Upfront payment to connect to district heating

Summary of experiences from Danish DH companies, and analyses of the impact on economy

DBDH

GRØN ENERGI

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1 Introduction and summary

This report describes the results from a research project funded by the by The Danish District Heating Association's research and development funds. The goal is new knowledge about economy and risks when expanding district heating (DH) to new areas. The report contains a thematic summary based on collected experiences from Danish DH companies and DH experts, and a description of the data, method, and results from the analyses.

One of the major uncertainties when developing DH in an area is whether people and companies want to connect. The economy of a DH project benefits significantly if more people connect and if they connect early on. Before the energy crisis, Danish DH companies struggled to get potential customers to abandon their natural gas boilers and connect to DH instead. There was moderate interest, and it was sometimes difficult to get enough people interested at the same time to reach a high enough connection rate for the projects to fly.

As a result, Danish DH companies worked to develop ways to increase the connection rate to DH. One way was to decrease the amount of money that new customers should pay upfront when connecting. Either by reducing the connection fee or offering a service agreement on the DH unit, as an alternative to new customers buying the unit themselves.

This project brings an overview of the preferences and actions of new DH customers. A better understanding can be used to adjust offers to new customers, and at the same time contribute to a more robust business case for the DH company – also after the energy crisis. We believe that this knowledge is relevant to any country that is establishing or extending DH systems.

Each DH company has a unique situation, and the world is changing rapidly. Hence, it is important to notice that the specific numbers and results in this report are a mirror of the assumptions behind the analyses. The aim of the analyses is to describe insights and provide examples on how the economy of company and customers are affected by the design of the offer to connect to DH. This can add insights and new questions to the discussions of opportunities and risks when developing DH.

Expanding DH can be both complex and a large task in comparison to the size of the DH company. One of the questions is how much money to ask from customers upfront. The very short summary is, that it is possible to improve the connection rate and the economy of the project through an active effort, and the rewards are significant.

The section about practical experiences from Danish DH companies can provide a greater understanding of potential customers, and the section contains a list of tested actions that helped increase the connection rate. The section about the analyses summarises the results that also provide insight into other topics through a series of sensitivity analyses.

It is important to notice that prices on both fuels and DH equipment have changed significantly over the past few years, and that the development of the prices is difficult to predict. Assumptions and results in this report is not representative of the current situation, but on the other hand, it was never the intention that numbers from this analysis should be used directly in specific projects. The purpose has been to illustrate correlations and effects – and to add new perspective and inspiration to the discussions and specific calculations involved in expanding DH to new areas. Specific business cases for DH requires specific knowledge of local circumstances, technical solutions, and current prices.

Among the main findings are:

- The connection rate is of great importance to the economy, and the analyses illustrate the magnitude of the effect at 70% connection in the baseline scenario, at 10% additional connection after 15 years, and at mandatory connection of 95% of potential consumers.
- Interest rates and investment costs are of great importance to the economy, and considerations about financing and risks must be considered carefully and balanced against higher connections rates achieved through discounts on the upfront payment. In particular, when interest rates are increasing.
- The strength of a common heat supply. The total cost is lower if everyone connects to district heating. This results in lower heating costs for consumers. Also, the investment costs are lower when DH is established in the whole area in one go.
- The assessment period is important, and the effect of using an assessment period different than the typical Danish choice of 20 years has been studied.
- Different loan types have different risks. Further, the significance of whether the consumer or the district heating company takes out the loans has been investigated.

District heating is a key tool to achieve a sensible green transition. By sharing experiences both locally and across borders, DH can develop quicker and better.

In particular, the project would like to thank the DH companies Assens Fjernvarme, Egedal Fjernvarme, Haderslev Fjernvarme, Høje Taastrup Fjernvarme, Kredsløb, Næstved Fjernvarme, VEKS, and Viborg Varme, and also the technical consultant DFP and the DH communications expert Fjernvarmens Informationsfond.

2 Experiences from Danish DH companies

Eight cases have been investigated, and the experiences are thematically summarised below.

2.1 The effect of changing the upfront payment

The experience among Danish DH companies is that changing the up-front payment has a significant effect, leading to more people signing up. Potential customers compare the upfront payment for an individual heat pump, and a large upfront payment can be difficult to fit into a household budget. As an alternative to a large upfront payment, the payment can be included in the DH bill over many years. This means that the DH company will need to borrow more money, but it might be a good idea if it also means that more customers will connect to DH.

For this reason, it is relevant to look at both the connection fee and the option to provide a service agreement for the DH unit. In Denmark, these are the two main parts of the upfront payment for a new DH customer.

2.2 The use of discounted connection fees has changed

During the energy crisis, the focus shifted in the DH companies. People were now eager to connect, but the concern is whether their interest to connect is robust or a short-term effect that evaporates when energy prices stabilise. This has brought about a change in the use of discounts on the upfront payment. It is rare to see upfront payments that would secure the entire investment in Denmark, but discounts are smaller, and some projects have increased the upfront payment.

Before the energy crisis, discounted upfront payments were typically between 0 and 3000 Euros. Now, a broader spectrum is seen depending on the situation. Some DH companies have the philosophy that everyone should be able to have a green heat transition and that connection fees should not stand in the way if the business case is robust. Others have started increasing up-front payments as a tool to reduce financial risks and make sure that people are earnest about connecting. Also, the limit for what people consider a bargain has shifted upwards – allowing the DH companies to secure more funding up-front without significantly affecting the number of customers connecting.

Three recurring questions:

1) Planning: We can get a high enough connection rate?

2) Tendering: Prices and abilities to deliver on time is under pressure – will the budget hold?

3) Up to and after the start of operation: Will the customers stay connected?

The balance between the one-time payment (connection fee) and the annual capacity tariff over the next 10, 20, or 30 years will influence these three questions. This is further investigated in the analyses described later in this report.

The local situation matters, and the optimal price depends not only on the general economic and political situation. The income level, the value of the building, and the size of the current heating bill also matters. To set the best price, experts talk about a gut feeling based on knowing the local situation and dialogue with potential customers.

2.3 A process that has brought success

Two essential parameters in a DH business case are the connection fee and connecting customers in one go to keep costs low. Making use of the psychological effects helps to achieve both. Typically, the process will run like this:

- A time-limited offer: "Connect now and get a large discount on your connection fee." If enough people sign-up for the project to be economically viable, DH will be developed in the area.
- When the dates for digging are set, a new offer is made: "We come to your area to dig during this period. If you sign up before we start digging, you can still connect with a (smaller) discount".

The second offer also has a sizable effect, and the extra customers connecting adds little additional costs and much value. This will boost both the economy and the robustness of the DH projects.

The most important is to get a high connection rate, and a well-designed discount on the connection fee can prove to be a successful contributor. Another benefit of this process is that many new consumers will join at the same time. This will reduce the costs for establishing DH, as it is expensive and time consuming to plan and move machines and equipment back into the same area multiple times.

2.3.1 A discount alone is not enough

A good DH project must be attractive to the customers and a robust investment for the DH company. In any given situation, the DH company has a range of parameters that can be adjusted to create the most suitable solution. The size of the upfront payment is one parameter, and others are related to financing, depreciation, tariff structure, and assessment period.

		Trust & interest to join	
		low	high
Up-front payment	low	?	✓
	high	🚫	✓

Changing the upfront payment has an impact and can be a valuable tool, but the correct use depends on the circumstances. An illustration based on experience and analyses.

When trust and interest are moderate or high, there is room to adjust the up-front payment and balance it against needs such as the ability to secure cheap financing, agility to make the most of strategic opportunities, risk mitigation, and compliance with regulation. Investigating the ability and willingness to make up-front payments and using sensitivity analyses to understand the risks can help DH companies decide which offer to make to potential customers in a new DH area.

If the trust and general interest in joining DH is low, the up-front payment would still have an effect, but it would not address the principal risks of the project. In this case, the DH company should consider that a discount alone might not be enough and use other tools to improve trust and interest. In the case of low trust, a high up-front payment might even reinforce the distrust if people feel the DH company is trying to transfer all the risk to them.

2.4 Service agreement for the DH unit

With a service agreement, the DH company owns the DH unit in the building. It handles servicing, repairing, and replacing it when needed. The Danish DH companies design the service agreements to cover the costs. The agreements give customers value and enable optimised operation of the DH system.

Benefits for the customer

- No unforeseen expenses.
- Approximately the same price but higher value compared to owning the unit.
- Better and easier service and maintenance.
- Improved system efficiency and immediate detection and correction of errors or suboptimal operation. In some cases, the households even make a profit when the improved operation of the unit more than covers the costs of the service agreement.

Benefits for the DH company

- Better service for the customers at no added cost.
- Access to data and the ability to remotely optimise unit operation bring new options: Immediate error detection, adjust settings to improve overall energy efficiency, locate the installations that prevent the entire system from running as optimal as possible, and new services to increase comfort.
- Having only a few types of units makes servicing and IT integration easier.

2.5 The target is a high connection rate

The connection fee is a one-time payment, whereas the capacity tariff is paid every year to cover the fixed costs of the DH company. The more connected customers that share in covering these costs, the lower the heat price, and the lower the risks for the DH company.

