EUDP 11-I, J. no. 64011-0076

Heat Pumps for Domestic Hot Water Preparation in Connection with Low Temperature District Heating

Appendix 2: Traditional Network vs. LTDH Network with Heat Pumps

Author: Michael Mølgaard Markussen, Grontmij

Work Package 02

Grontmij A/S
Granskoven 8
2600 Glostrup
Denmark
T +45 4348 6060
www.grontmij.com

CVR No. 48233511

Technical Note

Traditional network vs. LTDH network with heat pumps

10 January 2012
Project:30.9026.01

Prepared : Michael Mølgaard Markussen

Checked : Johnny Iversen

Enclosure :

Copy to :

TABLE OF CONTENTS

1 INTRODUCTION

This technical note highlights the advantages/ disadvantages from a technical, economical and energy related perspective for low temperature district heating (LTDH) with integrated heat pump for preparation of domestic hot water (DHW) compared with traditional district heating.

The low temperature and traditional district heating systems will be compared in a system supplying new low energy houses following the Danish energy frame building regulation BR10 class 2015. The comparisons between the systems will be based on simulations of a new built area.

The new build area consists of 116 family houses. Two cases are considered. The first case is terrace houses with an area of 95 m^2 in average. The second case is detached houses with an area of 159 m^2. For simplifications detailed network simulations are made on the detached houses and consequences in case of terrace houses are discussed based upon the results and conclusions for the detached houses.

All of the new built houses have floor heating. The temperature needed for space heating is therefore only 30-35 ˚C. For domestic hot water the temperature requirement at the tap is 45 ˚C.

In traditional systems and future low temperature systems, without any temperature booster for DHW, the supply temperature should be at least 65 ˚C, when the DHW tank is placed on the secondary side. This is not a limitation for a low temperature system with integrated heat pump.

The technical solutions are therefore different depending on whether a traditional system or a low temperature system with a heat pump is used. By simulating different network solutions the most economical and technically best solution is found.

2 GENERAL CONSIDERATIONS AND ASSUMPTIONS

This section highlights the general assumptions and considerations that have been assumed for the simulations.

2.1 The network

Figure 1 shows the distribution network. The branch pipes that are connected from the distributions network and to the houses are not shown. The branch pipes are connected from the dots symbolising a loop to the consumers.

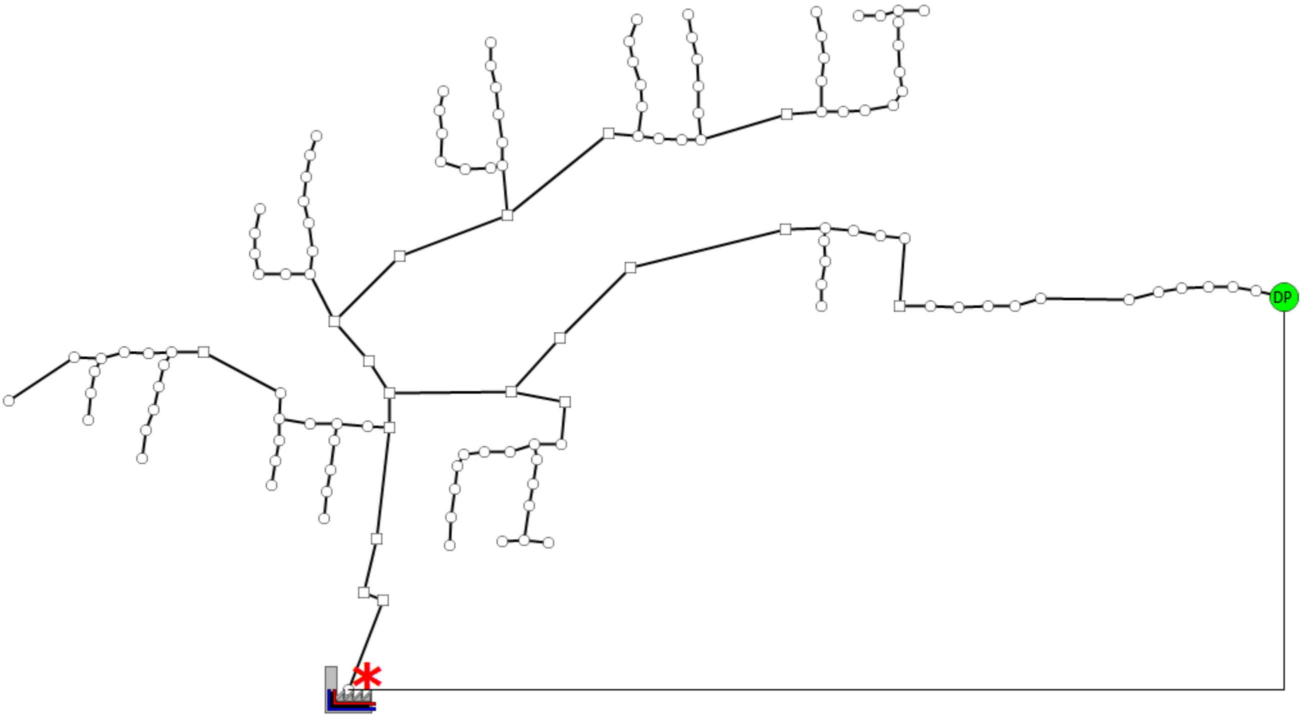


Figure 1: The considered distribution network

2.2 Pipe specifications and investment cost

The distribution network is simulated with Logstor's PEX Flex PN6 twin pipes in series 2. For pipe dimensions larger than DN 40, Logstor PEX Flex single pipes are used for the simulations.

