexible main stop valves
for house inlets

Materials
Material: Polyurethane
Class: B2 acc. DIN 4102
Density: 55-60 kg/m³
Thermal conductivity: 0,029 W/mK
Temperature: Max. 130°C (short peak 140°C)

Applications
For insulation of BROEN flexible main stop valves DN20-25.
Kit consisting of 2 x 2 polyurethane shells and spacers for mounting
between valve and wall fitting. Easy mounting by means of stainless
steel brackets.

Notice
Only for straight positioned flexible main stop valves.



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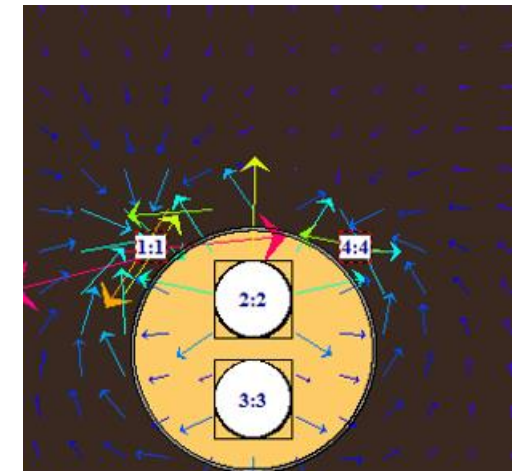
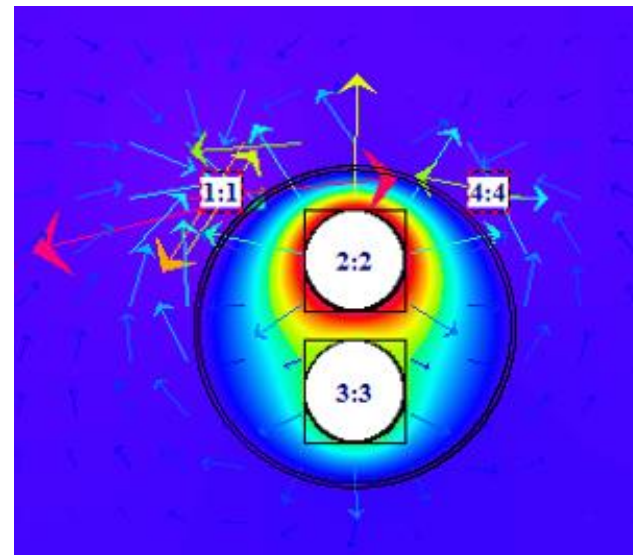
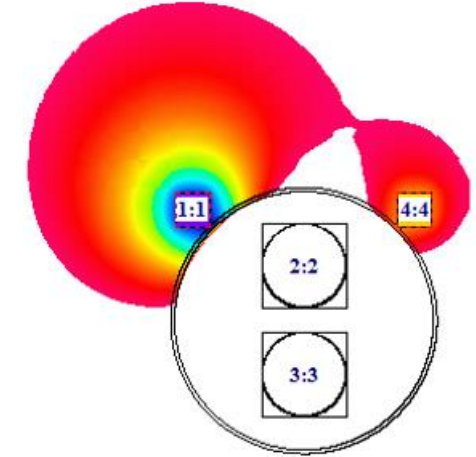
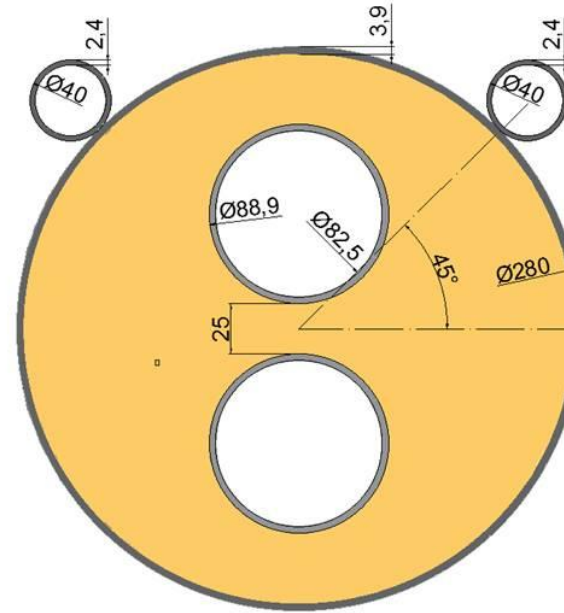