The up-front payment plays a role, but the most important tool is effective communication. Keeping people informed, being transparent, building trust, and sharing information about the benefits of having DH. Here are some examples of how Danish DH companies have worked to increase the connection rate:

- Clear, honest, and early communication. Even if many things are still uncertain, share your vision and give information when you can. This will help prepare people and create an understanding that could prevent individual heat pumps from being installed in areas better suited for DH.
- Contact large potential customers directly. They are important to get the needed connection rate and the system's long-term efficiency. Set the scene for a long-term collaboration and scout for potential suppliers of surplus heat. Keep a special eye out for the development of new city areas.
- Local ambassadors can be good and trustworthy advocates for DH development. These can be locals with an interest in getting DH themselves. Find them and work with them!
- Information meetings at the local school, sports arena, assembly hall, or anywhere with enough room. Make an offer and a process that is attractive and easy to understand for potential customers. Address all concerns and bring a DH unit so people can see what it looks like and how little space it takes up in a home.
- Collaborate with the municipality. The municipality can assist with the process, is used to stakeholder involvement, and share a common goal, as establishing more sustainable DH will help the municipality reach its climate goals.
- Find the right level for the connection fee. Low enough not to be a barrier to the connection rate, high enough not to jeopardise company liquidity or the ability to invest in other projects.
- Give customers a choice between owning the unit or having a service agreement with the DH company. The new service agreement option has become very popular in Denmark, with about 90% of new customers choosing this option and existing customers asking for the option to join as well.
- Make it easy to leave DH, and communicate exactly what to do if someone wants to leave DH. This will increase trust and reduce the fear of being trapped. People should stay with DH because it is good and cheaper.
- A guarantee that the DH company will fix your heating if your current system breaks down while you wait for DH to be installed. This prevents people from being forced to reinvest in a new gas boiler or invest in another alternative such as a small heat pump. This is a way to keep customers unconcerned and committed to DH while waiting to be connected. Once connected, people very rarely want to leave DH, but the waiting period is a risk to handle.
- Meet end-users where they are online with competent communication: Use Facebook (or other social media). As each project covers a small geographical area, it is not expensive to target exactly the potential customers in that area. With remarkable success, some DH companies have hired a company with knowledge of DH and communication to handle their Facebook communication during the expansion period.

- Give people the option to connect now, but activate the connections years later.
- Collaborate with local plumbers. They know the area and people listen to their advice.
- There are actions that can help to underline that DH (in Denmark) is a local and not-for-profit company. Like using a local sport association to distribute flyers – keeping the money in the community instead of paying to a big postal service.

A political tool to ensure a high connection rate is to make it mandatory to connect to DH, but even so, these ideas could be used to increase customer satisfaction and move attention to the benefits of DH.

2.6 The same tariffs for everyone

All Danish DH companies provide a short document explaining terms and tariffs. This document is sent to the Danish energy regulator. It must be fair, transparent and apply to all customers of the same type. Typically, there are a few different customer types. There are many strengths and economic benefits in having a joint DH system, and these cannot be specifically assigned to individual users. Costs and benefits are shared, and everyone in the DH system shares the same tariffs. The size of the heating bill depends on the consumption, but the prices are calculated using the same formula and under the same terms. This is a principle that has proven to be powerful, and it means that the aim is to connect and integrate new customers into the DH system on equal terms with all existing customers. This does, however, also have to comply with the Danish heat law that has a strong focus on consumer protection – preventing negative price impacts on existing customers when connecting additional customers. A solution to comply with both demands is to assign a temporary, additional tariff to new areas. An example of this could be a 10-year additional tariff to cover a heat transmissions line to supply a neighbouring area or town.

2.7 Typical questions from potential customers

Potential customers always ask about the price, and they struggle to understand things like tariffs and technical terms. This means that efforts must be made to deliver well-prepared and clear communication. Words used by experienced DH people may have to be explained or replaced. There are questions about the technical solutions and what they will look like in the area, and in- and outside the buildings. Other questions reveal a fear of being stuck with DH and not have the option to leave or choose another heat solution. This can be a real barrier to join, so these questions should also be taken seriously, even though this is not really a problem in Denmark.

And then there is the impatience and the frustrations from people struggling to pay for their current form of heating. When will DH be rolled out in my area? Why do we have to wait until 2028? Why don’t you just start digging? Also here, the way forward is openness and dialogue. Share your plans and prepare informative and easy-to-understand answers.

2.8 Typical discussions in the board of the DH companies

A detailed discussion of the business case and processes is naturally in focus. The use of sensitivity analyses has been part of the feasibility studies for a long time, and with the fluctuations seen over the past years they are getting even more attention. More what-if situations are analysed and discussed, and this includes bigger variation from the best-estimate numbers. There is also a larger focus on risks and how to assess and handle them.

The Danish experience is that people can be influenced by a good local effort. This is seen to enhance both trust and connection rate, and the list above can be a good place to start the discussions in the board.

3 Economic analyses

This part of the report describes the economic results depending on the design of the connection offer for new DH customers. The economy for both customer and DH company is investigated based on a series of described assumptions. The DH system has many typical traits of a Danish DH system, but it is not a specific system from the real world, and the results are analytical.

Among the main findings are:

- The connection rate is of great importance to the economy, and the analyses illustrate the magnitude of the effect at 70% connection in the baseline scenario, at 10% additional connection after 15 years, and at mandatory connection of 95% of potential consumers.
- The strength of a common heat supply. The total cost is lower if everyone connects to district heating. This results in lower heating costs for consumers.
- The assessment period is important, and the effect of using an assessment period different than the typical Danish choice of 20 years has been studied.
- Different loan types have different risks. Further, the significance of whether the consumer or the district heating company takes out the loans has been investigated.

3.1 Method and assumptions

The analysis is conducted in a spreadsheet-based model, developed for this project in partnership with the consultancy DFP. The model's results include:

- Net present value (NPV) – user/DH utility
- Annual costs for the consumer
- Comparisons between DH and individual heat pumps
- Graphical outputs, e.g. company financial balances

The inputs and assumptions of the model and the Base Scenario are summarized in the tables below. Amounts indicated are ex. VAT, unless otherwise stated. Prices and other assumptions vary depending on time and circumstances, and these analyses are not transferrable to actual projects. The purpose of the analyses is to investigate and describe correlations and effects, and this has been done based on the assumed data. Assessments of actual projects require analyses on the specific situation and with current figures.

INVESTMENT			
NAME	**AMOUNT**	**SOURCE**	**NOTE**
Distribution system (header pipes)	8 100 EUR/connection	DFP	The larger pipes distributing heat from heat production and storage sites to the

			consumption areas. Price at 100% connection rate.
Branch pipe	5 400 EUR/connection	DFP	Pipe connecting the main network to end-user
Substation (DH unit)	3 200 EUR/connection	DFP	Assuming 100% loan financing in the Base scenario "Substation bought"
Loan repayment period DH	30 years		
Assessment period	20 years		
Heat pump	19 500 EUR incl. VAT	OK heat pump supplier	
Technical lifetime heat pump	16 years	Danish Energy Agency's Technology Catalogue	
Loan interest (user)	6%	OK heat pump supplier	
Loan interest (company)	2.6%	DFP	
The DH utility's loan type	Annuity loan	Assumed	
Discounting – consumer	No	Assumed	May be equal to the loan interest
Discounting – DH utility	Yes – 2.6%	Same as the loan interest	Financial discounting, not socioeconomic
Subsidy	0	Assumed	

OPERATION			
NAME	**AMOUNT**	**SOURCE**	**NOTE**
Electricity price – inflexible heat pump	Full electricity price	Danish Energy Agency's prerequisites	Adjusted to 2022 level
Electricity price – flexible heat pump	Reduced to 55% of the full electricity price	Danish Energy Agency's prerequisites	Adjusted to 2022 level
Variable heat tariff	58 EUR/MWh excl. VAT in year 1	The Danish Utility Regulator's 2021 statistics. EUR 60 on average + 20% in assumed 2022-	Indexed to electricity price, so decreases over time. Average of 50% lowest variable heating price plus 20%

		price increases = EUR 72 incl. VAT	for the recent price increase
DH production price	EUR 44	The contribution margin is set at 13 EUR/MWh	Indexed to electricity price
Capacity tariff	Varies (EUR 3.7 EUR/m^2/year in Base Scenario)	Model output	
Meter charge	54 EUR/year	DFP	Annual fee for the heat meter
Electricity charges and tariffs	Included	Danish Tax Authority and others	Applies to individual heat pumps. Grid tariffs are not indexed to electricity price
Substation subscription (service agreement on DH unit)	354 EUR/year incl. VAT (29 EUR/month)	DFP	Only considered in the end-user economy. Assumed cost neutral in business economy and therefore not included

CONVERSIONS FROM NATURAL GAS TO DH			
NAME	**AMOUNT**	**SOURCE**	**NOTE**
Total number of houses	450	Assumed	
Connection rate share of the total in Base scenario	70%	Assumed	
House type	Standard house (130m^2, 18.1 MWh/year)	Assumed	

TECHNICAL REQUIREMENTS			
NAME	**AMOUNT**	**SOURCE**	**NOTE**
Heat loss DH	15%	Assumed	
Heat pump (7 kW) efficiency	315%	Danish Energy Agency's Technology Catalogue	

Unless otherwise stated, all financial figures are projected with an inflation factor specified by the Danish Energy Agency.

Some assumptions are still aligned with the situation in August 2023. Such as the heat price, as seen from the latest heat price statistics from the Danish Utility rRegulator (Forsyningstilsynet). On the other hand, interest rates and investment costs have increased very significantly.

The analysed case is an expansion project where the DH company can deliver the heat for the additional 450 connections from existing heat production. This is why the table does not contain costs for new heat production. This is an example representing a conversion project where heating with natural gas is replaced by district heating. All Danish DH systems will be fully CO_2-neutral no later than 2030.

