Cool ways of using low-grade heat sources from cooling and surplus heat for heating of energy efficient buildings with new low-temperature district heating (LTDH) solutions.

Deliverable no.: **D1.3**

Name of deliverable: **Thematic workshops distribution side**

Revision no.: **2.0**

Due date of deliverable: M15

Actual submission date: M15, final M20 (updated M36)

Start date of project: 1st October 2017

Duration: 48 months

Organisation name of lead contractor for this deliverable: COWI Denmark A/S (COWI-DK)

Authors: Emanuele Zilio, Reto M. Hummelshøj (COWI-DK)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 767799

Dissemination level:		
PU	Public	**X**
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including the Commission Services)	
CO	Confidential, only for members of the consortium (including the Commission Services)	

Disclaimer

This document reflects only the author's view and the Agency and the Commission cannot be held liable for any use made of the information it contains.

The participants of the COOL DH consortium do not assume any responsibility for any use of the presented project results and deliverables as whole or in part.

Scope of deliverable

The report aims to summarise the activities and the information in relation to the workshop series about the distribution side installations. The focus of the workshops was on the following topics:

- New design concepts for optimisation of LTDH distribution systems
- New pipe components for LTDH distribution systems underground
- New high-efficient pipe types for internal distribution in buildings
- New metering concepts

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 where 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				
	First workshop	*Second workshop*	*Third workshop*	*Site visit*
Demand side	March 20th, 2018	November 15th, 2018	March 26th, 2019	
Distribution side	April 6th, 2018	November 15th, 2018		
Supply side	April 5th, 2018	November 15th, 2018		March 21st, 2018

The two workshops regarding the distribution side installations were held at COWI's office in Lyngby (Denmark). The first one on the 6th of April 2018, while the second one was held on the 15th of November 2019.

Perspective of deliverable

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

- New design concepts for optimisation of LTDH distribution systems → which can be applied in Østerby and Brunnshög and further projects
- New pipe components for LTDH distribution systems underground → which can be applied in Østerby and Brunnshög and further projects

- New high-efficient pipe types for internal distribution in buildings → which can be used in Xplorion/Høje-Taastrup townhall and further projects
- New metering concepts → which can be implemented in Xplorion/Høje-Taastrup townhall and further projects

Involved partners

COWI A/S (COWI-DK).

Prepared by: Emanuele Zilio, Maja Grud Minzari (COWI-DK) and Jenny Jamot (COWI-SE)

Checked by: Reto M. Hummelshøj (COWI-DK)

Approved by: Reto M. Hummelshøj (COWI-DK)

Summary

The two workshops gave insights to the participants about the distribution side installations. Both workshops were held at COWI Denmark's headquarter in Lyngby. On April 6th, 2018, the workshop focused on the state of the art of the DH distribution pipes, the design of a LTDH network and what it is important to consider when the return temperature must be optimised. After each presentation, the participants discussed about the possible development and investigation that must be undertaken during the project.

The outcome was inspiration for optimizing design using TERMIS simulation or similar. With available plastic materials, it is possible to increase the operation pressure up to 13 bars instead of the normal 6 bar (hereby pipe dimensions can be reduced and with that also cost and heat losses are reduced).

The second workshop was held on the 15th of November 2018, where the results from the different tasks were presented and discussed in order to be used in the following full-scale demonstrations in COOL DH (WP3 and WP4). During the workshop, the EU Officer gave interesting inputs about how to elaborate the results and what it is important to highlight in the different tasks. As closing activity, some participants visited the demonstration site located in Høje-Taastrup Municipality.

COOL DH
COOL DISTRICT HEATING

Table of contents

1 Minutes of the meetings

1.1 First workshop: Friday, April 6th, 2018

Title: COOL DH – Workshop Distribution Side Installations WP1

Date: 06-04-2018

Place: COWI, Parallelvej 2, Lyngby, Room P186/188

Prepared by: Jenny Jamot, 20-04-2018

1.1.1 Agenda

Friday, April 6th – Location: Lyngby **Distribution side**		Time + QA, min.
8:30	Coffee and welcome	15
8:45	Normal practice for DH piping, new designs and case study, Logstor	30+15?
9:15	Group discussions	20
9:35	Considerations when designing a new LTDH net, Kraftringen	25
10:00	Group discussions	15
10:15	**Coffee break**	15
10:30	Optimisation of return temperature a.o.: Real-life examples, COWI	30
11:00	Group discussions	15
11:15	Idea sharing from the group discussions, what can we take further	15
11:30	Evaluation of day 2 and was the expectations met?	10
11:40	Thank you and goodbye	5
11:45	**Lunch**	45
12:30-14:00	Time for open discussions and follow up	75

1.1.2 Participant list

- Lunds Universitet
- Kraftringen Energi AB
- Alfa Laval Corporate AB
- HTF - Høje Taastrup Fjernvarme
- Logstor A/S
- COWI AB
- COWI A/S

1.1.3 Introduction

COWI opened the meeting with a short introduction of the day's topic and presentation of the participants that did not already know each other.

1.1.4 Normal practice for DH piping, new designs and case study, Logstor

Logstor started their presentation with telling about how they are working with state-of-the-art practise today and explained the process during the COOL DH project.

It will consist in specifying requirements for new pipes used for LTDH. Including media pipes, couplings, multimedia pipes etc.

In order to do this, they need to know the temperature and pressure profiles that Kraftringen and HTF are planning on operating at in their new LTDH networks.

Logstor started with showing how flexible pipes can be used in district heating today. There are EN Standards available for temperature profiles up to 80°C, which is higher than the levels for this project.

The standards specify minimum requirements for lifetimes, which are 29 years at 80°C + 1 year at 90°C, which is the defined peak value, + 100 hours at 95°C, which is defined as the malfunction level.

Today PE-X pipes are typically used, since this is the type of piping that is used inside buildings for VVS etc., and therefore there are available standards. Logstor showed some examples of how the PE-X pipes are configured with the different levels of the inner pipe, the foam barrier and the outer layer.

With respect to compression and press couplings the available standards are also the ones that are used for pipes inside buildings, which was the benchmark when these types of pipe systems were designed.

First it was mostly single pipes, but Logstor are seeing more and more twin pipes, among other things to reduce heat losses. There are even solutions with up to four media pipes inside the same insulation.

Logstor further shared that they see a general development where temperatures are decreasing more and more.

Logstor mentioned that previously they have always worked with steel pipes, which need to be welded together, by trained personnel with correct certificates that sometimes can be hard to get hold of. That is also an interesting aspect and advantage of flexible plastic pipes.

Insulation

In a district heating pipe, there is typically an outer layer (kappa) and one insulation layer, with one, two, three and even four media pipes moulded into the foam.

How can this be optimised?

- Thickness of the outer layer (kappa)
- Single or twin pipes
- Density of the foam (has a great impact on the insulation, it's not the foam that creates the insulating barrier, it is the gases that are contained within it).
- The gases used inside the foam.

It is possible to have different types of barrier layers that prevents the gases from diffusing out and air diffusing in over time. It is not so hard to make a pipe with a fantastic insulation capability over a year or two, but in a longer perspective, this effect will be relevant.

Logstor uses cyclopentane in their foam. The difference in insulating capability can be shown with the property lambda which is 0.12 W/mK for cyclopentane and 0.027 W/mK for air, which means a lot in terms of insulation.

Logstor mentioned one of their pipes with a five-layer barrier as an example. Barrier materials that can be used are EVOH, PVDC and aluminium, depending on pipe type and application.

COWI enquired whether this was normal practice or specific for Logstor, to which Logstor replied that it is their solution.

COWI also enquired whether it is possible that the insulating gases diffuses into the pipe, and Logstor admitted that that could be the case as well.

Logstor further expressed that there is a wish to have leakage detection in the pipes, and that's why it is important with a full barrier layer, both in the outer layer and in the pipe material. Kraftringen enquired whether EVOH is enough for this purpose and the answer from Logstor was that it was not, if we look at a 30-year perspective.

COWI wondered why it is important with leakage detection and pointed out that in case this function is there it is also important to know where the leak is. Logstor pointed out that this is part of the COOL DH project, and that with their pipes it is possible to locate a leakage.

Logstor continued with sharing one of their challenges. When using aluminium, it results in less flexible pipes, and it is not so easy to straighten out from the pipe rolls, but aluminium is needed as a barrier material. For the larger dimensions, it's not possible to have the pipes on rolls, the maximum length will be determined by the size of the truck, and the pipe sections must be joint later.

COWI asked how long rolls of pipes that are possible to make in 32 mm size, that is possible to transport by truck. Logstor replied that 300 m is possible, the limit is that they get so heavy that special machines are required to lift them off the truck.

COWI added that it is good property to have flexible pipes when laying a new pipe network in an existing area where it's good to be able to fit the pipes around bends and existing structures, like for example Østerby in the COOL DH project.

Logstor continued with showing a connection and telling that usually a leak at a connection would not be detected, but with their new system it is possible. This is good since it is often here, we see the leakages. COWI enquired whether it could be sufficient to only have leak detection in the joints but Logstor explained that even if it is most common with leakages in the joints they see it along the pipes as well e.g. when someone accidentally digs through a pipe, so detection is needed along the full length of the pipe.

COWI mentioned that he has seen a system where voltage through the aluminium was measured and used to detect leakage. Logstor replied that it is not something they use, and if the outer layer gets a cut, you will lose the detection ability.

COWI concluded that the pipes are to be put down in Lund very soon and in Høje Taastrup in about a year, so there is not time to have too many new features.

<u>Couplings</u>

Logstor presented some of their coupling types.

Press couplings are a very popular type of coupling, can be joined together with a simple hand tool. Should not be used for parts that are inside insulation.

PERT is possible to weld together, by butt welding or electrofusion. These are well known techniques for the contractors, not just for district heating pipes.

Logstor added that they also have push couplings.

COWI mentioned that operators are usually concerned about press couplings, and welds usually create some sort of security/comfort for the people working with it. Logstor agreed and said that it is their experience as well. They added that their press coupling doesn't take up much more space than the pipes, which is a large advantage, welds take up more space.

Lunds Universitet wondered how the couplings work with the twin or even quattro pipes, is there double couplings? Logstor said that would be a challenge, because in such a case, it is very important that they get exactly the same distance between all the pipe parts, and it would also mean a lot of different products, so today they are joint independently.

Logstor also added that the inner pipe is fixed to the insulation and it's therefore not possible to shift the pipes in respect to each other.

<u>Temperature profiles</u>

In the COOL DH project, the temperature is 62°C and the pressure is up to 16 bar.

Logstor has received temperature and pressure profiles from HTF and Kraftringen.

Lund:

Temperature: 65°C, with short time peaks of 70°C and malfunction levels of 80°C.

Pressure: 10 bar. The design pressure shall be 10 bar, but operating pressure will be 6 bar.

Høje Taastrup:

Temperature: 55-60°C, with short term peaks of 65°C and malfunction levels of 85°C.

Pressure: 10-16 bar.

Logstor has used these numbers to calculate different scenarios for the lifetime of different pipelines.

For the Danish system they have looked into using PERT, with the goal to reach a lifetime of 30 years. By using allowable tensions, the suitable pressure class can be obtained.

With an SDR (a measure on the relation between the pipe wall thickness and the diameter) of 7.4, it is theoretically possible to reach 12.7 bars. This type of pipes is used for drinking water etc. which means there is a lot of practical experience regarding e.g. couplings. Most likely this pressure level is the upper limit for this kind of plastic pipes, while keeping within practical available techniques according to standards.

All safety factors are according to standards.

If we look at the Swedish side, it is possible, with an SDR of 7, to reach a theoretical pressure level of 11.8 bar, which is suitable for the 10 bars that is requested in the Swedish system.

This shows that it is possible to deliver this type of plastic pipes for the COOL DH project, but if we are going up towards 16 bar, it might be a problem.

It should also be noted that this is based on calculations on pipelines. It must also be ensured that couplings etc. are suitable, since they are usually based on 10 bars. Logstor also pointed out that these assumptions are based on the information regarding the temperature and pressure levels they have received from LTF and Kraftringen, and it is important that it doesn't change significantly, since the piping calculations then might not be valid.

Next step for Logstor is to order materials and conducts tests. The plan is to produce PERT pipes with a thin aluminium barrier against steam and oxygen, that are flexible, at least up to 110 mm.

Lunds Universitet pointed out that the temperature variations shouldn't have such large effect on the lifetime of plastic pipes as they do not expand and retract the same way metals do. Logstor agreed but added that the calculations rather look at what the material can withstand, and that e.g. pressure impulses can be relevant. They also added that Logstor has produced PE-X pipes in 25 years and in their experience the pipes typically live longer than what they are calculated for.

COWI enquired about the internal surface, is the roughness a factor over time? Logstor replied that it is not something they have heard about, and not something they think would be an issue.

Heat recovery pipes

A new type of pipe that Logstor labels as a heat recovery pipe was discussed.

1.1.5 Considerations when designing a new LTDH net, Kraftringen

Kraftringen showed a map covering the district heating network for Lund, Lomma, Eslöv and the connecting pipelines to Landskrona and Dalby.

Brunnshög is situated in the north-eastern part of Lund, and there are new building projects all over the area for the next few years. It is a rather large area and in 30 years the estimation is that about 40.000 people will live and work here.

This will require a lot of energy, but there is also ESS and MAX IV, and other future producers of waste heat in the area. There is especially a lot of low temperature waste heat to accommodate.

Kraftringen therefore needed to start thinking through what could be done in the area, and the outcome was a low temperature district heating network. Furthermore, plans were needed for what type of pipes, pressure and temperature levels that were suitable, which has been and still is a lively discussion.

Kraftringen presented a picture showing the district heating network that has been worked out. The main distributing pipeline will be put along the new tramway that is also being built. This created a lot of problems and opportunities. The only thing that is far along in the design phase is the tramway, which is being built as we speak. This means that if the district heating pipeline needs to cross the tramway at any point, these crossings must be put down already now, it will not be possible to cross over at a later stage. But to know the crossings, Kraftringen needs to know how the streets are running, which are not yet designed.

The solution was that Kraftringen pushed Lund municipality to specify the streets. Discussions were also held about the tramway, since the original plan was to build houses very close to the tram, which would also create problems for the district heating pipes.

Another issue is of course that it is difficult to know the heating demand for an area where no buildings or streets are designed yet. Kraftringen has therefore estimated the heating demand and dimensioned the main distributing pipeline according to a future estimated demand. The side branches have also been estimated, but these are possible to change in the future if needed.

COWI enquired whether not all planned houses in the area should be connected to the new LTDH network, and the reply from Kraftringen was that in Sweden there is a free market, and no one is forced to have district heating. A follow-up question about what else there is to choose from was asked and Kraftringen replied that there is a competing company and that office buildings might choose to have heat pumps. Another aspect of designing the network right and efficient from the start is that it will also be harder for competitors to get into the market.

Kraftringen continued to explain that the plan is to use PE-X pipes for the lower dimensions. Totally there is 6 km of planned pipeline, of which 2.3 is plastic. Kraftringen added that this is what is planned today, and that the network will be expanded over the next 20-30 years.

Kraftringen presented some challenges that were not foreseen:

The Brunnshög neighbourhood is supposed to be new and green, a dream for a city architect. The idea is to use the space more efficiently, with e.g. less space between the houses and the streets. But there should also be space to plant trees. In one occasion the architects wanted to keep it open whether trees should be planted on one side or the other of a street, which made it impossible to determine where to lay down the district heating pipe.

In principle, the only available space for the district heating pipes has been the roadway, and this space should also have room for water and sewage pipelines, fibre cables, electric cables, street lightning etc. Eventually everyone has succeeded in laying this "puzzle".

Kraftringen continued with showing the timeline for the Brunnshög area and that for Kraftringen it is going according to schedule. Logstor enquired about the timeline for the flexible pipelines and the reply was that it should be in about a year or so. The main distribution pipeline will be started later this year, and the streets are being built in Q2 2019, and in connection with that, all infrastructure will put down into the ground as well. This is the earliest possible, it is always possible that there will be delays to a large city project like this.

COWI enquired what design criteria Kraftringen have for the pipes and they replied that it is 65 degrees and 6 bars. It is based on an estimated heating demand. He also mentioned that they had originally planned to have thick insulation layer but due to space limitations they have been forced to decrease that slightly. He continued with explaining that they have gotten dispensation from the requirement to have minimum 25 cm distance between the pipes. For the large DN250 pipes they use single piping, but for smaller dimensions they use twin pipes where possible. But it can be an advantage in the early stages to book space to use single piping, then there will always be enough space for twin piping.

Kraftringen added that the pipe dimensions are rather large considering today's demand, but the idea is that the network shall be able to work throughout the expansion the next couple of years. The closer we are to the customer, the better and more precise we can dimension. But today we are using large dimensions to be able to connect future customers.

Kraftringen also added that even if the planned operated pressure is 6 bar, it's of course advantageous if it's possible to run at 10 bar, which will be the design criteria for the pipes.

COWI asked wat the requirements on the customers are? Kraftringen replied that 10 bar is the requirement on the customer.

COWI asked if it is possible to lay the pipes on top of each other. Kraftringen replied that the city planners have asked them to do that, but that Kraftringen has said no to that, it creates a lot of issues in case some maintenance is required.

Lunds Universitet asked when the network will be finished and when the first customers will be connected. Kraftringen replied that several deliveries are set to start fall 2019, but a few of them are supermarkets and schools, and in case there are no buildings ready around them, there will be no kids for the schools or customers for the supermarkets, so it is unlikely that it will be needed already then. Kraftringen added that the network never will be finished.

COWI asked what the minimum and maximum temperature on the supply temperature is for the network and Kraftringen replied that 62 degrees is set as both max and min.

Logstor added that that will not be a problem at 10 bar, it is only when the pressure levels are up to 16 bar where there can be problems at these temperatures.

Logstor enquired whether Kraftringen has leak detection on the main distributing pipeline.

Kraftringen answered that there are two alarm wires, which is standard on all their newer district heating pipelines. Furthermore, the main pipeline is laid in connection with a fibre cable, so it could be possible to connect it for real time surveillance. The possibility exists but the plan today is that you must go down to measure it.

Logstor added that they would recommend a real time solution. The later you discover a leakage the more piping you will have to open and replace, and that will be much more expensive than installing real time surveillance. If you just get one leak, it will be paid for, especially when space is limited. Logstor explained that their system won't give a GPS coordinate for the leakage, but a distance along the pipeline, so if you know your network it can be located. Kraftringen agreed that that is sufficient.

1.1.6 Optimisation of return temperature a.o.: Real-life examples, COWI

Heat losses within buildings

COWI showed an example of a typical installation for a housing complex, with three floors. One circuit for space heating and one for domestic hot water.

In this type of installation, we see rather large heat losses per m², some of it will contribute to the space heating, and therefore be utilized, but in best case this is only valid for 30-50% of the heat loss.

Therefore, there is a large potential in using twin pipes, and COWI presented a university study that had investigated this. The aim of the project was to utilize shorter pipes, and collect them together, and therefore reduce the heat losses.