The pipe specifications are shown in Table 1.

Logstor PN6		Pex service pipe			Outer casing		
DN	type	Ø out	Wall thick.	Ø in	series	Ø out	Wall thick
mm		mm	mm	mm		mm	mm
12	twin	16	2,2	11,6	series 2	110	2,5
16	twin	20	2	16	series 2	110	2,5
20	twin	25	2,5	20	series 2	125	2,5
25	twin	32	2,9	26,2	series 2	125	2,5
32	twin	40	3,7	32,6	series 2	140	3
40	twin	50	4,6	40,8	series 1	160	3
50	single	63	5,8	51,4	series 2	140	3
65	single	75	6,9	61,2	series 2	160	3
80	single	90	8,2	73,6	series 1	160	3
100	single	110	10	90	series 1	160	3

Table 1: Pipe specifications

The heat transfer coefficient has been generated from Logstor's calculation program.

$$h = \frac{q}{l \cdot \Delta T} = \left[\frac{W}{m \cdot K}\right]$$

For heat loss calculations both the single and the twin pipe system are handled as a single pipe system, with a pipe temperature that is the average of the supply and return temperature.

$$h = \frac{q}{l \cdot \left(\frac{(T_s + T_r)}{2} - T_{so}\right)} = \left[\frac{W}{m \cdot K}\right]$$

Where *q* is the heat flow, *h* the heat transfer coefficient, *l* is the length of the pipe system, T_s is the supply temperature, T_r is the return temperature and T_{so} is the soil temperature.

The soil temperature is 10 °C in the calculations.

In Table 2 the investment costs for different pipe dimensions are shown. The investment cost includes pipes and components, pipe work, earthworks, project design and supervision and incidental expenses. The table is based on experience from Grontmij and pipe costs from Logstor.

Logstor PN6		Investment Cost	Heat transfer coefficient
DN	type		
mm		kr./m	W/m/K
12	twin	950	0,108
16	twin	970	0,127
20	twin	1.210	0,134
25	twin	1.330	0,171
32	twin	1.550	0,193
40	twin	1.940	0,218
50	single	1.990	0,263
65	single	2.300	0,277
80	single	2.570	0,361
100	single	2.970	0,542

Table 2: Investment cost and heat transfer coefficient for simulated pipes.

2.3 District heating for two types of houses

Two types of houses with different heat and capacity demand are considered in the new build area. A district heating network supplying a 95 m^2 terrace house, and a network supplying a 159 m^2 detached house.

The network and the routing of the pipes are assumed identical for the simulations for the two types of houses.

Because a terrace house and a detached house will have different plot sizes, the branch pipes can't be assumed to have the same length. The branch pipes are estimated to be 10 m in average for the terrace houses and 15 m for the detached houses.

Each house has a branch pipe for itself.

2.4 Heat demand and peak capacity demand

Table 3 shows the heat demand and peak capacity demand for the two types of houses. The heat demand is calculated with regard to the Danish energy frame building regulation BR10 for low energy class houses 2015.

Three different heat demands are calculated for the two houses.

The heat demand in the *Class 2015 frame* are calculated from energy frame (30 + 1000/A) kWh/m^2. The heat demand for *Class 2015 calculated* is according to the assumptions used for energy frame calculations with an indoor temperature of 20℃ and DHW that are dependent on house area. The realistic heat demand is based on more realistic DWH consumption with 800 kWh per persons a year and with indoor temperature of 22-24℃. The number of family members is 3 and 4 for the terrace and detached family houses respectively.

These calculations are more detailed described in a separate note on heat demand.

		Heat demand per year			Capacity
Houses	Energy	space heating	DHW	Heat demand	peak demand
types	Frame	kWh	kWh	kWh	kW
95 m2	Class 2015 frame	---	---	3850	---
	Class 2015 calculated	2600	1241	3841	---
	Realistic consumption	3700	2400	6100	3,4
159 m2	Class 2015 frame	---	---	5770	---
	Class 2015 calculated	2524	2077	4601	---
	Realistic consumption	4040	3200	7240	3,4

Table 3: Heat and peak capacity demand for the simulated houses

Table 3 shows that there is a large difference in whether the heat demand is calculated from BR10 or with more realistic assumptions. For the 95 m^2 terrace house the heat demand is 6 MWh a year and the peak capacity demand is 3,4 kW. For the 159 m^2 detached house the heat demand is 7.2 MWh a year and 3,4 kW in peak capacity demand.

It is, however, only for a very short time in the year that the capacity is peaking. Figure 2 shows the heat capacity demand for the 159 m^2 house as a function of hours in the year.

To simplify the DHW capacity demand it is assumed that the demand is constant during the day and year. In reality the capacity demand for DHW is varying through the day dependent on the size of the DHW tank that's chosen.