It is assumed that owners take out 0% in profit, as this is a Danish case. DH is consumer-owned in Denmark, and both municipally- and cooperatively-owned companies operate as not-for-profit.

The costs for the individual heat pump only include the heat pump itself. Necessary costs to reinforce the electricity grid are not included in the calculations.

The Danish Energy Agency's electricity price projection has been adjusted in year 1 to the average price for the second half of 2022. That is, from 0.22 to 0.27 EUR/kWh. The adjusted price gradually meets the Danish Energy Agency's figures until year 5, from which the Danish Energy Agency's uncorrected figures are used.

Cf. Figure 1 the heat production price is indexed to the Danish Energy Agency's uncorrected electricity price.

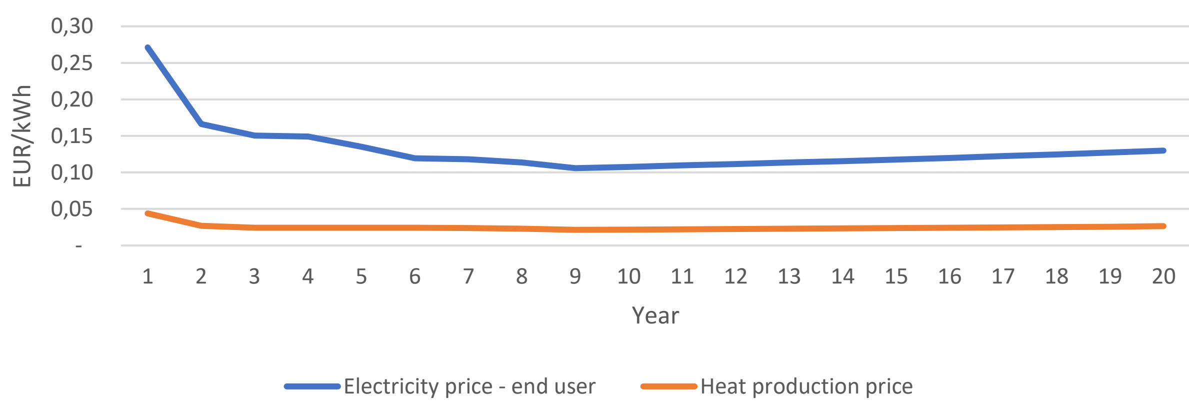

Figure 1 Heat production price indexed to electricity price. These price assumptions are used throughout the analyses.

To compare heat pumps and DH on an equal footing, it is assumed that the self-financed part of the substation plus the connection fee equals the payment for the heat pump in year 1. In this way, the customer always pays the same amount of cash "out of their pockets", regardless of technology analysed. This equates the technologies. Scrap value is not included, as reinvestment in the heat pump and DH substation is assumed to be fully debt-financed over the technology's lifetime.

3.1.1 Total investment, scaled by number of connections

The scale of investment depends on the number of connections. That said, the "base investment", i.e. the header pipes deployed regardless of the connection rate of end-users, is the major and fixed part of the investment. Even in the case of 100% connection rate (all 450 end-users), the distribution system accounts for 60% of the investment costs in this example. The significant fixed share of investment underlines the importance of sharing the cost as widely as possible. The grey line in Figure 2 shows the cost share of the header pipes per end user. It illustrates the significant impact of high connection rates. Getting from the first few connections to the mid-levels are especially important. In this example, the strongest impact is the 50% cost reduction when expanding from 50 to 100 end-users.

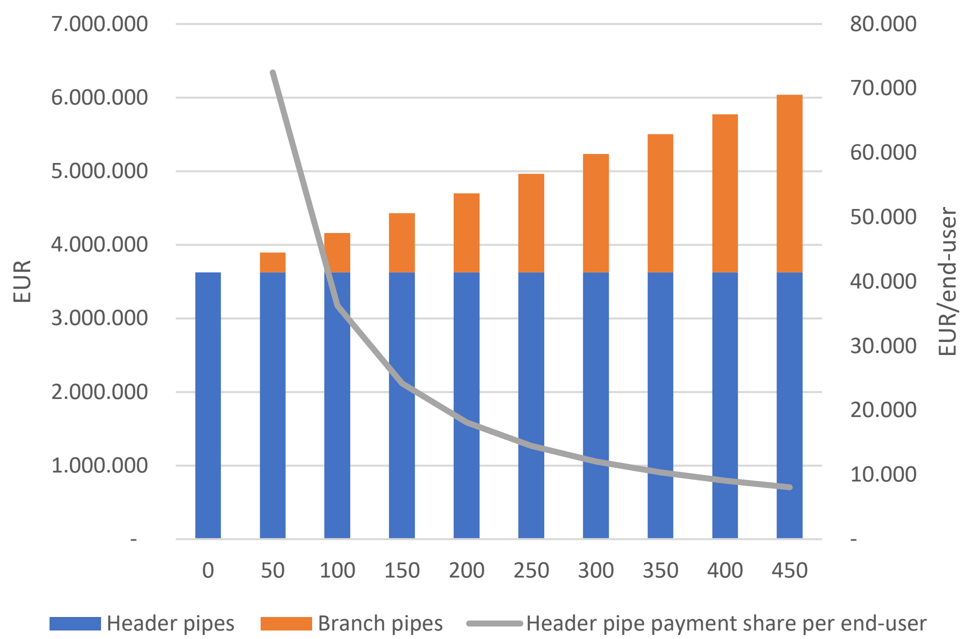

Figure 2 Investment amount, scaled by number of connections. The cost for header pipes (distribution system without branch pipes to the buildings) has the largest overall share. Illustrative example analysis, based on the study's assumptions.

In the analyses, it is assumed that the existing heat production can cover the supply of the new area. If this is not the case, it would mean a larger (blue) part of the investments, and this would make a high connection rate even more important.

3.2 Base Scenario assumptions

Summarized from the above tables, the Base Scenario consists of the following assumptions:

- The DH investments are divided into two variations, respectively "substation purchased" and "substation subscription". These describe the customer's two options and are only analysed in terms of user economics. When purchasing a substation, the entire purchase is debt-financed.
- EUR 0 in connection fee from the customer to the DH plant (all is financed by the capacity tariff)
- 450 convertible standard houses (18.1 MWh/year), of which 70% (315) will be connected in year 1. No subsequent connections
- 20-year assessment period; 30-year annuity loan on pipes
- Consumer loan interest 6%; DH utility loan interest 2.6%
- Variable heating tariff 58 EUR/MWh ex. VAT

3.3 Results of the Base Scenario

In the following, the economic results of the Base Scenario are described for end-users and for the DH utility. Subsequently, these results are expanded through sensitivity analyses such as additional customers connecting after 15 years or significantly increased investment costs. The Base Scenario is based on assumptions stated in the tables described in Method and assumptions.

3.3.1 The Base Scenario results – End-user

In terms of end-user economics, the competitiveness of the DH conversion is considered by comparing DH to the primary alternative: an individual heat pump. This is analysed based on annual costs in the 20-year assessment period.

Figure 3 compares annual costs over the entire assessment period. The curve's initial downward slump is due to the Danish Energy Agency's expectation of the expected reduction in electricity prices from 2022's high prices. In year 17, the heat pump's annual costs increase, as reinvestment is made in a new heat pump (assumed technical life of 16 years). In this scenario, DH is competitive with the heat pump in all years.

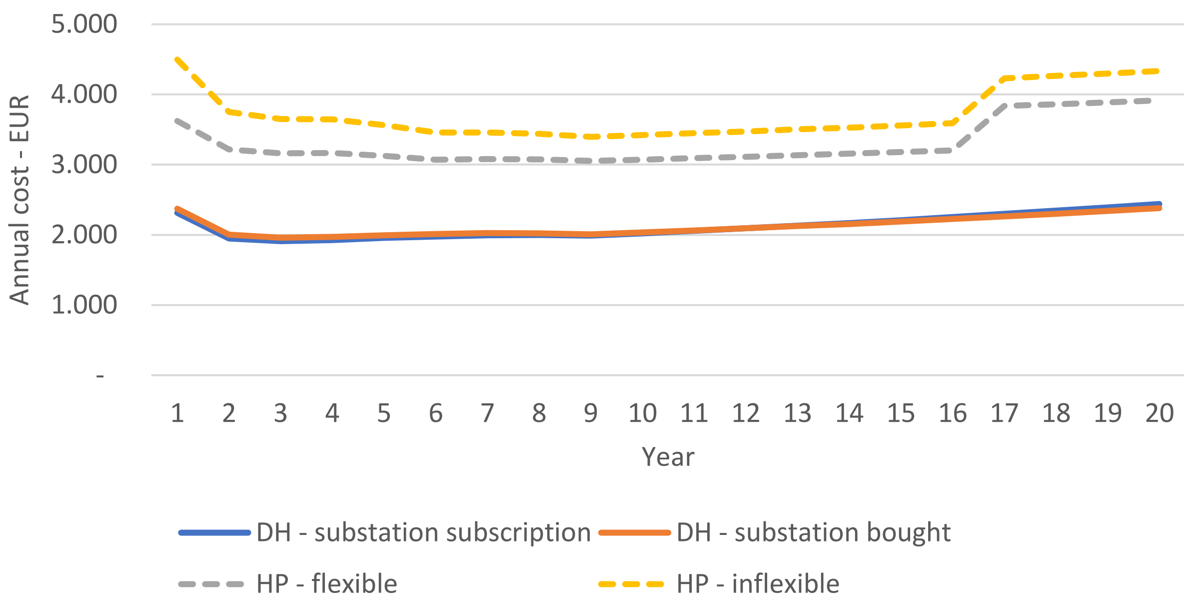

Figure 3 The Base Scenario's end-user economy, where annual costs for DH and heat pumps are compared. Illustrative example analysis, based on the study's assumptions.