New District Heating pipes with heat loss recovery system

- Twin pipes with heat loss recovery pipes inside the casing
- or
- Twin pipes with heat loss recovery pipes inside the casing

Concept - zero loss of energy:

- Recover the heat loss from a transmission line by a extra heat recovery glycol pipe string. This collected the energy that can then be reused in a heating/cooling pump – like geothermal heating.
- We expect that for the demo sites in Lund and Høje Taastrup, the placement of the heat recovery pipes will be outside the casing at around ± 45 degree from center as a trade of with easy installation.



We have a first draft of a installation manual ready New District Heating pipes with heat loss recovery system

- Close to be ready

Flexible pipes

We expect in April to have final result from our coupling/connection test. Fit for purpose test according to EN22391 / EN 21003.

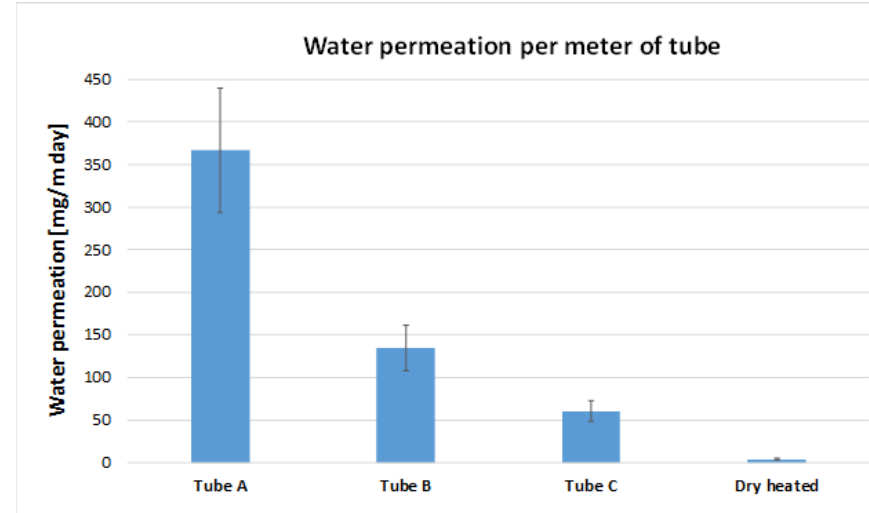
We expect around week 21 to have first trial production of MP connections in the new dimensions 16-32 mm.

We expect in September to have passed the 1 year test at external institute. Ok until now. Thermal stability test running (8760 h), ISO 22391-2

We still have water vapour test to be carried out as well as defining the target level.

There has been measured on three tubes, received from Logstor:

1. Tube A, White PEX tube 32 x 2.9 mm, outer diameter 32 mm and wall thickness 2.9 mm.
2. Tube B, Black PEX tube with metal coating 32 x 4.4 mm
3. Tube C, White PEX tube 32 x 4.4 mm with aluminum foil layer on the outside.



High risk during the last month:

- We got trouble with the new foam solution. The foaming gas have only been granted to us based on a maximum 2 year dispensation/trial production.
- We are still fighting on getting PE-RT as media pipes into the EN 15632 through the Working Group 10 again. We do not see this included during the next 2 years due to missing acceptance from mainly the existing EU producers of PEX pipes.

Conclusion on this is that we do not today see as big a potential marked for the solution in near future! – Even though all is tested according to the Flexible standard. In the longer run we do foresee a marked for this solution.

Important information

- Ongoing “go/no go” test still running – alternative solution – steel pipes above 32 mm. (Thermal stability test running (8760 h), ISO 22391-2)
 - We can not give any guarantee for the flexible pipes in the developing phase, until approved by internal procedures including external tests.
- From approved drawing and component list we look at up to 15 weeks lead-time.
- As we have not tested the alarm system “live” we need to select a limited area of the demo sites in Lund and Høje Taastrup for trial instead of the full site.