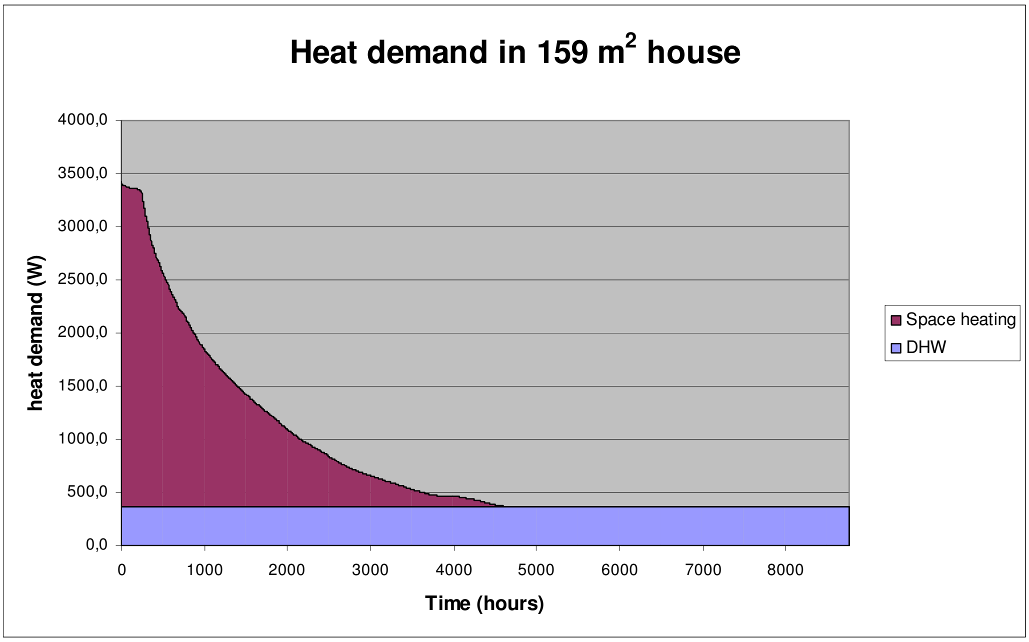


Figure 2: Heat load demand for the 159 m2 detached house.

Because the capacity requirement is varying through the year, it is necessary to simulate the network for different periods. The heat capacity demand is divided into 6 periods where the demand is similar. This is illustrated in the table below.

	time interval		time period	Average
periods	hours	hours	hours	capacity [W]
1	0	233	233	3371
2	234	530	296	2859
3	531	1400	869	1926
4	1401	2790	1389	1063
5	2991	4650	1659	511
6	4651	8760	4109	365

Table 4: Different periods with similar heat demand for the detached house.

2.5 Pressure in the network

The network is dimensioned so that the critical consumer has at least 0.5 bar of pressure difference.

The network is designed so that there is 6 bar of pressure in the supply pipe and 1 bar of pressure in the return pipe during peak capacity. In Figure 3 this is shown for the 80 / 25 ˚C network.

In order to optimise the network it is an advantage to raise the supply temperature during peak load. This way the pipe dimensions will be as small as possible and this results in higher flow velocity in the off-peak periods.

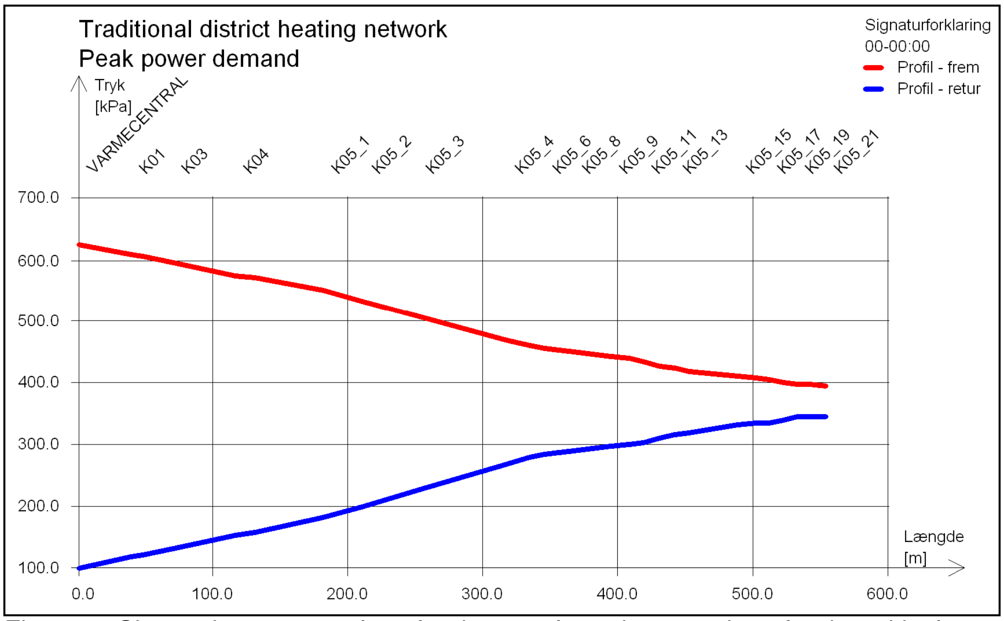


Figure 3: Shows the pressure loss for the supply and return pipes for the critical path.

2.6 Temperature loss in the network

The temperature loss in the pipe network is an important issue. During peak load periods the temperature drop in the supply pipe is a couple of degrees. But in the summer period where the demand is less than 10 % of the peak demand there can be temperature drops of more than 20 ˚C in the supply pipes.

One of the designing parameters of the system is that the supply temperature should be at least 65 - 60 ˚C for traditional district heating systems with DHW tank on the secondary side. For DHW tank on primary side the supply temperature can be lowered to 55 - 50 ˚C. The network should therefore be designed so that the critical consumer is supplied with those temperatures.

For a LTDH system with a heat pump for preparation of DHW it is important to be aware of this temperature drop as well. A low supply temperature influences the efficiency and the size of the heat pump.