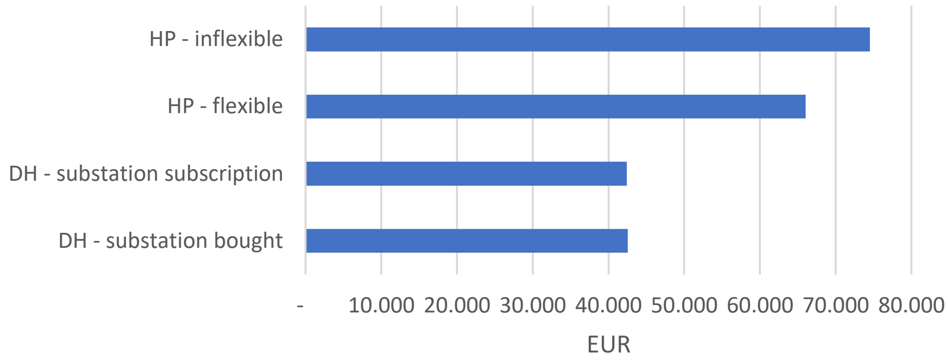

Figure 4 End-user net present value in EUR of respectively DH and individual heat pump. With the 0% discount rate, it is the sum of undiscounted costs over the assessment period (20 years). Illustrative example analysis, based on the study's assumptions.

Looking at the present value, i.e. user economic costs for the entire project period (Figure 4), the most expensive DH solution ("substation subscription" – with very small margin to "substation bought") costs 60% of the cheapest heat pump solution (flexible heat pump). Note that in the user economic calculation in the Base Scenario, no discount is applied (i.e. "discounting" with 0%).

Figure 5 compares costs in year 1 with average costs for the period considered. For DH, the most significant reduction is seen in the variable tariff's share. The same applies to the heat pump. The reason is the expected reduction in the electricity price from year 1 (2022) compared to the following years.

The annuity - repayment and interest on the loan - constitutes a significant part of the cost of the heat pump, but only a limited part in the "substation purchased". This is because DH customers' connection fee is EUR 0 (repaying connection through the capacity tariff), while heat pump customers must finance 100% of the heat pump. See the method section for an elaboration of assumptions about financing.

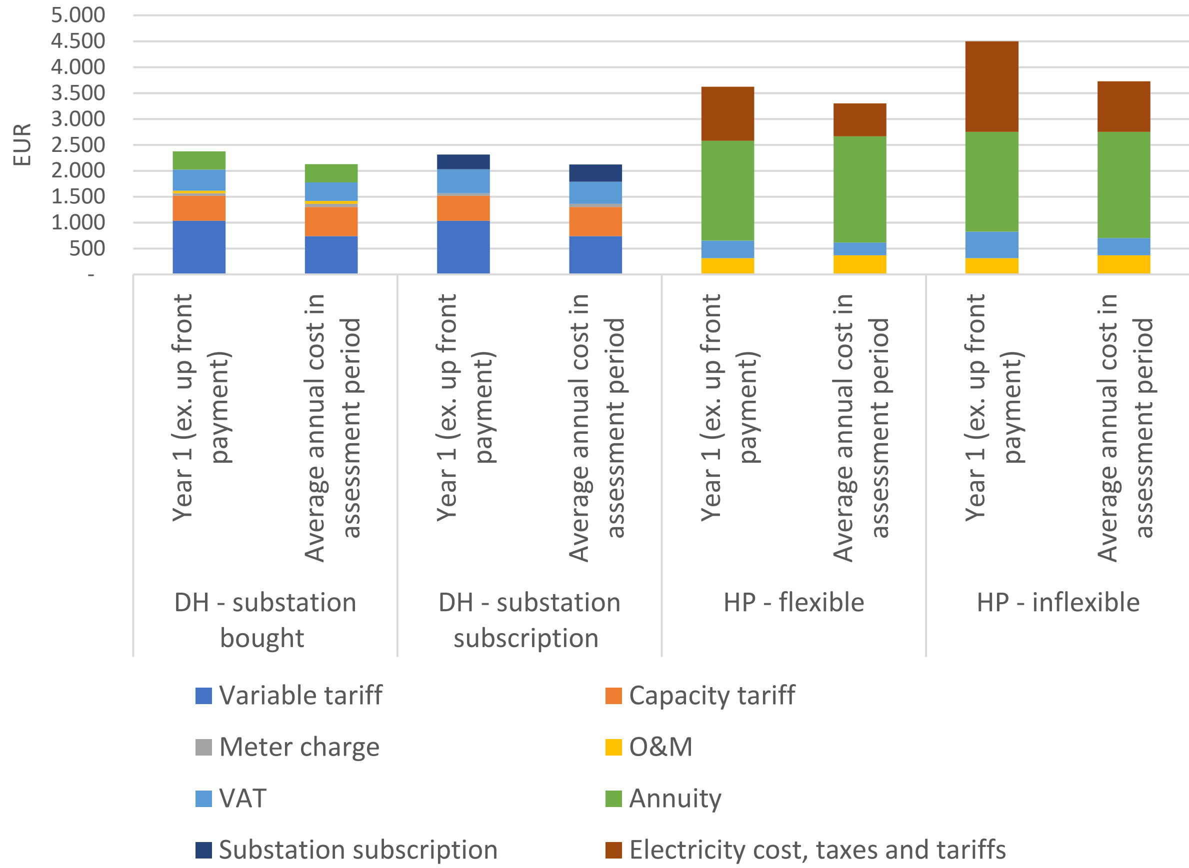

Figure 5 Annual costs for DH and heat pumps. Split into year 1 and as an average price over the entire period. These are different due to inflation, energy prices etc. Illustrative example analysis, based on the study's assumptions.

3.3.2 The Base Scenario results – DH utility

In the Base Scenario, the capacity tariff is determined as the value that gives the project a present value of EUR 0 over 20 years. In this case EUR 3.7/m^2/year. Figure 6 shows the annual balance, i.e., the total result of income and expenses in the project, as well as the accumulated balance for the entire project over 20 years.

The project's first 9 years produce a deficit, after which the balance becomes positive. From year 18, the accumulated balance is positive. The reason for this is that

- the capacity tariff is inflation-corrected (i.e. increases in line with inflation)
- the variable heat price decreases (indexed by electricity price)
- the loan amount is constant (i.e. not rising with inflation)

From year 19, it becomes a profitable business benefitting the entire company.

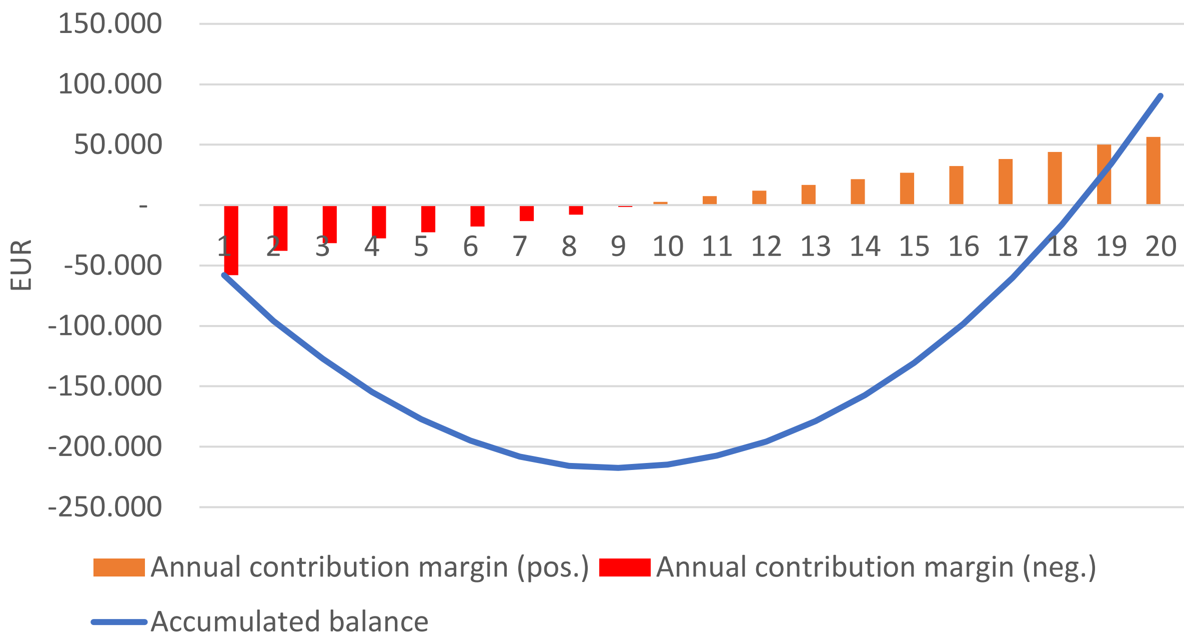

Figure 6 Base Scenario balance over the 20-year assessment period. The project breaks even after year 18. Illustrative example analysis, based on the study's assumptions.

3.4 Sensitivities

In the following, sensitivities are analysed to determine the impacts of deviations from the assumptions in the Base Scenario.

3.4.1 Upfront payment vs. connection rate

This project focuses on the effect of reduced connection fees and the relation to connection rates. As described earlier in this report, the experience is that a lower connection fee results in a higher connection rate. However, it is difficult to put a direct formula on this, as it depends on current energy policy, international prices and events, as well as local conditions such as income base and value of the building.