Another part of the study looked at increasing the maximum allowable pressure loss in the pipes, but this did only contribute ca 5-10% to the positive results,

If the system is optimised, it is possible to go from losses of 7.8 kWh/m²/year to 2.2 kWh/m²/year. If, in addition to this, flat stations were implemented it was possible to get down to even lower losses of 1.9 kWh/m²/year.

It is important that if flat stations are installed, they should be located as close as possible to the consumer, so the pipes can be as short as possible.

On a final note COWI added that if the heat losses inside buildings can be utilized, which is during the cold months, where it adds to the overall space heating demand, the calculated improvements must be reduced by 30-35% in all the above cases.

If the space heating circuits can be closed off during the warmer months, there is a great energy saving potential.

RTO – Return temperature optimisation

COWI showed a presentation which explained that if the supply temperature is optimized, it will generate a higher flow, higher velocities, more resistance and more required pumping energy. If we optimize on the return temperature on the other hand, the opposite is true.

An optimized return temperature can generate less heat losses in the network, savings in pumping energy, increased capacity, and also an increased production of heat and electricity. All which are arguments for a lower return temperature.

If we optimize the supply temperature, we cannot avoid the fact that there is a minimum temperature that we must uphold at the periphery of the network. But if the return temperature can be lowered it will affect the whole supply and return temperature curve in a whole other manner.

COWI showed a tool that is used for a district heating network in Denmark, where a "smiley face" indication is used on a map of the district heating network. A green happy face means a customer with a good and low return temperature, whereas a red grumpy face means there is a problem with a too high return temperature. This is a simple and effective way to visualize where in the network there are problems with high return temperatures. An insufficient cooling, and hence a high return temperature, is often due to an issue with the automation, e.g. a valve that is not closed enough. It can affect the whole district heating network badly.

If we look at the trends for the return temperature, we can see that it swings a little, and typically increases during the summer months, which could be due to installed bypasses. There should be a better cooling of the domestic hot water, but from what we can see that is not happening.

COWI presented an actual case with return temperature optimization, for the district heating network in the Danish town Middelfart, that COWI had worked with.

The size of the network was 5500 customers, 78 km mains piping and 65 km branch pipes.

After the optimization the result was a 2°C lower return temperature in average, which equalled 3800 MWh/year in savings, a total of 1.4 million DKK/year. Furthermore, it meant that another 1.5 million DKK could be saved on not buying energy savings obligations.

The pay-back time was less than 6-12 months.

These are just the direct savings, there are also indirect savings connected with an increased efficiency in the energy production facility connected with a lower return temperature, so there can be other advantages and savings too.

COWI enquired how Kraftringen works with this and they replied that they have a system similar to the smiley-face tool COWI showed, where they can identify customers with high return temperatures. If there is a customer with problems, an e-mail will be sent out to them. The program will generate a "top 10" list, of the week's worst/highest return temperatures.

COWI presented another case, for the area Østerby, where high heat losses were experienced when the demand were much lower than expected, so the pipes were over dimensioned. A heat loss of 7°C were observed over 200 m, which in short shows room for improvement.

Today the network is operated at 65/48°C, and the plan is to lower it to 55/30°C. The pressure level is 10-13 bar, which is the design pressure for the pipes, but in practice the operating pressure is much lower.

Three scenarios are investigated. One is the reference case. one is a normally dimensioned series 3 twin pipe and the last is a hydraulically optimized system with series 3 twin pipes. Steel pipes.

COWI presented the results in tables on the screen and explained that it is possible to reduce the dimensions significantly if the network is optimized. Heat loss reduced to about 11% (37 kW) as preliminary figures.

A question was raised regarding the time schedule for the project and COWI explained that there are two possible extreme cases. On the one hand a decision could be made that decides that nothing should be done at all, the answer will available the 1st of June. On the other hand, if there is a positive decision it could mean the new pipes go into the ground already next year. Even if the decision is negative there is an old heating central in the building complex that need to be exchanged in the near future, and in that case, there is at least some optimization possibilities with that.

COWI wondered how district cooling can be connected in the best possible way. In such case there will be 4 pipes, 2 supply pipes and 2 return pipes. A solution could be to have heat pumps at the consumers, which means that the district cooling pipes can be much shorter, and it would only be necessary to route district heating close to the customer.

HTF replied that it is not so positive if they invest in new cooling centrals. COWI agreed but stated that all customers don't necessarily need the same solution, it is possible for some to have a heat pump and others to have cooling supplied from the central.

1.1.7 Final Discussions

It was discussed what value that can be attributed to the flexibility of the pipes, especially when laying pipes in areas with existing buildings and development. For these types of areas there will always come up situations where you encounter cables or similar in the ground that are not put down according to the plan, and that must be bypassed and routed around. In such cases it is advantageous with flexible pipes, which will mean that we save on the unforeseen costs, even if the pipes themselves are a bit more expensive.

A question was raised about the bend radius, and Logstor replied that it is 8-10 times the diameter. It is beneficial if the temperature is minimum 5°C, which ensure the pipes are flexible enough.

A PE-X pipe with aluminium barrier is more expensive than a steel pipe, but if couplings are included, the total cost for flexible pipes will be lower.

It was noted that it would be good for the project if these costs where quantified so that they would be comparable to conventional steel pipes.

Kraftringen mentioned that they did an after calculation for the pipes they have already installed in plastic and compared that to what the cost would have been for steel pipes, and the result was that it was cheaper with plastic pipes. They will share their findings with the projects.

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

Title: COOL DH – Innovation Workshop WP1

Date: 15-11-2018

Place: COWI, Parallelvej 2, Lyngby, Auditorium

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

1.2.1 Agenda

Thursday, November 15th – Location: COWI A/S, Parallelvej 2, DK-2800 Kgs. Lyngby Meeting room: Auditorium		Time min.
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, University of Lund	20
10:50	Questions and discussion	10
11.05	**Coffee break**	15
11:20	D2.11 Optimizing cascade couplings for optimal use of low temperature sources, Kraftringen and COWI	20
11:40	Questions and discussion	10
11.50	D2.5 LTDH Connected appliances, Kraftringen	20
12.10	Questions and discussion	20
12:30	**Lunch**	45
13:15	D2.4 Solution for multi-family houses, Kraftringen	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

- European Commission
- Euroheat and Power
- Lund Universitet
- LKF - Lunds Kommuns Fastighets AB
- Cetetherm

- Høje Taastrup Fjernvarme
- 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

Presented in the deliverable "D1.2 Thematic workshops demand side".

1.2.6 Task 2.3.1 Optimising cascade coupling, Kraftringen and COWI

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

1.2.7 D.2.5 LTDH connected appliances, Kraftringen

Presented in the deliverable "D1.2 Thematic workshops demand side".

1.2.8 D.2.4 Solution for multifamily houses, Kraftringen

Presented in the deliverable "D1.2 Thematic workshops demand side".

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

Presented in the deliverable "D1.2 Thematic workshops demand side".

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

The activities in the task was market surveys, media pipe testing, corporation with coupling suppliers, lobbying for better legislative framework. The market is very conservative. Logstor works with development of new PE pipes with "aluwrap" oxygen barrier and leak detection (not in market today). Klaus brought example products to show. Dimensions will be up to 63 mm in twin pipe and 75 mm in single pipes. 8600 hour accelerated test is ongoing.

Objective: to develop new multimedia pipe with zero heat loss. COWI presented results from thermal analysis of pipe layouts simulated with HEAT 2. The concept shows great potential. Development results are kept confidential at least until spring 2019.

1.2.11 D3.1 & D3.2 Status of Xplorion, LKF

Presented in the deliverable "D1.2 Thematic workshops demand side".

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

The optimisation of a LTDH network starts in the early design stage since the choices made are going to influence the heat losses during the operation period. To optimise the network, some main factors must be considered: pipe length, pipe insulation, pipe size and distribution principle in buildings. The optimisation processes of the two demo sites was presented, showing good results in terms of substantial heat loss reduction in Østerby's network, compared to the existing network. In the same way, it is foreseen that in Brunnshög's network the heat losses are kept low in relation to the total delivered energy when the city area is fully developed.

1.2.13 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 several 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

2 Presentations

First workshop on demand side: Friday, April 6th, 2018

LOGSTOR

LTDH flexible pipe system status service pipe 04-2018

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

04/2018

PER

COOL DH
COOL DISTRICT HEATING

Co-funded by the European Union

State of the art - practice today

Flexible pipes are designed and produced following the requirements of EN15632 series

For polymer based service pipes the requirements and solutions today are:

Requirements

4 Classification

4.1 Operating temperatures and service life

Pipe systems according to this European Standard are designed for a service life of at least 30 years when operated with the following temperature profile:

29 years at 80 °C + 1 year at 90 °C + 100 h at 95 °C.

Other temperature/time profiles can be applied in accordance with ISO 13760 (Miner's Rule). Further information is given in Annex A.

The maximum operating temperature shall not exceed 95 °C.

Typical solutions - pipes

EN ISO 15875-2:2003, *Plastics piping systems for hot and cold water installations —- Crosslinked polyethylene (PE-X) — Part 2: Pipes (ISO 15875-2:2003)*

EN ISO 21003-2, *Multilayer piping systems for hot and cold water installations inside buildings — Part 2: Pipes (ISO 21003-2:2008)*

EN ISO 15876-2, *Plastics piping systems for hot and cold water installations — Polybutylene (PB) — Part 2: Pipes (ISO 15876-2:2003)*

Typical solutions - connections

Mechanical Couplings according to the same family of standards

-compression

- press couplings

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

COOL DH temperature & pressure profiles

- Overall target:
  - Temperature 62 degrees
  - Pressure up to 16 bar

We have asked for temperature and pressure profiles from UTIL-SE and UTIL-DK

UTIL-SE

	Expected load profile per year over the lifetime of 30 years											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Operating Temperature ºC	65	65	65	65	65	65	65	65	65	65	65	65
Operating pressure Bar	10	10	10	10	10	10	10	10	10	10	10	10
Short term peak temperature ºC	70	70	70	70	70	70	70	70	70	70	70	70
Period of peak hours/month	24											
Malfunction temperature peak	80											
Period of malfunction hours/month	100											

Preferred operating pressure is 10 bar but the system is designed today as a 6 bar system

UTIL-DK

	Expected load profile per year over the lifetime of 30 years											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Operating Temperature ºC	60	60	55	55	55	55	55	55	55	55	60	60
Operating pressure Bar	10-16**)											
Short term peak temperature ºC	65	65	60	60	60	60	60	60	60	60	65	65
Period of peak hours/month	24											
Malfunction temperature peak	85											
Period of malfunction hours/month	0*)											

**) depends on end user installation (flatstation)

*)30h In worst case every 10 years

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Design based on the given data

- UTIL-DK with a temperature profile as listed and by applying Miners rule we can calculate expected lifetime of the different pipe solutions. Based on the general data we have on PERT Type II we can estimate the following:

Calc of lifetime of PE-RT type II pipes based on Miners Rule EN ISO 13760					**UTIL-DK**					
σ	**safety factor**	**σ_{safe}**	**load time**	**load time**	**Temp T_i**	**Temp T_i**	**lifetime t_i**	**fraction of year a_i**	**a_i/t_i**	**Expected lifetime**
Mpa		Mpa	years	hours	^oC	K	Years	%	%/Years	Years
4,05	1,5	6,08	19,33	169330,8	55	328,15	1013	64,43	6,361E-02	
4,05	1,5	6,08	9,66	84621,6	60	333,15	10	32,20	3,069E+00	
4,05	1,3	5,27	1	8760	65	338,15	10896	3,33	3,059E-04	
4,05	1	4,05		100	85	358,15	247966	0,04	1,534E-07	
4,05				262812,4				100	3,133E+00	**31,9**

Max operating pressure at given SDR levels	SDR	7,4	12,7	bar
	SDR	9	10,1	bar
	SDR	11	8,1	bar

- So based on the inputs we can, by using PE RT type II SDR 7,4, achieve a lifetime of 30 years at a pressure level of 12,7 bar

COOLDH COOL DISTRICT HEATING
Co-funded by the European Union

Design based on the given data

- UTIL-SE with a temperature profile as listed and by applying Miner rule we can calculate expected lifetime of the different pipe solutions. Based on the general data we have on PERT Type II we can estimate the following:

Calc of lifetime of PE-RT type II pipes based on Miners Rule EN ISO 13760					**UTIL-SE**					
σ	**safety factor**	σ_{safe}	**load time**	**load time**	**Temp T_i**	**Temp T_i**	**lifetime t_i**	**fraction of year a_i**	a_i/t_i	**Expected lifetime**
Mpa		Mpa	years	hours	°C	K	Years	%	%/Years	Years
3,78	1,5	5,67	30	262800	65	338,15	30	96,74	3,220E+00	
3,78	1,3	4,91	1	8760	70	343,15	29978	3,22	1,076E-04	
3,78	1	3,78		100	80	353,15	3564047327	0,04	1,033E-11	
3,78				271660				100	3,220E+00	**31,1**

Max operating pressure at given SDR levels	SDR	7,4	11,8	bar
	SDR	9	9,5	bar
	SDR	11	7,6	bar

- So based on the inputs we can, by using PE RT type II SDR 7,4 achieve a lifetime of 30 years at a pressure level of 11,8 bar

COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union

Next step

- LTDH
- Finalize design based on PE RT approach
- Combine the design with possible solutions for connectors
- We will prepare pilot production of PE RT pipes (Incl a barrier for oxygen and water vapour)
- Make qualification of supplier of Multilayer pipes based on PE RT
- Start investigations on alarm system and insulation optimization

- Heat Recovery pipe
- Further investigations of design in balance with heat pump design, cooling needs etc

Background for calculations

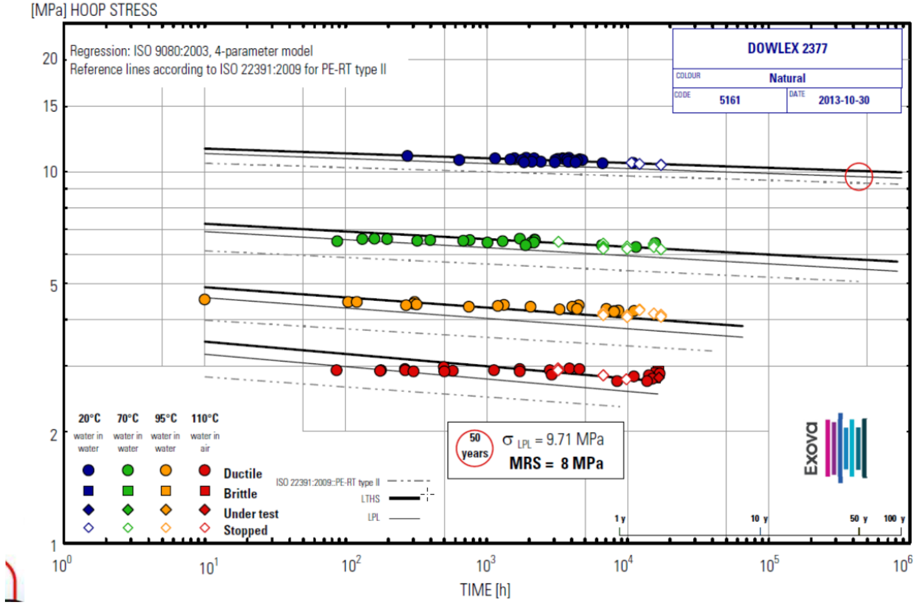
Plastics pipes for the conveyance of fluids under pressure — Miner's rule — Calculation method for cumulative damage

1 Scope

This International Standard specifies a method for calculating the maximum allowable hoop stress applicable to pipes exposed to varying internal pressures and/or temperatures during their expected lifetime. This method is generally known as Miner's rule.

It is necessary to apply Miner's rule to each failure mechanism separately. Thus, for mechanical failure due to internal pressure, other failure mechanisms, such as oxidative or dehydrochlorinative degradative failure mechanisms, are to be neglected (assuming, of course, no interaction). A material may be used only when it is proven to conform to all failure mechanism criteria.

ISO 9080 Regression



4.2 Evaluation of σLCL-values

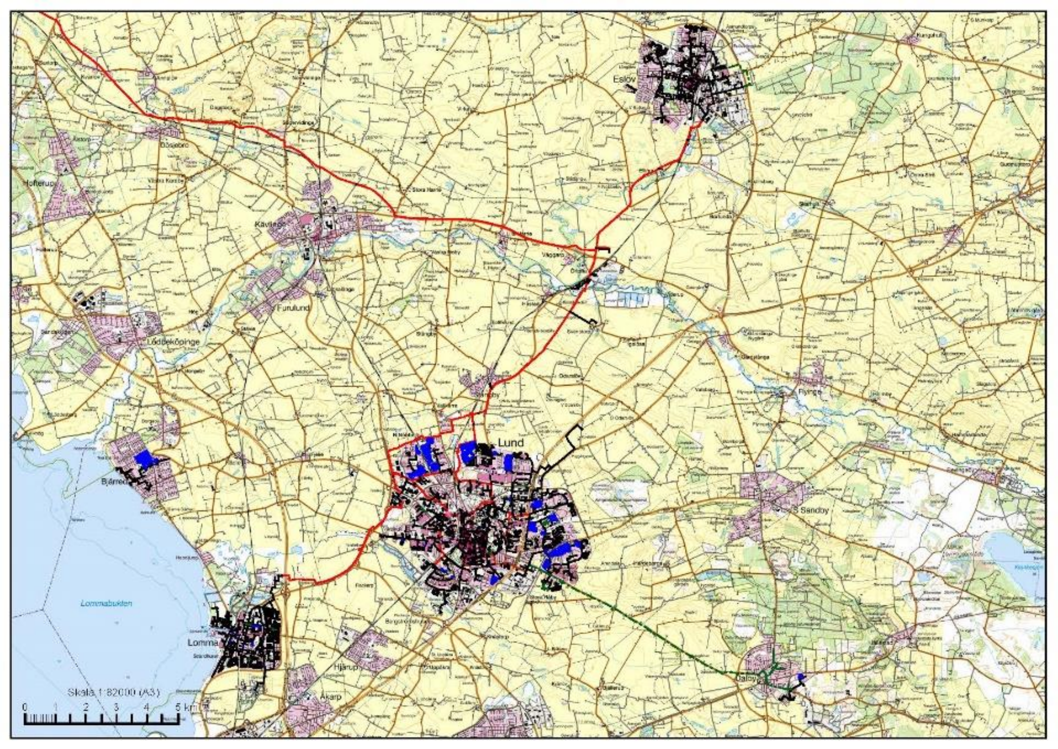
The pipe material shall be evaluated in accordance with EN ISO 9080 or equivalent where internal pressure tests are made in accordance with EN 921:1994 to find the σ_{LCL}-values. The σ_{LCL}-value thus determined shall at least be as high as the corresponding values of the reference curves given in Figure 1 over the complete range of times.

NOTE 1 One equivalent way of evaluation is to calculate the σLCL-value for each temperature (for example 20 °C, 60 °C and 95 °C) individually.