Figure 4 shows the temperature drop for a traditional 80 ˚C network in the summer off-peak period. The temperature drop in the network can be more than 20 ˚C for the critical consumer.

If it is not possible to supply 65 - 60˚C to the critical consumer with secondary DHW tank, circulations can be installed in the network. This will influence the temperature in the return pipes and thereby produce a higher flow in the network.

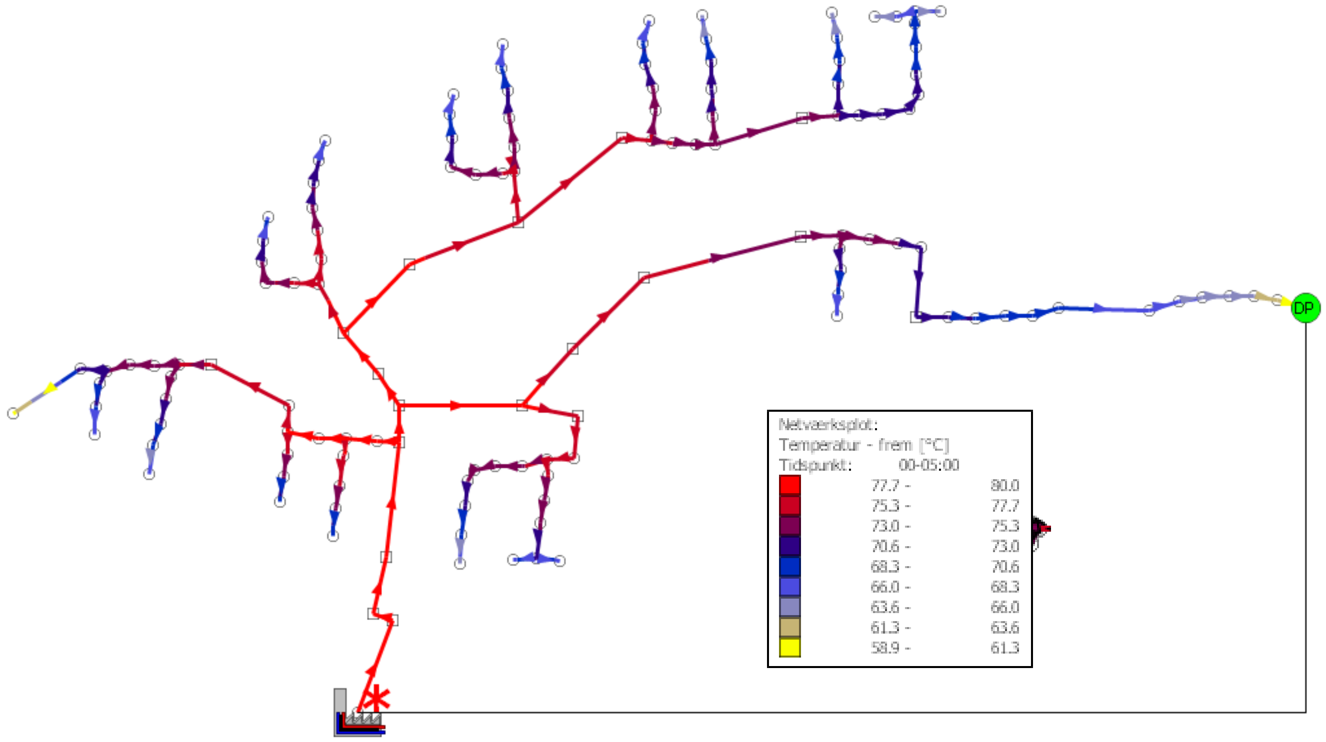


Figure 4: The temperature level in the supply pipes during an off-peak period

2.7 Temperature level at consumer

One of the primary parameters in designing the network is the supply temperature at the consumers. The supply temperature is dependent on the required temperature level of the stored hot water.

There are two types of hot water stored – when district heating water is stored (primary side) and when domestic hot water is stored (secondary side).

2.7.1 Traditional system with DHW tank on secondary side

To prevent legionella the temperature of domestic hot water stored should be 55-60 °C. For systems with DHW tank on the secondary side there is required **65 ˚C** in the network at the critical consumer.

2.7.2 Traditional system with DHW tank on primary side

There are not problems with legionella when hot water is stored on the primary side. To provide domestic hot water at 45 ˚C the temperature in the storage tank of 50-55 ˚C is needed. The storage tank on the primary side is about 40 % larger than secondary side storage tanks. The temperature level for the network at the critical consumer is **55 ˚C** for these systems.

2.7.3 LTDH system with HP and DHW tank on primary side

The district heating unit for a LTDH system with integrated heat pump and DHW tank on the primary side is dependent on the supply temperature. If the supply temperature is varying a lot during the year then the capacity of the heat pump will vary over the year. This will make the technical solution of the heat pump more complicated. Moreover a lowering in the supply temperature will not only increase the electricity demand because of a lower COP value but will also influence the capacity because the heat pump has to raise the temperature from a lower temperature level.

The supply temperature at the critical consumer for LTDH systems with integrated heat pump on the secondary side is set to **40 ˚C**.

2.7.4 LTDH system with HP and DHW tank on secondary side

A LTDH system with integrated heat pump on the secondary side is not as dependent on the supply temperature as the previous one with heat pump on primary side. The COP value is lowered with a lower supply temperature, but the capacity of the heat pump is not influenced in the same way.

The heat loss in the network for different supply temperatures at the critical consumer are varying. Supply temperatures between 20 and 30 ˚C in off peak periods are investigated.