To illustrate the impact and importance of having a realistic understanding of this, Table 1 shows two different situations. The red line represents a situation where the up-front payment is a significant barrier to potential customers, and only 50% would connect if the connection fee is 3.400 €. The dotted line represents an area where the up-front payment is less of a barrier. Perhaps because it is a wealthier area, or their current heat supply is more expensive. The table also illustrates just how valuable it is to put some effort into connecting more customers.

Analyses like this can help DH companies decide on the criteria for going ahead with a project and to better understand the consequences of some of the risks involved. For their company and for this project, is it better to ask for 1.700 € in connection fee and aim for a 70% connection rate, or to ask for 10.100 € and aim for a 50% connection rate if they are satisfied with a calculated break-even after 20 years? Or if increasing cost levels are a concern, perhaps they recalculate to better understand the consequences of that risk and decide to play it more safely.

The lines should not be interpreted as a definitive correlation but as an indication of how good the financial buffer is in the project, and what a reduced connection fee means for the company's finances.

Table 1 Net present value of a generic project for different combinations of connection rates- and fees. The red line illustrates an area where a high connection fee represents a major obstacle, while the dotted line represents an area where the connection fee has less effect, perhaps because households in that area have a better economy or because there is more to save compared to the heating they have today. Numbers and lines are for general illustration and are not numbers from a specific project.

Connection fee [EUR/connection] incl. VAT, ex. substation

NPV [MEUR] / Share of end-users	-	1 700	3 400	5000	6 700	8 400	10 100	11,700	13 400	15 100	16 800
30%	-1.6	-1.4	-1.3	-1.2	-1.0	-.9	-.8	-.6	-.5	-.3	-.2
40%	-1.2	-1.0	-.8	-.6	-.5	-.3	-.1	.1	.3	.5	.7
50%	-.8	-.6	-.3	-.1	.1	.4	.6	.8	1.1	1.3	1.5
60%	-.4	-.1	.2	.4	.7	1.0	1.3	1.5	1.8	2.1	2.4
70%	0	.3	.6	1.0	1.3	1.6	1.9	2.3	2.6	2.9	3.2
80%	.4	.8	1.1	1.5	1.9	2.3	2.6	3.0	3.4	3.7	4.1
90%	.8	1.2	1.6	2.0	2.5	2.9	3.3	3.7	4.1	4.5	5.0
100%	1.2	1.7	2.1	2.6	3.0	3.5	4.0	4.4	4.9	5.4	5.8

3.4.2 The company's loan options

Financing investments in DH is generally not difficult for a DH utility in Denmark. After a mandatory approvement process via the municipality, a DH company can obtain loans with a municipal guarantee either through municipal bond finance (KommuneKredit) or commercial banks, and the loans are considered low risk. Considerations in Denmark are more about which type of loan to choose.

Risk can be reduced by accelerated repayment of loans. It can, for example, be relevant if, in the short term, the company has good competitiveness with alternative forms of heating, while the long-term competitiveness is unclear. Specifically, the risk is reduced by the fact that faster loan repayment means less debt in the later years of the project. Of course, risk can also be mitigated by other means (e.g. customer payment upon disconnection).

In this sensitivity analysis, the Base Scenario's annuity loan is compared to a serial loan. In annuity loans, the same annual amount is paid throughout the period, while the serial loan starts with high payments, which are then reduced (a fixed amount is repaid; interest payments decrease over time). The advantage of a serial loan is that the company pays off a larger amount in the early years. E.g. after 10 years in the Base Scenario, where MEUR 1.8 has been repaid, which is MEUR 0.4 more than with an annuity loan. Figure 7 shows that serial loans increase the annual consumer price by EUR 67-94/year in the first 20 years. After the 20 years, the competitiveness of district heating improves, since more of the loan has been repaid. This can reduce the long-term competitive risk for the district heating company.

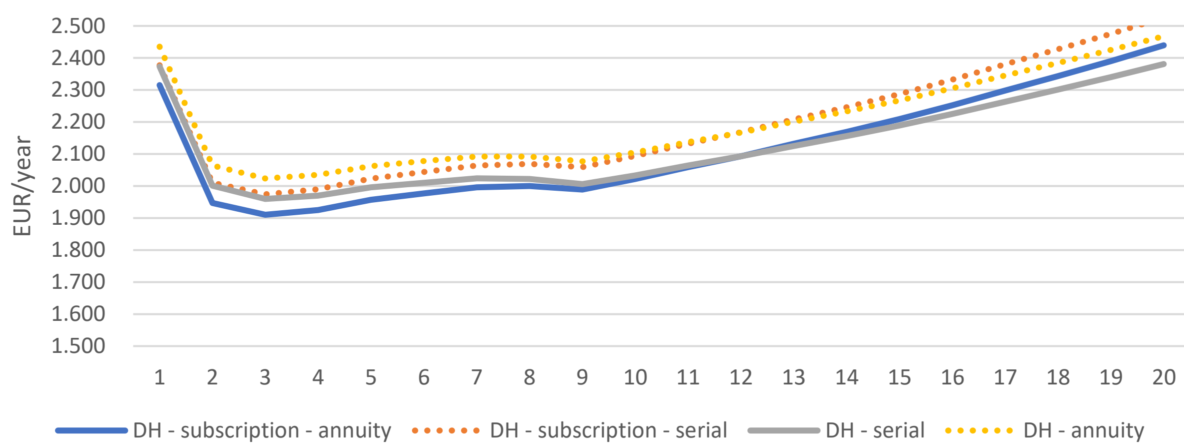

Figure 7 Annual consumer costs for DH depending on the DH company's loan type - annuity loan vs. serial loan. Illustrative example analysis, based on the study's assumptions.

If the DH is competitive with the alternatives – Figure 8 – it may be relevant to choose a slightly higher end-user cost at the start, to reduce the risk from longer loans. Conversely, the serial loan is about MEUR 0.3 "more expensive" compared to annuity loans in the 20-year assessment period. This is simply because more money is paid during that period with the serial loan. Over the 30-year repayment period, there is no price difference between the two loan types. In the present example, the difference between DH and an individual heat pump is so large that the type of loan is not decisive for the competitiveness between the heating solutions.

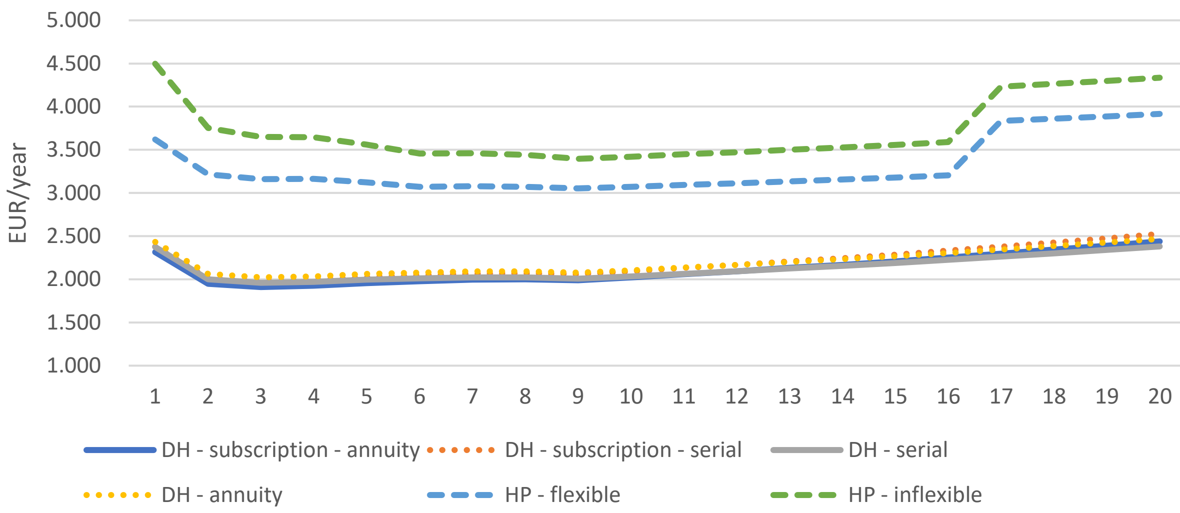

Figure 8 Annual consumer costs for DH and heat pump. For DH, depending on the DH company's loan type - annuity loan vs. serial loan. Illustrative example analysis, based on the study's assumptions.

The company's payment profile and share of instalments and interest can be seen in Figure 9. The payment profile for annuity loans (green) is constant, while serial loans (purple) start high and end low.