NOTE 2 The reference curves in figure 1 in the temperature range of 10 °C to 95 °C are derived from the following equation:

$$\log t = -105,8618 - \frac{18506,15 \log \sigma}{T} + \frac{57895,49}{T} - 24,7997 \log \sigma$$

Kraftringen district heating

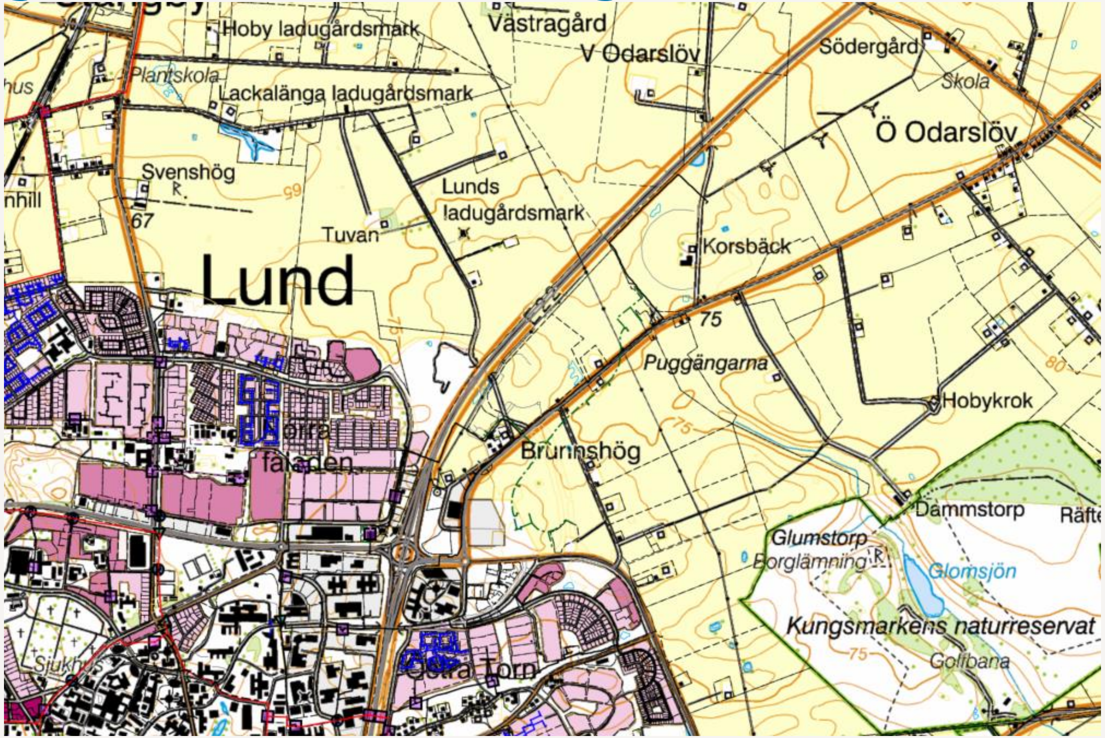


kraftringen

COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union

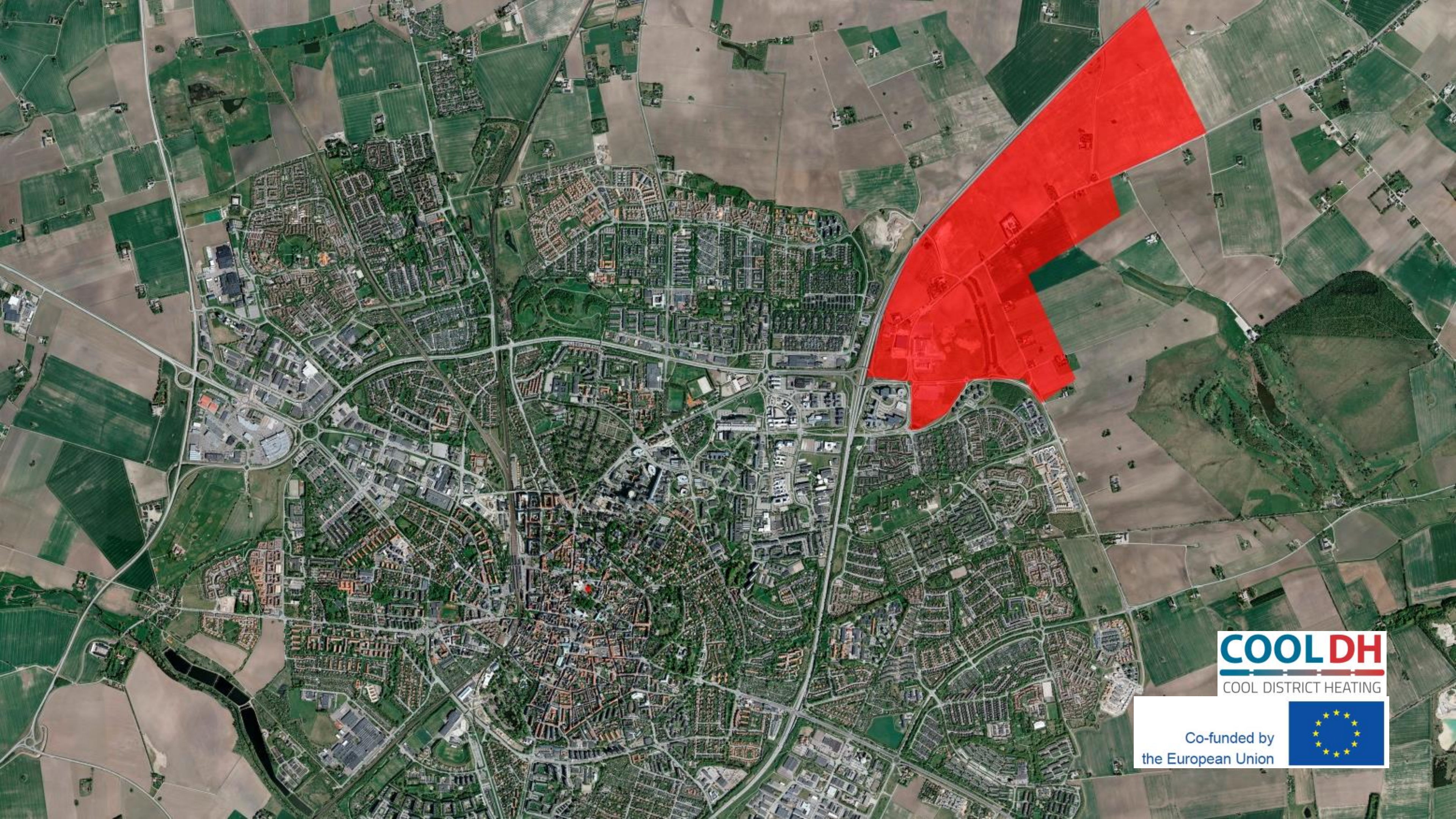
Kraftringen district heating



COOL DH
COOL DISTRICT HEATING

kraftringen

Co-funded by
the European Union



COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union

Brunnshög, MAX IV, ESS

kraftringen

COOL DH
COOL DISTRICT HEATING

Co-funded by the European Union

Background summary

- Loads of recoverable heat at low/medium temperatures
- A new city district will be built in the same area
- This district will be based upon innovation and innovative ideas

⇒Can we build a local low temperature heating network?

⇒Yes we can…but:

Co-funded by the European Union

Workshop 5-6 April, Lyngby

Questions, challenges, opportunities

Visualize?

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

Low temp and legionella? (regulations?)

Services?

Price structure?

Demand side effects?

Applicability in other DH area

Function?

Demo possibility

Remote control? (customer, utility?)

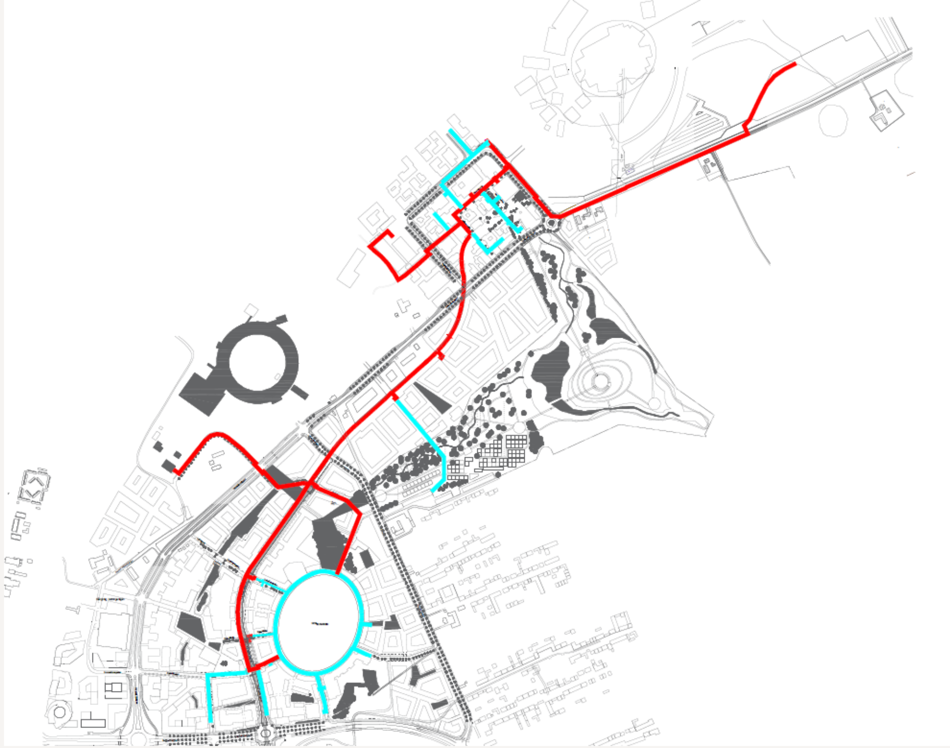
Prosumers

COOL DH
COOL DISTRICT HEATING

kraftringen

Co-funded by the European Union

Kraftringen LTDH network

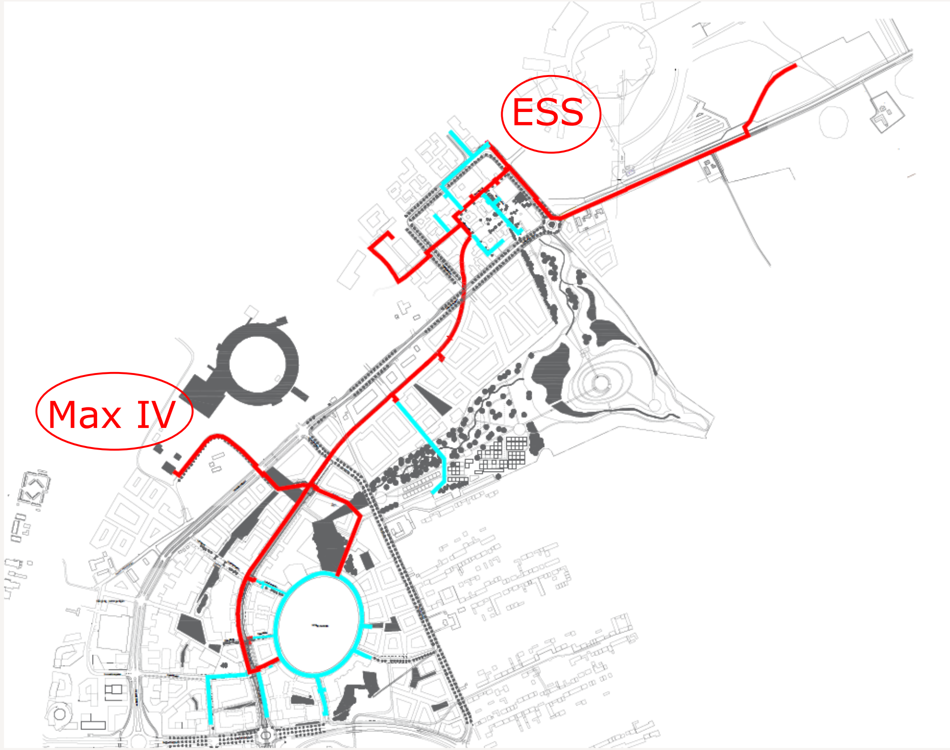


kraftringen

COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union

Production side installations

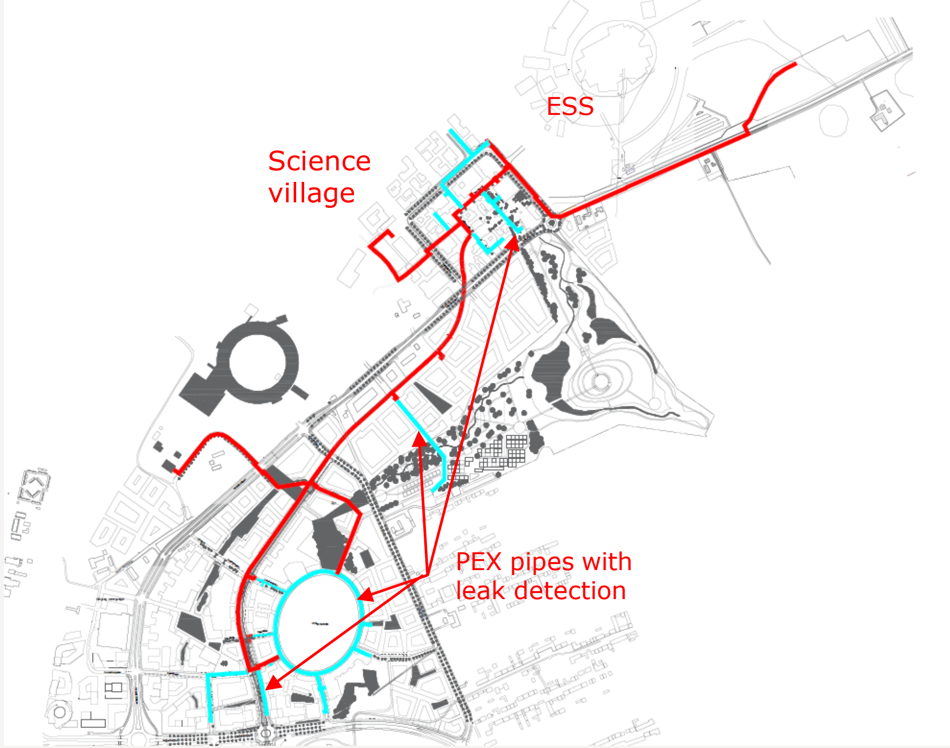


COOL DH
COOL DISTRICT HEATING

kraftringen

Co-funded by
the European Union

Distribution side installations

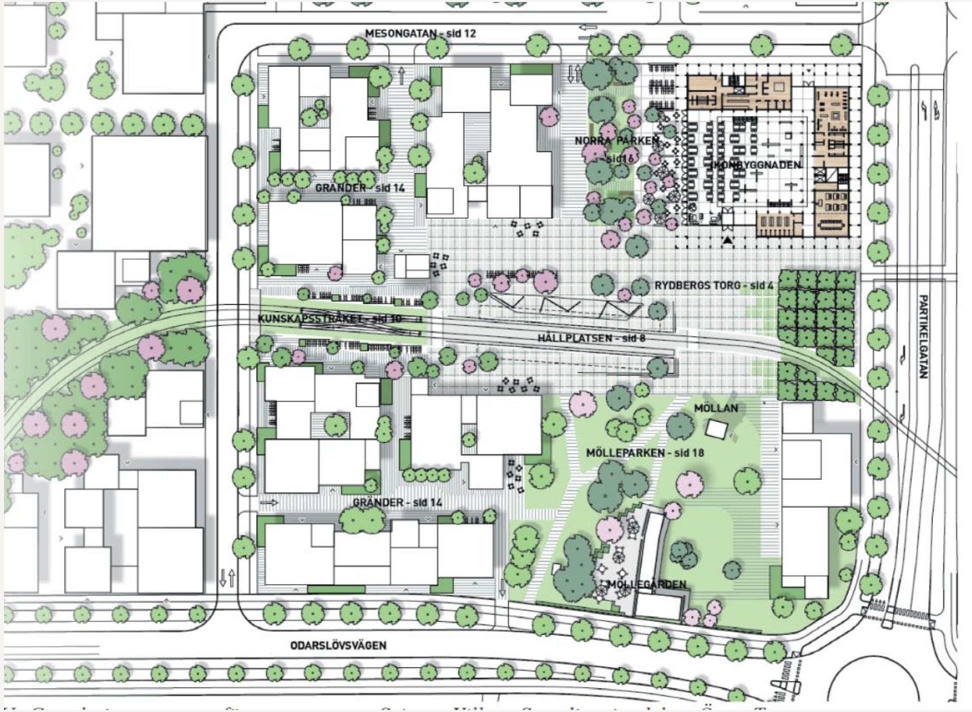


kraftringen

COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union

Unexpected challenges to be handled



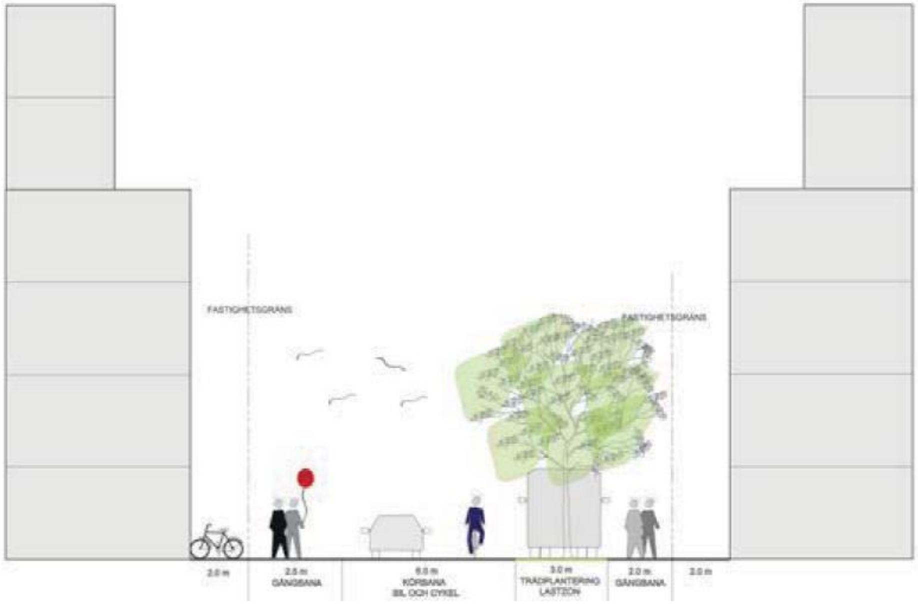
COOL DH
COOL DISTRICT HEATING

kraftringen

Co-funded by
the European Union

Unexpected challenges to be handled

- Cool DH
- District Cooling
- Electric cables
- Optic cables
- Sewer
- Water
- Street lightning
- Trees