3 INVESTMENT COST

The investment cost for a network is dependent on the temperature difference between supply and return in the peak period.

Therefore the investment cost for district heating networks with different temperature levels in the peak period is studied.

The investment cost is calculated for a network supplying the 159 m^2 detached houses.

3.1 Supply temperature 80 ˚C

In a traditional district heating system with a supply temperature of 80 ˚C and a return temperature of 25 ˚C, the pipe dimensions are as shown in Table 5.

Pipe dimensions		Investment cost	
DN	m	kr./m	kr.
DN 12	2.380	950	2.261.038
DN 16	319	970	309.634
DN 20	471	1.210	569.898
DN 25	163	1.330	217.003
DN 32	123	1.550	190.712
DN 40	131	1.940	255.091
Sum	3.588		**3.803.375**

Table 5: Pipe dimensions and investment cost

The investment cost for the considered district heating network is DKK 3.8 million.

3.2 Supply temperature 65 ˚C

Instead of a supply temperature of 80 ˚C, the network can be lowered to 65 ˚C with a return temperature of 25 ˚C. The pipe dimensions are greater than in the 80/25 ˚C network, as it is shown in Table 6.

Pipe dimensions		Investment cost	
DN	m	kr./m	kr.
DN 12	2253,08	950	2.140.426
DN 16	405,21	970	393.054
DN 20	334,89	1.210	405.217
DN 25	290,34	1.330	386.152
DN 32	172,92	1.550	268.026
DN 40	14,42	1.940	27.975
DN 50	117,07	1.990	232.969
Sum	3587,93		**3.853.819**

Table 6: Pipe dimensions and investment cost

The investment cost for this type of network will be about DKK 3.85 million. This is very similar to the 80 ˚C system.

3.3 Supply temperature 45 ˚C

If the supply temperature is lower to 45 ˚C with a return temperature of 25 ˚C the pipe dimensions are further increased as shown in Table 7. There are in this case needed DN 65 pipes to supply this area.

Pipe dimensions		Investment cost	
DN	m	kr./m	kr.
DN 12	1952,05	950	1.854.448
DN 16	427,99	970	415.150
DN 20	239,22	1.210	289.456
DN 25	322,47	1.330	428.885
DN 32	276,2	1.550	428.110
DN 40	201,25	1.940	390.425
DN 50	51,68	1.990	102.843
DN 65	117,07	2.300	269.261
Sum	3587,93		**4.178.578**

Table 7: Pipe dimensions and investment cost

The investment cost is calculated to DKK 4.2 million, and significant higher investment cost than for the higher supply temperatures.

3.4 Supply temperature 40 ˚C

Table 8 shows a network with a supply temperature of 40 ˚C and a return of 25 ˚C.

Pipe dimensions		Investment cost	
DN	m	kr,/m	kr,
DN 12	1952	950	1.854.448
DN 16	291	970	282.173
DN 20	246	1.210	297.817
DN 25	221	1.330	294.568
DN 32	460	1.550	712.504
DN 40	163	1.940	316.530
DN 50	123	1.990	244.850
DN 65	14	2.300	33.166
DN 80	117	2.570	300.870
Sum	3588		**4.336.926**

Table 8: Pipe dimensions and investment cost

The investment cost is DKK 4.3 million.

3.5 Supply temperature 35 ˚C

Table 9 shows a network with a supply temperature of 35 ˚C and a return of 25 ˚C.

Pipe dimensions		Investment cost	
DN	m	kr,/m	kr,
DN 12	1952	950	1.854.448
DN 16	149	970	144.598
DN 20	279	1.210	337.493
DN 25	289	1.330	384.583
DN 32	324	1.550	502.169
DN 40	290	1.940	563.260
DN 50	136	1.990	269.963
DN 65	37	2.300	85.698
DN 80	14	2.570	37.059
DN 100	117	2.970	347.698
Sum	3588		**4.526.969**

Table 9: Pipe dimensions and investment cost

The investment cost is DKK 4.5 million.

3.6 Conclusions

Figure 5 shows the investment cost as a function of the temperature difference. The figure shows that there is little difference in the investment cost until the temperature difference is less than 20 ˚C. The difference is about 1 % between networks with supply temperature of 80 C and 65 ˚C.

For a temperature difference of 10 ˚C there is almost 20 % difference in the investment cost.

From an investment point of view, it is therefore recommended, that the network is optimised for a temperature difference between supply and return that is not lower than 40 ˚C during peak load.

The networks are simulated with the 159 m^2 detached houses. If the simulations had been made for 95 m^2 terrace houses the investment cost would have been less because of shorter branch pipes. But the conclusions would have been the same because the peak power demand is the same.