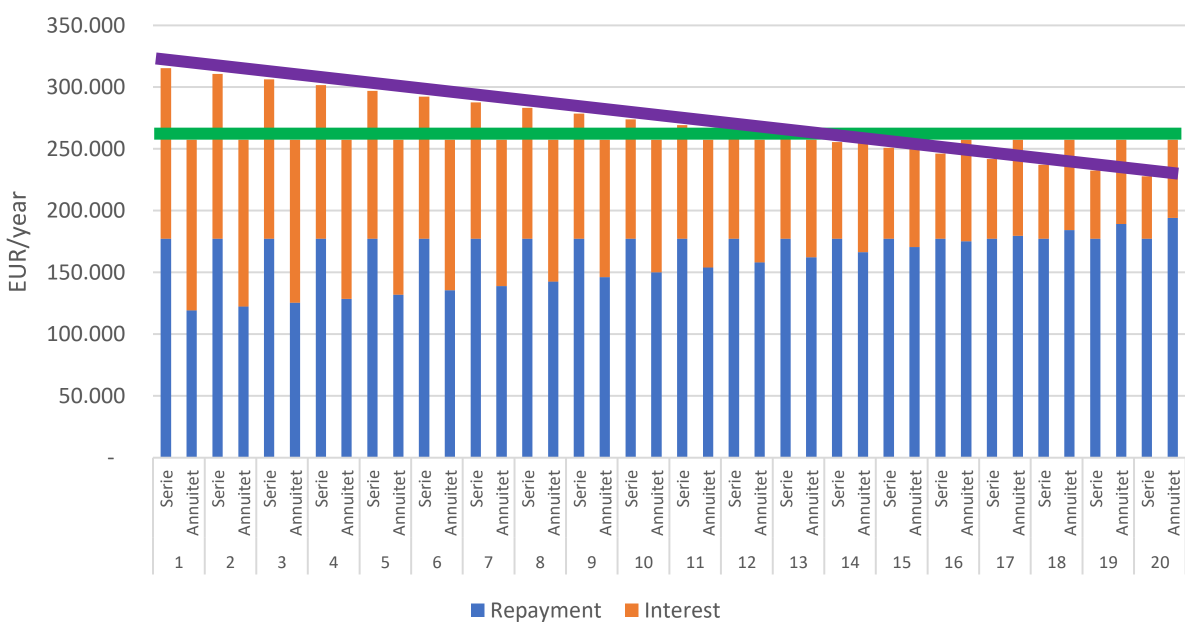

Figure 9 Payment profiles for interest and instalments for the district heating company. Annuity loan vs. serial loan. Illustrative example analysis, based on the study's assumptions.

3.4.3 Assessment period

In the Base Scenario, the assessment period is 20 years, 70% connection rate, EUR 0 in connection fee and EUR 3.7/m^2/year in capacity tariff. As seen from Table 2, the DH project's net present value decreases if the assessment period is less than 20 years. Conversely, the net present value increases when the assessment period is extended.

This is because the capacity tariff is defined as the value that has a DH utility economic present value of 0 over 20 years. In other words, the capacity tariff must be increased to reach a net present value of 0 in e.g. 10 years instead of 20. In that case, the capacity tariff would increase from EUR 3.7 to 4.2/m^2/year. All things equal, a short assessment period puts DH at a competitive disadvantage against other forms of heating.

Table 2 The effect of the assessment period on the company's financial present value [million EUR]. The Base Scenario is marked in blue. Illustrative example analysis, based on the study's assumptions.

	NPV [MEUR]	Connection fee [EUR/connection] incl. VAT, ex. substation										
		-	1 700	3 400	5000	6 700	8 400	10 100	11 700	13 400	15 100	16 800
Assessment period [yrs.]	5	-0.2	- 0.1	0.0	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8
	10	-0.2	- 0.0	0.2	0.3	0.5	0.7	0.9	1.1	1.3	1.4	1.6
	15	-0.1	0.1	0.4	0.6	0.9	1.1	1.4	1.7	1.9	2.2	2.4
	20	0	0.3	0.6	1.0	1.3	1.6	1.9	2.3	2.6	2.9	3.2
	25	0.2	0.6	1.0	1.4	1.7	2.1	2.5	2.9	3.3	3.7	4.0
	30	0.5	0.9	1.4	1.8	2.2	2.7	3.1	3.5	4.0	4.4	4.8
	35	1.4	1.8	2.2	2.7	3.1	3.5	4.0	4.4	4.9	5.3	5.7
	40	2.2	2.7	3.1	3.5	4.0	4.4	4.8	5.3	5.7	6.2	6.6

If the assessment period is increased to e.g. 35 years, then the capacity tariff can be reduced to EUR 2.6/m^2/year. Figure 10 illustrates another effect of a longer assessment period. As the loan runs for 30 years, there is an opportunity to reduce the heat price when the 30 years are over, if the assets are still in operation in the DH system.

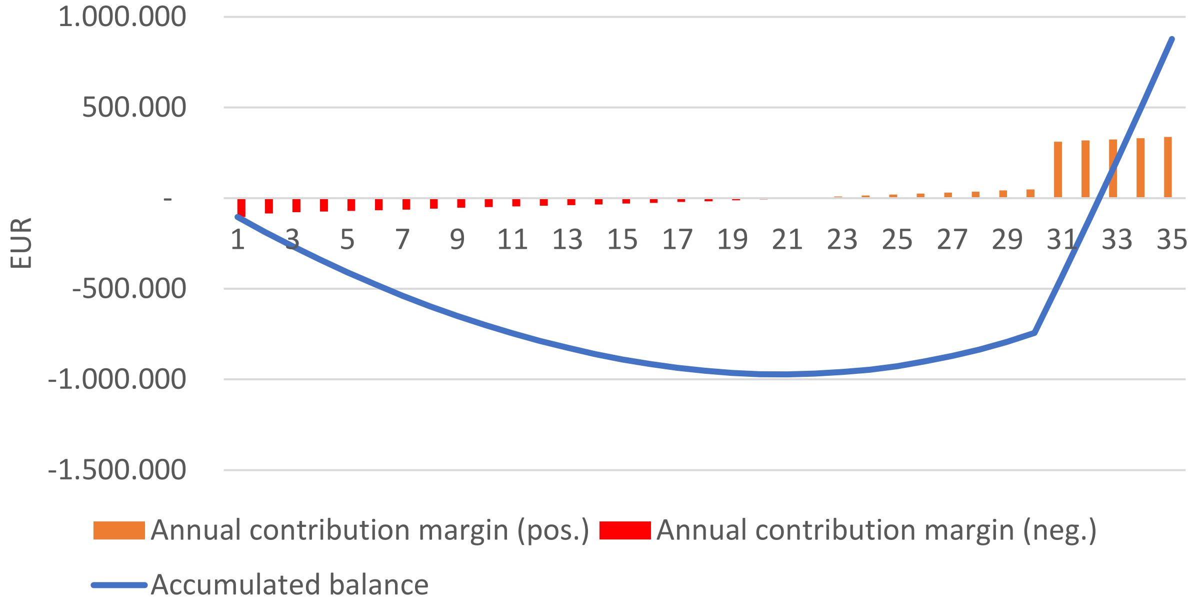

Figure 10 Company financial balance for an assessment period of 35 years. When the loan ends after 30 years, the annual balance improves substantially. Illustrative example analysis, based on the study's assumptions.

3.4.4 Instalment/depreciation period

Just like the assessment period, the term of the loan also has an impact on the company's finances. Presently, 30 years is the maximum term in Denmark, while the technical life of pipes is 40 years or more. Cf. Figure 11, an increased repayment period results in a "flatter" accumulated balance, which means a smaller financial deficit in the first part of the period.

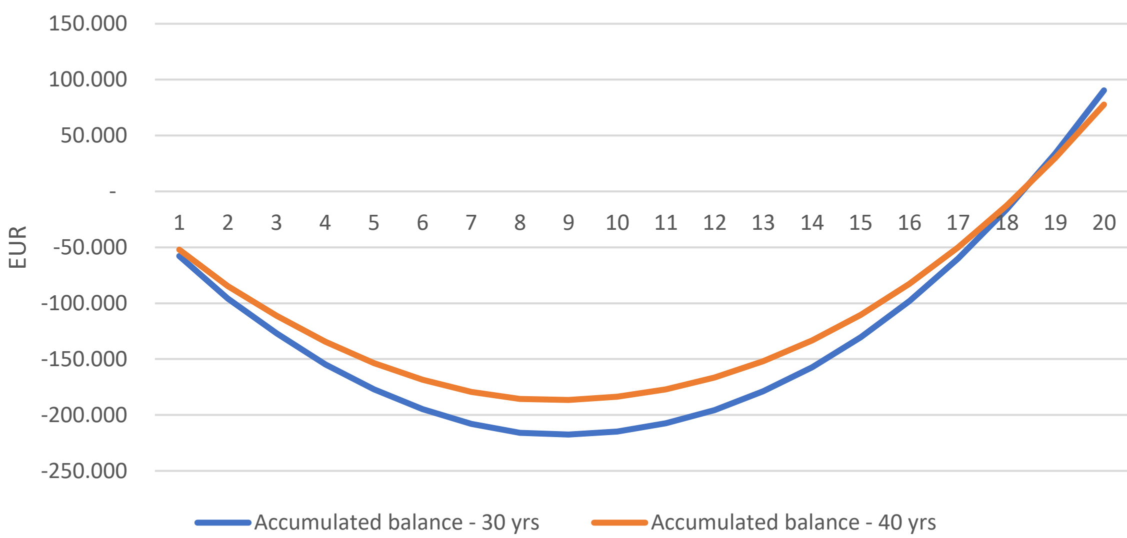

Figure 11 Company financial balance at 30 and 40-year repayment period. Illustrative example analysis, based on the study's assumptions.

If the repayment period of the loan is increased to the technical lifetime of 40 years, the capacity tariff can be reduced by approx. 25% (from EUR 3.7 to 2.8/m^2/year). Cf. Figure *12* this corresponds to a reduction in average annual costs from EUR 2 110 to 1 960/year – a EUR 150 reduction in annual costs. Numbers like this can be included in risk assessments regarding the depreciation period.