Gatusektion Inre Loopen

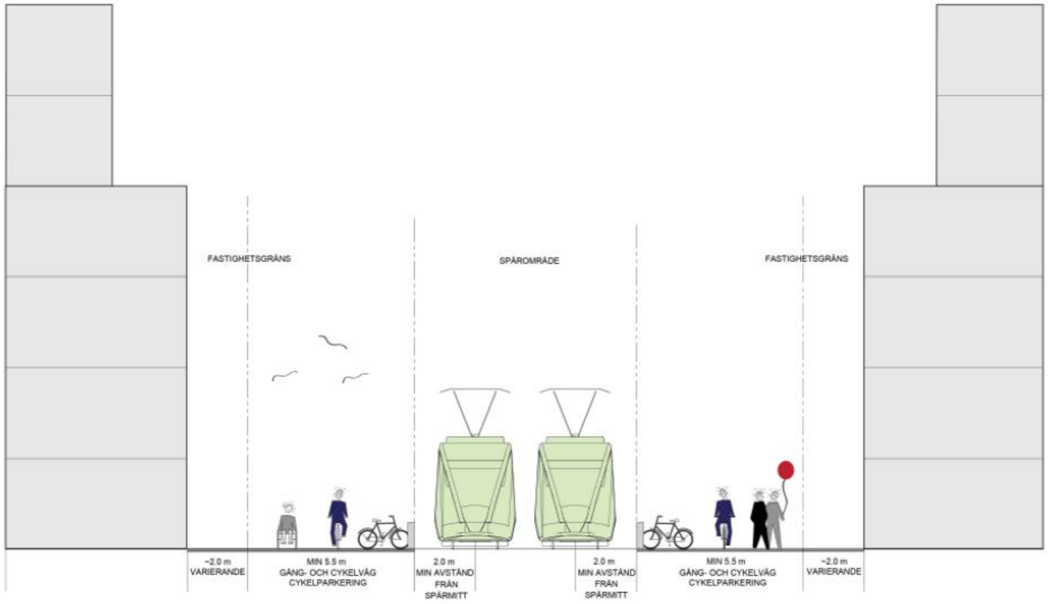
COOL DH
COOL DISTRICT HEATING

kraftringen

Co-funded by the European Union

Unexpected challenges to be handled

- Cool DH
- District Cooling
- Electric cables
- Optic cables
- Sewer
- Water
- Street lightning
- Trees



Sektion spårväg

COOL DH
COOL DISTRICT HEATING

kraftringen

Co-funded by the European Union

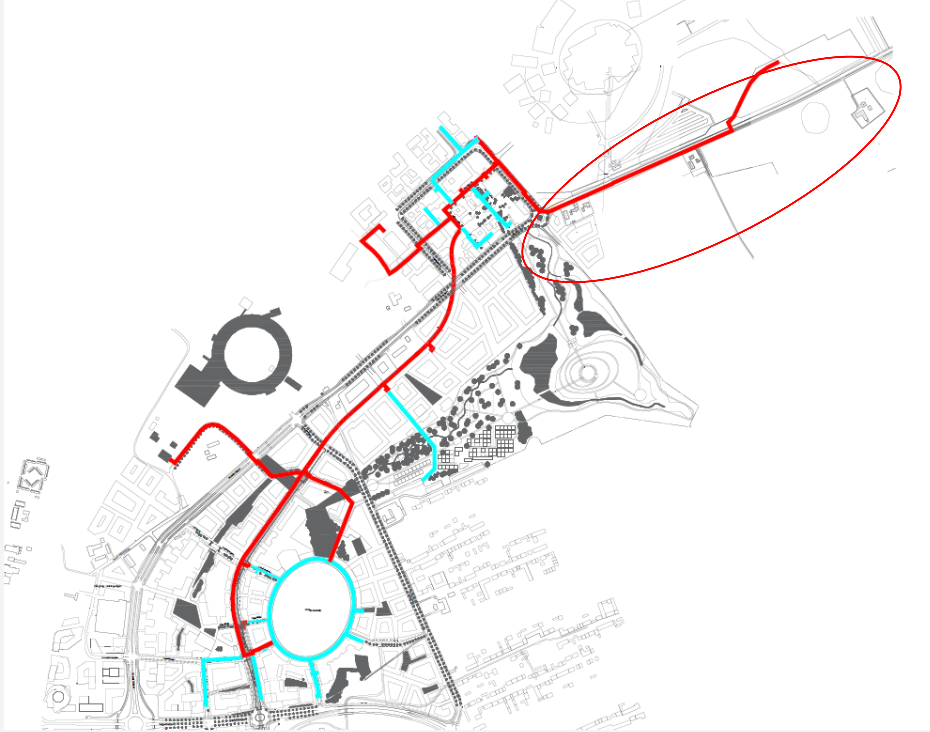
Workshop 5-6 April, Lyngby

Time plan

		2018				2019				2020				2021			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Stamledning	Projektering																
ner till upptäcktsgatan	Genomförande																
Stamledning	Projektering																
Nobelpark-Solbjersväg	Genomförande																
Vektorsgatan-Max IV	Projektering																
	Genomförande																
Spårvägsdepån	Projektering																
	Genomförande																
Nobelparken	Projektering																
	Genomförande																
Mesongatan SO	Projektering																
	Genomförande																
Mesongatan-Nanolab	Projektering																
	Genomförande																
Ledning Flexihuset	Projektering																
	Genomförande																
Utrustning Max IV	Projektering																
	Upphandling																
	Genomförande																

Co-funded by the European Union

Distribution - Tram depot



kraftringen

COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union

Distribution - Tram depot

Questions?

WP 1 workshop distribution side

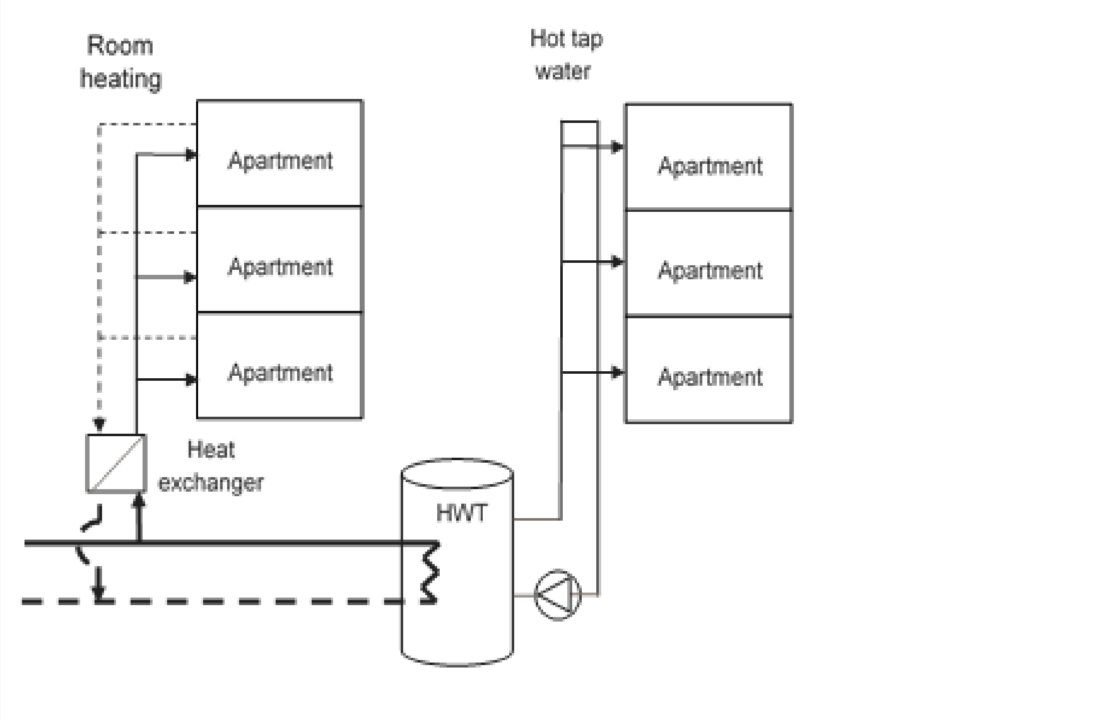
Reto M. Hummelshøj

6. April 2018

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

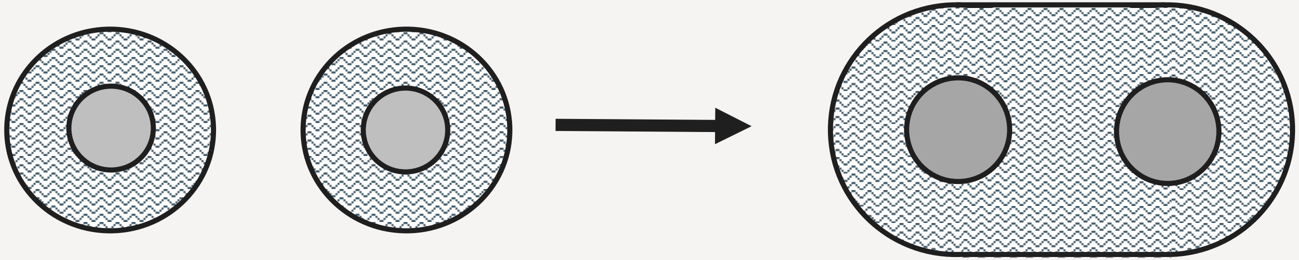
COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union
COWI

Room heat and hot water distribution systems



COOL DH COOL DISTRICT HEATING
Co-funded by the European Union
COWI

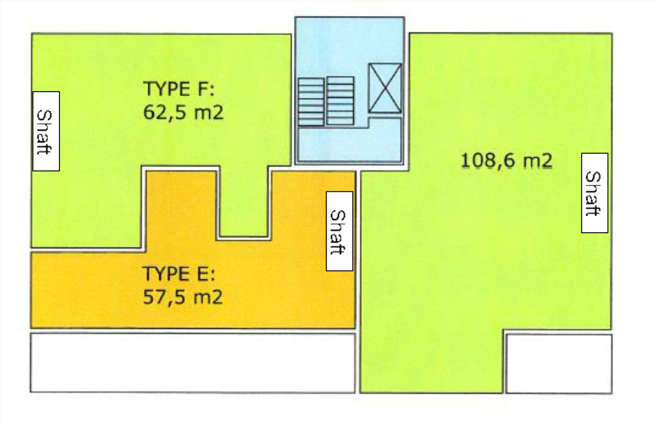
Factor 1 examined – insulation



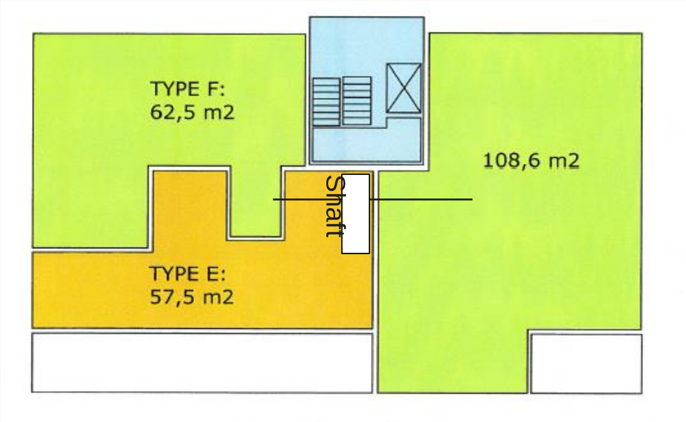
Separate insulation vs. joint insulation: Reduction of heat loss by 30% for joint insulation

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union
COWI

Factor 2 examined – distribution principle



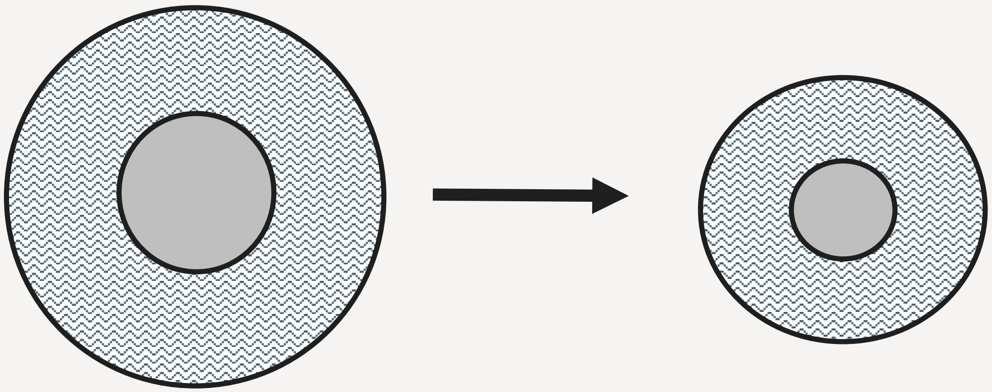
One installation shaft and set of pipes pr. column of apartments



One installation shaft pr. staircase

COOLDH COOL DISTRICT HEATING Co-funded by the European Union COWI

Factor 3 examined – increase max. allowable pressure drop in pipes



Increase max. allowable pressure drop → *Pipe diameter can be decreased* → *Reduced heat loss*

The max. allowable pressure drop in flat calculations are increased from 200 Pa/m to 500 Pa/m has been investigated

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union
COWI

Conclusions

- **Traditional distribution systems can be optimized to reduce the heat loss from 7.8 kWh/m^2/year to 2.2 kWh/m^2/year**

- **The option with the least amount of heat loss will be**
  - flat station system with one shaft pr. staircase and high pressure drop leading to a theoretical heat loss of 1.9 kWh/m^2/year.

- **Using one vertical set of pipes pr. staircase instead of three vertical pipes will significantly reduce the annual heat loss – 30 - 35% depending on the type of scenario – due to SHORTER pipes**

  - Flat stations must be located close to the shaft in order to avoid bypasses in the flat stations
  - The hot water pipes in the apartments must be short to reduce water loss.

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union
COWI

Conclusions – cont'

- If heat loss from the pipes and flat station systems is a benefit for heating the apartments during the heating season, it will reduce the calculated heat loss by 30 – 35% for all scenarios.
- **Main conclusion is that distribution system need to be optimized independently of choice of system.**
- In the traditional scenarios, the space heating system can be switched off outside the heating season.
- System cost is almost equal to flat stations and traditional systems in the actual case.

COOL DH COOL DISTRICT HEATING Co-funded by the European Union COWI

What is the **first** thing to **do**?

RTO

Return **T**emperature **O**ptimization - The Road to better District Heating!

Compared- what do you get?: FTO/RTO?

FTO –

- Higher flow,
- Larger velocities,
- More resistance,
- Higher power expenditures,
- Possible new pumps,
  Complaints from customers?

Gains: Heat losses saved! Money on the bottom-line, fast in action!

RTO –

- Lower flow,
- Smaller velocities
- Less resistance,
- Lower power expenditures,
- No new pumps,
- Complaints from customers?

Gains: Heat losses saved! Money on the bottom-line, fast in action!

COOLDH COOL DISTRICT HEATING Co-funded by the European Union COWI

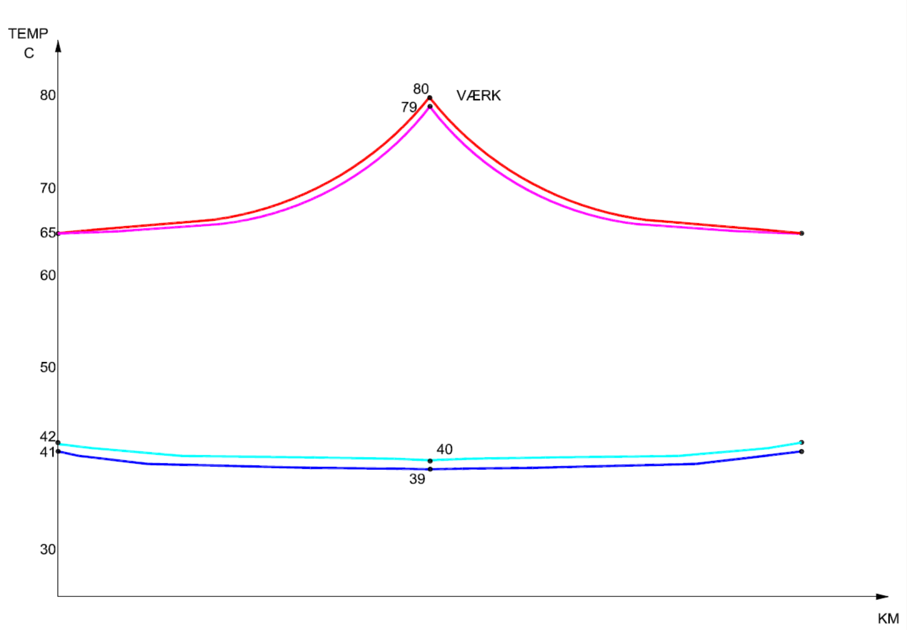
Gains from RTO:

1. Lower Heat losses
2. Savings on Pumps
3. Larger Capacity in the DH-network
4. Improved Production of Heat and Electricity

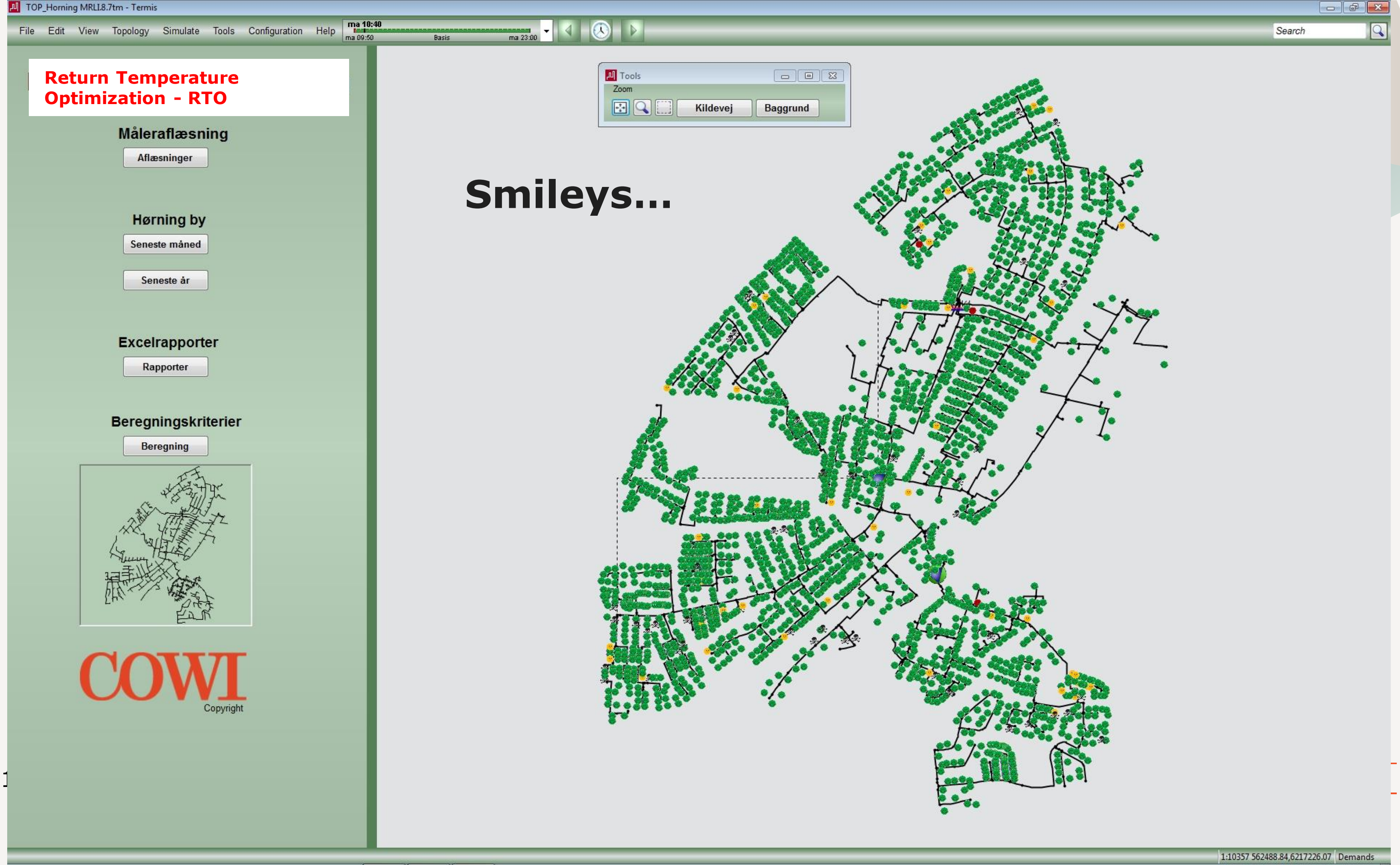
What is the best thing to do?