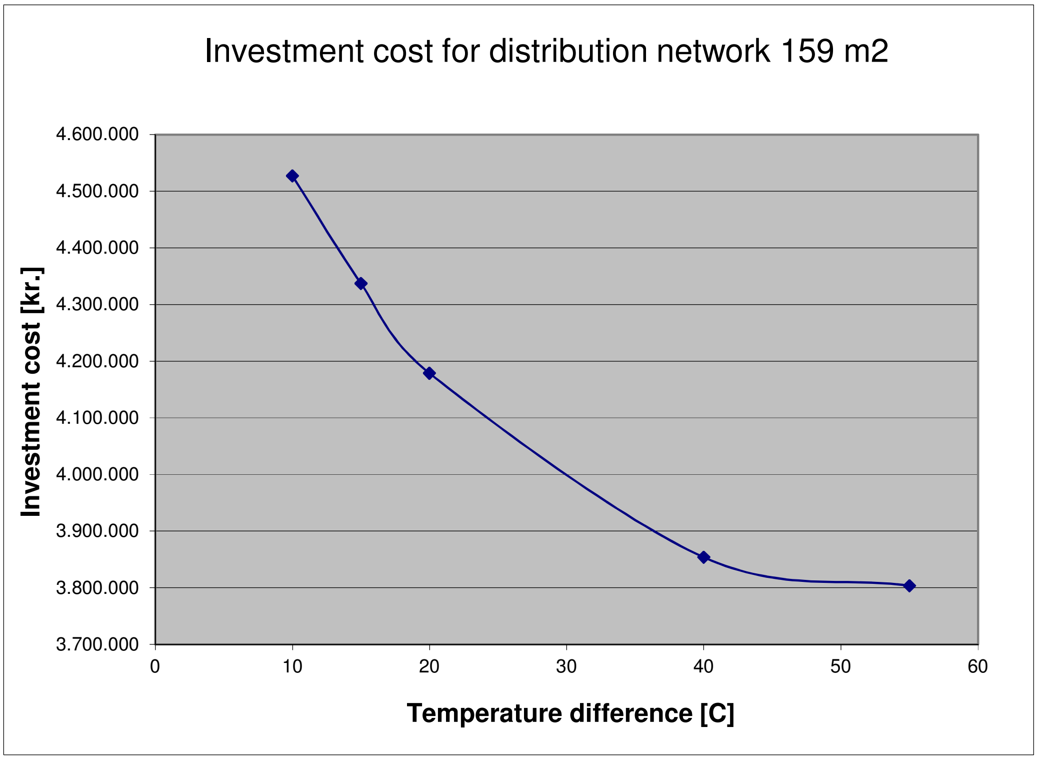


Figure 5: Shows the investment cost as a function of the temperature difference between supply and return.

4 HEAT LOSS

The heat loss is dependent on the dimensions of the pipes and temperature levels in the network.

It is therefore necessary to design a network based on a simulation in the peak load and then calculate how this network will be influence over the year. There are different supply and return temperatures in the network dependent on the overall system. In this section simulations are made with temperature levels for traditional district heating with DHW on primary/secondary side and simulations for district heating with an integrated heat pump on primary and secondary side.

All calculations are based on heat and peak demand for the 159 m^2 detached houses.

With floor heating in every house it is assumed that the return temperature for space heating is 25 ˚C. This is a realistic value for new low temperature houses with focus on low return temperature. This is not the same for older floor heating systems.

4.1 Traditional DH system with DHW tank on secondary side

It is assumed that the secondary side DHW tank produces a return temperature of 30 ˚C in average. In the peak period the overall return temperature from each house is 25 ˚C because 9/10 of the district heating is used for space heating. In the summer period the return temperature is 30 ˚C because there is no use of space heating.

In the summer period there is a small need for circulations to prevent that the supply temperature drops below 65 ˚C. The overall return temperature in the network is 35 ˚C in the summer period.

Period	time	supply temperature		Return	Heat loss in distribution network			Electricity con-sumption pump	
		Station	Crit, con,	temp,					
	hours	[C]	[C]	[C]	[kW]	[MWh]	%	[kW]	[MWh]
1	233	80	76	25	18,3	4,3	4%	1,11	0,26
2	297	80	76	26	18,4	5,5	5%	0,77	0,23
3	870	80	74	27	18,5	16,1	8%	0,31	0,27
4	1390	80	70	28	18,3	25,4	13%	0,10	0,14
5	1860	80	65	30	18,2	33,8	23%	0,03	0,06
6	4110	80	65	35	19,3	79,3	31%	0,02	0,10
Sum	8760					164,4	16%		1,05

Table 10: Temperature levels and heat loss for periods with different heat demand.

The yearly heat loss in the network is 164 MWh and this corresponds to a heat loss of 16 %. There is a low electricity demand for pumping. This is less than 1 % of the heat loss.

4.2 Traditional DH system with DHW tank on primary side

Instead of a supply temperature of 80 ˚C, the network can be lowered to 60-65 ˚C when the DHW is placed on the primary side.

This network cannot operate with a 60 ˚C supply temperature in the winter period because the supply temperature should be 55 ˚C at the critical consumer. In the summer period the supply temperature is raised to 67 ˚C and the return temperature is 35 ˚C. In this system there is some need for circulation.

Period	time	Supply temperature		Return	Heat loss in distribution network			Electricity con-sumption pump	
		Station	Crit. con.	temp.					
	hours	[C]	[C]	[C]	[kW]	[MWh]	%	[kW]	[MWh]
1	233	60	58	25	14,6	3,4	4%	1,72	0,40
2	297	60	57,5	26	14,7	4,4	4%	1,33	0,40
3	870	60	56,5	27	14,9	13,0	6%	0,39	0,34
4	1390	62	56	28	15,3	21,3	11%	0,12	0,17
5	1860	65	55	30	16,0	29,7	21%	0,05	0,10
6	4110	67	55	35	17,3	71,3	29%	0,04	0,18
Sum	8760					143,0	15%		1,58

The yearly heat loss is 143 MWh and this is 13 % less than for the 80 ˚C system. There is a low electricity demand for pumping and it corresponds to approx. 1 % of the heat loss.

4.3 LTDH system with heat pump on primary side

Two network designs are considered.