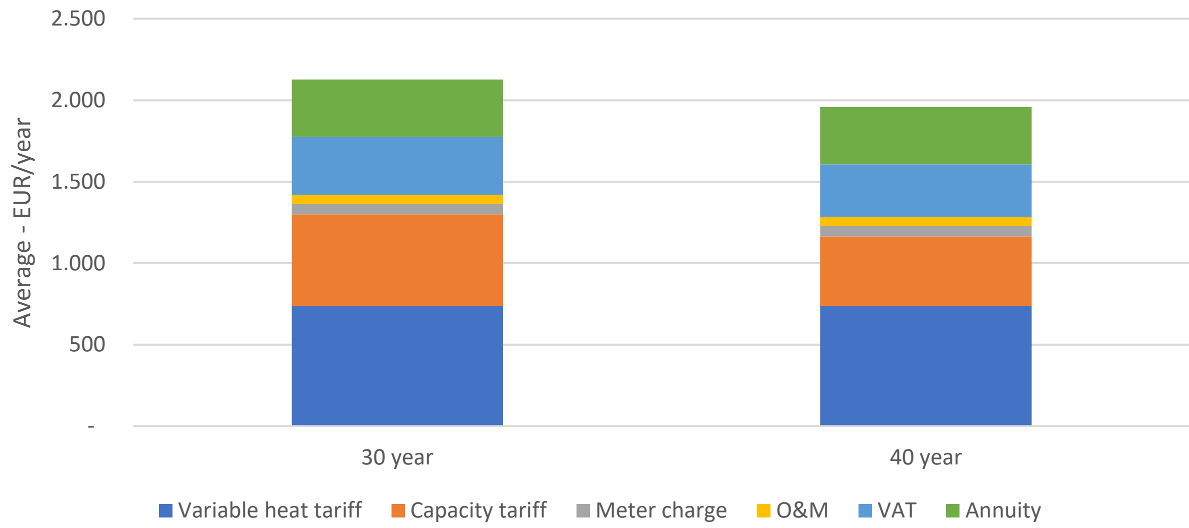

Figure 12 A DH consumers' average annual payment, 30 vs. 40-year repayment period, in the case of buying the substation. Illustrative example analysis, based on the study's assumptions.

3.4.5 Additional consumer connections

The Base Scenario assumes 70% connection at the start of the project, while there is the possibility of further connections later on. In the first example - Figure 13 - it is assumed that a further 10%-points of end-users (from 70% to 80%) are connected after 15 years. This period has been chosen based on the technical lifespan of individual heat pumps, as interest in DH may arise when the heat pumps need to be replaced. Even if the latecomers pay no connection fees, the overall economy still improves because more customers will share the costs for the DH system. The later connections result in a reduction of the capacity tariff from EUR 3.7 to 3.4/m^2/year in the assessment period. Agreements such as "cold plug" (installation of a branch pipe which is put into use at a later point) and campaigns after e.g. a 15-year period can thus pay off. However, the capacity tariff should hardly be determined based on expected later connections, as the future degree of connection is of course uncertain.

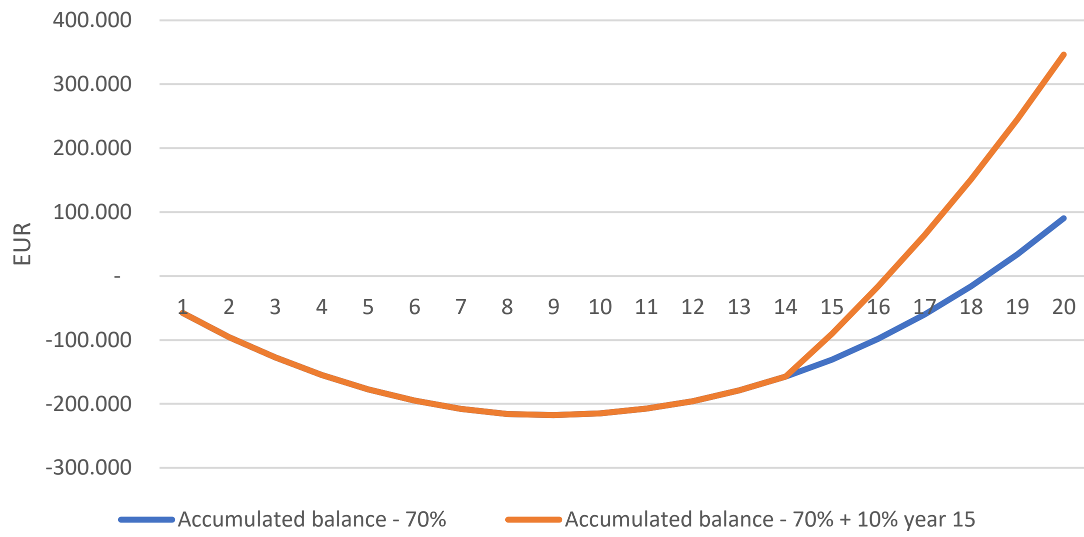

Figure 13 DH utility's balance at Base Scenario and additional connection of 10%-points new customers in year 15. Illustrative example analysis, based on the study's assumptions.

In the case of a mandatory connection obligation (e.g. 95% end-users connected after 7 years), it provides a sufficiently high level of certainty to lower the capacity tariff from the start. All things being equal, an obligation to connect will reduce both user- and business-economic costs. Figure 14 shows the relation between connection rate and user economy (left), and the level of the capacity tariff (right). Here, both the end-user's total payment for the entire 20-year period, as well as the capacity tariff, are reduced in line with the connection rate. There is thus a clear economy of scale correlation with the degree of connection.

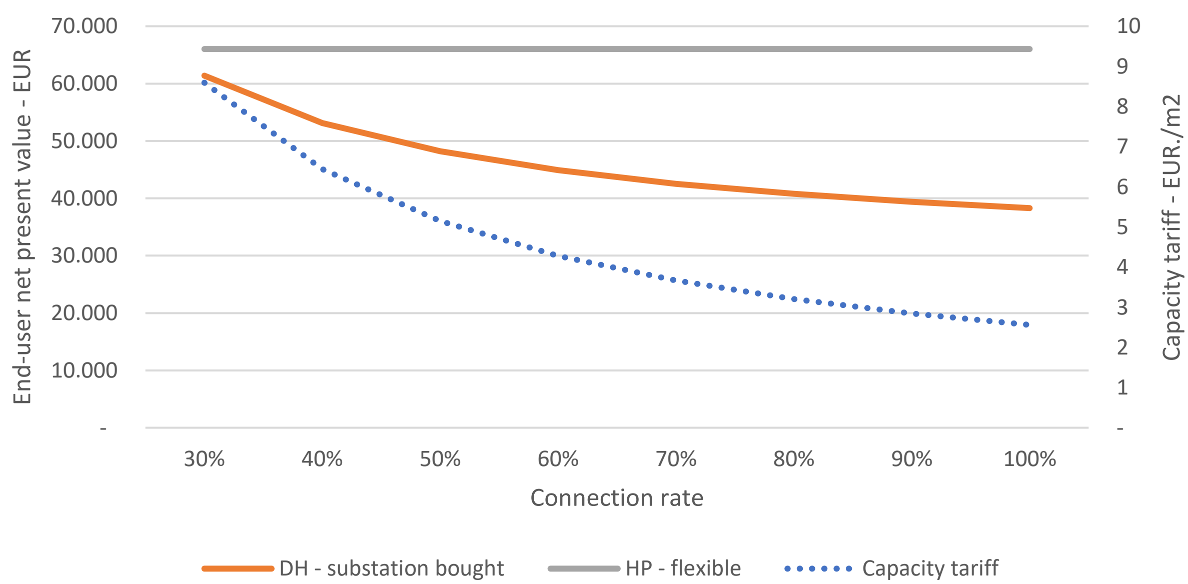

Figure 14 The importance of the connection rate for end-user economy (left) and capacity tariff (right). Illustrative example analysis, based on the study's assumptions.

The effect of connection rates on the total cost for all heat consumers can also be illustrated in another way. The columns in Figure 15 show the total costs of the 450 consumers over the 20 years of the project, divided into district heating and heat pumps, respectively. The dotted green line indicates that a pure heat pump solution is cheapest until DH reaches 30% connectivity. Thereafter, the total consumer costs decrease in line with the connection rate to district heating. The scale economy of district heating is thus significant in this example. For example, with 90% connection to district heating, the total cost to heat the whole area with all 450 consumers is 64% of the total cost in a pure heat pump scenario. Seen from the perspective of the town or city area, this illustrates how a high connection rate can bring economic benefits to the local community.