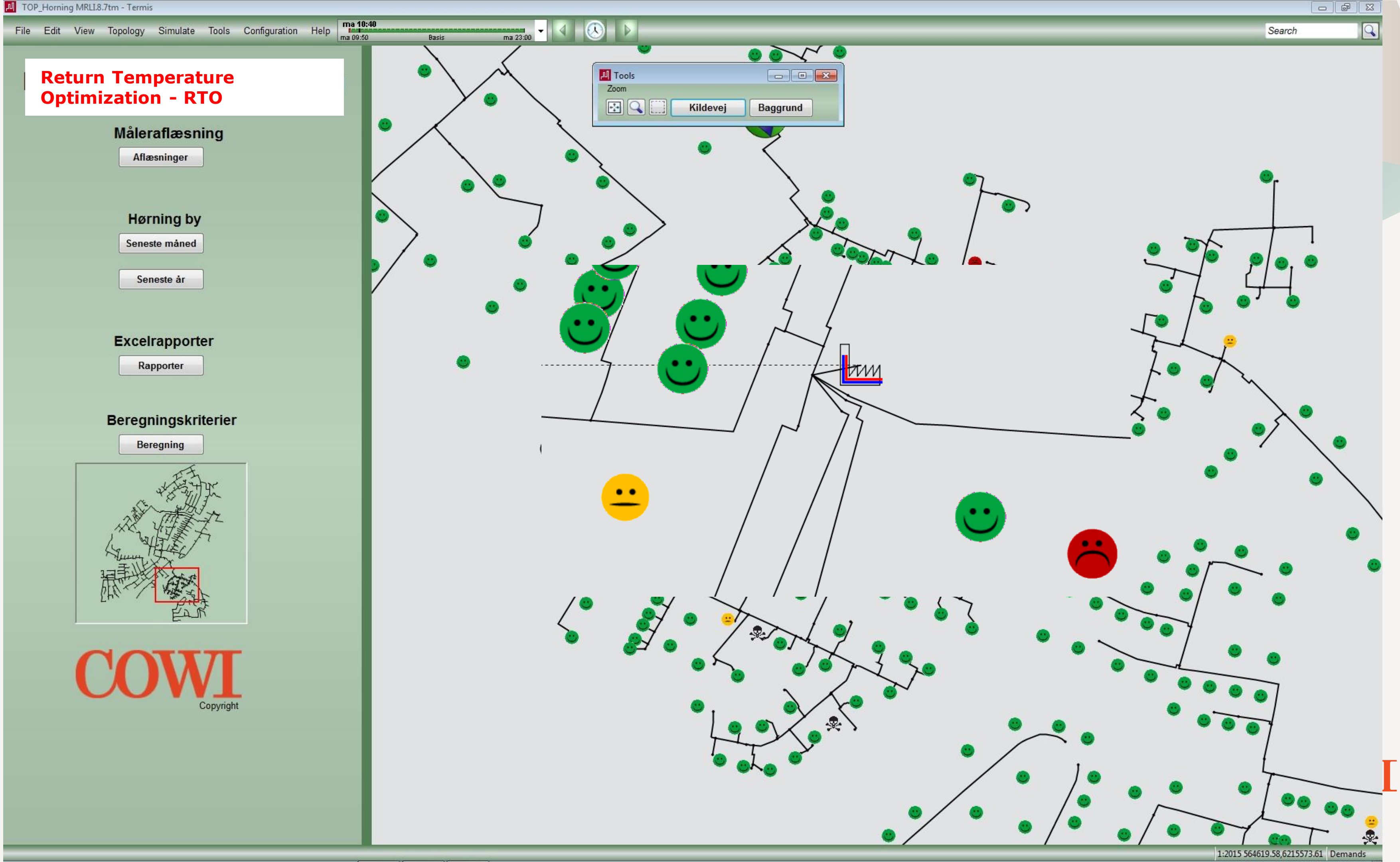
Lower the flow or return temperature 1 degree?

Or is it the same same?



COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union
COWI


TOP_Horning MRLI8.7tm - Termis
File
Edit
View
Topology
Simulate
Tools
Configuration
Help
ma 10:40
ma 09:50
Basis
ma 23:00
Search
Return Temperature
Optimization - RTO
Måleraflæsning
Aflæsninger
Hørning by
Seneste måned
Seneste år
Excelrapporter
Rapporter
Beregningskriterier
Beregning
COWI
Copyright
Tools
Zoom
Kildevej
Baggrund
Smileys...
1:10357 562488.84,6217226.07
Demands



TOP_Horning MRLI8.7tm - Termis
File
Edit
View
Topology
Simulate
Tools
Configuration
Help
ma 10:40
ma 09:50
Basis
ma 23:00
Search
Return Temperature Optimization - RTO
Måleraflæsning
Aflæsninger
Hørning by
Seneste måned
Seneste år
Excelrapporter
Rapporter
Beregningskriterier
Beregning
COWI
Copyright
Tools
Zoom
Kildevej
Baggrund
1:2015 564619.58,6215573.61
Demands

Return Temperature Optimization - RTO

TOP_Horning MRLI8.7tm - Termis

File Edit View Topology Simulate Tools Configuration Help

Marts afkøling [°C]

Nettet

Alle data

Forbrugere

Højeste T-retur

Forbrugere

Produktion

Seneste år

Maintenance

Management

Oversigt

COWI

Copyright

Top50_T-retur(18).xls [Kompatibilitetstilstand] - Microsoft Excel

I9 =+Consumer!I10

	Installations ID	Name	Adresse	Volumen	Forbrug	Fremløbstemperatur	Returtemperatur	Afkøling	Beregning -->	Forudsat Retur-temperatur	Ny afkøling	Ny volume	Volume sparet
2				m³	KWh	°C	°C	°C		°C	°C	m³	m³
3	10402865	Ejerforeningen Brødregården	Frisegade 18A	622	12.706	79,2	61,2	17,6	-->	40	39,2	279	343
4	10404534	H & M Hennes & Mauritz A/S	Jernbanegade 13	297	4.452	81,2	68,1	12,9	-->	40	41,2	93	204
5	10403033	Ejerforeningen Østerbrogade 28, Nykø	Østerbrogade 28C	250	2.346	78,7	70,6	8,1	-->	40	38,7	52	198
6	10402890	Ejendomsselskabet Lynggaard ApS	Slotsgade 5	478	7.727	80,2	66,1	13,9	-->	40	40,2	165	313
7	10405400	Intelligent Handel ApS	Toldbodgade 11	454	4.022	78,7	70,9	7,6	-->	40	38,7	89	365
8	10403098	Guldborgsund Kommune	Østerbrogade 5	728	3.270	78,8	74,9	3,9	-->	40	38,8	72	656
9	10402851	Janne Ljungstrøm	Klosterstræde 2	727	2.287	81,1	78,3	2,7	-->	40	41,1	48	679
10	10402757	Boligselskabet Fjordparken	Jes Jessensgade 23A	781	7.597	79,6	70,3	8,4	-->	40	39,6	165	616
11	10403804	Bendt Gustav Klinke	Bellingevej 9	242	1.569	78,8	73,2	5,6	-->	40	38,8	35	207
12	10403202	Henrik Krog Christensen	Vestensborg Alle 48	335	1.772	80,9	76,3	4,6	-->	40	40,9	37	298
13	10400226	Guldborgsund Kommune	Torvet 3	883	20.661	81,4	60,6	20,1	-->	40	41,4	429	454
14	10400048	J S Sko ApS	Jernbanegade 14	312	5.803	80,1	63,8	16,0	-->	40	40,1	125	188
15	10402750	Schulz Ejendomme Aps	Herningvej 18	370	4.440	78,5	67,9	10,3	-->	40	38,5	99	271
16	10406471	Guldborgsund Kommune	Nørregade 17B	1.114	4.603	74,8	71,2	3,6	-->	40	34,8	114	1.001
17	10400477	Boligselsk. Vendersbo Guldborgsund	Vendsysselvej 22	1.251	26.643	74,5	56,0	18,3	-->	40	34,5	665	586
18	10403027	A.B.C. Ejendomme Aps	Fromsgade 39	306	2.623	77,2	69,4	7,4	-->	40	37,2	61	245
19	10400341	Rørsø ApS	Skolegade 31	258	3.263	78,6	67,7	10,9	-->	40	38,6	[illegible]	185
20	10403134	Nykøbing f Realskole	Holchsgade 5	[illegible]	[illegible]	77,6	69,6	7,9	-->	[illegible]	[illegible]	[illegible]	369
21	10402719	Bogholdergaarden A/S	Jernbanegade 21	[illegible]	[illegible]	80,6	57,9	22,7	-->	40	40,6	723	574
22	10401912	Anders Steinmarck Skov	Enighedsvej 32	524	6.490	80,1	69,3	10,7	-->	40	40,1	139	385
23	10402950	Frimurerlogen Dagmar	Brovejen 2	413	7.954	77,9	61,1	16,6	-->	40	37,9	180	232
24	10401663	NORDIC SUGAR A/S	Østerbrogade 4A	1.019	10.457	80,8	71,9	8,8	-->	40	40,8	220	799
25	10400282	Leif Ole Olsen	Læsøvej 12	272	838	74,2	[illegible]	[illegible]	-->	40	34,2	21	251
26	10406453	Dab	Eskilstrup Vestergade 14	488	10.122	[illegible]	[illegible]	[illegible]	-->	40	34,3	254	234
27	10403727	Skov Bo V/Anders Skov	Langgade 23A	490	731	[illegible]	[illegible]	[illegible]	-->	40	40,2	16	474
28	10400152	Cieslak Aps	Høstsgade 2	362	6.904	79,7	63,2	16,4	-->	40	39,7	150	213
29	10402817	Mette Falk Andersen	Jernbanegade 27A	1.102	7.593	81,5	75,4	5,9	-->	40	41,5	158	944
30	10401044	Inger Elisabeth Hinsby	Fr. VII's Gade 1	685	1.604	78,2	76,2	2,0	-->	40	38,2	36	649
31	10402676	Tdc Services A/S	Tværgade 1A	845	13.427	81,4	67,3	13,7	-->	40	41,4	279	566
32	10404187	Ole Schulz Biler ApS	Herningvej 11	1.576	11.937	81,4	74,9	6,5	-->	40	41,4	248	1.328
33	10400061	Boligselsk. Vendersbo Guldborgsund	Vendsysselvej 2	803	25.429	77,1	49,8	27,2	-->	40	37,1	590	214
34	10403356	CYKLEBØRSEN, NYKØBING F. HOLDING ApS	Pomonagade 9B	314	1.337	76,1	72,4	3,7	-->	40	36,1	32	282
35	10400776	Mette Susan Hansen	Kohavevej 7	281	1.040	77,7	74,2	3,2	-->	40	37,7	24	257
36	10402852	Eskil Irminger	Nørrevang 37	268	1.557	76,3	71,2	5,0	-->	40	36,3	37	231
37	10402321	Boligselskabet Fjordparken	Colbjørnsensvej 35	1.267	43.694	79,6	49,2	29,7	-->	40	39,6	948	319
38	10401415	Peter Graae Jeppesen	Kretavej 14	701	1.566	74,3	72,4	1,9	-->	40	34,3	39	662
39	10403801	Nykøbing f Andelsboligforening	Christiansmindevej 21	432	7.679	76,5	61,1	15,3	-->	40	36,5	181	251
40	10400151	Ejerforeningen Hotel Baltic	Jernbanegade 47	1.361	21.289	81,4	67,8	13,5	-->	40	41,4	443	918
41	10403703	A/S A Schillers Maskinfabrik A/S	Gartnervej 15	406	5.175	75,4	64,2	11,0	-->	40	35,4	126	280

Top 50 højeste T-retur | Consumer | INFO

1104 m³

114 m³

Saved 1001 m³

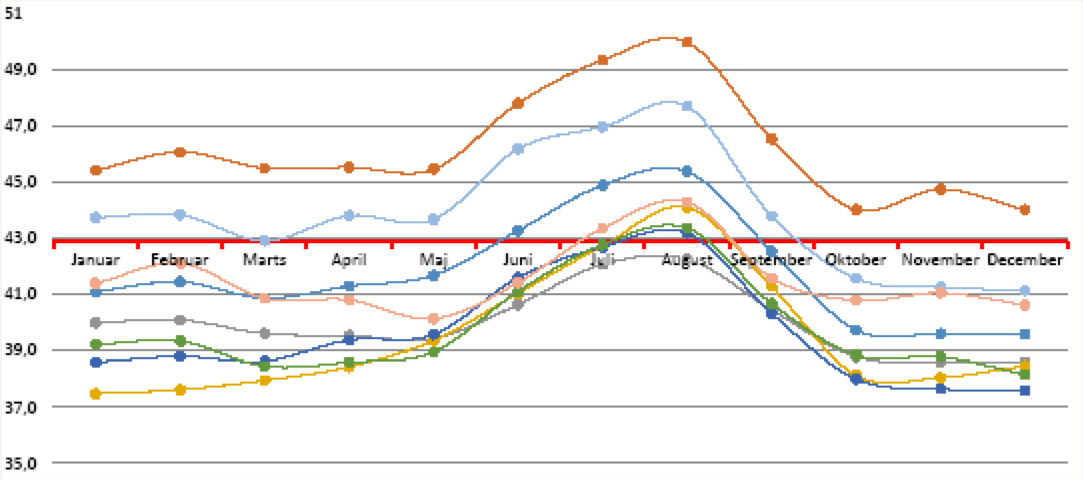
Better data from 2 way meters

Here we have 8 different consumers – all of them with variation in the yearly return temperature

When using the yearly average return temperature we disregard the fact

that the return temperature **vary from 44 to 50 degree** (top data)

So using meter data gives us more correct return temperatures for all our customers



COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union
COWI

Good investment – actual case - Middelfart

- Middelfart town, 5500 customers, 78 km mains and 65 km branch pipes

- RTO results:
  - 2 deg. reduced return temp => 3800 MWh/yr saving = 1.4 mio. DKK/yr
  - Reduced purchase of energy saving obligation worth = 1.5 mio. DKK

- First year saving 2.9 mio. DKK i.e. pay-back less than 6-12 months

COOL DH COOL DISTRICT HEATING Co-funded by the European Union COWI

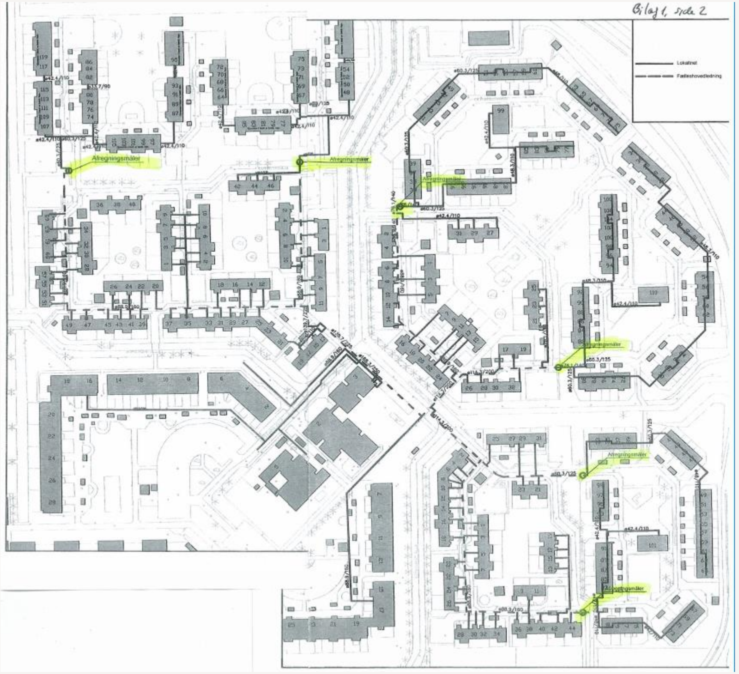
Grid optimisation – Østerby case

COOLDH COOL DISTRICT HEATING Co-funded by the European Union

COWI

Current situation - Østerby

- Very large heat losses, due to lower demand with new windows and oversized pipes.
- 7 deg. loss in flow temp. over 200 m (observed 11th Dec 2017 noon) 65/48°C



- design temperature 85/50°C
- max pipe size DN150

COOL DH COOL DISTRICT HEATING Co-funded by the European Union COWI

Heat losses comparison

Heat loss	Single pipes - series 1 (*)(**)	Double pipe - Series 3 (*)	Reduction
	W/m	W/m	%
DN20	13	7,1	45%
DN25	14,7	7,0	52%
DN32	15	7,8	48%
DN40	17,1	8,9	48%
DN50	18,9	8,6	54%
DN65	22,2	9,8	56%
DN80	22,8	10,3	55%
DN100	24,4	11,1	55%
DN125	28	10,7	62%
DN150	32,7	12,0	63%

* Based on new standard catalogue Isoplus steel pipes.

** The reference pipes in Østerby are more than 30 years old, and certainly have greater heat loss.

New pipes => more than 50% savings!