First network that is considered is a network with 45 ˚C supply temperature in peak period. This results in greater pipe dimensions and thereby a higher investment cost. This network has lower temperature in peak period and lower resistance in the network in off peak period.

Second network that is consideration is a network with 65 ˚C supply temperature in peak period. This network has smaller pipe dimensions and lower investment cost.

4.3.1 45 ˚C supply temperature in peak period

In a LTDH system with the heat pump placed on primary side, the temperature at the critical consumer is set to 40 °C.

The network is simulated with 45 °C supply temperature in the peak demand.

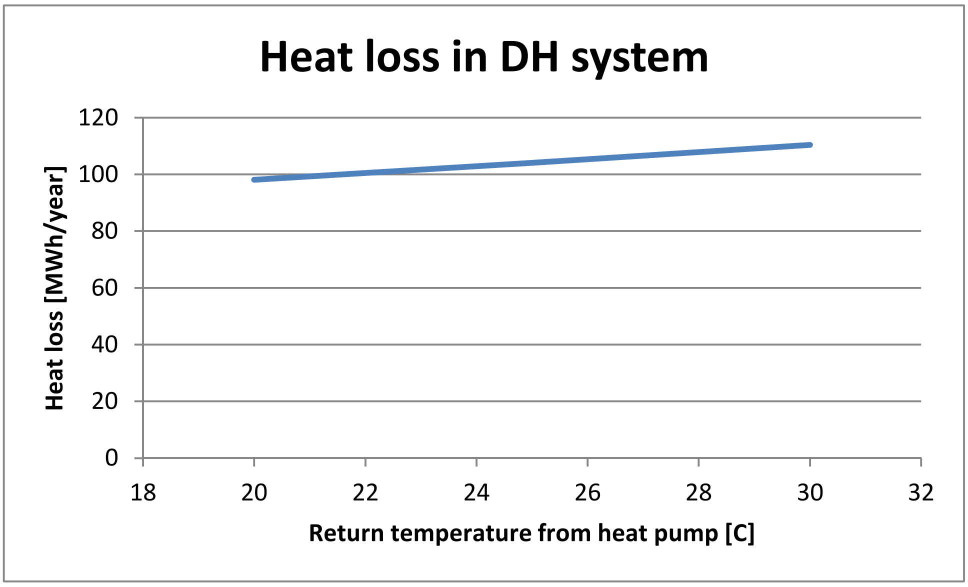
Table 11 shows the heat loss and electricity consumptions with a return temperature of 25 °C from the heat pump.

Period	time	supply temperature		Return	Heat loss in			Electricity con-	
		Station	Crit. con.	temp.	distribution network			sumption pump	
	hours	[C]	[C]	[C]	[kW]	[MWh]	%	[kW]	[MWh]
1	233	45	44	25	12,3	2,9	3%	3,00	0,70
2	297	42	41	25	11,9	3,5	3%	3,01	0,89
3	870	42	40,5	25	11,5	10,0	5%	1,11	0,97
4	1390	42	40	25	11,4	15,8	8%	0,31	0,43
5	1860	45	40	25	11,8	21,9	17%	0,11	0,20
6	4110	48	40	25	12,1	49,9	22%	0,04	0,17
Sum	8760					104,0	11%		3,36

Table 11: Temperature levels and heat loss for periods with different heat demand.

This network has a yearly heat loss of 104 MWh. This is 36 % less than for the traditional system. The electricity demand is approx. 3 % of the heat loss.

The heat loss in the network will be influenced if the return temperature from the heat pump is either raised or lowered. The figure below shows this effect.



4.3.2 65 ˚C supply temperature in peak period

In a LTDH system with the heat pump placed on primary side, the temperature at the critical consumer is set to 40 °C.

The network is simulated with 65 °C supply temperature in the peak demand.

Table 12 shows the heat loss and electricity consumptions with a return temperature of 25 °C from the heat pump.

Period	time	supply temperature		Return	Heat loss in		mass	Electricity con-	
		Station	Crit. con.	temp.	distribution		flow	sumption pump	
	hours	[C]	[C]	[C]	[kW]	[MWh]	kg/s	[kW]	[MWh]
1	233	65	62,5	25	15,7	3,7	2,42	1,51	0,35
2	297	58	56,5	25	14,9	4,4	2,50	1,56	0,46
3	870	48	47	25	12,0	10,4	2,44	1,49	1,30
4	1390	42	40,5	25	10,6	14,7	1,88	0,75	1,04
5	1860	44	40	25	10,7	20,0	0,88	0,13	0,24
6	4110	46	40	25	11,0	45,0	0,60	0,06	0,25
Sum	8760					98,2			3,65

Table 12: Temperature levels and heat loss for periods with different heat demand.

This network has a yearly heat loss of 98 MWh. This is actually lower than the 45 ˚C network simulated above. The lower heat loss is a consequence of smaller pipe dimensions.

4.4 LTDH system with heat pump on secondary side

In the same way as for the primary side two network designs are considered.

First network that is considered is a network with 45 ˚C supply temperature in peak period..

Second network that is consideration is a network with 65 ˚C supply temperature in peak period.

4.4.1 45 ˚C supply temperature in peak period

Because the heat pump is placed on the secondary side the supply temperature can be lowered in the summer period.