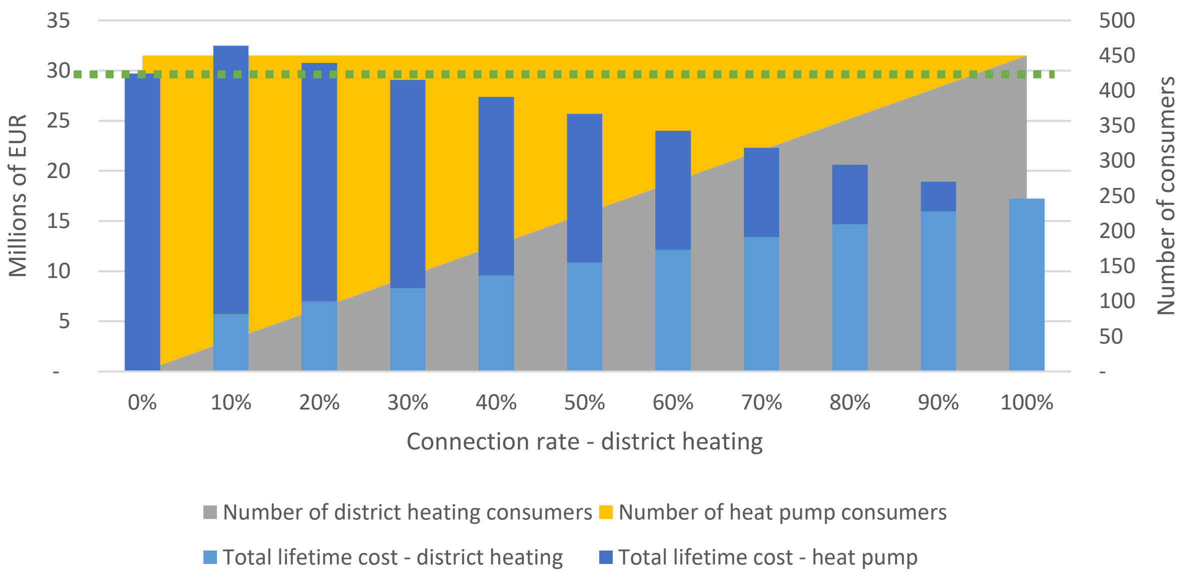

Figure 15 Illustration of economies of scale in district heating, where higher connection rate leads to lower total heating costs for consumers. Illustrative example based on analysis on described assumptions.

The timing of the mandatory connection (assuming 95% of all customers connected in the given year) also has a significant effect: the earlier the obligation to connect, the greater the improvement to the business case. Simply because the fixed costs can be shared among more customers. Figure 16 shows the company's financial results under mandatory connection at 3, 7 and 10 years. With a corresponding capacity tariff of EUR 2.3, 2.6 and 2.8/m^2/year. The analysis does not consider legal, practical, or political barriers.

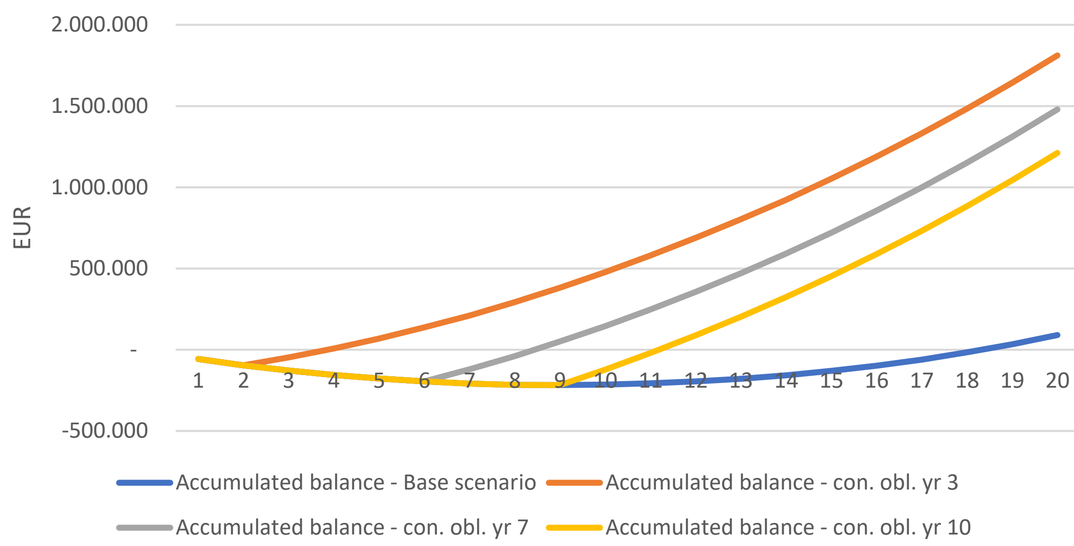

Figure 16 DH utility economic effect of connection obligation, going from 70% to 95% connection rate, after different notice periods. Illustrative example analysis, based on the study's assumptions.

3.4.6 End-user financing

The Base Scenario is based on a loan interest rate of 6% for individual consumers. Public conversion campaigns and private players may offer different interest rates. This, in turn, may shift the competitiveness between DH and heat pumps. Cf. Figure 17, loan interest particularly affects the heat pump. This derives from the heat pump being loan-financed, while the DH (apart from the substation) is financed via the DH company. All things being equal, in this example the loan interest has no significance concerning the competitiveness of DH as the cheapest technology.

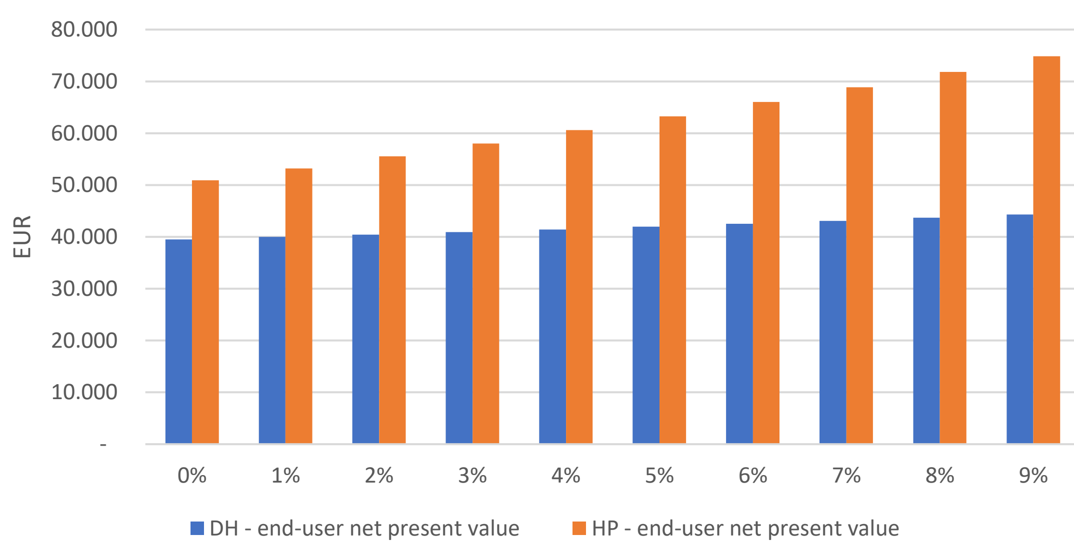

Figure 17 The influence of the consumer's loan interest on the economic present value of DH and heat pumps. Illustrative example analysis, based on the study's assumptions.

In the Base Scenario, EUR 0 is assumed as the connection fee. This means that the customer has no upfront payment for the connection fee (paid over the capacity tariff) or substation (loan-financed). This gives the DH customer a lower lifetime cost than the heat pump customer, as the latter must finance everything themselves at a higher loan rate than the DH company.

3.4.7 Much higher investment costs

Recent years have seen large fluctuations in the prices of materials and labour. It is therefore essential to examine the influence of increased investment costs on the economy. If a doubling of investment costs is assumed, which is covered by an increased capacity tariff, then this results in a significant increase of the capacity tariff from EUR 3.7 to 9.1/m^2/year. In that case, it would be advantageous to increase the connection fee to decrease the capacity tariff. Otherwise, DH may become uncompetitive. Figure 18 has the variable tariff and O&M unchanged, while the increased capacity tariff rises to a level where DH's competitiveness may be challenged.

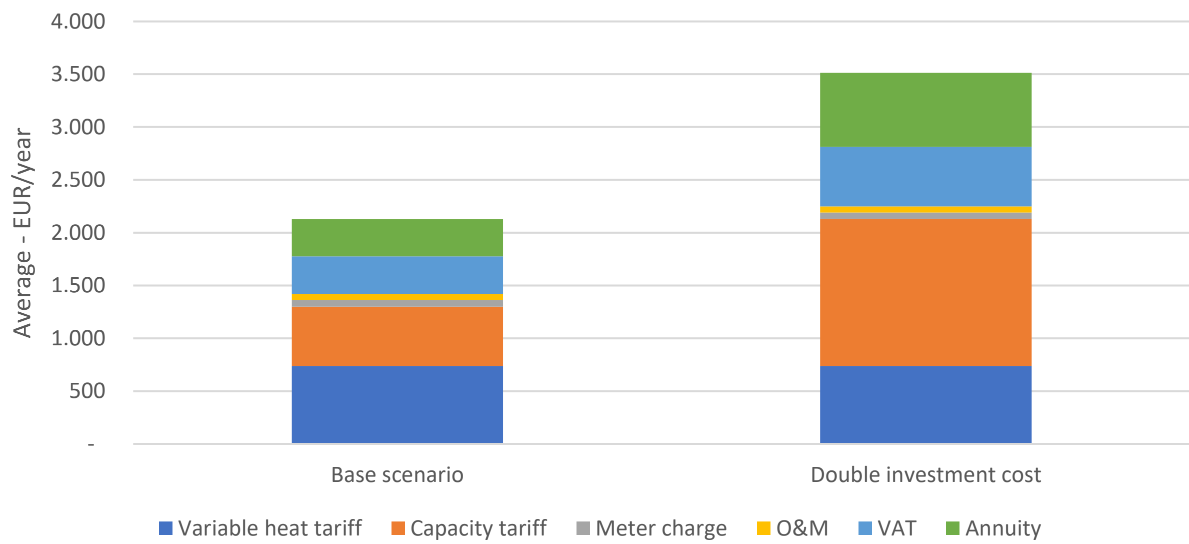

Figure 18 District heating consumers' average annual payment, Base scenario vs. doubled investment cost. For comparison, the annual cost for heat pump consumers is 3 300 EUR. Illustrative example analysis, based on the study’s assumptions.