(before reducing temperature)

COOL DH COOL DISTRICT HEATING Co-funded by the European Union COWI

Pipe networks in the 3 scenarios

	Reference		Optimised system		Hydraulically optimised system	
Type	Series 1 single steel pipe	_	Series 3 double steel pipe	_	Series 3 double steel pipe	_
DN20	0	m	0	m	**1.294**	m
DN25	53	m	0	m	**511**	m
DN32	773	m	435	m	**370**	m
DN40	438	m	514	m	**312**	m
DN50	633	m	951	m	**248**	m
DN65	168	m	614	m	**48**	m
DN80	657	m	44	m	**211**	m
DN100	150	m	195	m	0	m
DN125	83	m	275	m	0	m
DN150	17	m	0	m	0	m
SUM	**2.971**	**m**	**2.994**	**m**	**2.994**	**m**

Can it be PE twin?

Straight pipes

Design criteria – optimised scenario

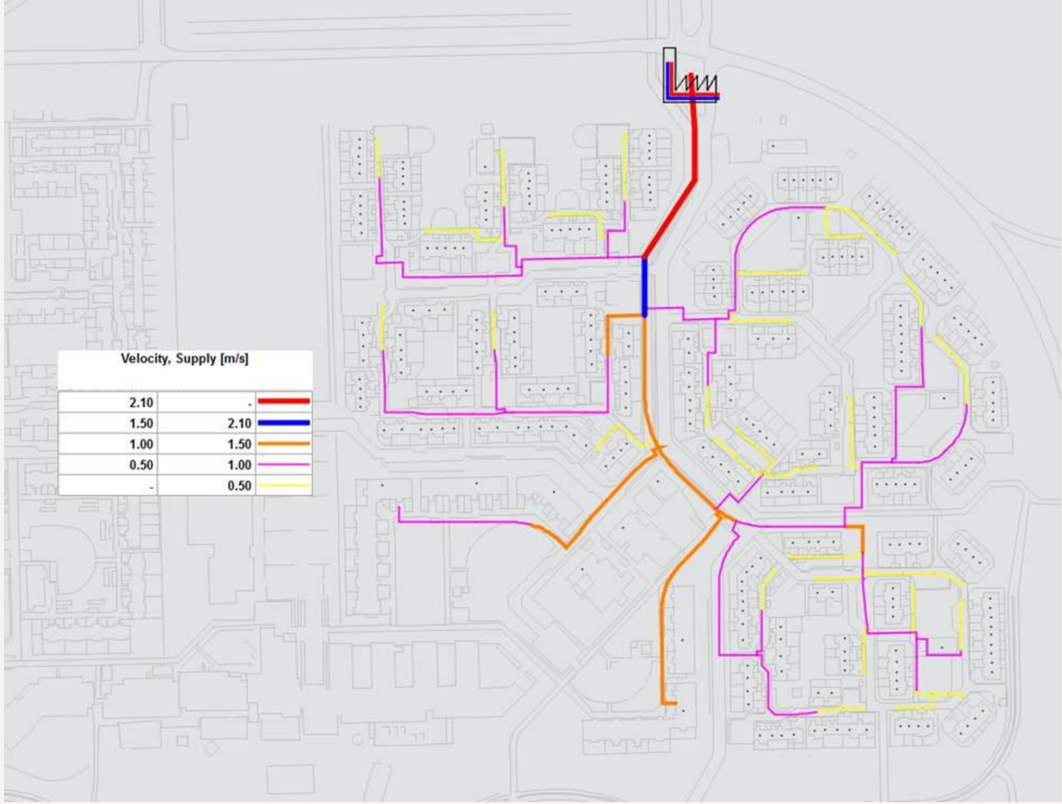
- Optimised:
- - Temperature set: 55°C supply / 30°C return
- - Pressure level: expected 10-13 bar (not reached)
- - Expected thermal power: ca. 1.2-1.4 MW-th
- - Consumer DH-unit is connected directly to the supply pipes

- - No maximum pipe dimension
- - Velocity max. 1.2 m/s
- - DP max. 100 Pa/m

Design criteria – hydraulically optimised scenario

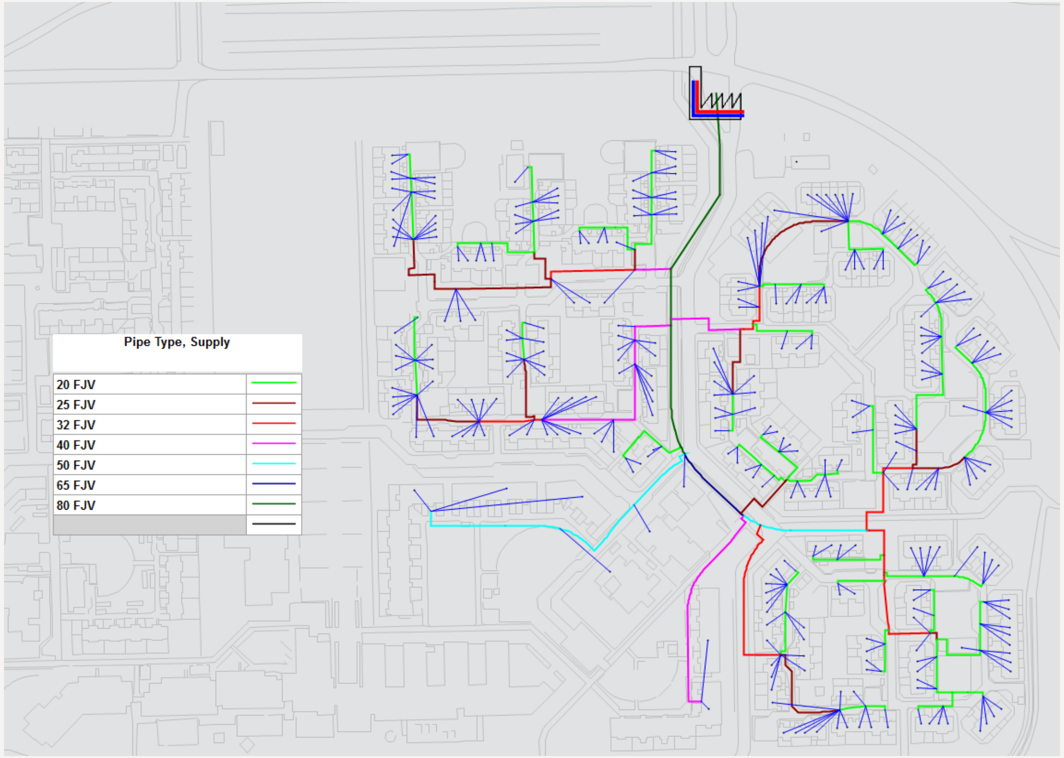
- - Temperature set: 55°C supply / 30°C return
- - Pressure level: expected 10-13 bar
- - Expected thermal power: ca. 1.2-1.4 MW-th
- - Consumer DH-unit is connected directly to the supply pipes
- - Expected DP at the consumer is assumed to be 0.5 bar

- - Maximum pipe dimensions: DN80
- - Velocity max. 1.5 m/s except DN80 where it is allowed up to 2.3 m/s



Heat loss reduced from 67 kW to 37 kW about 11% of delivered energy an net as preliminary figures = 45% savings

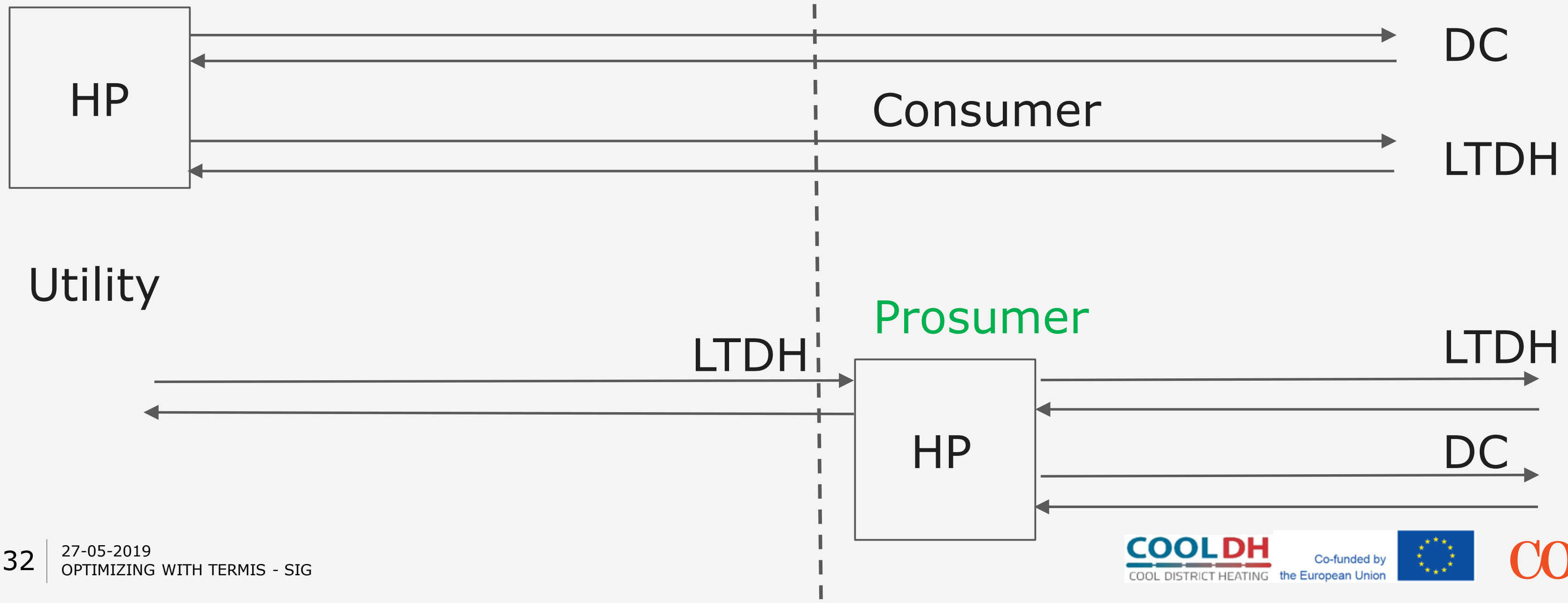
New district heating network – hydraulically optimised scenario



COOLDH
COOL DISTRICT HEATING
Co-funded by the European Union
COWI

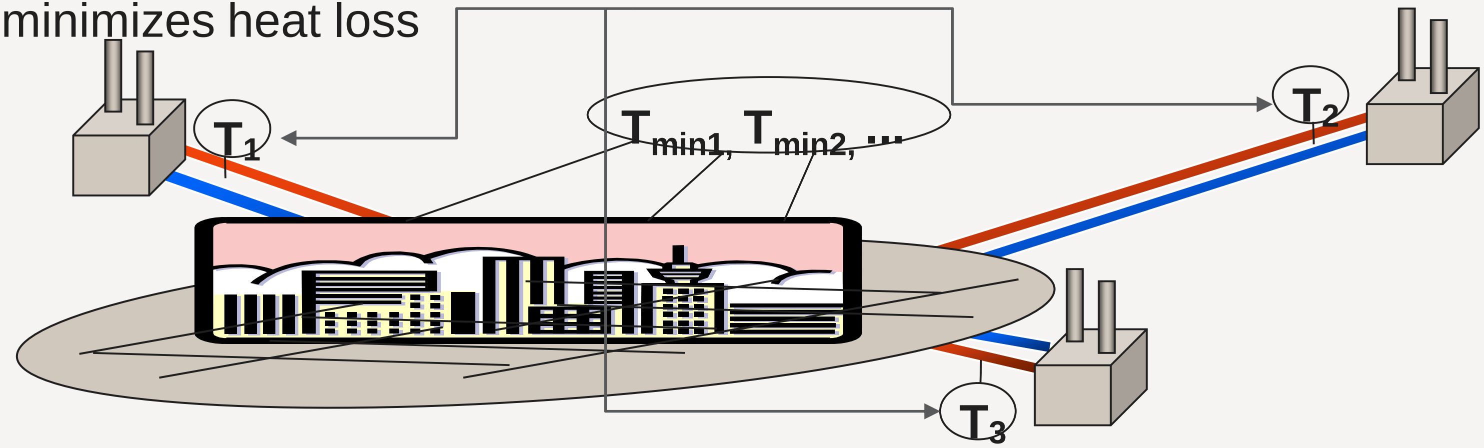
What is the best connecting for DC in Høje-Taastrup?

- District cooling and district heating **vs** only district heating at consumer



TERMIS
Flow Temperature Optimization - FTO

Ensures optimal set points for inlet temperatures => minimizes heat loss



Generally, immediate savings of 2-5%!

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union
COWI

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

Meeting 15 Nov 2018
WP 1 workshop

Reto M. Hummelshøj

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

Introduction

- **Objective of meeting**

- DAY 1: Knowledge sharing
  - Based on innovation work in WP2

Best Practice workshop 1 → Innovation → Presentation of results in workshop 2

- Day 2: Annual meeting - Status of work packages & next steps
  - COOL DH is now in M14

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

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?

COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union

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**

COOLDH COOL DISTRICT HEATING
Co-funded by the European Union

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

COOLDH COOL DISTRICT HEATING
Co-funded by the European Union

Program

Thursday, November 15th – Location: COWI A/S, Parallelvej 2, DK-2800 Kgs. Lyngby Meeting room: Auditorium		Time min.
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 discusssion	10
11.05	**Coffee break**	15
11:20	D2.11 Optimising cascade couplings for optimal use of low temperature sources, Martin Gierow, Kraftringen and Niklas Bagge Mogensen, COWI	20
11:40	Questions and discusssion	10
11.50	D2.5 LTDH Connected appliances, Sara Kralmark, Kraftringen	20
12.10	Questions and discusssion	20
12:30	**Lunch**	45
[illegible]	[illegible]	[illegible]

COOLDH
COOL DISTRICT HEATING

Co-funded by
the European Union

Cont’d

13:15	D2.4 Solution for multi family houses - Arnela Kursumovic, Kraftringen	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

COOLDH COOL DISTRICT HEATING
Co-funded by the European Union

Short presentation

- Name
- Organisation
- Role in project e.g. WP leader

- Remember to sign attendance list

COOLDH
COOL DISTRICT HEATING
Co-funded by the European Union

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

COOLDH
COOL DISTRICT HEATING
Co-funded by
the European Union

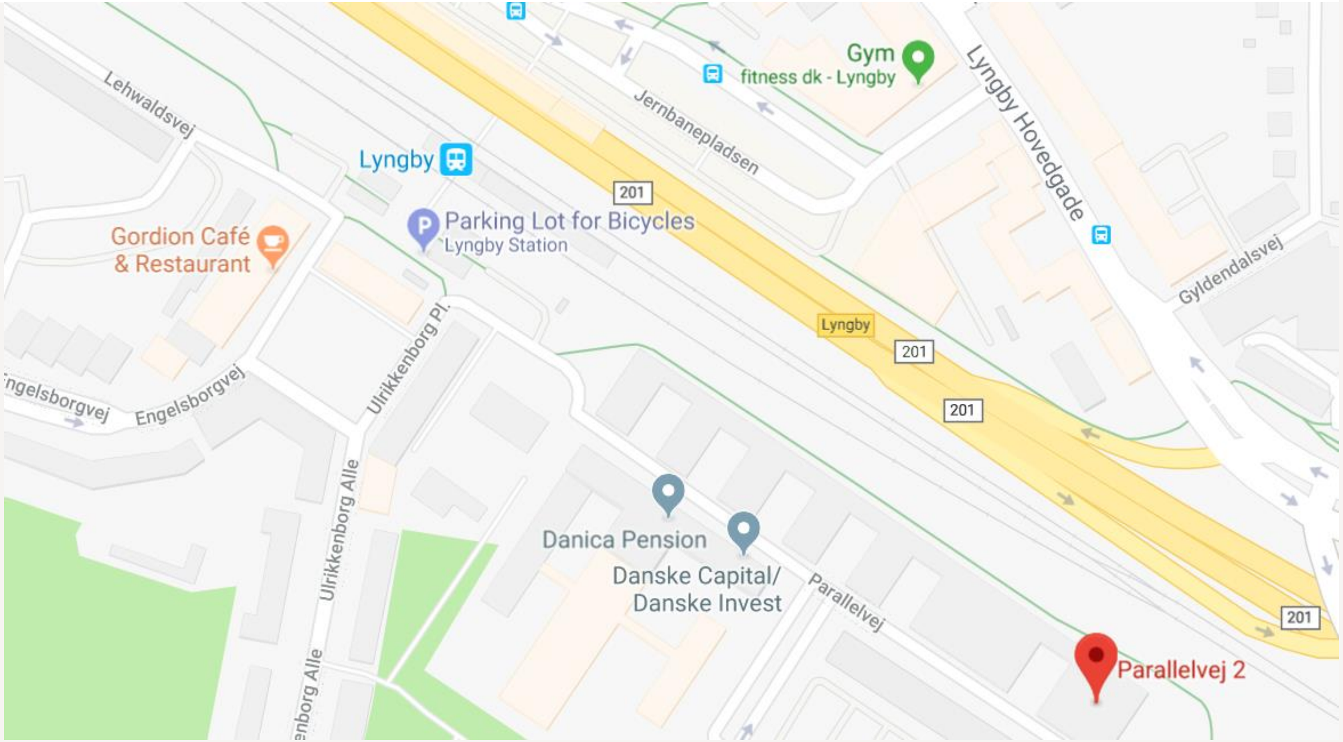
Bilateral discussions

- Pipe design
- Metering

- Meeting tomorrow in MEETING ROOM 181 at 8.15

COOLDH
COOL DISTRICT HEATING
Co-funded by
the European Union

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



According to the rules it will be individual bills

COOLDH
COOL DISTRICT HEATING
Co-funded by
the European Union

COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union

LOGSTOR development status
(confidential)

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

Author(s): Senior Product Manager Klaus G. Lauridsen, LOGSTOR
Emanuele Zilio, COWI DK

Task 2.2.2

Results

- What was the objective(s)?
  - New pipes for low temperature DH marked, flexible, improved insulation, weldable and with leak detection in dimensions up to D110 mm.
- What did we do?
  - Step 1: Marked survey for possible sourcing of pipes and evaluation of possible coupling types.
  - Step 2: DIY media pipe test in parallel with sourcing possibilities.
  - Step 3: Test together with coupling suppliers.
  - Step 4: Initiate the needed internal forced aging and pull out test to validate and where failed re-done and re-tested pipes and couplings.
  - Step 5: Initiate 3rd party tests and approvals proces - ongoing.
  - Step 6: Production trial with improved foam and 3rd party lambda tests and planned trial with alarm detection – ongoing.
  - Step 7: Pushing through CEN workgroup 12 to have new pipe material included in EN 15632, all test done and planned accordantly.

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Task 2.2.2

Results

- What are the results?
  - The 4 new coupling types passed internal pull out and forced aging test. Final type/concept defined end Nov-18.
  - DYI pipe system frozen.
  - DYI media pipe concept passed 3rd party Oxygen barrier test, ISO 17455. Thermal stability test running (8760 h), ISO 22391-2. Lambda test running. Planned test is water vapour test. 3rd party coupling test, when coupling concept are frozen.
- What can we and other learn from it?
  - Use marked standards as much as possible to insure the idea and innovations have any business potentials.
  - Remember the marked is very conservative, with good reason as lifetime is + 30 years.