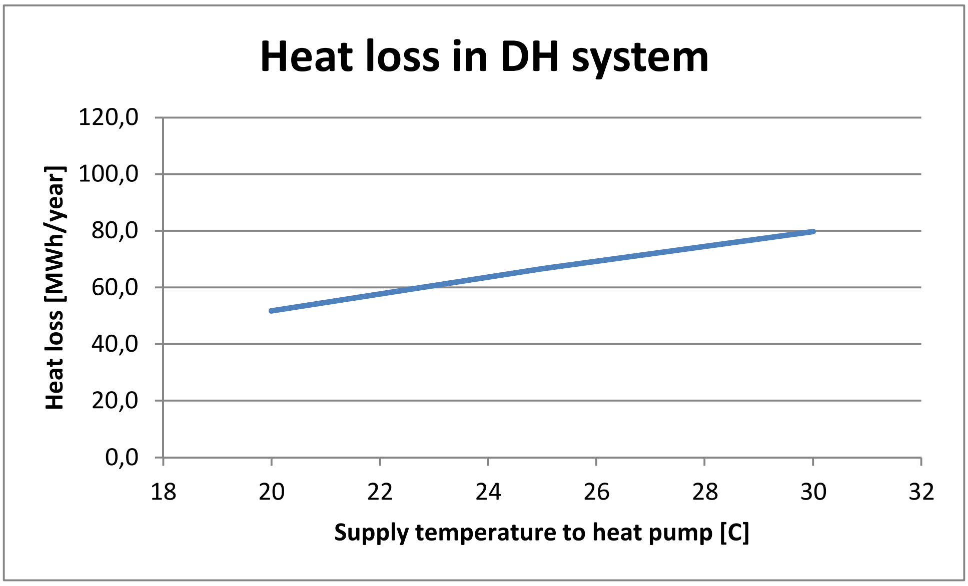
This network is designed as the previous one with a supply temperature of 45 ˚C and a return temperature of 25 ˚C. In the summer period the supply temperature is further lowered to 25 ˚C with a return temperature of 20 ˚C.

Period	time	supply temperature		Return	Heat loss in distribution network			Electricity consumption pump	
		Station	Crit. con.	temp.					
	hours	[C]	[C]	[C]	[kW]	[MWh]	%	[kW]	[MWh]
1	233	45	44	25	12,3	2,9	3%	2,94	0,69
2	297	42	41	25	11,9	3,5	3%	3,01	0,89
3	870	37	36	25	10,3	8,9	4%	2,72	2,37
4	1390	32	31	25	9,0	12,6	7%	2,53	3,52
5	1860	27	26	21	6,8	12,7	10%	0,66	1,22
6	4110	26	25	20	6,3	26,0	13%	0,34	1,39
Sum	8760					66,6	7%		10,08

Table 13: Temperature levels and heat loss for periods with different heat demand.

This network has a yearly heat loss of 66 MWh. This is 60 % less than the traditional network. The electricity consumption is approx. 15 % of the heat loss.

The figure below shows a sensibility analysis of the heat loss as a function of the supply temperature to the heat pump. The return temperature from the heat pump is set to 5 °C below the supply.



4.4.2 65 ˚C supply temperature in peak period

Because the heat pump is placed on the secondary side the supply temperature can be lowered in the summer period.

This network is designed as the previous one with a supply temperature of 65 ˚C and a return temperature of 25 ˚C. In the summer period the supply temperature is only lowered to 28 ˚C with a return temperature of 20 ˚C. This is such that the electricity consumption is limited.

Period	time	supply temperature		Return	Heat loss in distribution network			Electricity con-sumption pump	
		Station	Crit. con.	temp.					
	hours	[C]	[C]	[C]	[kW]	[MWh]	%	[kW]	[MWh]
1	233	65	62,5	25	15,7	3,7	4%	1,51	0,35
2	297	58	56,5	25	14,9	4,4	4%	1,56	0,46
3	870	48	47	25	12,0	10,4	5%	1,49	1,30
4	1390	38	37	25	9,7	13,5	7%	1,46	2,03
5	1860	30	29,5	20	6,8	12,6	10%	0,47	0,88
6	4110	28	27,5	20	6,3	26,0	13%	0,40	1,64
Sum	8760					70,7	8%		6,66

Table 14: Temperature levels and heat loss for periods with different heat demand.

This network has a yearly heat loss of 71 MWh.

4.5 Conclusions

It is hard to see the LTDH system be carried on the economic value of the heat loss alone. The LTDH system must to a great extend be justified on the value of low district heating temperature level.

Table 15 shows the operation cost of the evaluated DH networks.

In the table a district heating price of 350 kr./MWh and a electricity price of 1.000 kr./MWh is used.

There is a difference of 32 – 46 % in yearly operation cost savings between the low temperature network and the traditional network. There is approx. 20.000 - 25.000 kr. a year in savings for LTDH network compared to traditional networks.

Scenarios		Heat loss in network			Pump energy		Operation cost	savings
		MWh	%	kr.	MWh	kr.	kr.	%
Traditional network	DHW,secondary side	164,4	16,4	57.531	1,05	1.055	58.586	-
	DHW, primary side	143,0	14,6	50.056	1,58	1.581	51.637	(12)
LTDH network	DHW, primary, 45 C	104,0	11,0	36.404	3,36	3.355	39.759	(32)
	DHW, primary, 65 C	98,2	10,5	34.362	3,65	3.651	38.013	(35)
	DHW, secondary 45 C	66,6	7,3	23.298	10,08	10.078	33.376	(43)
	DHW, secondary 65 C	70,7	7,8	24.732	6,66	6.663	31.396	(46)

Table 15: The operations cost for different district heating networks.