COOLDH COOL DISTRICT HEATING
Co-funded by the European Union

Task 2.2.2

Perspective

- Exploitation and replication:
  - How are results exploited and to which markets?
    - Until now results are used to validate or adjust solutions = re-test.
  - Who are potential users?
    - District Heating companies
  - Suggestions for business models? As-Is
  - Planned dissemination activities?
    - Home page, leaflet, exhibitions, DH national events(like "Fjernvarme Landsmøde"). Pending as development is not finalized.

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Task 2.2.3

Results

- What was the objective(s)?
  - New multimedia pipes with zero heat loss.
- What did we do?
  - Step 1: Concept is on hand, but it is very difficult produce and install in real life.
  - Step 2: Working on simplify and make more realistic to produce and install.
- What are the results?
  - We have some alternatives shared with COWI for evaluation.
- What can we and other learn from it?
  - The more we add and specialize our pipe systems the more we need to customize design and solution for each installation.
- Exploitation and replication:
  - How are results exploited and to which markets? No activities yet.
  - Who are potential users? No activities yet.
  - Suggestions for business models? No activities yet.
  - Planned dissemination activities? Home page, leaflet, exhibitions, DH national events(like “Fjernvarme Landsmøde”). Pending as development is not finalized.

COOLDH COOL DISTRICT HEATING
Co-funded by the European Union

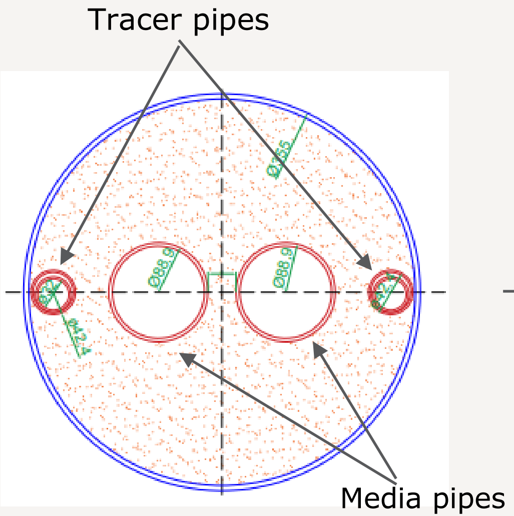
Methodology

Heat losses simulations for new multimedia pipes

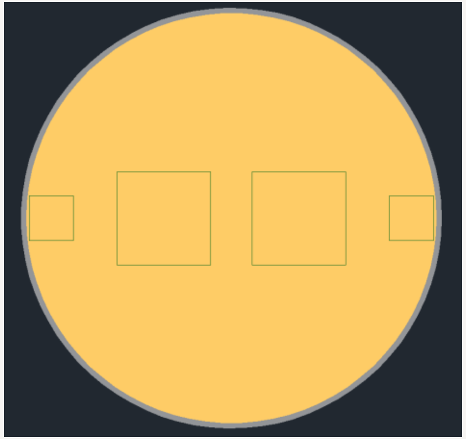
- Model implementation (simulation on HEAT 2)
- Analysis of the total heat losses

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

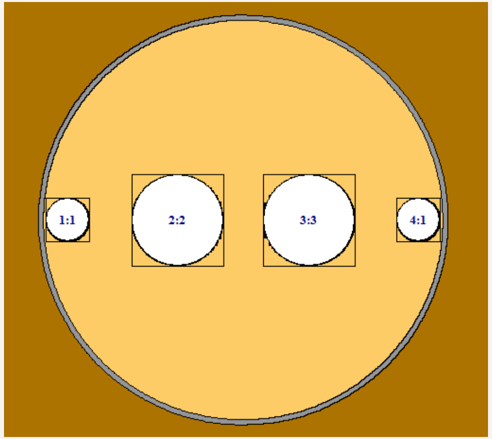
Model implementation



› Prototype



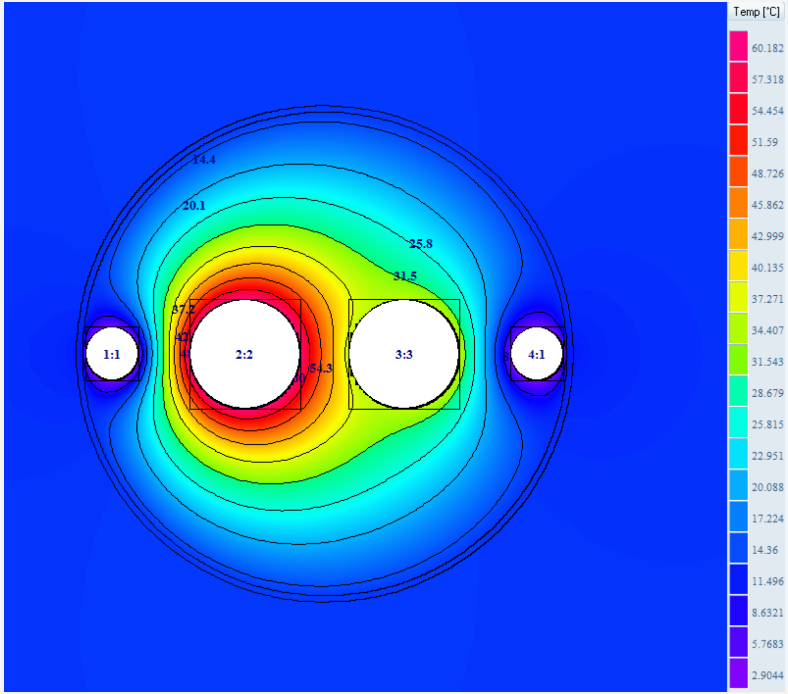
› AutoCAD

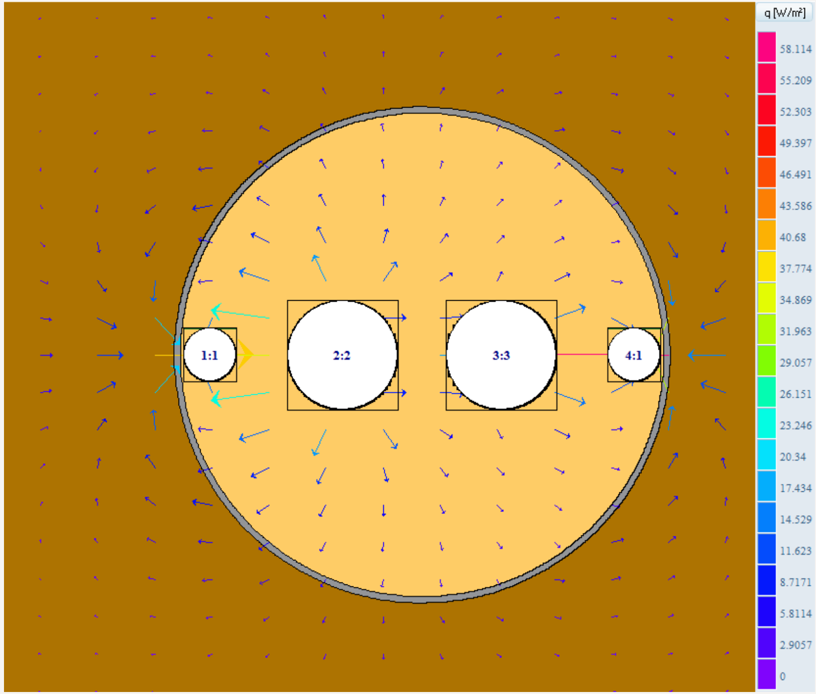


› Heat2

COOL DH
COOL DISTRICT HEATING
Co-funded by
the European Union

Heat 2 simulations





› Temperature distribution

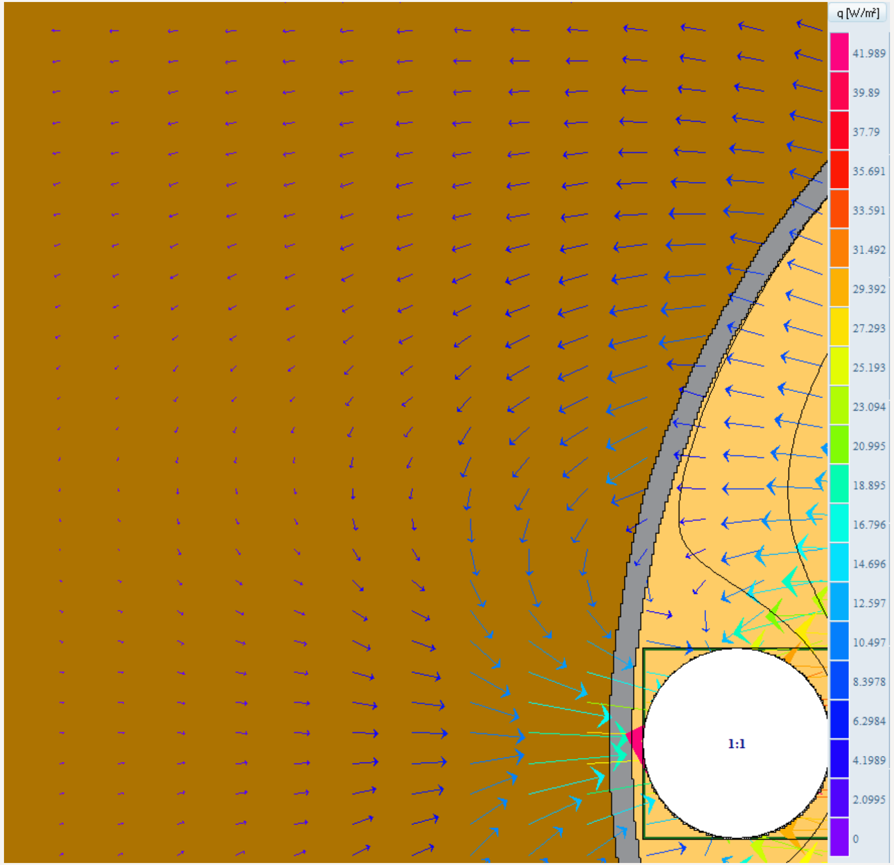
› Heat flow

COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union

LOGSTOR Development status

Heat 2 simulations

Heat flow around the tracer pipe:



COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union

Results

Heat losses from the pipes in different months:

January

Pipe	Lower [W/m]	Right [W/m]	Upper [W/m]	Left [W/m]	Tot [W/m]
	Outdoor temp [°C]: 0,1		**Soil temp [°C]:**	2,6	
1	-0,3113	-1,3279	-0,3025	0,0481	-1,8935
2	1,5610	1,2851	1,5735	2,4521	6,8717
3	0,6201	1,3104	0,6327	-0,8333	1,7298
4	-0,0922	0,4293	-0,0841	-0,6872	-0,4342
					6,2738

April

Pipe	Lower [W/m]	Right [W/m]	Upper [W/m]	Left [W/m]	Tot [W/m]
	Outdoor temp [°C]: 5,7		**Soil temp [°C]:**	4,8	
1	-0,4088	-1,3486	-0,4096	-0,4923	-2,6594
2	1,5027	1,2700	1,4971	2,4126	6,6823
3	0,5618	1,2708	0,5562	-0,8484	1,5404
4	-0,1897	-0,1113	-0,1913	-0,7079	-1,2002
					4,3631

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Results

Heat losses from the pipes in different months:

July

Pipe	Lower [W/m]	Right [W/m]	Upper [W/m]	Left [W/m]	Tot [W/m]
	Outdoor temp [°C]:	16,4	**Soil temp [°C]:**	13,8	
1	-0,7071	-1,4092	-0,7130	-2,0853	-4,9146
2	1,3125	1,2265	1,2979	2,2970	6,1339
3	0,3715	1,1553	0,3569	-0,8917	0,9920
4	-0,4880	-1,7042	-0,4947	-0,7685	-3,4554
					-1,2441

Average

Pipe	Lower [W/m]	Right [W/m]	Upper [W/m]	Left [W/m]	Tot [W/m]
	Outdoor temp [°C]:	8	**Soil temp [°C]:**	8	
1	-0,5025	-1,3672	-0,5009	-0,9826	-3,3531
2	1,4410	1,2568	1,4402	2,3772	6,5152
3	0,5001	1,2354	0,4993	-0,8615	1,3733
4	-0,2834	-0,6015	-0,2825	-0,7265	-1,8939
					2,6415

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Next steps

Heat losses simulations

- Replicate the process for other geometries
- Analyse and compare the heat losses

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Thank your for your attention!

COOL DH
COOL DISTRICT HEATING
Co-funded by
the European Union

COOL DH
COOL DISTRICT HEATING

Co-funded by
the European Union

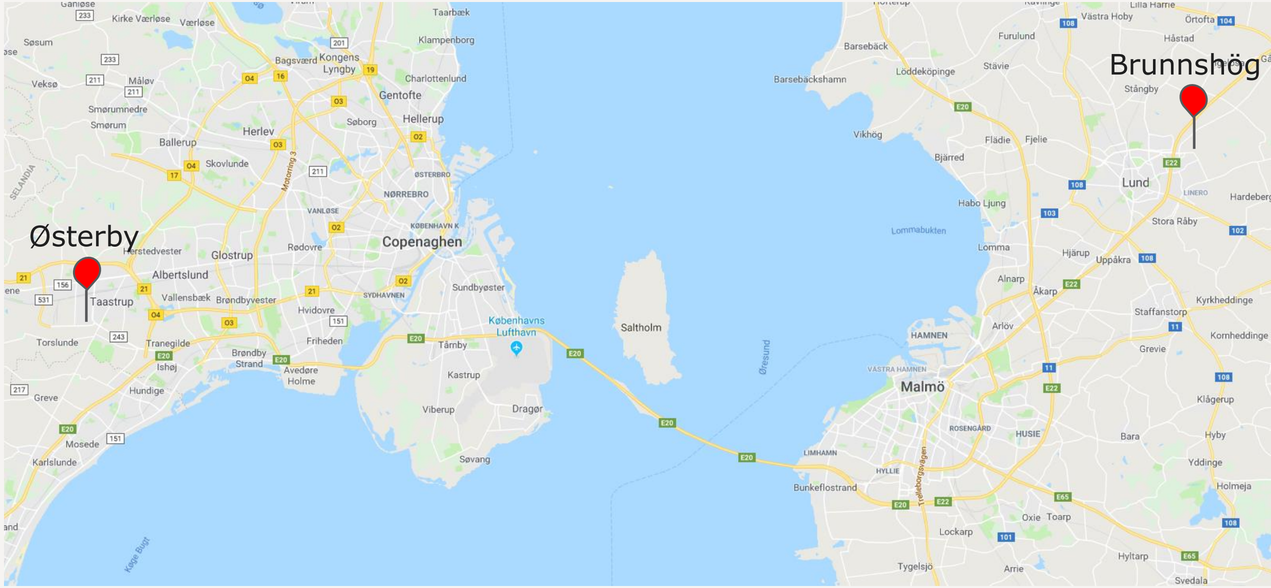
D2.7
New design concepts for optimisation of LTDH distribution systems

"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
- Network design optimisation factors
- Østerby network optimisation
- Brunnshög network optimisation
- Dos and Don’ts
- Perspective



Collaborators:
Kraftringen (Sweden),
COWI (Denmark).

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Aim of the deliverable

Background

The heat loss is around 17% in energy dense areas and around 35% where energy density is low. Energy for pumping is normally less than 2% of supplied heat. Higher cost for heat losses than pumping → Optimise the systems: reduce heat losses and increase pressure losses.

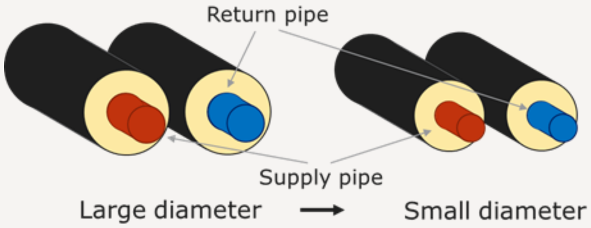
Pre-investigation → Network optimisation

- Thermal and hydraulic simulation:
  - Østerby (Høje Taastrup) – TERMIS
  - Brunnshög (Lund) – NETSIM
- Dos and don'ts

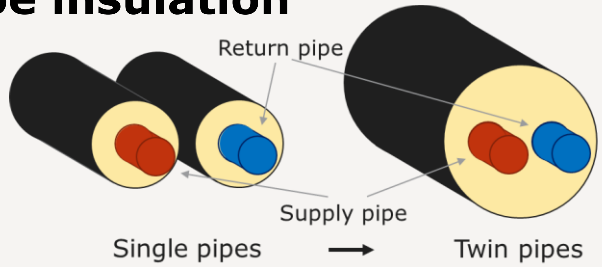
COOLDH COOL DISTRICT HEATING
Co-funded by the European Union

Network design optimisation factors

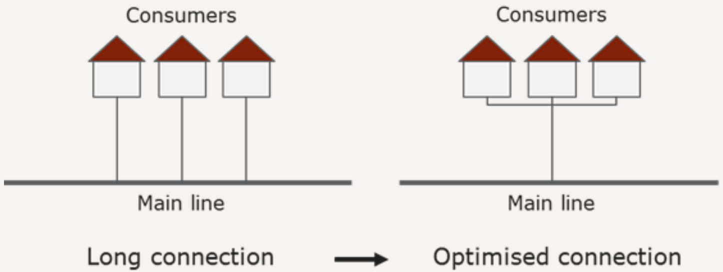
Pipe size



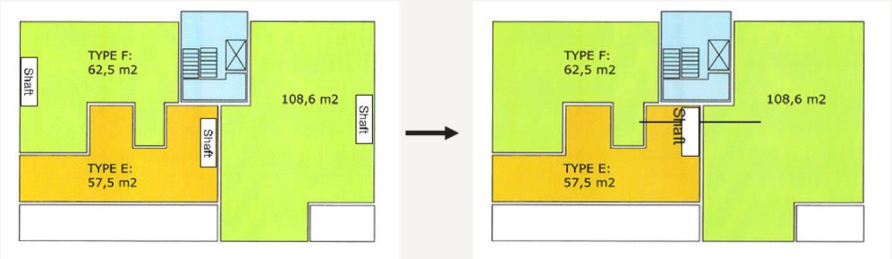
Pipe insulation



Pipe length



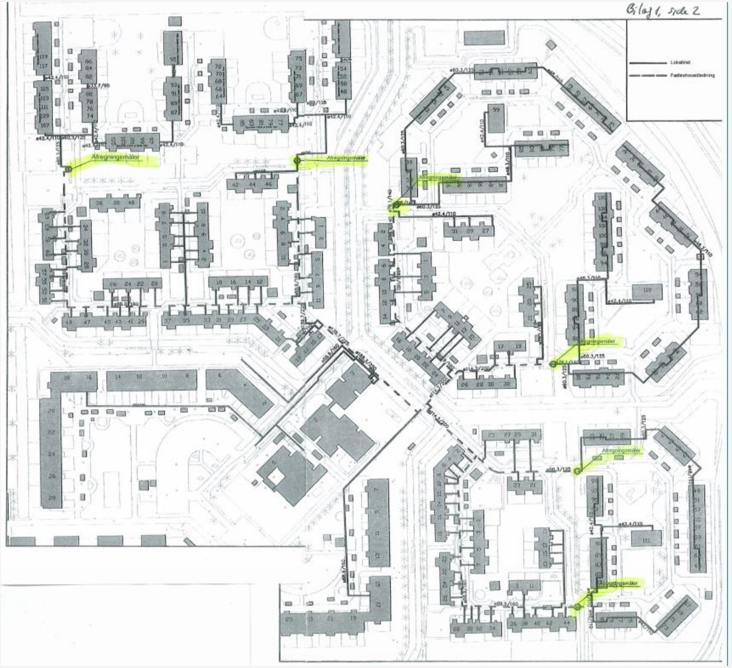
Distribution principle in the buildings



COOL DH
COOL DISTRICT HEATING
Co-funded by
the European Union

Østerby network optimisation – current situation

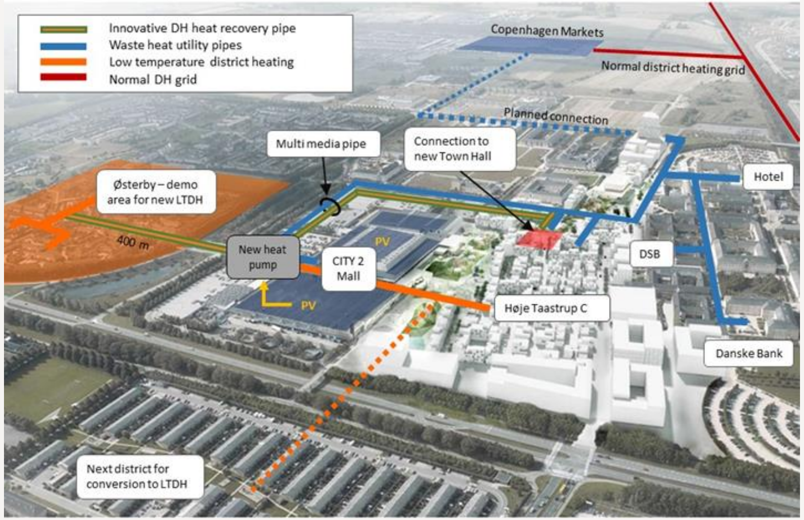
- Design temperature 85/50°C
- Max pipe size DN150, Series 1
- Very large heat losses, due to lower demand with new windows and oversized pipes
- 7°C drop in flow temperature over 200 m (observed 11th Dec 2017 noon) 65/48°C

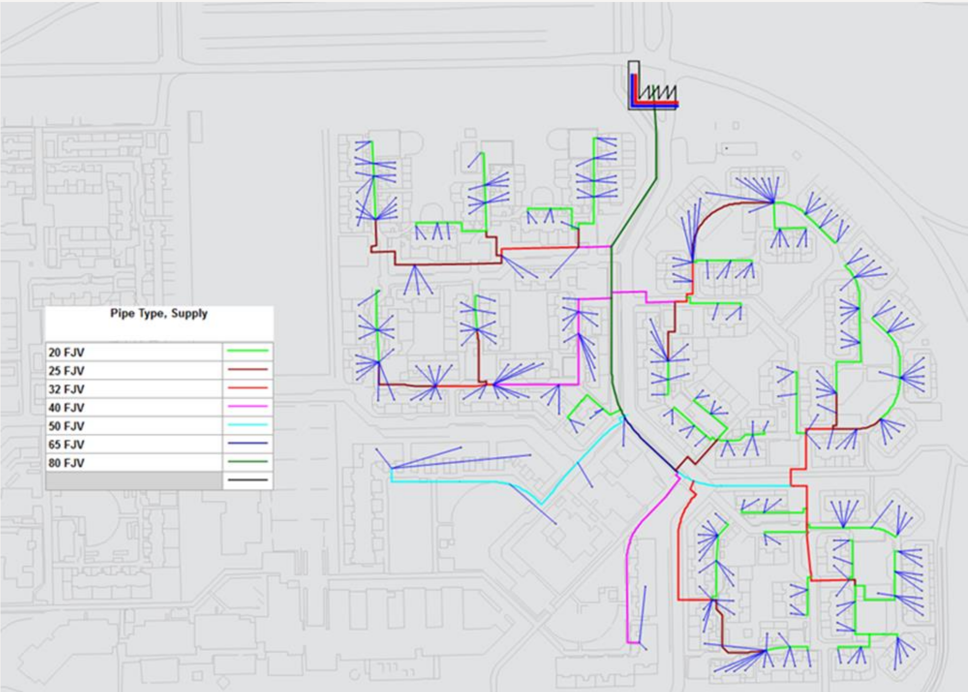


Østerby network optimisation

Østerby network (no service pipes):

› Initial optimisation: 413 users





COOL DH COOL DISTRICT HEATING Co-funded by the European Union

Østerby network optimisation

› Lower losses with better pipes – average 50% savings! (before reducing temperature)

Pipe type	Single pipes - Series 1 (*) (**)	Double pipe (Twin) - Series 3 (*)	Heat losses reduction
	[W/m]	[W/m]	%
DN20	13	7.1	***45%***
DN25	14.7	7.0	***52%***
DN32	15	7.8	***48%***
DN40	17.1	8.9	***48%***
DN50	18.9	8.6	***54%***
DN65	22.2	9.8	***56%***
DN80	22.8	10.3	***55%***
DN100	24.4	11.1	***55%***
DN125	28	10.7	***62%***
DN150	32.7	12.0	***63%***

** Based on new standard catalogue Isoplus pipes.*

*** The reference pipes in Østerby are more than 30 years old, and they certainly have greater heat losses.*

COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union

Østerby network optimisation

› Initial optimisation (main connections)

Pipe Type	Step 0 Reference scenario 65/48°C Single pipes - Series 1 (**)	Step 1 Pipe optimisation (*) Double pipe - Series 3 (**)	Step 2 Hydraulic optimisation (*) Double pipe - Series 3 (**)
DN20	0 m	0 m	***1294 m***
DN25	53 m	0 m	***511 m***
DN32	773 m	435 m	***370 m***
DN40	438 m	514 m	***312 m***
DN50	633 m	951 m	***248 m***
DN65	168 m	614 m	***48 m***
DN80	657 m	44 m	***211 m***
DN100	150 m	195 m	*0 m*
DN125	83 m	275 m	*0 m*
DN150	17 m	0 m	*0 m*
SUM	2971 m	2994 m	***2994 m***

** Additional to the previous optimisation step*
*** Based on new standard catalogue Isoplus steel pipes*

Can it be PE?

COOL DISTRICT HEATING
Co-funded by the European Union

Østerby network optimisation

Design criteria

› Not hydraulically optimised

Design criteria: Reference scenario and Step 1 - Pipe optimisation
Temperature set: 55°C supply / 30°C return
Pressure level expected = 10-13 bar (not reached)
Expected thermal power = approx. 1.2-1.4 MW_{th} *(*)*
The consumer's DH-unit is connected directly to the supply pipes
No requirement for maximum pipe dimension
Maximum design pressure gradient = **100 Pa/m**
Maximum design velocity = **1.2 m/s**
(*) with all the consumers connected (entire Østerby district)

› Hydraulically optimised

Design criteria: Step 2 - Hydraulic optimisation
Temperature set: 55°C supply / 30°C return
Pressure level expected = 10-13 bar
Expected thermal power = approx. 1.2-1.4 MW_{th} *(*)*
The consumer's installation is connected directly to the supply pipes
Pressure difference at the user installation ΔP = 0.5 bar
Maximum design pressure gradient = **500 Pa/m**
Maximum design velocity = **1.5 m/s** but it is allowed up to 2.3 m/s in DN80 pipes
(*) with all the consumers connected (entire Østerby district)

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Østerby network optimisation

- Initial optimisation: main connection (no service pipe)

Scenario	Supply temp. [°C]	Return temp. [°C]	Heat losses [kW]	Improvements
Reference network with reduced temperature	65	48	**67**	Lower temperature
Step 2	55	30	**37**	Lower temperature + new twin pipes

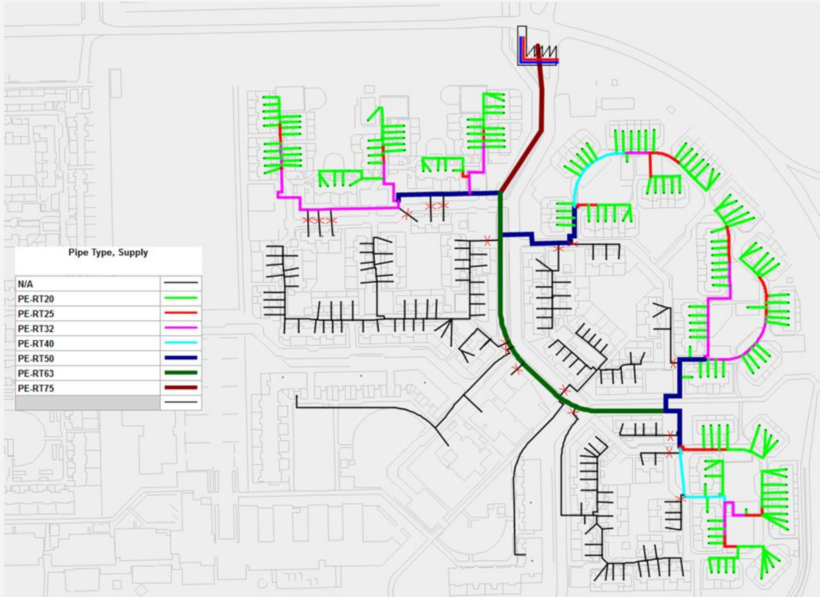
- 45% heat losses reduction

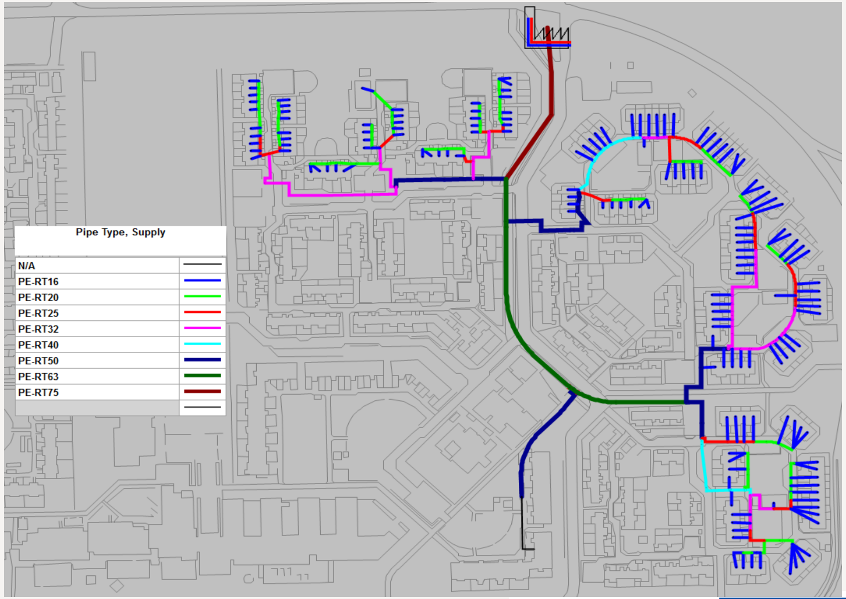
COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Østerby network optimisation

Length optimisation (including service pipes)

› 159 users





COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Østerby network optimisation

Length optimisation

Pipe Type	Step 3 Pipe optimisation (*) Plastic twin pipes - Series 3 (**)	Step 4 Length optimisation (*) Plastic twin pipes - Series 3 (**)	Step 5 Hydraulic optimisation (*) Plastic twin pipes - Series 3 (**)
PE-RT16	0.0 m	0.0 m	**1933.4 m**
PE-RT20	4651.4 m	2825.0 m	**891.6 m**
PE-RT25	425.4 m	481.8 m	**481.8 m**
PE-RT32	821.2 m	780.6 m	**780.6 m**
PE-RT40	239.2 m	244.2 m	**244.2 m**
PE-RT50	652.4 m	492.0 m	**492.0 m**
PE-RT63	445.0 m	445.0 m	**445.0 m**
PE-RT75	213.2 m	213.2 m	**213.2 m**
PE-RT90	0.0 m	0.0 m	0.0 m
PE-RT110	0.0 m	0.0 m	0.0 m
SUM	7447.8 m	5481.8 m	**5481.8 m**

** Additional to the previous optimisation step*
*** Based on plastic pipes catalogue from Logstor.*

- 2 km reduction of service pipes length
- PE-RT16: reduced waiting time for the users after idle load

COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union

Østerby network optimisation

Length optimisation

Scenario	Supply temp. [°C]	Return temp. [°C]	Heat losses [kW]	Improvements
Step 3	55	30	**17.2**	New plastic twin pipes
Step 4 (PE-RT 20)	55	30	**13.2**	Length optimisation
Step 5 (PE-RT 16)	55	30	**13.2**	Hydraulic optimisation

- 23% heat losses reduction with length optimisation
- Heat losses 10.8% of the delivered energy → Goal achieved
- Result of the total optimisation process → heat loss reduction from 67 kW to 13 kW

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

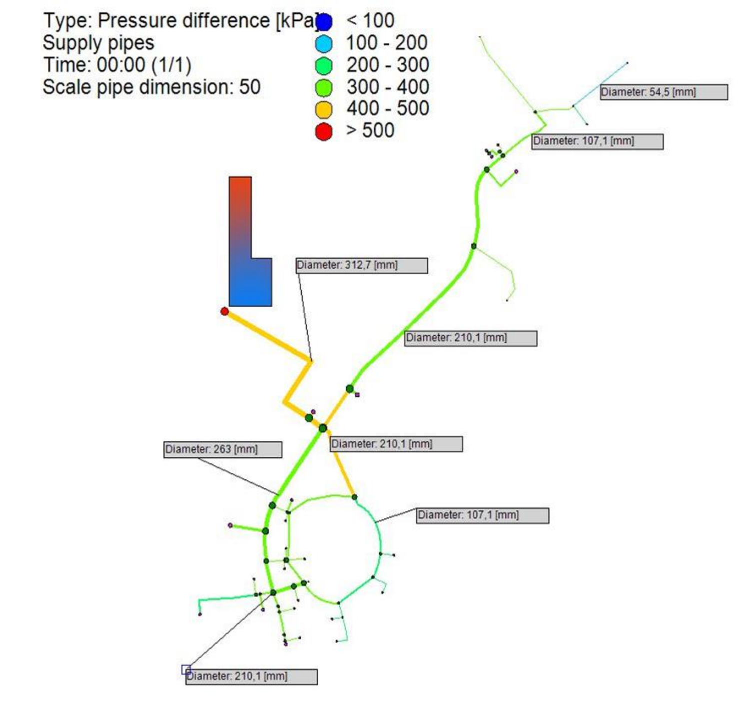
Brunnshög network optimisation

New area under development

- › Heat demand prediction
- › Oversized network

Scenario criteria - Brunnshög
Temperature set: 55°C supply (peak 65 °C) / 30°C return
Maximum pressure level expected = 6 bar (willing 10 bar)
Minimum pressure level expected = 1 bar
Pressure difference at the user's installation ΔP = 0.8 bar
Expected production/consumption = 14.6 MW
Estimated losses in the main pipe system= 0.090 MW

- › 3 % heat losses full load (main pipes)
- › 9 % heat losses first period



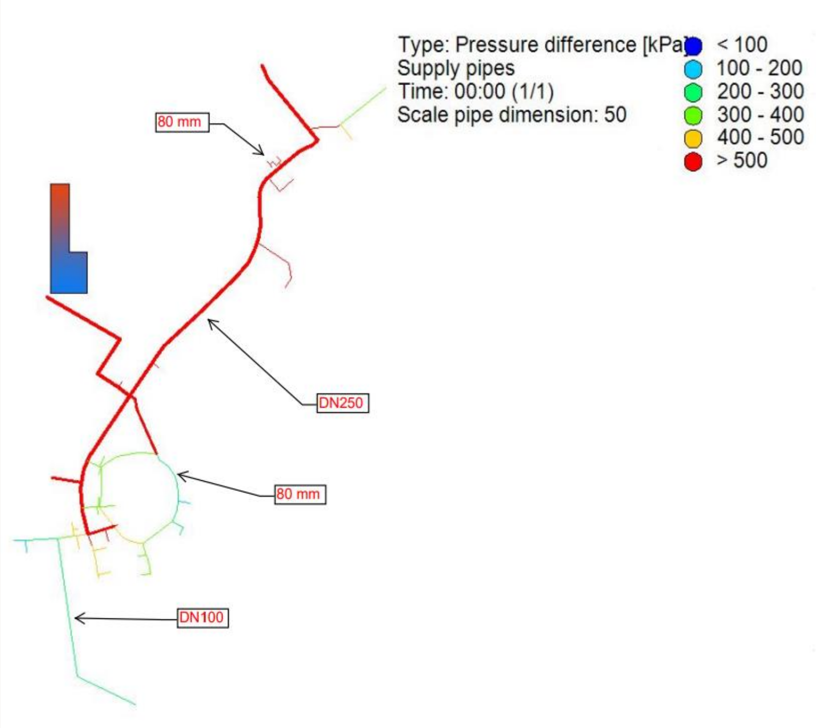
COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union

Brunnshög network optimisation

Same procedure:

- Hydraulically optimisation
- Use of plastic pipes
- Higher pressure with the new pipes

Optimised scenario criteria - Brunnshög
Temperature set: 55 °C supply (peak 65 °C) / 30 °C return
Maximum pressure level expected = 10 bar
Minimum pressure level expected = 1 bar
Pressure difference at the user's installation ΔP = 0.8 bar
Expected consumption = 17 MW



COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union

Dos and don’ts

Dos

- Length optimisation
- Reduced network temperature
- Pipe optimisation (twin pipes, higher insulation, smaller diameter)
- Careful evaluation of the heat demand
- Plastic pipes – lower maintenance
- DH-units – allow reduced temperature and individual metering
- Inform the consumers about low temperature possibilities

Same procedure on building level:

- Minimise the number of shafts in buildings

COOL DH COOL DISTRICT HEATING
Co-funded by the European Union

Dos and don’ts

Don’ts

- Long distribution pipes
- Oversized pipes
- Not considering the development plan of the area
- Low insulation level
- Dedicated shaft for each apartment

COOLDH COOL DISTRICT HEATING Co-funded by the European Union

Perspective

- Exploitation and replication:
  - DH companies interested in upgrading the grids
  - Consultants
  - Webinar possibilities

COOL DH COOL DISTRICT HEATING Co-funded by the European Union

Thank you for your attention!

COOL DH
COOL DISTRICT HEATING
Co-funded by the European Union